Approval Page

Addressing Accessibility Barriers in Online Learning: A DDR Model Use Study Augmenting the R2D2/C3PO Model

By

Brenda M Soto Martinez

Approved by the Doctoral Committee:

Dissertation Chair:	Degree Held	Date
Ann Armstrong, EdD Ann Armstrong, EdD (Aug 1, 2025 06:30:13 EDT)	EdD	Aug 1, 2025

Committee Member:	Degree Held	Date
Suzanne Dunn Suzanne Dunn (Aug 1, 2025 09:47:16 PDT)	PhD	Aug 1, 2025

Committee Member:	Degree Held	Date
Joanna Vance Joanna Vance (Aug 1, 2025 11:13:16 PDT)	PhD	Aug 1, 2025

Addressing Accessibility Barriers in Online Learning: A DDR Model Use Study Augmenting the R2D2/C3PO Model

Dissertation Manuscript

Submitted to National University

School of Education

in Partial Fulfillment of the

Requirements for the Degree of

DOCTOR OF EDUCATION IN INSTRUCTIONAL DESIGN

by

BRENDA M. SOTO

San Diego, California

July 2, 2025

Abstract

Creating accessible online courses starts with accessibility in mind, but addressing barriers to online learning represents a challenge for educators. The problem addressed in this study is that online educators and instructional designers experienced challenges with accessibility guidelines and their application when creating usable, accessible, and inclusive online courses due to limited and differing guidance at various levels. The purpose of this qualitative design and development model use case study was to enhance the existing R2D2/C3PO instructional design model by integrating accessibility strategies across all eight model components. The study involved 10 participants: six instructional designers and four accessibility experts. A purposeful sampling technique was used, supplemented by snowball sampling and an internet volunteer sample. An iterative three-phase approach—analyze, design, development, and evaluation, was implemented to address the three research questions. Data collection occurred iteratively among these phases through document analysis, semi-structured interviews, and a model accessibility enhancement questionnaire. The iterative analysis was conducted using NVivo and included a deductive thematic analysis using a predetermined list of start codes, an inductive thematic analysis, and a descriptive analysis using Excel for the ranking. The enhanced R2D2/C3PO/A model was iteratively developed and refined using expert feedback from the data collection and the themes generated. A final focus group and a nominal group technique were utilized to validate the model. The results indicated that a revised version of the R2D2/C3PO model, augmented to the R2D2/C3PO/A model, was successfully created, incorporating accessibility strategies for each model component. The experts' perspectives were pivotal in defining these strategies, which were further validated through a focus group and nominal group technique. The final model provides practical, actionable steps for integrating accessibility into the instructional

design process and addressing many learner needs. This study's findings have significant implications for improving accessibility in various educational contexts, including K-12, higher education, and corporate training. The R2D2/C3PO/A model offers institutions a framework for embedding accessibility throughout the course development process, with recommendations for professional development. The recommendations for future research include exploring this model in real-world course design, gathering learner feedback, particularly from individuals with disabilities, to assess its effectiveness in removing barriers.

Acknowledgements

This study is dedicated to those who gave me their unwavering support throughout the years since I embarked on my doctoral degree. First and foremost, I extend my most profound gratitude to my beloved husband, Joel, whose love, patience, constant encouragement, and significant sacrifices carried me through the most challenging phases of this journey. You have always cheered and embraced me in all my adventures without hesitation. Your love and support, when I struggled to believe in myself, have been my source of power beyond measure.

To my parents, your understanding, values, ethics, love, and education kept me grounded. Since I was a little girl, your support has always encouraged me to achieve my goals. I hope I can continue to make you proud.

The path to this accomplishment was far from easy. Juggling work, school, and the complexities and struggles of starting a family tested our resilience in ways I never anticipated. Yet, through these very struggles, I found the essence to continue, driven by the hope that one day, all the sacrifices and hard work would lead to something truly worth celebrating.

Recently, that hope became truth with the birth of our son, our rainbow baby. Ian Mateo, you are my greatest accomplishment, and the light that enlightens our lives. Your arrival has been a constant reminder that even in our most challenging times, there is always a reason to celebrate life, love, joy, and new beginnings. Thank you for choosing me to be your mother. You are the heart of this journey, and the reason I pushed through every challenge. Witnessing how brave you've been since you were born and seeing you smile daily is my retribution and reminder that all has a purpose. This achievement is for you and your future!

Living far from immediate family during the early birth of our son brought new and unexpected challenges. But I am grateful for my siblings, who got to us, and my extended family

who held us through this complex experience. Whether helping with household duties, babysitting Ian while I worked on this study, or offering encouragement during times of doubt, you were my pillars. I am truly fortunate to have such a caring network behind me.

Finally, acknowledge all the individuals who have been a part of my academic and professional journey. To my academic mentors, Dr. Ann Armstrong, Dr. Suzane Dunn, and Dr. Joanna Vance, who helped me reach this point, thank you for motivating me out of my comfort zone and challenging me to accomplish something great.

Thank you to everyone who walked with me on this challenging but rewarding path.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

Instructional design and online course development are intertwined concepts. In academic institutions, instructional designers play a leading role in the design and development of online programs (Singleton et al., 2019). The online learning platform continues to grow in various fields such as K-12, corporate, and higher education institutions (Armstrong & Gale, 2018). Kotera et al. (2019) reported that 70% of higher education institutions informed that having online programs is part of their long-term educational strategies. The growth of online learning and recent events such as the Covid-19 pandemic contributed to the expansion of online learning spaces by leading many educators to move from face-to-face to online learning (Cygan & Bejster, 2021). In these transitions from one learning modality to another, it is critical to take into consideration other aspects that can impact the learners experience, including accessibility needs for learners with disabilities.

Online learning and strategies should involve discussions about the accessibility of its content and the learner experience. Accessibility is becoming a major focus due to its impact on the growth of online learning courses and programs and other critical legal aspects (Lowenthal et al., 2020). The integration of instructional technologies and multimedia (graphics, audio, video, interactive presentations, or documents, among others) in online courses to present instructional content is a growing practice, and instructional designers and faculty should be aware of the barriers faced by learners with disabilities (Radovan & Perdih, 2016; Rodrigo & Tabuenca, 2020). Instructional designers, among others involved in the development of online courses, should understand strategies to lessen barriers for learners with disabilities in online courses.

Learners with Disabilities in Online Learning

Along with the growth of online learning, there is also a growth in people who are reporting a disability. In the United States, the range of people with disabilities went from 12% to 19% for noninstitutionalized people (Youngblood et al., 2018), which is approximately 50 million people or one in five (Moorefield-Lang, 2019). Institutions can use this data to make informed decisions about current or future program developments. Taking these numbers into consideration, online programs present an excellent opportunity for learners with disabilities and non-disabilities because they provide a flexible option to learn while meeting other commitments (Radovan & Perdih, 2016; Rao et al., 2015). The benefits that online learning provides to learners with disabilities might represent a new opportunity for instructional designers and online educators to create accessible and inclusive learning experiences.

Accessible and inclusive learning experiences are components that can be part of the development of online courses. There is a need to create inclusive experiences for learners and develop accessible content (Patzer & Pinkwart, 2017), giving instructional designers the opportunity to implement strategies to achieve accessibility. Using educational frameworks and guidelines like Universal Design for Learning (UDL), instructional designers and faculty should plan for instructional strategies that allow for learning environments suitable for a wide range of learners through a flexible, purposeful, and consistent design (Rao et al., 2015). Instructional designers and faculty should support all levels and skillsets of learners by providing clarity and scaffolding to lessen any surprise elements within the instructional content and navigation (Moorefield-Lang, 2019). Building materials in different formats (video, audio, text, graphics, among others) is a way to make them available not only to students with a visual, hearing, or learning disability but also to all learners who may learn differently (Patzer & Pinkwart, 2017).

The decisions made during the course design and development phases and through the course implementation will directly impact the learners, especially those with disabilities (Moorefield-Lang, 2019). These decisions should occur through informed choices by understanding the extent and impact of online learning practices and the types of disabilities experienced by learners.

There are 50 million people with disabilities, and the largest group is learners with disabilities (Moorefield-Lang, 2019). One out of seven learners is labeled as having learning disabilities, which include people that have learning difficulties or a cognitive disability (Moorefield-Lang, 2019). When looking at people with learning disabilities as a single group within peoples with disabilities, up to 20% of the global population has a language learning disability, with dyslexia being the most common (Radovan & Perdih, 2016). To provide learners with any disability with an accommodation requirement, postsecondary institutions offer more services and support to help these learners transition successfully, causing a positive increase in enrollments of students with disabilities (Erickson & Larwin, 2016). An estimated 11% of students enrolling in undergraduate programs in higher education institutions report having a disability (Rao et al., 2015). Recent investigations also show that more institutions, about 98% public institutions, are reporting an increase in enrollments of students with disabilities when compared to only 3% of institutions during the decade of the seventies (Erickson & Larwin, 2016). The growth of learners with disabilities enrolling in online courses should serve as a starting point for institutions and course development leaders to support initiatives that will help instructional designers and educators understand the guidelines, standards, and frameworks to address accessibility challenges in course materials.

Accessibility Guidelines and Standards

Various quality assurance frameworks and accessibility guidelines, such as the Web Content Accessibility Guidelines (WCAG), provide to some extent components to designers, faculty, and developers for online content (Radovan & Perdih, 2016). Researchers reviewed various quality assurance frameworks and standards from evaluation instruments to identify how these instruments addressed accessibility and their contribution to online course design and development (Baldwin & Ching, 2021; Lowenthal et al., 2021). Baldwin and Ching (2021) found that six evaluation instruments (Blackboard Exemplary Courses Rubric, Canvas Course Evaluation, Quality Learning and Teaching Instrument, CVC-OEI Course Design Rubric, Quality Matters, and Quality Online Course Initiative) out of seven provided a full specific section or multiple sections on accessibility, while the seventh instrument, Open SUNY Course Quality Review (OSCQR), integrated 15 standards addressing accessibility as part of the review process. They also found an absence of consistency and agreement among the reviewed instruments on how to check accessibility. It is key to highlight that one of the instruments, Quality Matters (QM), includes a disclaimer note that meeting their standards does not imply compliance with accessibility regulations (Baldwin & Ching, 2021). Similarly, Lowenthal et al. (2021) reviewed through an exploratory study 13 quality assurance frameworks. They ranked the frameworks on how each address accessibility. The discussion included the findings for the top six instruments, where OSCQR ranked first, followed by QM in second place (Lowenthal et al., 2021). Lowenthal et al. (2021) also found that OSCQR lacked a specific section for accessibility and that related standards appeared throughout the rubric. Although QM does not provide detailed examples throughout the rubric, there is a workbook with detailed annotations for subscribers (Lowenthal et al., 2021). The lack of consistency and clear advice to designers

(Baldwin & Ching, 2021) add to the need for educators and designers to understand the challenges that learners with disabilities face as well as ways to help them succeed in online environments (Lowenthal et al., 2020).

Statement of the Problem

The problem addressed in the study is that online educators and instructional designers experience challenges with accessibility guidelines and their application when creating usable, accessible, and inclusive online courses due to limited and differing guidance at various levels (Baldwin & Ching, 2021; Lowenthal et al., 2021). Instructional design has a limited availability of model use research to enhance the field (Armstrong & Gale, 2018). The limited availability of model-use research, along with the growth of online learning, is creating challenges for instructional designers and educators when creating accessible content due to their lack of experience in employing guidelines in practice (Acosta et al., 2020; Molanes-López et al., 2021). Therefore, it will be beneficial to differentiate accessibility from standards and frameworks.

Accessibility means having access to systems, products, services, or environments without barriers at the same rate as individuals without disabilities (Oswald et al., 2018; Sánchez-Vázquez et al., 2022). Accessibility standards are developed to grant learners access to and interaction with instructional materials and information (Baldwin & Ching, 2021; Lowenthal et al., 2021). Frameworks such as UDL use accessibility as a foundation but go beyond by providing a broader approach to creating a flexible learning curriculum for everyone (Singleton et al., 2019).

Research shows various standards and frameworks were created to evaluate and address accessibility in online learning; however, barriers for people with disabilities are still not adequately addressed (Acosta et al., 2020; Baldwin & Ching, 2021; Lowenthal et al., 2021).

Often, these resources and standards are subjective and use technical language that can become difficult to understand and apply (Acosta et al., 2020; Baldwin & Ching, 2021; Ingavélez et al., 2021). Failing to address the problem may result in online courses created by educators and instructional designers continuing to generate more barriers for learners with disabilities.

Purpose of the Study

The purpose of this qualitative design and development model use case study, which used expert instructional designers who are also experts in accessibility, was to describe the process of model development and validation to expand the validated, research-based R2D2/C3PO model to integrate accessibility options for each of the eight components of the existing model. The new updated model was validated using the Nominal Group Technique (NGT) with expert instructional designers with accessibility training and accessibility experts in online learning.

The study started with an in-depth content analysis using current peer-reviewed research to determine what strategies of existing quality assurance frameworks and other sources of accessibility guidelines for online learning existed in the research literature. The study continued with individual semi-structured interviews with the 10 experts in instructional design and accessibility. From the findings of the literature review and the interviews, a draft of the revised R2D2/C3PO model adding accessibility options that address accessibility in online learning for each component was created and sent to the 10 individual instructional designers and accessibility experts, along with a questionnaire using a Ranking Scale to rank and categorize the accessibility strategies for each component. The questionnaire included open-ended questions asking for feedback and recommendations with clear language and terminology. A focus group of four experts was conducted using the Nominal Group Technique (NGT), following Armstrong and Gale's (2018) method for model validation. Six participants were drawn from a personal network of previous peers and coworkers of instructional designers with accessibility training and 5 or more years of experience developing online courses and applying quality assurance frameworks and accessibility approaches, and accessibility experts that are certified in accessibility. To secure a sample of 10 participants, two additional plans were implemented. The first plan was to execute a snowball sampling inclusion criterion for existing participants to refer participants who met the requirements. This plan yielded zero results. An additional plan was to implement an internet volunteer sample to contact professional online connections and instructional design and accessibility social network sites to refer members to participate. This plan yielded four accessibility expert participants.

Introduction to Conceptual Framework

A conceptual framework is a synthesis of interlinked views supporting one another to better understand a topic of interest, phenomenon, or research problem (Imenda, 2014; Jabareen, 2009). Jabareen (2009) also considered that a conceptual framework represents a soft interpretation of intentions or understanding typically constructed through qualitative analysis. The conceptual framework elements for this study are accessibility, equity, and inclusion, Web Content Accessibility Guidelines (WCAG), Universal Design for Learning (UDL), Quality Matters (QM), and R2D2/C3PO.

Accessibility, Equity, and Inclusion

According to Baldwin and Ching (2021), accessibility represents access without barriers, while equity represents fairness and impartiality. Inclusion is providing all learners with access to quality education (Aryeh-Adjei et al., 2023). From an accessibility standpoint, although the definition of accessibility continues to evolve, this concept has become more prevalent in online learning due to its close relation to regulations, guidelines, and quality assurance frameworks set to develop accessible, equitable, and inclusive learning content for learners with disabilities (Lowenthal et al., 2021). Some of these guidelines and frameworks that include guidance to help developers and instructors develop accessible and equitable courses are WCAG, UDL, and QM.

Web Content Accessibility Guidelines

The Web Content Accessibility Guidelines (WCAG) are a series of 13 guidelines grouped into four principles—perceivable, operable, understandable, and robust—that apply to different technologies to provide an opportunity to assess web content for people with disabilities (Acosta et al., 2020; Lowenthal et al., 2021). Researchers found that although WCAG standards are commonly used as a source to determine accessibility strategies and approaches, there is a gap due to the lack of understanding and complexity in language by educators and designers that is affecting people with disabilities (Acosta et al., 2020; Bai et al., 2019). The lack of understanding of WCAG guidelines can lead designers to address accessibility concerns as general compliance checks using instructional design or quality assurance frameworks.

Universal Design for Learning (UDL)

Universal Design for Learning (UDL) guidelines guide educational practice by encouraging instructors to create flexible and equitable learning curriculum to reach diverse learners (Singleton et al., 2019). Universal Design for Learning expands upon accessibility and represents minimizing the obstacles in instruction and increasing the learning opportunities that will support all learners while aiming to achieve accessibility and equity to demonstrate knowledge and skills while engaged (Baldwin & Ching, 2021; Patzer & Pinkwart, 2017). Despite UDL being a framework to create flexible and equitable learning, other frameworks such as QM provide guidance for the instructional technology, and functional aspects of online learning accessibility.

Quality Matters

Quality Matters (QM) is a popular framework developed in 2003 for creating online courses that include accessibility checks and standards. The QM rubric mainly focuses on a model to assure quality in online courses that provides for eight general QM Standards (Gregory et al., 2020; Lowenthal et al., 2021). General Standard 8: Accessibility and Usability have seven specific standards in the rubric's seventh edition, focusing on course navigation, readability, accessibility of text, images, video, and audio, multimedia, and third-party accessibility (Quality Matters, 2023). Although QM reference in the annotation document UDL principles and WCAG, additional components to consider regarding accessibility in online courses include specific activities in synchronous sessions, such as those presented in the R2D2/C3PO model.

R2D2/C3PO

Bonk and Zhang (2006) introduced the R2D2 model for online learning activities, which includes four types of activities: (1) *Read*, (2) *Reflect*, (3) *Display*, and (4) *Doing*. Although this model considers learners of various learning styles, it does not mention other types of learners, such as students with disabilities. Armstrong (2016) introduced Bonk and Zhang's model adaptation, the R2D2/C3PO, adding components such as coaching, conviviality, critical incident technique, and planning, with instructional strategies and tools for synchronous sessions, later validated by experts (Armstrong & Gale, 2018). Although Armstrong enhanced the original model to adapt it to newer practices in online learning, recent events have shaken the online experience, making the inclusion of all learners a critical focus in the field.

Integration of Conceptual Framework Elements

The evolution and reach of online environments and learning in a post-pandemic world bring the opportunity to recognize the challenges that learners with disabilities face and the challenges that instructional designers and faculty experience in developing accessible online courses. The concepts of accessibility, equity, inclusion, WCAG, UDL, Quality Matters, and R2D2/C3PO came together to form the research problem and purpose of this research study to provide a model that supports the design and development of accessible online courses. The enhanced, updated model includes strategies that will help online educators and instructional designers address accessibility for each component and facilitate a usable, accessible, and inclusive learning experience for all learners.

Introduction to Research Methodology and Design

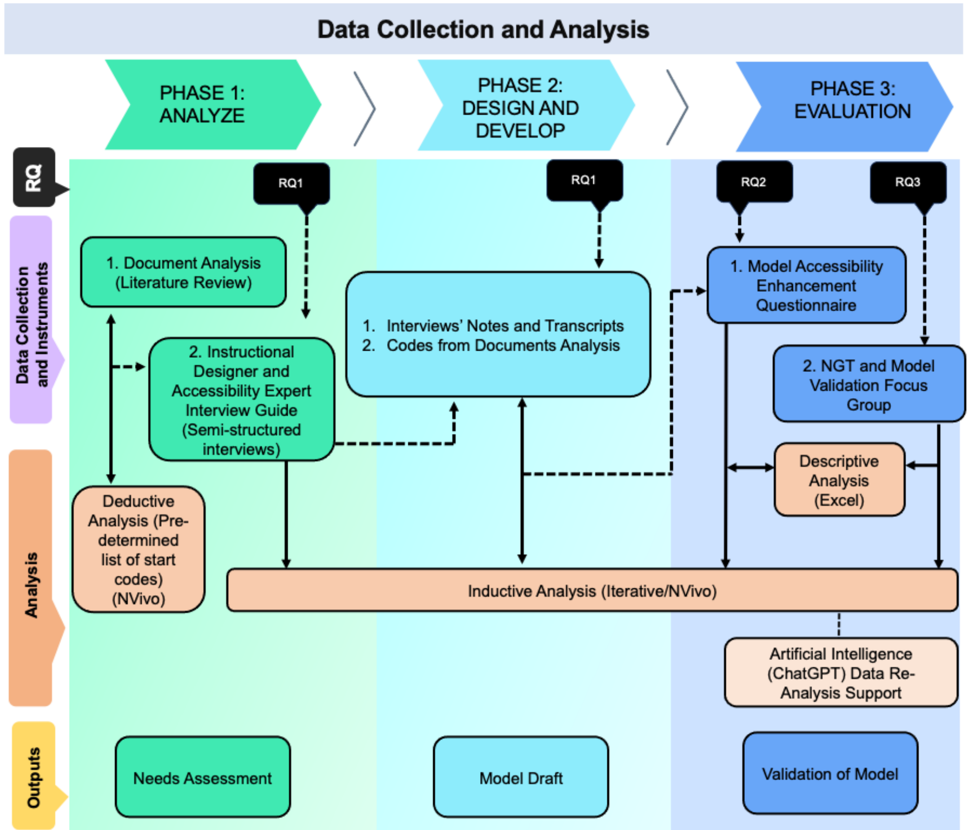
For this study, the selected methodology is qualitative research exploring through a design and development model use case study, the perspectives of instructional designers and accessibility experts about accessibility components and the recommendation of strategies to address accessibility in online courses. Qualitative research explores participants' perspectives, (Tomita et al., 2021) and achieves a study's trustworthiness through various data collection and analysis methods (Connelly, 2016). In this study, the recommendations for accessibility strategies emerged from the literature review, interwoven with the experts' inputs from the interviews, and the role of the researcher in this type of research. In qualitative research, researchers immerse themselves in the environment and are perceived by subjects as a participant facilitating the aspect of data collection because it is a task that can be completed by themselves through documentation, interview with participants, and direct observations of their behaviors (Chesebro & Borisoff, 2007; Cresswell, 2009; Cresswell & Poth, 2018).

From the perspective of instructional design (ID), the field has its core in the design and development of instructional products and programs (Richey & Klein, 2007). As part of a contribution to the field to address the needs of instructional designers, faculty, and developers in the design and development of accessible online courses, this study used design and development research (DDR) as a qualitative design using a model use case study. Using DDR, the study explored and augmented the R2D2/C3PO model to include each component's online accessibility recommendations and strategies. Richey and Klein (2007) defined DDR as a systematic study of design, development, and evaluation to establish an empirical basis for creating instructional or non-instructional products and enhancing existing development models. R2D2/C3PO is an adaptation of Bonk and Zhang's R2D2 model (Armstrong, 2016).

Bonk and Zhang (2006) introduced the R2D2 to reflect tasks, resources, and activities in online courses to address diverse learners. This model was later updated to the R2D2/C3PO model to help educators, including instructional designers, implement online learning solutions (Armstrong, 2016; Armstrong & Gale, 2018). However, with the evolution of online learning, it was critical to include learners with disabilities as part of that community of diverse learners that Bonk and Zhang used as points of reference to develop the R2D2 model. Instructional designers and accessibility educators were interviewed in this design and development research case study to determine instructional strategies and learning activities to address barriers for learners with disabilities through the updated model. The data collection process progressed in three phases. These phases are depicted in Figure 1.

Figure 1

Data Collection and Analysis Phases



***Research Questions**
RQ1: How did instructional designers and accessibility experts believe the R2D2/C3PO model can be expanded to integrate accessibility components?
RQ2: How did instructional designers and accessibility experts believe the updated R2D2/C3POA model can be used to remove barriers for learners with disability in online synchronous and asynchronous learning?
RQ3: What components of the updated R2D2/C3POA model did instructional designers and accessibility experts believe are best practices for implementing online courses, which are accessible to all students?

Phase 1: Analyze

In Phase 1, a document analysis of the R2D2/C3PO model and accessibility research articles was conducted as part of the literature review process to identify accessibility strategies to enhance the R2D2/C3PO model. Following this analysis, and before the semi-structured interviews, the participants, instructional designers, and accessibility educators received a package with information about the R2D2/C3PO instructional design model. Individual semi-structured interviews with the instructional designers and accessibility educators were conducted to discuss the model enhancement to integrate accessibility components. From the interviews, transcripts, and notes were generated. Transcripts were sent to participants for a member check to assure trustworthiness.

The data analysis process was iterative throughout the phases and data collection methods, using a combination of deductive and inductive coding with a thematic analysis approach. The use of a deductive analysis is an "analyst-driven" approach that leads to producing codes to a pre-specified conceptual framework, while an inductive analysis is a "data-driven" approach that produces codes that reflect the data rather than a pre-conception theory or conceptual framework, making it common the use of a combination of both (Byrne, 2021). The study began with a deductive analysis, and a predetermined list of start codes was generated from the literature review and conceptual framework using the research questions as a foundation. An inductive approach was used to code the data collected from the semi-structured interviews, transcripts, notes, and other qualitative data collected in later phases following an iterative process to Braun and Clarke's (2006) six-step thematic analysis. The six steps are (1) familiarizing with data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing a report (Braun & Clarke, 2006). The steps were revisited on a need basis in this phase to refine the codes, identify new themes and subthemes, and produce a thematic cross-analysis that fits the data.

Phase 2: Design and Develop

During the design and development phase, enhancements to the R2D2/C3PO model occurred using the data collected from the literature review, the predetermined list of start codes, and the initial set of themes and subthemes generated from the interviews. The enhancement consisted of adding to the new model R2D2/C3PO/A to integrate accessibility components from the literature review and the input of the instructional designers and accessibility experts during the individual semi-structured interviews.

Phase 3: Evaluate

The participants, who were instructional designers and accessibility educators, received the new R2D2/C3PO/A model and a model accessibility enhancement questionnaire in this phase. The model accessibility enhancement questionnaire included open-ended questions and a Ranking Scale from 1 (not important) to 4 (very important) to rank the strategies that can remove barriers for learners with disabilities. For the quantitative portion of the survey, the Ranking Scale, a descriptive analysis was conducted using Excel to determine the survey's average, mean, mode, standard deviation, and median results. Following the survey, a focus group using the NGT was conducted as a method for model validation and finalization. As previously discussed, an inductive approach following an iterative process using Braun and Clarke's (2006) six-step thematic analysis was used to analyze data collected from the focus group session, transcripts, and session notes.

As occurred in previous phases, the steps for thematic analysis were revisited on a needs basis to refine the codes, identify new themes and subthemes, merge or remove themes as needed, and finalize a thematic cross-analysis that fits the data. Following Armstrong and Gale's (2018) strategy to share analysis results, the results of this study are presented as a narrative and as a matrix summary to show the ranking and validation of the accessibility strategies for each of the model components. Participants received a summary of the focus group for a member check to assure trustworthiness. After participants' confirmation within the timeline provided about the integrity of the focus group summary and completing the analysis of the ranking for the accessibility strategies, the data was used to finalize the R2D2/C3PO/A model.

Methodology and Design Alignment

On the topic of online accessibility, various guidelines and standards exist. Still, designers and educators lack clear advice, increasing the challenges they face in developing accessible content and accessible media for learners with disabilities (Acosta et al., 2020; Baldwin & Ching, 2021). The model use case study aimed to obtain qualitative data through interactions with experts in the ID field and accessibility about the recommendations and needs of accessibility components in an updated model. The accessibility components were part of a survey to gather quantitative data as a ranking system to determine the elements that were to be included in the enhanced R2D2/C3PO model for online and synchronous learning. The experts validated the enhanced R2D2/C3PO/A model through a focus group. The validation process supports the study's trustworthiness and improves the practice.

Research Questions

The research questions focused on the expansion of R2D2/C3PO to include accessibility strategies for each of the components and the validation process of the augmented model based on the experience of instructional designers and accessibility experts.

RQ1

How do instructional designers and accessibility experts believe the R2D2/C3PO model can be expanded to integrate accessibility components?

RQ2

How do instructional designers and accessibility experts believe the updated R2D2/C3PO/A model can be used to remove barriers for learners with disabilities in online synchronous and asynchronous learning?

RQ3

What components of the updated R2D2/C3PO/A model do instructional designers and accessibility experts believe are best practices for implementing online courses, which are accessible to all students?

Significance of the Study

The contribution of this study to the instructional design field was significant due to the limited guidance on accessibility strategies for the design and development of online courses in instructional design models. Part of the contribution was to enhance an existing and validated instructional design model, R2D2/C3PO, to add accessibility (R2D2/C3PO/A) and provide strategies to remove barriers for learners with disabilities. After receiving the updated model, instructional designers and accessibility educators provided insight into the accessibility components they consider best practices to remove barriers for learners with disabilities, providing a clearer understanding of these practices. As part of the findings during a literature review, there was no mention of accessibility in instructional design models. Although there are accessibility guidelines for online content and quality assurance frameworks that include criterion checks in post-development phases, designers and instructors lack clear guidance to help learners with disabilities succeed in online environments (Baldwin & Ching, 2021; Lowenthal et al., 2021). Instructional designers and instructors will benefit from this study by effectively using the R2D2/C3PO/A model to design, develop, and implement accessible online learning experiences. Also, following this study, they should be able to make informed choices for strategies and methods that will benefit learners with disabilities by removing the barriers they experience in online learning environments.

Definitions of Key Terms

Accessibility

Accessibility represents having access without barriers (Baldwin & Ching, 2021). In online environments, accessibility, also known as web accessibility, means the goal of providing access to all users by facilitating flexible content that users can perceive, understand, navigate, and interact with on the web, including people with disabilities who require assistive technologies (Acosta et al., 2020; Ingavélez et al., 2021; Lebinick et al., 2020).

Disability

In the medical model, a disability is a physical or mental impairment that causes a person to experience barriers or difficulties in performing major life activities (Acosta et al., 2020; Miller, 2021). The social model extends disabilities as long-term physical, mental, intellectual, or sensory impairments that can prevent a person from equally participating in society (Miller, 2021).

Equity

Equity represents fairness and impartiality by providing learners with the tools and materials they need to succeed (Baldwin & Ching, 2021).

Inclusion

Inclusion is defined as providing all learners with access to quality education by meeting diverse learners' needs in a responsive and supportive way through teaching and learning interaction (Aryeh-Adjei et al., 2023; Joshi, 2022).

Inclusive Learning

Inclusive learning is defined as a process useful for increasing learner engagement and participation in the learning community and courses by decreasing their exclusion (Kafia et al., 2023).

Instructional Design (ID)

Instructional design refers to the academic field of instructional design and instructional technology, with specific concentration boundaries and emphasis (Devaughn & Stefaniak, 2020; Nworie, 2022).

Instructional Designer

Instructional designers are influential employees who use instructional design models to guide instructional design workflow and produce effective interventions (Hoard et al., 2019).

Learners with Disabilities/ Disability

Learners with disabilities are learners with a mental or physical impairment who have gained access to education and online education (Kotera et al., 2019).

Multimedia

Multimedia is a concept widely used in online courses that includes sound, music, pictures, videos, movies, and animations (Acosta et al., 2020).

Online Learning

Online learning is the experience of learning through technology and is considered a modern form of distance learning due to its flexibility and ability to promote interactions (Moore et al., 2011).

Quality Matters

Quality Matters is a quality assurance framework and rubric created in 2003 centered on eight general standards: (1) course overview and introduction, (2) learning objectives, (3) assessment and measurement, (4) instructional materials, (5) learning activities and learner interaction, (6) course technology, (7) learner and support, and (8) accessibility and usability (Lowenthal et al., 2021; Quality Matters, 2023).

Universal Design for Learning

Universal Design for Learning (UDL) is a series of principles that seek to minimize obstacles and maximize learning opportunities that support and engage all learners regardless of their situation or way of thinking (Baldwin & Ching, 2021).

Web Content Accessibility Guidelines (WCAG)

WCAG is an initiative that collects guidelines in four principles (1) perceivable, (2) operable, (3) understandable, and (4) robust, to provide web content accessibility standards to government, individuals, and organizations, to ensure that the created content is accessible to all users, and to encourage equitable and inclusive learning environments (Baldwin & Ching, 2021).

Summary

In recent years, the growth of online learning and the driven effects of the Covid-19 pandemic that moved many countries to remote learning have opened the space and the interest to continue discussing and exploring accessibility in online courses, becoming one of the critical contributions to online learning growth (Armstrong & Gale, 2018; Cygan & Bejster, 2021; Lowenthal et al., 2020). Instructional designers play a crucial role in designing and developing online learning experiences, and understanding the needs of learners with disabilities is relevant to the role (Singleton et al., 2019). Online learning provides new learning opportunities to learners with disabilities by providing a flexible environment to explore and navigate content while continuing with essential aspects of their lives (Radovan & Perdih, 2016; Rao et al., 2015). However, they could face barriers if the learning experiences were not designed and developed with accessibility in mind. Although web content guidelines such as the Web Content Accessibility Guidelines (WCAG) and quality assurance frameworks such as Quality Matters (QM) include accessibility checklist items, some questions and challenges still need to be addressed.

The problem addressed in this study is that most online educators, and instructional designers experience challenges with accessibility guidelines and their application when creating usable, accessible, and inclusive online courses, due to limited and differing guidance at various levels (Baldwin & Ching, 2021; Lowenthal et al., 2021). As previously discussed, online learning across multiple industries has experienced a significant growth in the number of learners with disabilities who enroll in online learning in higher education (Kotera et al., 2019; Lowenthal et al., 2021), increasing the challenges for instructional designers and educators as well when designing online courses due to the lack of experience in accessibility (Acosta et al., 2020; Molanes-López et al., 2021). Not addressing the problem could have linked consequences for instructional designers, educators, and learners with disabilities. Learners could continue to receive inaccessible content developed by instructional designers and educators, which can generate additional barriers. This study expanded an existing and validated instructional design model, R2D2/C3PO, using a design and development research (DDR) approach to explore and recommend strategies that instructional designers can implement to address accessibility by adding accessibility components to the enhanced R2D2/C3PO/A model. Expanding a validated model to include accessibility was a step to address the stated problem to provide instructional designers and educators with clear guidance when creating usable, accessible, and inclusive online courses to remove barriers for learners with disabilities. Some of these concepts formed the conceptual framework of this study.

The conceptual framework, a synthesis of interlinked views supporting one another to understand better the phenomenon (Imenda, 2014; Jabareen, 2009), focused on accessibility and equity, Universal Design for Learning (UDL), Web Content Accessibility Guidelines (WCAG), Quality Matters (QM), and R2D2/C3PO as the core topics to form the study's conceptual framework. Accessibility represents access without barriers; inclusion is granting learners quality education, while equity centers on a fairness and impartiality experience, concepts that set the foundation for UDL. Universal Design for Learning is a series of guidance in educational practice that expands upon accessibility to minimize the obstacles for learners and increase their learning opportunities (Baldwin & Ching, 2021; Patzer & Pinkwart, 2017). Other guidelines or frameworks that contributed to the conceptual framework were the WCAG and the QM Rubric. Both contributed to the field where WCAG includes 13 guidelines grouped into four principles, primarily focusing on addressing the accessibility of web content.

In contrast, QM include eight general standards to ensure the quality of an online course, whereas General Standard 8 focuses on accessibility and usability. Although both concepts address accessibility at some stage, either pre-or post-development, it was critical to consider specific activities in synchronous and asynchronous sessions as presented in the R2D2/C3PO model. The original model R2D2, initially introduced by Bonk and Zhang (2006), includes online learning activities for reading, reflecting, displaying, and doing. Also, it was later expanded by Armstrong (2016) with the R2D2/C3PO adaptation to add components such as coaching, conviviality, critical incident technique, planning, and instructional strategies. These concepts intertwined to set the conceptual framework that led the qualitative research and its findings.

Through a design and development model use case study, this qualitative research explored the perspectives of instructional designers and accessibility experts on accessibility components and strategies. Richey and Klein (2007) highlighted that the core of the instructional design field is the development of instructional products and programs, including the development of models, which is part of the outcomes of this study, with the enhancement of the R2D2/C3PO model to the R2D2/C3PO/A. The study included three research questions, (RQ1) how do instructional designers and accessibility experts believe the R2D2/C3PO model can be expanded to integrate accessibility components, (RQ2) how do instructional designers and accessibility experts believe the updated R2D2/C3PO/A model can be used to remove barriers for learners with disability in online synchronous and asynchronous learning; and (RQ3) what components of the updated R2D2/C3PO/A model do instructional designers and accessibility experts believe are best practices for implementing online courses. The study unfolded in three phases: (1) analyze, (2) design and develop, and (3) evaluate to answer the research questions.

Phase 1 focused on the literature review and document analysis through a deductive thematic analysis with a predetermined list of start codes and an inductive thematic analysis of the data collection through semi-structured interviews to answer RQ1. Phase 2 focused on collecting the data from the interview transcripts and notes and developing the R2D2/C3PO/A model to add additional answers to RQ1. Phase 3 addressed RQ2 and RQ3 through a model accessibility enhancement questionnaire, a focus group with a nominal group technique, and model validation through a Ranking Scale to rank the strategies. The qualitative data analysis process was iterative among all three phases for all data collection methods. The iterative process used a combination of deductive analysis (analyst-driven) and inductive analysis (data-driven). The deductive analysis was used to produce predetermined list of start codes and the inductive analysis to create data-driven codes using Braun and Clarke's (2006) six-step thematic analysis. A descriptive analysis was conducted for the Ranking Scale results generated during the model validation step to determine the average, mean, mode, standard deviation, and median.

This study provided instructional designers, faculty, and accessibility experts with a voice and a space to determine the best practices and strategies for accessibility in online learning. Although there are existing accessibility guidelines and frameworks, instructional designers and faculty struggle due to unclear guidance on how best they can support learners with disabilities to succeed in online courses (Baldwin & Ching, 2021; Lowenthal et al., 2021). This study also supported answering the research questions and provided instructional designers with a model that included accessibility as part of the design, development, and delivery strategies to support learners with disabilities by removing barriers while creating a usable, accessible, and inclusive online learning environment. In addition to discussing the research problem, the purpose of the study, conceptual frameworks, and the research design and methodology that led this study, the following chapter will expand on some of these concepts. Additionally, it will include in-depth details of the process followed in conducting the literature review and a literature review synthesis.

Chapter 2: Literature Review

The purpose of this qualitative design and development model use case study, using expert instructional designers who are also experts in accessibility, was to describe the process of model development and validation to expand the validated, research-based R2D2/C3PO model to integrate accessibility options for each of the eight components of the existing model. Online learning educators and instructional designers face challenges with designing accessible courses following and applying accessibility guidelines due to limited and differing guidance (Baldwin & Ching, 2021; Lowenthal et al., 2021). The following topics comprise the literature review: (1) database and search engine, (2) conceptual framework, (3) accessibility, equity, and inclusion and Web Content Accessibility Guidelines, (4) Universal Design for Learning, (5) Quality Matters, and (6) R2D2/C3PO. This research was conducted to understand and describe the scope of how accessibility guidelines are applied in online learning, the challenges educators and instructional designers face when designing accessible, usable, equitable, and inclusive online learning, and the barriers faced by learners with disabilities in online learning. The literature review concludes with a summary of key findings.

Databases and Search Engines

The search strategy involved using Google as a search engine to access the NU library database EBSCOhost as the primary method for the search. The specific limiters used were scholarly/peer-reviewed and published between 2000 to 2024 to obtain context in online learning growth, web accessibility, legal frameworks, and learners with disabilities. The published limiter between 2016-2024 was used to bring a current perspective on these topics and expand it to WCAG, UDL, QM, and R2D2/C3PO. Terms used to identify meaningful articles and studies included accessibility (OR digital accessibility, accessibility in online learning, accessible e-

Learning), WCAG (OR web accessibility, accessibility standards, WCAG AND countries OR enforcement), Universal Design for Learning (OR universal design, inclusive design), Quality Matters (OR online quality assurance, Quality Matters rubric, Quality Matters AND accessibility), R2D2/C3PO (OR R2D2). The Boolean operator OR was used to identify empirical research studies (Study OR research OR empirical OR data OR method OR qualitative OR quantitative). NU library databases Gale Educators 200 Collection and ERIC were used as a second method for the search following the same terms and limiters (peer-reviewed and published between 2016-2024 for most recent perspectives). The following section will introduce the conceptual framework for this study.

Conceptual Framework

In broad terms, a conceptual framework synthesizes existing views from theoretical and empirical findings available in the literature (Imenda, 2014). Although the conceptual framework is usually limited in scope, the researcher can implement and integrate the conceptual framework concepts by looking at the problem and understanding the phenomenon of interest or research problem (Imenda, 2014). The conceptual framework for this study was designed around creating accessible, equal, and inclusive online learning. As a foundation of online accessibility, multiple concepts, frameworks, guidelines, and models intertwine to remove barriers for learners with disabilities. Removing barriers for learners with disabilities might not require all educators to become accessibility experts (Rodrigo & Tabuenca, 2020). Still, it might be critical to understand online accessibility foundations since the accessibility and inclusiveness of learning have become a need for learners and educators (Patzer & Pinkwart, 2017). For the purpose of this study, online accessibility refers to accessible online learning, the experience of delivering instruction and learning through technology when instructors and learners are apart (Johnson et al., 2022; Moore et al., 2011), not remote learning, which is a limited transition from face-to-face learning that increasingly involves parents in formal education as intermediary educators (Lassi, 2022). Accessibility means that the highest number of users can use a system, product, service, or environment regardless of their abilities (Sánchez-Vázquez et al., 2022). Web accessibility, within the context of online learning, is developing websites and digital content in a manner that diverse learners can perceive, understand, navigate, and interact with the content (Alajarmeh, 2022). Equity relates to accessibility by providing learners with a fair and impartial experience regardless of their disability, social, and financial status (Baldwin & Ching, 2021; Samawi & Al-kreimeen, 2022). Inclusion goes beyond offering all learners access to quality education (Joshi, 2022). The accessibility, equity, and inclusion of online learning are essential in higher education institutions, and educators should meet the needs of all learners, including those with disabilities, to prevent generating disadvantages (He et al., 2022). Concepts, frameworks, guidelines, and models including online learning accessibility, equity, inclusion, Web Content Accessibility Guidelines, Universal Design for Learning, Quality Matters, and R2D2/C3PO form the conceptual framework of this study.

Accessibility, Equity, and Inclusion

A significant advantage of online learning is that it provides learners with flexible options such as environment and schedule to access content and accomplish their learning experience at their own pace, regardless of location (Fajardo-Flores et al., 2021). Learning online requires learners to achieve self-discipline and proficiency with technology to achieve better results (Rao et al., 2015). These requirements could generate barriers due to the learners' socioeconomic backgrounds and other factors that might influence the accessibility, equity, and inclusion of learners (Aquino & BuShell, 2020). Accessibility, equity, and inclusion might have their unique definition and description, but they blend for online learning accessibility. Accessibility refers to when all possible users should have access and be able to use a system, product, service, or environment without barriers (Baldwin & Ching, 2017; Sánchez-Vázquez et al., 2022). Equity is generally understood to mean that learners should receive fair and impartial learning experiences despite their disability and socioeconomic status (Baldwin & Ching, 2017; Samawi & Al-kreimeen, 2022). Inclusion may be defined as quality, meaning that learners should receive a quality education that meets their needs as they receive the support they need from educators (Aryeh-Adjei et al., 2023). Achieving accessibility, equity, and inclusion involve resources and efforts from institutions, educators, and instructional designers, among others, to create accessible, equal, and inclusive online courses (Coleman & Berge, 2018; Radovan & Perdih, 2016). Research around inclusive learning has been critical in the interpretation and engagement by educators and how they relate inclusive learning to disabilities or impairments (Natongo, 2019). These concepts are significant to this study because it could be argued that educators and instructional designers can provide learners with disabilities with a better learning experience by designing and creating accessible, equitable, and inclusive online courses. From another lens, research on the perception of educators about the accessibility of learning materials (Rice & Ortiz, 2020) and the perception of learners with disabilities in the use of technology in online learning (Aquino & BuShell, 2020) can benefit the instructional design field and the application of accessibility, equity, inclusion in other areas such as legal frameworks, policies, models, and standards.

Web Content Accessibility Guidelines (WCAG)

The Web Content Accessibility Guidelines were created to provide people with disabilities access to web content without barriers (Acosta et al., 2020; Kurt, 2019; Word Wide

Web Consortium [W3C], 2017). World Wide Web Consortium (W3C) published the first version of WCAG in 1999 up to the most current version, 2.2, to establish a methodology for evaluating and reporting accessibility on websites (Lowenthal et al., 2020; Molanes-López et al., 2021; W3C, 2017). Web Content Accessibility Guideines is a series of 13 technical standards applicable to web content that function around four principles—perceivable, operable, understandable, and robust (Acosta et al., 2020; Lowenthal et al., 2021; Patzer & Pinkward, 2017). Users must be able to: (1) perceive and detect the content, (2) operate the content by interacting with its component, (3) understand the information provided, and (4) use multiple devices to access the content (Baldwin & Ching, 2021). The inclusion of WCAG is significant to this study because these guidelines are used globally for web accessibility and could provide essential accessibility strategies to design and create accessible online courses. Web Content Accessibility Guidelines is present in various research studies since it is a common source to determine accessibility strategies and approaches (Acosta et al., 2020). Acosta et al. (2020) conducted a study using WCAG to propose new techniques to help authors and developers publish digital content. On the other hand, Bai et al. (2019) conducted a study to evaluate accessibility testing methods, including WCAG. Despite WCAG being the most used document for web accessibility (Sadness, 2021), the mention of WCAG in other frameworks can help educators and instructional designers evaluate other models and frameworks focusing on accessibility and universal design.

Universal Design for Learning (UDL)

Universal Design for Learning is an evidence-based framework that educators can implement to improve and optimize learning by minimizing barriers for all learners (Baldwin & Ching, 2021). The UDL emerged from Universal Design, a framework popular in architecture

(Rao et al., 2015), to become a framework with several guidelines to guide instructors to create flexible and equitable learning content to reach diverse learners (Singleton et al., 2019). Educators use this framework to create inclusive designs following the three UDL principles: (1) provide multiple means of engagement, (2) provide multiple ways of representation, and (3) provide multiple means of action and expression (Coombs, 2010; He et al., 2022; Patzer & Pinkwart, 2017). Although UDL aligns with accessibility, the framework provides a broader perspective since it minimizes the barriers to instruction to increase learning opportunities and provide learners equal and inclusive access to learning (Baldwin & Ching, 2021; Basham et al., 2016; Patzer & Pinkwart, 2017). It was relevant to include UDL in this study since it is one of the most referenced frameworks by educators and instructional designers when designing accessible and inclusive online learning, and UDL can contribute meaningful strategies to remove barriers for learners with disabilities. For example, Rao et al. (2015) research study focused on the experience of an instructor implementing UDL strategies in online classrooms to support diverse learners. The extension of UDL encourages the creation of flexible and equitable learning and is also cited in quality assurance frameworks as a best practice for creating accessible and inclusive online courses (Lowenthal et al., 2021).

Quality Matters

Quality Matters (QM) is a global organization that offers a rubric to lead the quality assurance in online lerning (Quality Matters, 2023). The QM rubric focus is on the quality of course design, content, delivery, support, and infrastructure, a common concern to accreditation agencies, faculty, and students (Gregory et al., 2020). The QM rubric is a popular framework developed in 2003 by Maryland Online Inc. consortium for measuring a course quality (Quality Matters, 2023). The QM rubric is the most recognized standard for quality assurance in online learning (Lowenthal et al., 2021; Wright, 2018). The QM rubric has eight general QM Standards that involve a peer review process to evaluate the online courses (Lowenthal et al., 2021; Wright, 2018). To address challenges in accessibility, General Standard 8: Accessibility and Usability have seven specific standards in the seventh edition, focusing on course navigation, readability, accessibility of text, images, video, and audio, multimedia, and third-party accessibility (Quality Matters, 2023). Quality Matters reference WCAG and UDL principles in their rubric workbook (Baldwin & Ching, 2021), a document only available to subscribing members that contains the fully-annotated rubric (Quality Matters, 2023).

Web Content Accessibility Guidelines has been part of various research studies, for example Baldwin and Ching (2021) and Lowenthal et al. (2021), that explored how to improve and assess the accessibility of online courses and compare the QM rubric with other evaluation instruments. The QM rubric was relevant to this study to understand further how General Standard 8 can benefit educators and instructional designers in designing and creating accessible online learning courses. Despite QM addressing accessibility through a specific section in the rubric, additional components regarding accessibility in online courses include particular activities in synchronous sessions, as presented in the R2D2/C3PO model.

R2D2/C3PO

R2D2/C3PO is an instructional design model with a focus on culture, learning, and technology (Armstrong & Gale, 2018), and this model is an enhanced version of Bonk and Zhang's (2006) R2D2 model. R2D2 is a model for online learning activities that has four quadrants or components: (1) *read*, (2) *reflect*, (3) *display*, and (4) *doing* to consider learners of various learning styles (Bonk & Zhang, 2006). Researchers consider R2D2 a novel approach to instructional design and to creating online courses (Bin Mubayrik & Al-Mutairi, 2022). The

R2D2 model experienced adaptations by Armstrong (2016) to add components such as *coaching*, *conviviality*, *critical incident technique*, and *planning* and *organization*, with instructional strategies and tools for synchronous sessions, later validated by experts (Armstrong & Gale, 2018, 2025). R2D2/C3PO was created to provide educators, instructional designers, and facilitators a tool to guide the design, development, implementation, and evaluation of online learning activities to support the learners' success (Armstrong & Gale, 2025). The addition of R2D2/C3PO to this study is relevant since it is a novel approach to designing online learning courses, and an enhanced model could significantly contribute to educators and instructional designers' strategies. Although Armstrong (2016) enhanced the original model, future research to add components to improve the model is encouraged by researchers (Armstrong & Gale, 2018, 2025).

Integration of Conceptual Framework Elements

The Covid-19 pandemic contributed to the growth of online learning in various industries (Burgstahler, 2021), but educators raised concerns about the challenges that learners with disabilities can face in online learning. Current information on creating accessible, usable, equitable, and inclusive online learning represents a challenge for educators due to the complexity level of existing guidelines (Baldwin & Ching, 2021). The discussed conceptual frameworks of accessibility, equity, inclusion, WCAG, UDL, Quality Matters, and R2D2/C3PO came together to establish the research problem, purpose of the research, and research questions. This alignment is to provide educators and instructional designers with a model that supports the design of inclusive online learning course materials to help remove barriers for learners with disabilities. The enhanced model, R2D2/C3PO/A, will provide educators and designers with accessibility strategies for each component to create an accessible, usable, equitable, and inclusive learning experience for all learners. Therefore, it is critical to expand on each of these conceptual frameworks. A discussion of accessibility, equity, and inclusion by exploring legal frameworks, discussing learners with disabilities, the disability models, the needs, and barriers of learners with disabilities, and accessibility guidelines to improve the web experience is presented in the next section.

Accessibility, Equity, and Inclusion

The objective of this section is to discuss the foundations of accessibility and equity, the perception of inclusivity in education, and the legal frameworks created to support people with disabilities and its extent to online learning. A discussion of the increase of learners with disabilities in online learning and the various categories of disabilities and provides an overview of two disability models, medical versus social is available in this section. This section includes an evaluation of the accessibility needs and barriers in online environments and guidelines supporting the development of accessible online content, such as the Web Content Accessibility Guidelines. It would be beneficial to start by understanding accessibility, equity, and inclusion.

The discussion of accessibility, equity, and inclusion is becoming more frequent in online learning, so it is important to clarify each term. Accessibility is the practice of providing access without barriers by designing and creating products, services, and environments usable by all people, including people with disabilities, within the same time frame as individuals without disabilities (Baldwin & Ching, 2017; Kyudong et al., 2019; Lowenthal et al., 2021; Oswald et al., 2018). Equity can be defined as fairness and impartiality and providing learners with what they need to succeed (Baldwin & Ching, 2017), despite income, internet access, disabilities, and other difficulties that will prevent them from participating in online classes (Samawi & Al-kreimeen, 2022). Inclusion is providing all learners with access to quality education, meeting their diverse needs in a responsive and supportive way by being actively involved in teaching and learning (Aryeh-Adjei et al., 2023; Joshi, 2022). Aside from the time required from faculty and designers to accomplish accessibility in online course design (Coleman & Berge, 2018), educational institutions must join the effort of providing an inclusive online environment that is flexible and adaptable to learners with disabilities (Kotera et al., 2019; Radovan & Perdih, 2016). Before creating an initiative toward inclusion, accessibility, and equity for learners with disabilities in online learning, a possibility for institutions is to define their perspectives on inclusive education.

The awareness of inclusion in online courses can represent an essential step to removing barriers and creating inclusive, accessible, and equitable learning experiences for students with disabilities. One study by Nantongo (2019) examined the education practitioner's interpretation of inclusive education during a flagship program in Uganda. The interpretation of inclusive education differs from being a route to reflective practice or inclusive pedagogical engagement since most participants consider inclusive education to be a concept associated with disabilities or impairments (Natongo, 2019). Participants in this study believed that adding labels or categories to learners affects the practice of inclusive education, raising questions about the sustainability of inclusive education (Natongo, 2019). The researcher concluded that the understanding of inclusive education lacks consistency among educators and that participants considered it a major socioeconomic commitment (Natongo, 2019). Although Natongo researched the interpretations of educators toward inclusive education in higher education environments, the study does not distinguish between the perceptions of traditional learning educators and online learning educators. A consistent interpretation of inclusive education and its connection to accessible and equitable online learning can inform legal frameworks and policymaking to benefit people with disabilities.

Legal Framework

International discussions around accessibility are a probable reaction to legal challenges experienced by some institutions, government agencies, and corporate organizations. It could be beneficial to understand existing legal frameworks that address accessibility to help inform decisions in online practices. The objective of this section is to shed light on existing legislation and regulations that address and protect people with disabilities and could apply to online settings. A discussion of the position of countries like the United States and Europe on global initiatives to address the rights of people with disabilities is included in this section. An examination of court rulings around accessibility in the United States that impacted educational institutions and organizations concludes this section.

United Nations Convention on the Rights of People with Disabilities (UNCRPD). The UNCRPD is an international treaty ratified by more than 140 countries (Feingold, 2017) and the most authoritative international statement on the rights of people with disabilities (Malaquias, 2022). The treaty recognizes the dignity and diversity of people with disabilities, and it provides them with globally accepted standards on equality and human rights within a social context and the freedom to make decisions for their lives based on informed consent (American Bar Association [ABA], 2015; Blanchfield & Brown, 2015; Feingold, 2017; Ferri & Giannoumis, 2014; Lord & Stein, 2018; United Nations Treaty Collection, 2006; Wescott et al., 2020). This treaty helps identify the rights of people with disabilities and the responsibilities and obligations of national governments to protect and promote these rights (Wescott et al., 2020). The treaty under the Convention on the Rights of People with Disabilities (CRPD) elaborates and clarifies existing human rights by outlining the rights entitled to people with disabilities, the same rights granted to everyone else, such as access to information and culture (Ferri & Giannoumis, 2014;

Wescott et al., 2020). It is appropriate to assume that the general language of access to information in this treaty also extends to content and materials provided by educational institutions and organizations.

Institutions and organizations that deliver information through training or educational content to their learners should consider evaluating the CRPD and the importance of providing an inclusive learning experience. For example, Joshi (2022) found that inclusive education helps learners with disabilities and their families from falling into chronic poverty. The CRPD Article 24 includes direct language calling for the right of inclusive education systems at all levels, not just buildings but also information and communication ecosystems (Lord & Stein, 2018). Since the signing of this treaty, countries like Argentina, China, Costa Rica, Dominican Republic, Hungary, and others, are attempting implementation efforts towards inclusive education (Cremin, 2016). Despite this implementation efforts, some countries like Nepal are experiencing a slow implementation process of the CRPD due to the lack of awareness of policymakers on matters of ideological support (Joshi, 2022). Similarly, Malaquias (2022) revealed that since the ratification of the CRPD by Australia's successive governments, there are still significant gaps in the achievement of human rights, and inequalities remain in place. It can be justified that there is a need to explore other countries further and how they might have created other regulations prior to the CRPD.

Over the past 20 years, there has been an awareness of the increased engagement of learners with disabilities in educational institutions. Australia created the Disability Discrimination Act (DDA) in 1992, while the United Kingdom (UK) created the Disability Discrimination Act in 1995 and the Equality Act in 2010 (Kotera et al., 2019). Although Australia has struggled with the implementation of the CRPD, the government points to its DDA as evidence of its domestic implementation efforts of international human rights obligations (Malaquias, 2022). The Equality Act of 2010 is currently the main anti-discrimination law in the UK and brought together other legislations, including the Disability Discrimination Act of 1995 (Miller, 2021). Following similar initiatives, the European Union launched a European Community Disability Strategy to provide a broader approach to accessibility, training, education, and equality (Ferri & Giannoumis, 2014). From a different perspective, the United States enacted the Americans with Disabilities Act (ADA) and the Rehabilitation Act (Oswald et al., 2018). Despite the recent emphasis on the increase of learners with disabilities in educational institutions, it can be meaningful for educators to understand the foundations of the ADA and Rehabilitation Act since these might continue influencing rulings in online learning in the United States.

Americans with Disabilities Act (ADA). ADA is a comprehensive collection of civil rights signed into law in the United States in 1990 (King & Piotrowski, 2021; Kurt et al., 2019; Lowenthal et al., 2020; Lowenthal et al., 2021). The ADA prohibits through its Title III the discrimination toward people with disabilities to grant them full and equal enjoyment of goods, services, facilities, and accommodations (King & Piotrowsky, 2021). ADA extends the protections under Section 504 of the Rehabilitation Act, impacting employment in state and local governments, public accommodations, telecommunications, commercial facilities, transportation, and educational entities, which must be nondiscriminatory (Lowenthal et al., 2020; Lowenthal et al., 2021). Kurt et al. (2019) established that ADA is the first major piece of legislation to enforce information accessibility in the United States. In an effort to grant rights to people with disabilities, it is probable that lawmakers considered amendments to the ADA to expand its coverage and define enforcement.

ADA was updated in 2008 to include amendments under the Americans with Disabilities Act Amendments Act (ADAAAA) (Lowenthal et al., 2020). The amendments expanded the definition of disability as a limitation of a major life function such as walking, learning, concentrating, immune system, normal cell growth, and endocrine system, among others (Lowenthal et al., 2020). To grant the protection of these civil rights for people with disabilities, the Department of Justice and the Department of Education are responsible for enforcing the ADA (King & Piotrowsky, 2021). Regarding education, ADA includes language indicating that private entities offering courses or examinations must offer them in accessible ways (Lowenthal et al., 2020), whereas regulations like the Rehabilitation Act include language calling out for non-discrimination in programs receiving federal funds (Lowenthal et al., 2021). Despite these critical changes, ADA continues to expand based on recent needs.

In 2024, the United States Department of Justice made a final ruling on Title II regulations to include specific requirements for making web content and mobile applications accessible for people with disabilities (ADA.gov, 2024). This ruling ensures that state and local governments follow WCAG 2.1 Level AA standards for web and mobile accessibility. State and local governments should comply with the ruling by April 2027. Some exceptions to this rule are archived content, password-protected individualized documents, and preexisting social media posts, among others (ADA.gov, 2024).

Rehabilitation Act. The Rehabilitation Act of the United States advocates for programs receiving federal financial assistance, including higher education institutions, to not discriminate against people with disabilities (Lowenthal et al., 2021). This act was established in 1973 and included two key sections, Section 504 and 508 (King & Piotrowsky, 2021; Lowenthal et al., 2020; Lowenthal et al., 2021). Section 504 prohibits organizations or educational institutions from denying services or benefits to people with disabilities or providing services that are not equal to those provided to people without disabilities (Lowenthal et al., 2020; Lowenthal et al., 2021). Section 508, updated in 2017, established equality in electronic and information technology to address and respond to new trends and technological innovations and to provide guidance toward accessibility as the first step of awareness for higher education institutions (King & Piotrowski, 2021; Lowenthal et al., 2021). Despite the existing regulations to protect people with disabilities, there is an outstanding question as to whether websites are public accommodation (King & Piotrowski, 2021) and how applicable and concerning this is for higher education institutions, academics, administrators, students, and their families, due to increasing complexity in commercialization (Kotera et al., 2019). Lowenthal et al. (2020) insisted that online educators and other learning professionals should be aware of the Rehabilitations Act, specifically sections 504 and 508. Their statement aligns somewhat with King and Piotrowski (2021), who argued that educational institutions' legal responsibilities are being challenged in court through Section 504 and ADA.

Court Rulings in the United States. In the past decade, the court might have made rulings in various cases involving website and online accessibility that are almost certainly impacting, to some extent, educational institutions and organizations. The United States had around 5,600 lawsuits filed between 2016-2017 alleging website inaccessibility under ADA (Alajarmeh, 2022). In 2017, a blind user, Juan Carlos Gil, took legal action against Winn-Dixie, a supermarket chain (King & Piotrowski, 2021). Gil alleged that Winn-Dixie violated ADA because he could not navigate the site with a screen reader, receiving the favor of the United States District Court ruling in the Southern District of Florida (King & Piotrowski, 2021). This ruling was taken because the court established that Winn-Dixie's websites were integrated with their physical locations, making it deemed of public accommodation (King & Piotrowski, 2021). This case significantly impacts educational institutions since their websites are integrated with their physical locations (King & Piotrowski, 2021), and the ADA highlights mandates for nondiscriminatory actions in educational entities (Lowenthal et al., 2021). Therefore, it is reasonable that there is a need to explore whether website accessibility guidelines or regulations could apply to online courses in educational institutions and to what extent Section 504, 508, and ADA apply to these environments.

Institutions like the University of California (UC), Berkeley, Massachusetts Institute of Technology (MIT), and Harvard University faced legal challenges regarding the accessibility of their online materials (Baldwin & Ching, 2021; King & Piotrowski, 2021). The National Association of the Deaf (NAD) filed a complaint against UC Berkley because a large portion of their online materials was not accessible for people with disabilities by not providing closed captions or alternative formats that could benefit visual, hearing, and deaf students (Baldwin & Ching, 2021). UC Berkley responded by pulling the videos from public access due to the high costs of making them accessible (Baldwin & Ching, 2021). NAD took similar action against MIT and Harvard through a federal lawsuit that alleged that these colleges did not provide accurately closed captioning in thousands of online video lectures and other materials, violating Section 504 and ADA (Baldwin & Ching, 2021; King & Piotrowski, 2021). Harvard reached an agreement with NAD to caption all new video or audio content produced on or after December 1, 2019, and posted on a university website, along with specific agreements for videos created prior to this date (Charmatz, 2020; National Association of the Deaf [NAD], 2019). These rulings favoring people with disabilities can become more common and likely become a first step toward informed decisions and policymaking in educational institutions and organizations.

Summary of Legal Framework. From the literature, it can be concluded that creating informed decisions in developing digital content to protect and grant an equal experience to learners with disabilities might require clear laws and regulations. More than 140 countries, except for the United States, agreed and ratified the United Nations on the Rights of People with Disabilities Treaty (Feingold, 2017). Although the CRPD is the most comprehensive international statement about the rights of people with disabilities (Malaquias, 2022), other countries have enacted regulations prior to the CRPD. Although the United States counts with the Rehabilitation Act and the Americans with Disabilities Act, state courts are making essential rulings, and many institutions and organizations are taking steps toward inclusion in online environments, policies are still needed (King & Piotrowsky, 2021; Oswald et al., 2018). In the United States, legal challenges in court against universities are increasing (King & Piotrowski, 2021), perhaps because there is an experiential approach rather than a policy-level approach, impacting people with disabilities by creating barriers for them (Kotera et al., 2019). In 2016, the United States Department of Education took a significant step by implementing legal settlements with various states to ensure web accessibility for learners with disabilities and establishing this as part of their aspirations for online equality (King & Piotrowski, 2021). An implication of this is the possibility that the rulings in cases around digital accessibility that favor people with disabilities are contributing to creating a precedent about the fundamental rights and recognition of learners with disabilities in online environments. A more comprehensive evaluation of learners with disabilities in online learning and the type of disabilities they experience can contribute to understanding their needs and the reasons behind the rapid enrollment growth in online courses.

Learners with Disabilities in Online Learning

Online learning is becoming a popular modality of instruction that provides access to education to people with disabilities, a group that is enrolling in online learning at similar rates as learners without disabilities (Alvarado-Alcántar & Keeley, 2020; Kotera et al., 2019). An overview of learners with disabilities in online learning and the various types of disabilities they experience, such as visual, hearing, physical, mobility, learning, and cognitive disabilities is provided in this section. This section also includes a discussion about the increase in people reporting a disability and how this increase is reflected in online enrollments for learners with disabilities.

In the 2020 Census, 26% of adults in the United States reported some type of disability, a 7.3% increase compared with the 18.7% of people that disclosed a disability in 2010 (Brault, 2012; Centers for Disease Control and Prevention [CDC], 2020). When looking at these numbers from a global perspective, in 2011, the World Health Organization (WHO) reported that 15% of the world's population had some type of disability (Acosta et al., 2020). Statistics around disabilities show that 75% of people with disabilities have more than one impairment, sometimes due to illness or accidents (Miller, 2021; Rodrigo & Tabuenca, 2020). While the data provided by the CDC and WHO shows an increase in adults reporting some type of disability, educational institutions and organizations might not have similar numbers, most likely due to learners not reporting a disability.

Many people, including learners, fail to report or disclose a disability to their institutions (Kurt et al., 2019), but this might change. A public university in the United States said 32% of its students declared a learning disability (Lowenthal et al., 2020). In the United States, between 2007 and 2016, there was an increase of learners reporting disabilities in higher education institutions from 11% to 19%, which represents an increase of 8% in 9 years, with an evident increase in reporting among students of two or more races and over 30 years of age. (Lowenthal et al., 2021). At institutional levels, 98% of institutions reporting enrollments of learners with disabilities increased compared to 3% in the decade of 1970 (Erickson & Larwin, 2016). This increase in diverse learners represents the role of institutions in providing more support, services, and transitions, but at the same time, the increase poses a challenge for designers and developers of online courses to meet the needs of this group of learners (Erickson & Larwin, 2016; Lowenthal et al., 2021). A possible step towards supporting learners with disabilities in online settings might be to understand the various types of disabilities, how they impact these learners, and strategies to provide accessible learning. For example, it has commonly been assumed that accessibility is only important for blind people, but instructional designers and other online professionals should be aware of the various conditions that impact people with visual disabilities (Miller, 2021).

Visual Disability. Learners with visual disabilities encompass learners that are blind or live with other disabilities, such as glaucoma, astigmatism, myopia, diabetic retinopathy, and color blindness, among others (Miller, 2021; Rodrigo & Tabuenca, 2020). In the United States, out of 26% of adults that have a disability, 4.6% of these adults have a visual disability (CDC, 2020). Learners with visual disabilities face various challenges accessing digital content, including multimedia and document forms, due to a lack of transcripts, audio descriptions, and tabbed navigation (Rodrigo & Tabuenca, 2020). Both Miller (2021) and Rodrigo and Tabuenca (2020) concurred on the importance of awareness by online educators' professionals of the challenges that learners with this type of disability face in online environments and the need for strategies to support these groups. Rodrigo and Tabuenca (2020) suggested providing learners with tools to manage the size of text and images, color contrast options that learners can use to change colors, using headings to facilitate screen reader readings, and using HTML language, transcripts, and audio descriptions. In contrast, Miller (2021) called for proactive action by online professionals by recommending using color-blind simulators to check how learners with visual disabilities will perceive the content and resources. Some of these challenges and strategies can also apply to situations that involve learners with hearing disabilities, which possibly impact several adults with various hearing conditions.

Hearing Disability. Learners with hearing disabilities live with mild hearing loss or difficulty to a substantial loss in both ears, people that use hearing aid devices, and people with complete hearing loss (Miller, 2021; Rodrigo & Tabuenca, 2020). This group represents 5.9% out of 26% of adults reporting this disability in the United States (CDC, 2020). Hearing disabilities most likely develop for various reasons, from genetic causes, complications at birth, infections, and exposition to excessive noise or high decibels (dB) in prolonged timeframes and aging, among others (Miller, 2021). Similarly to learners with visual disabilities, these learners face challenges with multimedia digital content, including audio and video, without closed captions or volume controls and limitations in color and font size for closed captions (Rodrigo & Tabuenca, 2020). Some strategies to support these learners are transcripts, closed captions, players that allow adjustments for captions size, complete control of media, and high-quality audio with clear sounds, among others (Rodrigo & Tabuenca, 2020; World Wide Web Consortium [W3C], 2017). These strategies might differ from those needed by other people with disabilities, like learners with physical and mobility disabilities.

Physical and Mobility Disability. Out of 26% of adults living with a disability in the United States, 13.7% reported having a mobility disability with difficulties walking or climbing chairs (CDC, 2020). From a digital perspective, a physical or mobility disability probably expands from these limitations of physical difficulties in accessing buildings. Regarding online learning, learners with physical and mobility disabilities live with conditions such as arthritis, paralysis, multiple sclerosis, cerebral palsy, and Parkinson's disease, among others (Miller, 2021). These learners face difficulties interacting or manipulating technology devices such as a mouse, keyboard, touchpad, or computer screen (Miller, 2021). This description is similar to that observed by Rodrigo and Tabuenca (2020), who indicated that physical and mobility disabilities are a set of alterations that affect the execution of movements impacting their ability to manage keyboard and mouse devices. Among the strategies that could benefit these learners are providing additional time to complete activities, adaptive devices, on-screen keyboard with trackball, voice recognition, eye tracking, and inclusive navigation designs that allow tabbing through content (Rodrigo & Tabuenca, 2020; W3C, 2017). Although people with physical and mobility disabilities are a large group, it is justified to explore another growing group, like people with learning and cognitive disabilities.

Learning and Cognitive Disability. Learning and cognitive disability are fundamental concepts that instructional designers and educators should be aware of because they are a growing group (Miller, 2021). In a report released by the CDC (2020), 10.8% of adults in the United States live with a learning or cognitive disability, having difficulty concentrating, remembering, and focusing. This group is the second largest group of people with disabilities, preceded by 13.7% of people with physical or mobility disabilities (CDC, 2020). These results are consistent with reports from the Department of Education in 2013, stating that out of 64% of students enrolled in higher education institutions, 31% had a learning disability (Koch et al., 2018). Psychiatric disabilities are one of the most significant learning disability sub-groups

(Murphy et al., 2019) and the largest subgroup of learners with disabilities on college campuses in the United States (O'Shea & Kaplan, 2018). Despite people with learning and cognitive disabilities being a growing group, it can be beneficial to clarify each disability.

The terms learning and cognitive disabilities are often employed interchangeably when discussing learning disabilities and might be critical to clarify the definition to differentiate each disability. Miller (2021) defined learning as conditions that create difficulties with memory and problem-solving, processing speeds, and attention difficulties. Within the context of cognitive disabilities, for example, mental illness focuses on anxiety, depression, post-traumatic stress disorders, bipolar disorders, schizophrenia, and obsessive-compulsive disorders, among others (Miller, 2021; Murphy et al., 2019). Both learning disabilities and cognitive disabilities might be categorized separately, but it can be concluded that they are intertwined since mental illness could affect learning abilities.

From the literature, it is evident that a considerable amount of research explores and discusses learning disabilities and the various types of disabilities that fall within this category. Learning disabilities include multiple disabilities such as autism, dyslexia, attention deficit with hyperactivity disorders (ADHD), memory loss, intellectual difficulties processing numbers or symbols, slower processing speeds, and concentration difficulties (Miller, 2021; Murphy et al., 2019). Dyslexia is one of the most known types of cognitive disability and one of the most reported in higher education (Lebenicnik et al., 2020). Dyslexia causes difficulties for learners in acquiring literacy skills and problems with reading, writing, and spelling, impacting the learner's reading comprehension and fluency (Kotera et al., 2019; Lebenicnik et al., 2020; Radovan & Perdih, 2016; Rodrigo & Tabuenca, 2020). Similarly to dyslexia, dyspraxia is another learning disability related to coordination skills concerning writing, remembering, and managing emotions (Kotera et al., 2019). From a different lens, learners with ADHD, a behavioral disorder characterized by hyperactivity, are susceptible to distractions impacting their academic work (Kotera et al., 2019; Rodrigo & Tabuenca, 2020). Cerebral palsy is another learning disability that, although it causes issues with movement, is also related to visual problems that can cause difficulty in learning (Kotera et al., 2019). Like these types of learning disabilities, it is almost certain that learners with psychiatric disabilities may experience similar challenges.

One in five learners in higher education institutions in the United States has a mental health condition and faces significant challenges in online learning settings (Koch et al., 2018). Learners with cognitive disabilities that experience a mental illness are characterized by suffering alterations in their cognitive and emotional processes (Rodrigo & Tabuenca, 2020). Among the challenges experienced by learners with cognitive disabilities are short and long-term memory, dysfunction in attention, and executive functioning impairments, which impact performance in academia, and challenges that transcend to social cognition and adjustments, such as getting along with others and difficulty interpreting negative feedback or criticism (Murphy et al., 2019). Similarly, Koch et al. (2018) considered these learners face challenges with functioning, disruptive medication side effects, and failure to use academic accommodations and resources, causing inadequate support from institutions or organization services. These learners also face anxiety due to ambiguous information, causing paranoia, alterations, and limitations in recognizing reality (Rodrigo & Tabuenca, 2020). Most of these challenges are not visible; therefore, exploring areas to improve learning and communication is important.

The invisibility of learning and cognitive disabilities might result in missing learning and communication opportunities (O'Shea & Kaplan, 2018). Learning and cognitive disabilities increase the complexity for designers and developers when creating content for online environments because they are not visible to developers and faculty and may require a self-disclose from learners because it impacts each learner uniquely (Coleman & Berge, 2018; Miller, 2021). Learners with learning disabilities face global challenges due to the high chances of providing incorrect answers, significantly written errors, and lack of organization and presentation of ideas, while learners with cognitive disabilities such as mental illness face challenges around reasoning and communication, causing paranoia or stage fright, situations that are linked to cognitive limitations. (Rodrigo & Tabuenca, 2020). Therefore, it can be justified to explore how institutions can support these learners to improve their academic progress.

Institutions are starting to provide more support, services, and transition planning for learners with cognitive and learning disabilities (Erickson & Larwin, 2016), but additional learning strategies might benefit these groups of learners. Some of the strategies to support learners with learning disabilities in online environments are clear and structured content, consistent labels and headings, link text, hierarchical navigation, and search, preventing flickering and flashing content, text to speech tools, among others (Rodrigo & Tabuenca, 2020; W3C, 2017). Learners with cognitive disabilities (i.e., mental illness) can benefit from these strategies by receiving clear instructions for tests and activities and flexibility in the assignment and test submissions (Rodrigo & Tabuenca, 2020). O'Shea and Kaplan (2018) reported that extended time on exams, reduced course load, stress and time management, and peer support programs are typical services institutions provide to students that register their disability. Based on the literature, it can be concluded that there is not enough evidence to establish these are standard practices in institutions available to all learners, regardless of their disability disclosure status. Having discussed learning and cognitive disabilities, among other disabilities, it might be beneficial to highlight important key points about learners with disabilities in online learning.

Summary of Learners with Disabilities in Online Learning. This section focused on learners with disabilities, the type of disabilities their participation in online settings, and the challenges they experience. As reported in the literature, online learning is becoming a popular method for learners with disabilities, as has already been observed in the increase of enrollments and disability disclosures in higher education institutions, with a rise of 8% from 2007 to 2016 (Alvarado-Alcántar & Keeley, 2020; Kotera et al., 2019; Lowenthal et al., 2021). This data aligns with the data reported through the 2020 Census that 26% of adults in the United States reported some time of disability, representing a 7.3% increase from the 2010 Census (CDC, 2020). Out of the 26% of adults with disabilities, 4.6% have visual disabilities, 5.9% have a hearing disability, 13.7% have a mobility or physical disability, and 10.8% have a learning or psychiatric disability (CDC, 2020). From these results, it can be concluded that mobility or physical disabilities and learning or psychiatric disabilities are the two largest groups of adults with disabilities who experience ADHD, memory loss, dyslexia, and executive functioning impairments, among others (Miller, 2021; Murphy et al., 2019). From these statistics, it can be concluded that there is an increase in people reporting a disability, and it might be appropriate to understand the implications and challenges they might face.

It is evident that learning and cognitive disabilities are invisible disabilities (O'Shea & Kaplan, 2018) and that these invisibilities increase the challenges to designers and educators since learners would need to disclose a disability to receive the support they need (Coleman & Berge, 2018; Miller, 2021). From a general perspective, learners with disabilities experience various challenges in online settings that include multimedia, lack of transcripts and transcripts accuracy, audio descriptions, tabbed navigation, interaction with technology, short or long-term memory issues, anxiety, and paranoia due to inflexible settings established in activities in learning management systems (Koch et al., 2018; Miller, 2021; Murphy et al., 2019; Rodrigo & Tabuenca, 2020). Given the challenges faced by learners with disabilities in online settings, it is hardly surprising that they will face issues with their academic progress in online learning due to these barriers. A discussion of frameworks and models of disability that could support a holistic approach to online learning design to support learners with disabilities is presented in the following section.

Disability Models: Medical versus Social

Strategies and policies that address disability concerns might be impacted by the approach taken between the social and medical models of disabilities, and it is vital to clarify their meaning and evolution. From a general perspective, the foundation and cause of the social model are that people face disabilities due to barriers in society and social structure, while the medical model's foundation lies on the impairment or difference of an individual (Miller, 2021; Silva Bampi et al., 2010). Disability models have undergone alterations or rejections throughout history since they could represent prejudice or bias (Haegele & Hodge, 2016; Lowenthal et al., 2021). However, the medical and social models have significant importance in understanding disability and discrimination, instrumental in the renewal of the ADA in the United States and the European Union Framework Directive (Bunbury, 2019). Understanding these conceptual models and how they address disability from a medical perspective versus a social view can be essential for inclusive online learning.

Medical Model. The medical model may be focusing on the health to categorize a disability and establish treatment. In the medical model, disability is linked to healthcare theories and practices and represents a limitation or a medical phenomenon that limits an individual functioning, creating a link between the disease and the individual's experience (Bunbury, 2019; Haegele & Hodge, 2016). The medical model assumes that an individual's disability is a result of an impairment of body structure or mind, being the impairment the leading cause of their limited autonomy and social interaction and exclusion (Bunbury, 2019; Haegele & Hodge, 2016; Silva Bampi et al., 2010). Under this model, treatments for people with disabilities focus on eradicating or fixing the impairment to achieve independence, while education systems attempt this through segregated special education classrooms (Haegele & Hodge, 2016). However, the approach in education and other services for learners with disabilities could vary from elementary to post-secondary levels and other entities.

Medical professionals act as gatekeepers over treatments and influence educational services and accommodations that learners with disabilities can receive, being a difficulty of the medical model (Hagaele & Hodge, 2016). Higher education institutions traditionally place the responsibility to disclose a disability on the individual to proceed with accommodations for their disability, a practice that aligns with the medical model (Lowenthal et al., 2021). Besides the influence of medical professionals and scientists over the treatment of individuals and the labels that this could generate to receive services, countries like the United States, United Kingdom, and Europe addressed the narrowness of this model to outline disability civil rights for their citizens (Bunbury, 2019; Haegele & Hodge, 2016). The medical model's view and focus on an individual have raised questions about society's role (Bunbury, 2019), leading to the social model of disability.

Social Model. The social model of disability emerged as a shift from medical perspectives that focuses on physical and mental impairments to the social and environmental factor that influences the disability experience of the individual (Ferri & Giannoumis, 2014; Wescott et al., 2020). The UNCRPD advocates for people with disabilities' human rights and affirms the social model by reflecting that disability originates from the failure of social environments to adjust to the needs of people with impairments (Ferri & Giannoumis, 2014). The social model establishes that disability is a result of restrictions imposed by society on people with impairments, excluding them from society's main activities (Haegele & Hodge, 2016; Silva Bampi et al., 2010) and advocates for the removal of these social barriers to promote inclusion and change (Bunbury, 2019). Promoting inclusion using the social model might require understanding the contrast between both models.

It is almost certain that the social model contrasts with the medical model, not only in conceptualizations but also in policies and educational focuses. In the social model, impairment is an abnormality of the body, while disability is the restriction on activities caused by society not considering people with impairments (Haegele & Hodge, 2016). In contrast with the medical model that seeks to eradicate or fix the impairment, the social model suggests solutions that come from the society rather than the individual with impairment by promoting political action, social justice policies and change to address discrimination, and respecting individuals as they are (Aquino & BuShell, 2020; Goering, 2010; Haegele & Hodge, 2016; Silva Bampi et al., 2010). In education, the social model contrasts with the medical model by shifting the focus from the learner's impairment to the course design and accessible materials (Lowenthal et al., 2021). After discussing both models, it will be beneficial to summarize the key aspects to understand these models better.

Summary of Disability Models. The medical and social model of disability, although different, are implemented in certain fields and regions besides the possible gap that may exist regarding descriptions and terminology acceptance. While the medical model is known for some as an old paradigm, the social model has been popular in academia but not collectively accepted due to several debates around the language associated with the model (Hagaele & Hodge, 2016). The terminology taken by regions in these discussions is varied. For example, the United States trends towards a civil rights platform for people with disability, while the United Kingdom uses terms such as a disabled person or disabled, aligning with the social model of disability (Silva Bampi et al., 2010). Despite the active discussion on these two models, understanding both models and their perspectives, as well as the barriers and needs that face people with disabilities, could be a critical step toward achieving online learning accessibility. Accessibility needs and barriers for learners with disabilities in online learning settings are expanded on the following section.

Accessibility Needs and Barriers for Learners with Disabilities in Online Learning

Accessibility is when most learners can access a service, product, or environment that provide technology and materials that reduces barriers for learners with disabilities (Sánchez-Vásquez et al., 2022). The needs and barriers faced by learners with disabilities in online learning, from technology to usable content are discussed in this section. The teachers' perception on the accessibility of online materials they produce and the perspective of students with disabilities about their device usage and online accessibility needs is analyzed in this section. This section includes an evaluation about the barriers that learners with disabilities face with online courses and materials, including popular materials like digital textbooks.

Accessibility Needs. The development of online courses and learning experiences should begin with accessibility in mind by considering starting with elements such as technology and learning materials. A successful accessible learning experience starts and ends with access to the course platform or web, the navigation, and the usable and accessible content (Lowenthal et al., 2020). However, the level of online accessibility in education is limited (Batanero et al., 2019), which continues to cause challenges and create barriers to supporting learners with disabilities (Kotera et al., 2019). Despite the online growth in past decades and the recent Covid-19 pandemic that continues contributing to this growth, educational systems that use online technologies to deliver online instruction should consider and invest in the creation of accessible materials by providing content in a variety of formats (Baldwin & Ching, 2021; Rice & Ortiz, 2020). Although learners with disabilities must have access to accessible online content, the instructors' awareness and perceptions towards the development of accessible materials is a step to make a difference in the learners' experience.

Rice and Ortiz (2020) conducted a quantitative study to survey the perceptions of teachers about accessibility in online course materials. Forty-seven certified teachers out of 111 of six K-12 virtual schools in the midwestern United States with seven months to 10 years of experience participated in the study. The schools that participated in this study faced corrective actions due to low graduation rates, and their teachers taught every subject, including special education (Rice & Ortiz, 2020). The researchers sent a survey to administrators and later distributed it to the teachers. The participants responded about their perceptions of accessible instructional materials in their online courses. The survey included a 7-point Likert scale ranging from strongly agree to strongly disagree (Rice & Ortiz, 2020).

Researchers found that participants considered that materials and technology were somewhat accessible (Rice & Ortiz, 2020). About 70% of the teachers who participated in the study agreed or strongly agreed that the learning management system (LMS) navigation was user-friendly and that the courses facilitated readability. Another finding by researchers is that most of the teachers agreed or strongly agreed that their online courses counted with accessible text and images, as well as alternative means of access to multimedia, with 66.1% and 53.2%, respectively. Although responses to these questions showed some agreement from many teachers, the decrease between the navigation and readability questions and the accessibility of content is noticeable. Regarding accessibility statements available in courses, 47% of participants agreed or strongly agreed that these statements were public in their classes (Rice & Ortiz, 2020).

An important aspect of this study is that only two of these schools provided synchronous sessions with instruction, increasing concerns about the need for accessible materials due to limited interaction between teachers and learners (Rice & Ortiz, 2020). A limitation of this study is that teachers could have thought that if they agreed that their materials were inaccessible, their responses would have some consequences for their employment (Rice & Ortiz 2020). Although the researchers addressed some aspects of technology by asking about navigation, along with the accessibility of instructional materials, expanding this study with a new sample, for example, higher education instructors, could provide a more comprehensive perspective regarding the usage and needs of digital accessibility and technology (Rice & Ortiz, 2020). Consequently, it can be beneficial to describe digital accessibility and expand on existing research on technology usage by learners with disabilities.

Digital accessibility represents the use of technology by learners with disabilities similar to those without disabilities (Basham et al., 2016). Aquino and BuShell (2020) conducted a study with students and students with disabilities to determine their device usage and accessible technology needs. Ninety post-traditional students out of 208 students solicited from a small private mid-Atlantic postsecondary institution participated in this quantitative study. Researchers provided participants with a survey designed to explore their device usage and perceptions of technology use, accessibility, and support in various online environments, from fully online, to other environments with online components such as e-Learning and blended learning. Participants were 25 years or older, enrolled in undergraduate and graduate programs, and considered themselves working adults (Aquino & BuShell, 2020).

Regarding device usage, Aquino and BuShell (2020) found that students owned laptops and smartphones, with about 91% and 96% responses, where fully online learners who participated in the study indicated greater academic success using laptops. Regarding their experience in online courses, participants in all groups rated their experience as good or excellent, with results between 73% and 78% (Aquino & BuShell, 2020). When evaluating the online accessibility and their institution's awareness of accessible technology needs in their courses, participants had mixed perceptions, with 33% responding neutral and 20% responding fair or poor. Researchers found a significant difference among participants with self-disclosed disabilities that ranked the awareness of their institution as poor at 43% (Aquino & BuShell, 2020).

Two significant limitations of this study were that (1) the survey did not include operational definitions of terms used in the survey, opening the space for their interpretations, and (2) there were only seven participants that self-identified as learners with disabilities (Aquino & BuShell, 2020). The researchers considered that providing descriptions of the terminology could have improved the accuracy of the results since there is ambiguity around online learning environments, especially between online and e-Learning. A small sample of learners with disabilities does not represent the struggles and needs of these learners at a greater scale, impacting possible strategies and approaches from institutions when designing and developing online courses (Aquino & BuShell, 2020). Aquino and BuShell (2020) advised that technology plays an essential role in learners' success, but it is meaningful to evaluate the integration of accessible technology and materials to fulfill the needs of learners with disabilities.

While there are various needs within online courses, the development of accessible materials and access to technology could be part of the primary course design strategies. Research called high-quality materials accessible to all learners a primary focus in educational environments and the need for specific technologies, such as laptops and other devices, necessary for successful academic completion (Aquino & BuShell, 2020; Rice & Ortiz, 2020). Although the use of mobile devices among learners with disabilities is increasing, there are still barriers to accessing content (Rice & Ortiz, 2020). Some researchers refute these claims that people with disabilities are abundant users of new technologies and mobile devices (Rodrigo & Tabuenca, 2020). Besides the technology and accessible materials needs, it is important to reinforce that learners should not accommodate in online learning environments; instead, these environments should change to accommodate their needs (Cifuentes et al., 2016; Rice & Ortiz, 2020). A possible step forward to fulfill the needs of learners with disabilities could be to recognize the barriers these learners face.

Barriers. The increase of learners with disabilities in online courses (Erickson & Larwin, 2016) provides an opportunity to explore their preferences towards online learning and understand the challenges and barriers they face. Learners with disabilities find accessibility, flexibility, self-paced learning, and organization of materials as part of the advantages of online learning that gives them control over their studies (Kotera et al., 2019). Apart from these advantages and the use of accessibility guidelines and standards for course design, disabled learners still face problems (Kyudong et al., 2019). Some of the challenges noted by learners with disabilities are issues with communication and a lack of clarity about directions (Rao et al., 2015). Besides these challenges, technology can be considered one of the major challenges.

The use of technology between online learning and face-to-face environments marks a difference in its impact on learners with disabilities. Learners use technology at greater rates in online learning than face-to-face classes, increasing barriers due to the limited use of accessible tech-based teaching methodology (Aquino & BuShell, 2020). A key aspect of accessible online learning is that the technology and content must be fully accessible by learners with disabilities, not only because accessible content is a best practice but because many countries might have laws toward online accessibility (Samawi & Al-kreimeen, 2022). Before focusing on developing accessible courses, designers and faculty should identify and understand the barriers faced by learners with disabilities to make informed decisions in the development process.

In a study with learners with mental disabilities, Murphy et al. (2019) reported that these learners face challenges in online learning materials from heavily visual and written mediums due to expressive language impairments. In contrast, the lack of visuals and audio can make it difficult for them to interpret the intentions of the originated communication from their instructor or peers, making asynchronous learning without linear presentation of materials confusing and overwhelming (Murphy et al., 2019). The researchers conducted this qualitative study in a northeastern public university with high socioeconomic, geography, and ethical diversity ranks (Murphy et al., 2019).

There were 1,665 students who responded to the survey, where 286 (17.2%) of learners self-reported a mental illness disability, and 75% identified themselves as female (Murphy et al., 2019). The survey included 20 multiple-choice questions for demographic, disabilities, services, the impact of disability passing score, and field of study, while the remaining questions focused on other aspects, including the challenges experienced in online learning (Murphy et al., 2019). Researchers reported that participants had previous experience with various learning management systems (LMS). In the online challenges questions, learners reported a lack of in-person contact with faculty, difficulty concentrating and focusing, and difficulty navigating the LMS, among others (Murphy et al., 2019). The major limitation of this study is that it was conducted in one university, preventing generalization and the low survey response rate (Murphy et al., 2019). Murphy et al. (2019) provided a new perspective on disability that is not often reviewed or considered in online learning accessibility. Other research can provide additional views of the barriers and challenges faced by learners with disabilities in online learning environments.

To highlight others' perspectives, Alvarado-Alcántar and Keeley (2020) conducted a phenomenological study to gather the view of learners with learning disabilities towards courses that include some online learning components. This study occurred at a high school in a larger school district in the southwestern United States with 1,400 students. An in-classroom presentation took place to recruit participants, where information was provided in English and Spanish due to the diversity of learners (Alvarado-Alcántar & Keeley, 2020). All recruited participants were from a single-class period and participated in 30-minute one-on-one interviews. The researchers found that all participants agreed that the static textbook document on the computer represents a reading issue and that the lack of ability to clarify instructions is another issue. Participants shared frustrations with broken or irrelevant links (Alvarado-Alcántar & Keeley, 2020). Departing from the barriers faced by learners with cognitive (i.e., mental illness) and learning disabilities, the possibility of reviewing barriers faced by all learners with disabilities, including those with visual, hearing, physical, and mobility disabilities, are key for online learning professionals.

Two possible common barriers are the lack of captions and course navigation. The absence of captions, and textual or descriptive transcripts when reviewing videos, impact learners with and without disabilities due to language limitations, while the absence of sign language excludes learners with hearing disabilities (Acosta et al., 2020; Lord & Stein, 2018). Course navigation can be another significant barrier in online environments preventing learners with disabilities, including those using assistive technologies (e.g., screen readers, joysticks, and keyboards), from accessing the content, properly navigating the website, or spending excessive time in navigation due to poor structure (Lord & Stein, 2018; Lowenthal et al., 2021; Oswald et al., 2018). Another significant barrier in the course navigation is broken links and buttons, and incorrect alternative text for buttons, disrupting the experience of learners with disabilities, causing, for example, issues in participating in discussion forums due to screen readers' action reading errors (Kyudong et al., 2019). From the literature, it can be concluded that these barriers not only disrupt the overall experience of learners with disabilities but could add significant stress to designers and faculty responsible for addressing them.

Designers and faculty can address barriers for learners with disabilities by designing courses that are usable, accessible, and inclusive (Lowenthal et al., 2021). An essential first step to achieving accessible courses is to evaluate the formats used to deliver content, such as documents or multimedia, and consider the adjustments needed to reach all learners (Oswald et al., 2018). Beyond evaluating the formats, developers, and designers should prioritize the use and provision of technology that meets the needs of people with disabilities (Acosta et al., 2020). Another critical step might be understanding, analyzing, and integrating accessibility guidelines, such as Web Content Accessibility Guidelines (WCAG). Before expanding on guidelines, it might be significant to summarize the needs and barriers of learners with disabilities to foresee ways to improve their learning experience in online environments.

Summary of Accessibility Needs and Barriers. As has been noted in the literature, despite the limitation of accessibility in online learning and the challenges faced by learners with disabilities, an inclusive experience starts and ends with access to resources, course platforms, friendly navigation, and usable and accessible content (Batanero et al., 2019; Kotera et al., 2019; Lowenthal et al., 2020). Regarding the accessibility of online materials, Rice and Ortiz (2020) focused their study on the perceptions of K-12 teachers from six schools. Although participants considered and perceived the online materials as accessible, some of their perceptions changed regarding the readability of these materials. Out of the six schools, only two schools had synchronous (live instruction) sessions, which could represent challenges for the students of the four schools that only used asynchronous (non-live support) instruction. It is key to highlight that this study lacked more questions focusing on digital accessibility and technology and that their responses to the original questions could be biased due to participants' employment status concerns (Rice & Ortiz, 2020). In contrast, Aquino and BuShell (2020) focused on the learner experience with technology in online learning settings in higher education. Although this study included multiple questions about the use of specific devices for online learning and the learner's satisfaction with the impact these devices had on their learning, the questions provided the learners with disabilities perspective regarding their institution's awareness toward accessible technology, where more than 40% rated it as poor.

While Rice and Ortiz (2020) and Aquino and BuShell (2020) conducted studies exploring the perspectives regarding technology and accessible instructional materials, these studies failed to provide more clarification towards specific needs and barriers around digital accessibility and the unique needs of learners with disabilities. On the other hand, Murphy et al. (2019) focused on the needs of learners with mental illness. Researchers found specific issues faced by these learners, such as challenges with heavy visual and written communication, asynchronous sessions without linear presentations, LMS navigation issues, and lack of contact with faculty (Murphy et al., 2019). While these findings are important and meaningful to the instructional design and online learning field, the sample of this study does not provide enough representation of learners with disabilities. Thus, a comparative study could provide an additional perspective on the needs and barriers faced by learners with disabilities.

Murphy et al. (2020) findings were similar to those reported by Alvarado-Alctántar and Keeley (2020) through a study to gather the view of learners with learning disabilities about the accessibility of online learning components. Researchers found that learners experienced challenges with static textbook documents on a computer, the lack of the ability to clarify instructions, and significant issues with broken or irrelevant links (Alvarado-Alcántar & Keeley, 2020). As noted earlier in the literature, learners with cognitive (i.e., mental illness) and learning disabilities might experience similar challenges and barriers. Therefore, it can be concluded that the findings by Murphy et al. (2020) and Alvarado-Alcántar and Keeley (2020) are applicable to learners that experience these two types of disabilities, regardless of the possible limitation of the sample.

The sample sizes and the lack of generalizability of learners with disabilities are common limitations of Rice and Ortiz (2020), Aquino and BuShell (2020), Murphy et al. (2019), and Alvarado-Alcántar and Keeley (2020) studies. Thus, future research could clarify the specific needs and barriers that learners with disabilities face in online environments. Besides these limitations, Rice and Ortiz (2020) and Aquino and BuShell (2020) agreed in the call for future research toward accessible, high-quality materials for all learners with a primary focus on educational environments and the need for specific technologies. A discussion of standard accessibility guidelines created with the purpose of developing accessible materials for the web is presented in the following section.

Web Content Accessibility Guidelines

Overcoming digital gaps and removing barriers for learners with disabilities involve using guidelines and standards as proposed by organizations and institutions (Acosta et al., 2020). Educational systems do not provide proper training regarding accessibility concepts and practices leaving practitioners without adequate knowledge for designing and testing accessibility (Bai et al., 2019). But the presence of Web Content Accessibility Guidelines (WCAG) in quality assurance frameworks provide designers, developers, instructional designers, and educators access to technical guidance (Lowenthal et al., 2021). The enforcement or established policies in various countries such as Argentina, Australia, Canada, Denmark, and Israel, among others, for part or all the WCAG standards (Bait et al., 2019; W3C, 2023) are considered part of the steps toward removing these gaps and barriers, despite how complicated, overwhelming, and confusing are these guidelines for novices (Lowenthal et al., 2021). A discussion of WCAG foundation, the evolution, principles, and conformance levels of these guidelines is provided in this section. Findings around techniques to support content authors and designers and the impact of WCAG when designing and testing for accessibility is also included in this section.

Given the enforcement in some countries and the presence of WCAG in quality assurance frameworks, exploring the description, foundation, impact, and use of WCAG provides an essential starting point for designers, developers, and educators. Sadness (2021) highlighted the importance of WCAG as one of the most widely used documents for universal accessibility. Similarly, Alajarmeh (2021) described WCAG as the most recognized Web accessibility guidelines worldwide. Web Content Accessibility Guidelines is a series of guidelines created to improve and provide accessible web content to a wide range of people with disabilities (Acosta et al., 2020; Kurt, 2019; Radovan & Perdih, 2016). From a user experience perspective, Kyudong et al. (2019) described WCAG as a method to provide equal access and mitigate barriers experienced by people with disabilities while navigating the web on various devices. From a technical perspective, various researchers point out that WCAG is a series of technical standards that apply to web-based platforms, authoring tools, and content accessed through computers and mobile devices (Acosta et al., 2020; Lowenthal et al., 2020; Patzer & Pinkwart, 2017). Web Content Accessibility Guidelines provides a shared standard for web content accessibility to meet the needs of individuals, organizations, and governments that expands to all public-facing web-built materials (Baldwin & Ching, 2021; Chee et al., 2022) from its creation by the World Wide Web Consortium (W3C) until present times.

WCAG's Foundation. Wide Web Consortium is the leading proponent of these accessibility standards as a methodology for evaluating and reporting accessibility on websites (Molanes-López et al., 2021; Radovan & Perdih, 2016). The W3C focuses on regulating web technologies as an organization, and WCAG is its most well-established guideline (Kurt, 2019). The W3C published the first version of WCAG through the Web Accessibility Initiative (WAI) to improve web accessibility up to the most recent updates (Baldwin & Ching, 2021; Chee et al., 2022; Lowenthal et al., 2020; Radovan & Perdih, 2016). The W3C published the first version of WCAG 1.1, in 1999, followed by 2.0 in 2008 (Alajarmeh, 2022; Kurt, 2019; Lowenthal et al., 2020; Kyudong et al., 2019). WCAG 2.1, was published in 2018 (Acosta et al., 2020; Baldwin & Ching, 2021; Lowenthal et al., 2020). WCAG 2.1 expands the WCAG 2.0 criteria by adding various technologies rather than focusing only on web technologies (Acosta et al., 2020). The latest version, WCAG 2.2, was published in 2023 with the addition of 9 success criteria from WCAG 2.1 (Ara & Sik-Lanyi, 2023; Krittika & Shimray, 2025). Although the initial trend was to update these standards about every 10 years, due to the fast-paced technological changes, the upcoming WCAG 3.0 is currently in the works and available as a working draft (Ari & Sik-Lanyi, 2023; Lowenthal et al., 2020). Having discussed the evolution of WCAG, it is necessary to explain the structure of these guidelines to have a clearer perspective on its purpose.

WCAG's POUR Principles. Web Content Accessibility Guidelines includes detailed guidelines and technical terms that have evolved in complexity and are distributed into four principles and three levels of compliance (Chee et al., 2022; Kurt, 2019). The four principles are: *Perceivable*, *operable*, *understandable*, and *robust* (POUR) (Chee et al., 2022; Kurt, 2019), while the three levels of conformance are Level A, Level AA, and Level AAA (Alajarmeh, 2022; Chee et al., 2022; Lowenthal et al., 2020). From a compliance perspective, level A of conformance represents the minimum accessibility of digital content, while AA is a more comprehensive level that assumes compliance with A and AA (Acosta et al., 2019; Chee et al., 2022; Lowenthal et al., 2020). Level AAA is the advanced and higher level of conformance, which includes meeting criteria A and AA (Acosta et al., 2019; Lowenthal et al., 2020), and AAA is considered the best practice for web accessibility (Chee et al., 2022). Regarding the four general principles, the user should perceive the content, operate the interface, understand the information provided, and the website hosting this information should be robust, meaning that it should work on various devices and along with assistive technologies (King & Piotrowski, 2021). Sadness (2021) linked perceivable with issues related to the output, operable is related to input issues, and understandable is related to the human and cognition around interface use. Considering this overview of WCAG principles and compliance levels, it would be helpful at this stage to expand on the four principles and the methods designers, developers, and educators can implement in online environments.

As explained earlier, WCAG's POUR are the general principles of these guidelines. The *perceivable* principle establishes that content must be perceived or detected by all people regardless of their disability (Baldwin & Ching, 2021). To make the content perceivable, designers and content developers should provide alternatives to this content, such as alternative text, captions, transcripts, and sufficient contrast, and make the content available to assistive technologies (Kurt, 2019). Users should be able to operate this content and interact with the components of the web page or online activity, as established in the *operabl*e principle (Baldwin & Ching, 2021). To accomplish this principle, users should be able to navigate, find, and interact with online content that does not cause seizures by using a mouse, voice control, and full keyboard functionality, as well as having enough time to read and interact with this content (Baldwin & Ching, 2021; Kurt, 2019). *Understandable* is the third principle in WCAG and establishes that users must be able to understand the information provided and the instructions to interact with the components (Alajarmeh, 2022; Baldwin & Ching, 2021). Addressing the understandable principle requires making the content readable and comprehensible for all users at the appropriate reading level, making content appear and work in predictable ways, and helping users to avoid and correct mistakes (Kurt, 2019). The fourth principle, *robust*, is how the online content should be used, processed, and understood on various devices and assistive technologies by maximizing compatibility with current and future technologies (Baldwin &

Ching, 2021; Kurt, 2019). Based on the literature, it can be concluded that WCAG principles focus on the user experience through the web experience and human cognition (Baldwin & Ching, 2021; King & Piotrowski, 2021; Kurt, 2019), while the conformance levels expand to compliance, legal determinations, and best practices of web accessibility (Acosta et al., 2019; Chee et al., 2022) which can balance the strengths and limitations of these guidelines.

Guidelines Strengths and Challenges. Among the strengths of WCAG is that these guidelines are comprehensive and, for some, easy to implement (Kurt, 2019). These guidelines are considered one of the most complete resources for developing accessible web and tools (Radovan & Perdih, 2016), and although they are specifically designed for the web, the principles apply to various types of interfaces outside of digital environments (Sadness, 2021). From another lens, Radovan and Perdih (2016) highlighted that although these guidelines have an important role in the development of web-based materials, it might be challenging to use the same approaches for a rich online learning experience, and using the guidelines might require a holistic approach focusing on usability, accessible learning, accessible courses, and adapting to cultural factors. Similarly, Patzer and Pinkwart (2017) considered that using WCAG should not replace the direct feedback provided by users and usability evaluations since WCAG does not consider education aspects. As previously discussed, another possible challenge of WCAG is that these guidelines are complicated and technical and could be overwhelming and confusing for novices in online accessibility (Lowenthal et al., 2021). This observation aligns with Acosta et al.'s (2020) explanation that WCAG compliance does not guarantee accessibility in web content because a given technique might not be suitable for a given technology. Web Content Accessibility Guidelines might require the use of more than one technique, and developers' lack of experience with web accessibility might create barriers (Acosta et al., 2020). From the literature, it can be concluded that novices might experience challenges using and testing WCAG as part of their tasks of creating accessible online courses, since it requires an understanding of various techniques and the needs of technologies and users with disabilities (Acosta et al., 2020; Lowenthal et al., 2021).

Novices and expert designers and developers can benefit from a set of techniques to achieve digital accessibility that can improve the experience of learners with disability in online learning. Acosta et al. (2020) conducted a study to propose a set of techniques for authors to meet the success criteria for the publication of digital content, specifically focusing on accessible multimedia content for the web. The purpose of these techniques is to help anyone, experienced and novice authors, with the evaluation and testing of web accessibility of multimedia content and cover the gaps in the guidance of WCAG (Acosta et al., 2020). In this study, researchers described multimedia on the web as media that includes sounds, music, videos, movies, and animations and accessibility terms related to multimedia such as audio descriptions, captions, clean audio, sign language, text video descriptions, transcriptions, and others (Acosta et al., 2020). Exploring existing standards and evaluating various sources could contribute to new potential techniques.

The creation of techniques could benefit from a phased process to potentially use various sources to ensure that guidelines are feasible. Acosta et al. (2020) used a four-phase method to conduct this study. In Phase 1, the researchers studied the standards and accessibility documents proposed by WAI and other sources, including WCAG, ATAG, and User Agent Accessibility Guidelines (UAAG). Phase 2 consisted of filtering the criteria and conformance levels on each of the guidelines to focus on the creation and publication of accessible media. Researchers interpreted the success criteria during Phase 3 and completed the results and discussions during a two-step Phase 4. In the first step of Phase4, they proposed techniques to guide authors to meet the success criteria for accessible media content, while in the second step, they discussed and detected gaps among the guidelines evaluated (Acosta et al., 2020). Thus, from the gaps found in the evaluation process, it is relevant to identify the existing guidelines that will contribute to the new techniques.

Regarding the creation of techniques, a key aspect would be understanding the application of WCAG guidelines to multimedia in online and digital environments and to what extent they can remove the barriers faced by people with disabilities. Researchers found that 19 success criteria from ATAG could apply to publishing accessible multimedia, while 13 criteria from WCAG can be interpreted to create accessible media content (Acosta et al., 2020). From these findings, researchers proposed 278 novel techniques to guide compliance and 80 possible failures that negatively affect compliance. A limitation of this study is that it focused on multimedia accessibility criteria and not evaluating other aspects of online accessibility (Acosta et al., 2020). While researchers considered that the proposed techniques could be used to evaluate existing authoring tools' features and functions, they call for future work on proposing techniques for compliance with other success criteria. From this study, it can be concluded that 278 new techniques contribute to the body of knowledge, but these techniques might not remove the gap that affects people with disabilities due to the generalization in the writing of standards (Acosta et al., 2020). Although Acosta et al. focused their research on evaluating WCAG and other standards to create techniques for the creation and publication of accessible content, it could be significant testing WCAG standards toward accessibility needs.

Accessibility Testing. Testing accessibility using existing automatic tools may fail to identify all potential issues (Kurt, 2019), and performing tests using various methods could help designers, developers, and educators experience some of the needs faced by learners with disabilities. Bai et al. (2019) conducted a quantitative study to evaluate various accessibility testing methods for multiple disabilities. Researchers included WCAG since it is the de facto standard and, as previously noted, legally enforced in several countries as a default for testing and creating accessible web content. Web Content Accessibility Guidelines was tested and compared with other testing methods such as (1) Siteimprove, which includes automatic checkers, (2) Cambridge Simulation Glasses to simulate general visual impairments, (3) Screen Reader, which informed visually impaired users of the content through spoken-aloud or braille reader, (4) Dyslexia Simulator, to simulate the experience of users with dyslexia, and (5) Personas as a method for becoming familiar with a user group (Bai et al., 2019). Evaluating various testing methods could require various iterations to collect the data successfully.

Researchers conducted the study in a two-pilot series where the scenarios and methods selected were verified as appropriate (Bai et al., 2019). The main study evaluation occurred in four months with seven teams across six public and private companies and 53 participants (Bai et al., 2019). Each participant tested two to three methods during a 10-minute session for each method and a 3-minute session to complete the feedback form for each evaluation. Researchers collected all the forms through Google Forms and used the USE questionnaire system consisting of 30 questions using a 7-point Likert scale to rate usefulness, satisfaction, ease of use, and ease of learning (Bai et al., 2019). Having discussed the data collection process of the Bai et al. (2019) study, it will be beneficial to expand on the interest of participants in the offered testing methods.

With respect to testing methods, it is necessary to consider tester preferences along with the ease of learning, ease of use, and the usefulness of each method when testing and understanding the needs of people with disabilities. Bai et al. (2019) found that, surprisingly, WCAG had the fewest evaluations and was one of the methods with the lowest scores, below a median of four, with a significant difference from the other methods. Participants showed a lack of motivation to test this method and expressed the method is hard to use. Still, participants agreed that WCAG is a useful method (Bai et al., 2019). These results contrast with the other methods since Dyslexia Simulator, Cambridge, Siteimprove, and Screen Readers received more evaluations and better rates, especially in ease of learning and ease of use (Bai et al., 2019). The Personas method received fewer evaluations, and although this method is difficult to learn and understand, it received good scores throughout, except for usefulness. Although the Siteimprove model received greater scores than WCAG due to the ease of its automation process, participants were less likely to understand some of the terminologies since this method does require prior knowledge of WCAG (Bai et al., 2019). Therefore, it can be concluded that testers prefer more automated processes, but they will still face some challenges when technical terminology, such as WCAG, is involved. It is necessary to expand on the limitations declared by researchers in the study.

The findings in this study were subject to at least three main limitations. The most important limitation lies in that the data collection and analysis might have been impacted by bias from the varied roles of participants and influence from researchers (Bai et al., 2019). A second limitation is that participants filed forms that might have been impacted by social desirability bias. Lastly, participants had only 10 minutes to evaluate each method, whereas more complex methods like WCAG require more than 10 minutes to conduct an evaluation (Bai et al., 2019). Despite the limitations of this study, it is evident that WCAG represents a challenge for testers and expanding on the accessibility testing of digital materials using these guidelines provides a clearer perspective of its impact between experts and novices.

The proper identification of accessibility barriers in digital materials by evaluators and educators could be impacted by their experience in the subject and possible familiarization with WCAG success criteria (Molanes-López et al., 2021). Molanes-López et al. (2021) conducted a quantitative study to evaluate a set of digital materials, specifically learning videos, with 72 novice evaluators that received basic accessibility training to see if they could identify accessibility issues on these materials using WCAG success criteria. Participants were students enrolled in a Massive Open Online Course (MOOC) that received basic training on video accessibility focusing on accessibility of digital documents, images, audio, and videos (Molanes-López et al., 2021). Participants were assigned to two groups, Group A and Group B, to review a video created for each group. Researchers created video B in the first place, and it was reviewed by a group of experts that identified several accessibility issues and provided a list of recommendations for the video remediation. After reviewing this list, researchers completed video A, which included the revisions from the experts, who marked this video as accessible for learners with visual disabilities (Molanes-López et al., 2021). Videos were assigned to each group, and participants completed a questionnaire with 14 statements using a Likert scale, from "(1) Strongly disagree" to "(5) Strongly agree", where statements 1 to 7 were from WCAG success criteria. Researchers used a nonparametric statistical test to analyze the data collected. Thirty-one responses from Group A and 41 from Group B were submitted since the groups were homogeneous. Researchers found no statistical difference in the results, where 83.33% of Group A participants rated the A video as accessible, while 77.50% of participants in Group B rated the B video as accessible. These results aligned with the agreement where 90% or higher of participants in both groups considered that the videos were complying (Molanes-López et al., 2021). Based on these findings, it can be concluded that the tester experience might influence accessibility evaluations, and it will be justified to evaluate all possible limitations to achieve better results.

The findings in this study are subject to three main conclusions. First, although novice evaluators and educators can identify accessibility problems on videos, one reason they could overlook these problems is due to the lack of expertise on issues that require specific background knowledge. Second, using WCAG to address and test accessibility outperforms using generic statements to identify accessibility issues and the cause of the problem. Third, WCAG success criteria might require prior knowledge or additional clarification needs to be provided since some criteria, like the 1.4.1 "Use of color," could be understandable but hard to apply by novice evaluators and educators (Molanes-López et al., 2021). Additional research can help support evaluators in properly using accessibility standards.

A significant aspect is that future research should consider minimizing the study's limitations. Molanes-López et al. (2021) asked for several considerations in future research. First, use videos with more significant accessibility issues and request participants to classify various levels of accessibility. Second, include participants with disabilities as part of the practice to receive their perspective. Third, include additional practices to train novice participants to assess WCAG guidelines and success criteria, especially those that are hard to understand and apply (Molanes-López et al., 2021). Overall, WCAG provides what most consider a crucial guide to developing accessible experiences, but it would be relevant to review and summarize the key aspects of WCAG and findings on the studies around these guidelines.

Summary of Web Content Accessibility Guidelines. As has been noted, there is a need for proper training in the accessibility subject and its concepts for adequate practice and testing (Bai et al., 2019). Although educational systems might not provide proper training, the presence of accessibility technical standards, such as WCAG, in quality assurance frameworks represents a positive step toward supporting designers, developers, instructional designers, and educators to create accessible online courses (Lowenthal et al., 2021). Web Content Accessibility Guidelines is known worldwide and is the most recognized document guideline for universal digital accessibility (Alajarmeh, 2022; Sadness, 2021), and the use of WCAG in research studies was noticeable in the literature. Some research studies that discussed WCAG focused on the use of these standards for the creation of new frameworks or techniques, while others focused on the understanding of these standards for testing accessibility. For example, Acosta et al. (2020) focused their study using WCAG and other standards to propose a new set of techniques to meet success criteria in the publication of digital content, especially accessible multimedia. It is relevant to highlight that researchers identified 13 WCAG criteria that could be interpreted for multimedia content. These findings contributed to the body of knowledge and the proposed 278 techniques to support novices and experts in evaluating accessibility. A significant limitation is that the study focused on media accessibility and bypassed other aspects of online accessibility (Acosta et al., 2020).

Similarly, Molanes-López et al. (2021) focused their study on the accessibility of videos as digital materials. Contrary to Acosta et al. (2020), Molanes-López et al. (2021) conducted their study with novice testers, where 90% of participants considered both videos to be accessible. Researchers concluded that although novices can identify accessibility issues, they might overlook some significant issues due to their lack of experience. Researchers also noted that WCAG outperforms generic accessibility statements (Molanes-López et al., 2021). From a different standpoint, Bai et al. (2019) conducted a study to evaluate various testing methods for multiple disabilities, including WCAG, since it is the most known and default standard method. The WCAG had fewer evaluations among participants, and although participants considered WCAG a useful method, it received a poor score as it is hard to use. All researchers agreed that future studies should include more participants with disabilities to understand their perspectives and needs better (Acosta et al., 2020; Bai et al., 2019; Molanes-López et al., 2021). In summary, WCAG, along with other factors such as legal frameworks, learners with disabilities, disability models, and accessibility needs, might be vital to accessibility, equity, and inclusion in online learning.

Summary of Accessibility, Equity, and Inclusion

The foundations of accessibility, equity, inclusion, and legal frameworks were discussed in this section. In the literature, the accessibility term is defined as to provide access without barriers to everyone, including people with disabilities (Baldwin & Ching, 2017; Oswald et al., 2018). Equity is the act of being fair and impartial in providing people with what they need regardless of their situation (Baldwin & Ching, 2017; Samawi & Al-kreimeen, 2022). Regarding the term inclusion, Aryeh-Adjei et al. (2023) and Joshi (2022) agreed that inclusion is providing all learners access to quality education, meeting their diverse needs. As previously noted, some legal regulations and initiatives that seek to provide people with disabilities an accessible, equal, and inclusive experience are the UNCPR, Australian and United Kingdom's Disability Discrimination Acts, UK's Equality Act, and United States' ADA and Rehabilitation Act. Concerning the United States, ADA, and the Rehabilitation Act have impacted court rulings against major higher education institutions like UC Berkeley, MIT, and Harvard regarding the accessibility of their online materials (Baldwin & Ching, 2021; King & Piotrowski, 2021). From the literature, it can be concluded that the clarity of foundational concepts, key regulations, and the court rulings influenced the growth and impact of learners with disabilities in online environments and how educational professionals perceive their needs and barriers.

The growth and impact of learners with disabilities in online settings, their disability needs, and challenges was expanded in this section. From the literature, it is noticeable that online learning is a popular option for learners with disabilities and that enrollment rates are increasing (Alvarado-Alcántar & Keeley, 2020; Kotera et al., 2019). Although many people fail to disclose their disabilities, this behavior is changing since institutions in the United States are reporting an increase in learners with disabilities disclosing a disability (Kurt et al., 2019; Lowenthal et al., 2020). Although learners with disabilities might experience unique needs based on their disability, it can be concluded that there are common challenges, such as access to multimedia and forms and lack of transcripts, captions, color contrasts, navigation issues, and issues manipulating technology devices (Miller, 2021; Rodrigo & Tabuenca, 2020). Based on their needs, it is justified to evaluate web accessibility guidelines, such as WCAG, to provide accessible learning experiences.

Having discussed WCAG in this section as a default method for creating web accessibility, it will be significant to clarify essential key points. Web Content Accessibility Guidelines potentially addresses user and technical experiences. From a user perspective, WCAG does provide equal access to the web and mitigates challenges faced by people with disabilities (Kyudong et al., 2019). Acosta et al. (2020), Lowenthal et al. (2020), and Patzer and Pinkwart (2017) considered that the technical perspective focuses on the technical components of the WCAG standards, such as web-based platforms, tools, and access to information through devices such as computer and mobile. The WCAG's POUR principles could be broken into the needs and achievable aspects of each principle, such as (1) focus on providing alternative solutions to learners, like captions or transcripts (*perceivable*), (2) providing the ability to navigate and interact with content (*operable*), (3) write content that is at the appropriate reading level and predicable (*usable*), and (4) work in multiple devices and with assistive technologies (*robust*) (Baldwin & Ching, 2021; Kurt, 2019). Although WCAG is a widely known method for standards, it is valuable to explore additional options to help designers, developers, and educators fulfill the need of learners with disabilities.

As previously analyzed, learners with disabilities face numerous challenges in online settings. Mitigating these challenges involves designers proactively following guidelines and best practices for making the web and online experience accessible to achieve greater inclusion (Kotera et al., 2019; Lowenthal et al., 2020; Miller, 2021). For example, standards such as WCAG are referenced in quality assurance frameworks, which could provide online educators and instructional designers with technical guidance (Lowenthal et al., 2021). Researchers have been discussing in the literature the importance of standards and how these standards could become complicated, overwhelming, and confusing for novices (Acosta et al., 2020; Lowenthal et al., 2021). Researchers' discussions could provide a perspective to explore other frameworks to facilitate designers and educators to start with accessibility in mind. An introduction to instructional design R2D2/C3PO model and quality assurance frameworks and their impact on accessible online learning experiences will be discussed in the following section.

Instructional Design: Frameworks and Model for Online Learning

Understanding and using instructional design frameworks and models that includes sections and principles with a focus on accessibility is key to create accessible, equitable, and inclusive online learning. An instructional design model and frameworks used by instructional designers and educators to develop online learning experiences is discussed in this section. This section includes a discussion of Universal Design for Learning (UDL) for inclusive design and the roles of educators, as well as standards and strategies for inclusive experiences. Quality Matters (QM) and its rubric from the lens of accessible online courses and an introduction to the R2D2/C3PO instructional design model are also discussed in this section.

Universal Design for Learning

Universal Design for Learning (UDL) is the most common framework to accommodate the needs of all learners applied in education and is at the forefront when considering strategies to achieve accessible online courses (Burgstahler, 2021), and understanding its origin and progression is relevant for the discussion. Universal Design for Learning originated from Universal Design (UD), a concept that began in the 1990 decade in the field of architecture with an emphasis on designing functional and accessible physical environments (Rao et al., 2015). Around the same time, the Universal Design movement transcended educational settings to create equally accessible learning environments for learners and become UDL (Lowenthal et al., 2020; Oswald et al., 2018; Rao et al., 2015). UDL was developed by the Center for Applied Special Technology (Burgstahler, 2021; Coombs, 2010) and is centered on scientifically based research (Basham et al., 2016). Therefore, it will benefit the field to expand on the UDL framework.

Universal Design for Learning is one of the most common frameworks in education (Burgstahler, 2021), and understanding its role in accessibility is key for the instructional design field. UDL is an evidence-based framework that improves and optimizes teaching and learning by minimizing obstacles all learners face (Baldwin & Ching, 2021; Orellana et al., 2022).

Universal Design for Learning is frequently used and cited in quality assurance frameworks as a best practice for creating accessible courses (Lowenthal et al., 2021). Educators and instructional designers implement UDL to design and improve course content and instructional activities so they can be functional and usable by the greatest number of learners rather than following a reactive or remediation approach (Kaatz, 2021; Lowenthal et al., 2021). From an accessibility lens, UDL promotes inclusive learning and aims to achieve accessibility and equity (Baldwin & Ching, 2021; Orellana et al., 2022). Basham et al. (2016) pointed out that the UDL framework provides a much broader perspective on inclusive learning than accessibility alone. Similarly, Baldwin and Ching (2021) considered that UDL expands upon accessibility by offering everyone access to learning and addressing equity by providing development strategies to grant equal access without making reactive adjustments. Using UDL shifts the focus from learners' disabilities to the potential benefits of incorporating inclusive designs in courses that will benefit all learners (Lowenthal et al., 2021). Therefore, it is relevant to understand the role and impact of educators in inclusive design.

Educators and Inclusive Design. Scholars have discussed the role of educators in accessible, equitable, and inclusive designs, and it will be beneficial to the field expanding on this aspect. Rice and Ortiz (2020) highlighted that the responsibilities involving the instructional planning and implementation of courses tend to exclude those accountable for addressing and ensuring accessibility. Basham et al. (2016) considered that instructors can be more impactful by making better-informed decisions during the design, implementation, and testing. From a different perspective, Martin et al. (2021) pointed out that, compared to face-to-face instructors, online professionals should have additional competencies to efficiently develop accessible courses. For example, subject matter experts should identify appropriate resources and use a variety of sources that are helpful and accessible to students, while instructional designers or developers should be the head of inclusive design in the various formats used (Martin et al., 2021). Based on this information, it is justified that instructors and instructional designers have some unique responsibilities toward accessibility. From an educational perspective, it will be beneficial to understand what might be limiting these roles from integrating universal design for learning and inclusive practices.

Understanding the challenges and opportunities for accessible and inclusive learning experiences might significantly contribute to educators and instructional designers. Baldwin and Ching (2021) considered that current information on creating accessible, equitable, and inclusive online learning experiences is complex to process and understand. Similarly, Kaatz (2021) highlighted that for instructors and designers, creating ADA-compliant courses is time-consuming and difficult, primarily if addressed as a remediation system rather than starting with accessibility and inclusivity in mind since the beginning of the development. Inclusive designs should be woven into evaluation instruments rather than providing accessibility focus stand-alone sections to promote a proactive approach by educators and instructional designers (Baldwin & Ching, 2021). Cifuentes et al. (2016) discussed that instructors and designers should follow UDL principles to accommodate learners. An example of these accommodations is providing closed captions to videos and transcripts for audio (Cifuentes et al., 2016). The instructional design field will benefit from exploring how online educators use UDL to create inclusive experiences for their learners.

Regarding accessible and inclusive course design, it is crucial to explore the experience of educators and instructional designers when implementing accessible and inclusive strategies. Rao et al. (2015) conducted a case study to evaluate one instructor's experience who applied

UDL principles in her online course to provide cognitive support for diverse learners. The instructor of this case study was a subject matter expert in literacy instruction who did not have instructional design or technological expertise. The instructor adapted UDL strategies from Rao and Tanners (2011) and included these strategies in her course that was part of the undergraduate teacher certification program. The course was designed following a five-phase approach using ADDIE (Analysis, Design, Development, Implementation, and Evaluation) (Rao et al., 2015). Therefore, it is justified to expand on these phases.

During Phase 1 (analysis), the instructor evaluated the characteristics of students who would enroll and developed a scope and sequence (Rao et al., 2015). Following Phase 1, the instructor proceeded with phases 2 and 3 to design and develop the course objectives, resources, materials, weekly activities, and assessments in varied formats, including 3-4 synchronous sessions. During Phase 4 (implementation), the instructor eliminated the textbook and applied strategies such as a welcome email, a detailed syllabus with clear expectations, timely and constructed feedback, and included multimedia to support learners (Rao et al., 2015). The instructor provided audio narrations for PDFs. In the last phase (evaluation), 70 students were enrolled and participated in the program. All learners who participated in the course answered the survey of ten multiple-choice questions, a five-point Likert scale, and several open-ended questions to evaluate the course elements that used UDL principles (Rao et al., 2015). What follows are the findings of the study conducted by Rao et al. (2015).

Researchers found that over half of the students picked traditional ways of learning, such as reading the material, compared with 43% who preferred a combination of audio and reading (Rao et al., 2015). None of the students selected audio only as a preference. Some reasons for learners not to select audio options were that text-to-speech was incorrect in pronunciation, and they felt the speech was robotic and hard to follow. Most learners thought it was positive having both options. Learners preferred short-less points assignments because they felt they could learn more and understand the materials better and that these strategies helped them achieve better results (Rao et al., 2015). Based on this study, expanding on the principles and strategies that could provide inclusive experiences is justified.

Principles and Strategies for Inclusive Experiences. If we accept the premise that educators can rely on UDL principles to build flexible options for learners (Rao et al., 2015), evaluating these principles and what each represents is a step to expand their knowledge. The UDL framework has three principles: (1) provide multiple means of engagement, (2) provide multiple ways of representation, and (3) provide multiple means of action and expression (Coombs, 2010; He et al., 2022; Lowenthal et al., 2020; Lowenthal et al., 2021). Basham et al. (2016) highlighted that these principles support the UDL framework in offering variability to all learners by proactively and iteratively designing learning. Similarly, Baldwin and Ching (2021) indicated that UDL principles offer learners flexible pathways adjusting learning to the needs of the individuals. The literature highlights the importance of the principles; hence, it is justified to explore these principles further.

Describing each UDL principle is important to provide additional context to educators and instructional designers on how to apply these principles. The multiple means of engagement principle is defined as increasing the level of active learning by encouraging self-reflection and monitoring, helping learners see the relevance of the course topic and varying instructional strategies throughout the course to keep diverse learners engaged (Baldwin & Ching, 2021; Lowenthal et al., 2020; Patzer & Pinkwart, 2017). The second principle, multiple ways of representation, means providing the course content in more than one format using a variety of strategies, methods, and tools (Baldwin & Ching, 2021; Coombs, 2010; Lowenthal et al., 2020). An example of this principle is using a video to explain a concept or bring the varied perspective of multiple authors around a concept (Lowenthal et al., 2020). Finally, multiple means of action and expression is providing learners with various ways to demonstrate their learning, for example, formative assessments, projects, and learning through visual, written, oral, or other modes to help learners demonstrate their skills and knowledge (Baldwin & Ching, 2021; Lowenthal et al., 2020; Rice & Ortiz, 2020). It is relevant to mention that in the literature, this principle is commonly named as multiple ways of action and expression (Baldwin & Ching, 2021; Basham et al., 2016; Coombs, 2010; Lowenthal et al., 2021), but Lowenthal et al. (2020) and He et al. (2022) referred to this principle in some instances as multiple ways of assessment. Despite how these principles are described in the literature, it is evident that there is a general agreement around the terminology and foundations.

Summary of Universal Design for Learning. A discussion of UDL, its origins, and the roles of educators and instructional designers in creating accessible online courses was provided in this section. Rice and Ortiz (2020) study evaluated the experience of one instructor who applied UDL to her class. An interesting observation from this case study is that most learners favored traditional ways of learning the content, but learners found it beneficial to have the option to choose from the various formats available to them (Rice & Ortiz, 2020). It is key to highlight that UDL has three principles as its foundation to provide multiple means of engagement, representation, and action and expression (Lowenthal et al., 2020; Lowenthal et al., 2021). It is important to note that although UDL can contribute to the accessibility of courses, some instructors may want to use Quality Matters since it provides best practices on course design and accessibility (Murphy et al., 2019). An introduction to quality assurance framework, Quality Matters and expand on their accessibility standards is presented in the following section.

Quality Matters

Educators and designers' expertise in design and education have significant input on the quality of a course (Kaatz, 2021). Quality assurance frameworks, such as Quality Matters (QM), are developed to guide educators and instructional designers in the initial design of online courses and to evaluate its overall design (Lowenthal et al., 2020). This section includes a discussion of the QM framework and rubric focusing on accessibility. An examination on how QM performs as one of the national course evaluation instruments, how it addresses accessibility, and its impact on educators when designing courses is also provided in this section.

Exploring what quality assurance is and how QM became a widely used framework will be beneficial to understand the foundations of QM. The term quality assurance originally started in the manufacturing industry, but in education, it translates to the means institutions can guarantee that the standards and quality of their offerings are adequately maintained and enhanced (Kaatz, 2021). Quality assurance frameworks are reminders of items educators should consider when designing online courses, and educators rely on them to create high-quality online courses (Lowenthal et al., 2021). Lowenthal et al. (2021), Moorefield-Lang (2019), and Wright (2018) agreed that QM is one of the most recognized standards for quality assurance in online education. From the literature, it is evident QM is a popular framework, and it will be beneficial to discuss its creation process.

Outlining the progress and evolution of QM to its current state is key to provide educators and instructional designers with a better perspective of their reach, standards, and focus on online learning accessibility. A group of Maryland colleges called Maryland Online Inc.

created Quality Matters in 2003 through funds from the Department of Education (Lowenthal et al., 2021; Rice & Ortiz, 2020; Wright, 2018). In 2014, QM became a separate non-profit and international organization focusing on creating and revising online learning standards and processes, with over 60,000 members in 2020 (Kaatz, 2021; Lowenthal et al., 2021). The QM rubric is a standardized rubric that involves a peer review process to assess online courses (Wright, 2018). The rubric's current edition is the seventh and consists of eight general standards: (1) Course overview and introduction, (2) learning objectives (competencies), (3) assessment and measurement, (4) instructional materials, (5) learning activities and learner interaction, (6) course technology, (7) learner support, and (8) accessibility and usability (Kaatz, 2021; Moorefield-Lang, 2019; Quality Matters, 2023; Wright, 2018). Standard 8, accessibility and usability, use best practices and UDL guidelines to create accessible, usable, and inclusive courses for all learners (Lowenthal et al., 2021; Robinson & Wizer, 2016). This standard includes seven specific standards: (1) Course navigation facilitates ease of use, (2) the course design facilitates readability, (3) text in the course is accessible, (4) images in the course are accessible, (5) video and audio content in the course is accessible, (6) multimedia in the course is easy to use, and (7) vendor accessibility statements are provided for the technologies used in the course (Lowenthal et al., 2021; Quality Matters 2023). It will be meaningful for the field to explore additional research on the evaluation and presence of accessibility standards in quality assurance frameworks, including QM.

Some researchers have explored accessibility standards through the lens of quality assurance frameworks and instruments. Baldwin and Ching (2021) conducted an exploratory study to help improve accessibility in online course design by peer-reviewing and synthesizing accessibility standards in seven national online course quality evaluation instruments in the

United States. These instruments were Blackboard Exemplary Course Program Rubric, Canvas Course Evaluation Checklist, CVC-OEI Course Design Rubric, Open Suny Course Quality Review (OSCQR) Rubric, Quality Learning and Teaching Instrument (QLT), Quality Matters (QM) Rubric, and Quality Online Course Initiative (QOCI). Researchers sought to answer how these evaluation instruments for online courses addressed accessibility and what these standards identified as recurrent accessibility themes to guide online course design. Researchers selected only publicly available instruments, including the sixth edition of the QM rubric (Baldwin & Ching, 2021).

Baldwin and Ching (2021) conducted a content analysis to locate standards that mentioned accessibility and found that all instruments, except for OSCQR, included a specific section or sections for accessibility, being accessible multimedia, the most common theme found in six instruments. Although none of the themes addressed the UDL framework, all seven instruments encouraged inclusive and equal course design for learners (Baldwin & Ching, 2021). Another significant finding is that the instruments do not provide clear advice to course designers. Researchers highlighted that the QM rubric provides additional advice through the QM workbook, an option only available to paid subscribers (Baldwin & Ching, 2021). Although this study provides a perspective from evaluators, it might be beneficial to expand on other views.

Similarly to Baldwin and Ching (2021), Lowenthal et al. (2021) conducted another exploratory study to analyze how online quality assurance frameworks address accessibility. Although Blackboard Exemplary Course Program (ECP), Open SUNY Course Quality Review (OSCQR), and Quality Matters (QM) are the most widely used, researchers included additional frameworks for 13 quality frameworks (Lowenthal et al., 2021). All researchers involved in the study were experienced online educators who independently analyzed each quality assurance framework using guiding questions that mainly focused on accessibility, ranking the standards, and identifying components to reuse for a new set of accessibility standards. After the evaluation, researchers compared their results and participated in a focus group to discuss their evaluation and to reach a consensus (Lowenthal et al., 2021). Researchers ranked OSCQR as the highest framework with a score of 8 out of 10 points, followed by QM in second place with a score of 7.50. Researchers found that the QM accessibility standards and supporting materials, rubric, and workbook were comprehensive since the annotated workbook referred to specifically UDL and WCAG guidelines (Lowenthal et al., 2021). Although the QM rubric and workbook are comprehensive, researchers noted that some terminology, such as ease of use, was ambiguous and could confuse less experienced educators and instructional designers (Lowenthal et al., 2021). Based on the research, it can be concluded that despite QM being one of the most used frameworks, it could provide more precise statements and standards for educators and instructional designers.

Summary of Quality Matters. A definition of quality assurance and exploration of quality assurance frameworks and what it represents to education were included in this section. In general, quality assurance is a reminder of items for educators to consider when creating online courses (Lowenthal et al., 2021). Quality Matters is the most recognized and used framework and includes eight general standards (Moorefield-Lang, 2019). From the lens of accessibility, QM has a specific section focusing on accessibility, and it has been researched on various occasions to find its effectiveness in addressing accessibility. Baldwin and Ching (2021) and Lowenthal et al. (2021) studied QM and other frameworks to find out how these frameworks address accessibility. Baldwin and Ching (2021) and Lowenthal et al. (2021) agreed that quality assurance frameworks have some challenges and limitations in advice to designers when reviewing accessibility. None of these frameworks addressed UDL in the standards, except for the QM workbook, an option only available to paid subscribers (Baldwin & Ching, 2021; Lowenthal et al., 2021). Although QM is recognized as one of the most used frameworks (Lowenthal et al., 2021; Moorefield-Lang, 2019; Wright, 2018), evaluators ranked QM second for accessibility standards due to the challenges of ease of language (Lowenthal et al., 2021). Despite the recognition of QM, it is justified to explore additional instructional design models. The R2D2/C3PO instructional design model is discussed in the following section.

R2D2/C3PO

For educators and instructional designers involved in online learning, using R2D2 brings the opportunity to achieve higher success rates with diverse learners (Bonk & Zhang, 2006). The R2D2/C3PO instructional model and its original form, the R2D2 are discussed in this section. The four quadrants of this model and its evolution to the R2D2/C3PO are also discussed in this section. Lastly, a model validation study for the R2D2/C3PO follows the discussion.

The *read*, *reflect*, *display*, and *do* (R2D2) is a novel approach and instructional design model to design and develop online courses with active learning activities to encourage outcome-based education (Mubayrik & Al-Mutairi, 2022; Youngwanichsetha et al., 2019). Bonk and Zhang (2006) considered that R2D2 fosters reflection on tasks, resources, and activities to address different learning strengths and preferences. Similarly, Olivares et al. (2020) indicated that this model is crucial since it addresses the diverse preference of online learners. From a different perspective, Armstrong and Gale (2018) shared that this model strongly focuses on culture, learning, and technology, making it appropriate for contexts such as K-12, higher education, healthcare, military, and corporate settings. Thus, it is important to expand on this model and its components.

R2D2 Components. R2D2, designed by Bonk and Zhang (2006), is a model for online learning, and it consists of four components or quadrants: (1) read, (2) reflect, (3) display, and (4) do (Armstrong & Gale, 2025; Bonk & Zhang, 2006; Mubayrik & Al-Mutairi, 2022; Olivares et al., 2020). The first quadrant is *read*, which consists of providing methods to learners to build knowledge through assigned reading content and listening to lectures or podcasts (Bonk & Zhang, 2006; Olivares et al., 2020; Youngwanichsetha et al., 2019). The second quadrant is *reflect*, which means using self-reflection or examinations to reflect on what learners have learned through blogs, writing tasks, and portfolios (Bonk & Zhang, 2006; Olivares et al., 2020). The third quadrant is *display* and is for learners to demonstrate what they have learned through visual representations such as animations, maps, virtual tours, timelines, or problem-solving strategies (Bonk & Zhang, 2006; Olivares et al., 2020; Youngwanichsetha et al., 2019). The fourth quadrant is *do*, meaning learners should present achieved learning outcomes by applying what they have learned through hands-on procedures such as simulations, real-life scenarios, and cases (Bonk & Zhang, 2006; Olivares et al., 2020). Although this model has been considered a novel approach to instructional design (Mubayrik & Al-Mutairi, 2022; Youngwanichsetha et al., 2019), it is relevant to explore its enhancement.

Model Enhancements. R2D2 was enhanced to include five additional components with explanations to incorporate instructional strategies and activities into each component when using video conferencing tools in synchronous formats (Armstrong & Gale, 2025). The use of R2D2 for effective synchronous sessions required expanding the model with five additional components: coaching, conviviality, Critical Incident Technique, planning, and organization

(C3PO) (Armstrong & Gale, 2025). *Coaching* is the fifth component of the enhanced model and means that instructors will coach the students and guide them through knowledge acquisition through scaffolding and interactive feedback (Armstrong & Gale, 2025). The sixth component is *conviviality*, and it means that instructors will act as coaches and guidance by building rapport with learners through facial expressions and body language (Armstrong & Gale, 2025). The *Critical Incident Technique* (CIT) is the seventh component (Armstrong & Gale, 2025). Instructors should use the CIT form or poll to determine the student's reaction to the materials and tools used during the session (Armstrong & Gale, 2025). The last component covers *planning* and *organization*, which means that a detailed syllabus or trainer manual should be the blueprint for the synchronous session since it is vital to the success of the design, development, implementation, and evaluation of these sessions (Armstrong & Gale, 2025). The enhanced R2D2/C3PO model is a tool for instructional designers, educators, and facilitators to guide the design, development, implementation, and evaluation of learning activities and synchronous sessions (Armstrong & Gale, 2025). Exploring the R2D2/C3PO enhancement and evaluation could provide educators with an understanding of a model enhancement and validation process.

Creating or enhancing an instructional design model might need expert validation to help understand its creation process. Armstrong and Gale (2018) conducted a descriptive qualitative study to describe the model creation process for the R2D2/C3PO and eSuccess instructional design models. With this study, researchers looked to systematically validate the two models using a survey and the nominal group technique (NGT) with expert instructional designers. Participants in this study were instructional design experts in online learning across various industries (Armstrong & Gale, 2018). Five experts reviewed the materials on the models and provided comments prior to the meeting. Three of five participants attended a 90-minute focus group discussion to evaluate and comment on each element in both models. Participants completed a survey to rank elements of each model using a Ranking Scale from not important (1) to very important (4) (Armstrong & Gale, 2018).

Armstrong and Gale (2018) analyzed data using descriptive statistics generated in Excel for the survey responses. Researchers used NVivo software to generate themes from the focus group discussion to establish a preliminary list of start codes. Researchers found that all but three components of the R2D2/C3PO received at least a three in the ranking, while the eSuccess received similar results (Armstrong & Gale, 2018). Researchers called for several perspectives for future researchers. First, researchers called for using a quantitative correlational analysis of different components for both models to validate major categories to enhance them and their importance to researchers and practitioners. Second, to apply the models in practice to report the findings in a design and development model research study to expand the research. Third, to provide additions to the model components or categories to enhance the instructional design models (Armstrong & Gale, 2018). From this study, it can be concluded that although experts ranked the elements as important additional research around its application and future enhancement might be relevant to the field.

Summary of R2D2/C3PO. The R2D2 instructional model, its foundation, and its evolution was discussed in this section. R2D2, a model created by Bonk and Zhang (2006), is considered a novel approach to instructional design (Mubayrik & Al-Mutairi, 2022; Youngwanichsetha et al., 2019). The foundation of this model relies on fostering activities in online settings through its four quadrants, *read*, *reflect*, *display*, and *do*, to address the preference of diverse learners (Bonk & Zhang, 2006; Olivares et al., 2020). This model evolved to R2D2/C3PO, with a strong focus on culture, learning, and technology in online learning

(Armstrong & Gale, 2018). An introduction to research conducted for the R2D2/C3PO with a model creation and validation focus was also discussed in this section. Armstrong and Gale's (2018) study included R2D2/C3PO and emphasized describing the model creation and validation process. Although the researchers conducted the study using a second instructional design model, eSuccess, their findings and future call for research is relevant to the instructional design field. Researchers called for an addition to the model components or categories to further enhance the instructional design model, including accommodations for students with diverse types of disabilities (Armstrong & Gale, 2025), making it appropriate for the evolution of R2D2/C3PO.

Summary of Instructional Design: Frameworks and Model for Online Learning

This section included a discussion about Universal Design for Learning (UDL) as a framework and its role in accessible, equal, and inclusive learning. The UDL framework was developed to create equal and accessible learning environments for learners (Lowenthal et al., 2020; Oswald et al., 2018; Rao et al., 2015). This framework is used in quality assurance frameworks (Lowenthal et al., 2020), and it expands upon accessibility to address barriers at the beginning of the development rather than a remediation phase (Baldwin & Ching, 2021). An analysis of the role of educators in inclusive design and the impact of UDL principles in inclusive education was also presented in this section. Basham et al. (2016) and Martin et al. (2021) agreed that educators should be more impactful and have more competencies to create successful online learning experiences. The three UDL principles are means of engagement, means of representation, and means of action and expression. They are essential to keep learners active and engaged by providing content in various formats and allowing them to demonstrate what they have learned (Baldwin & Ching, 2021; Lowenthal et al., 2020). A discussion on Quality Matters was also provided in this section. Quality Matters is a guide for educators and instructional designers for the initial design of online courses and for evaluating their overall design (Lowenthal et al., 2020). The QM rubric includes eight general standards, with standard eight focusing solely on accessibility and inclusive design (Lowenthal et al., 2021; Robinson & Wizer, 2016). Besides being one of the most used frameworks, QM ranked second by evaluators due to the challenge of ease of language when evaluating accessibility (Lowenthal et al., 2021). Lastly, the R2D2/C3PO instructional design model was introduced in this section. R2D2, created by Bonk and Zhang (2006), evolved into the R2D2/C3PO, a model validated by instructional design experts. A key aspect to highlight from this study is that Armstrong and Gale (2018) called for additional research on adding additional components or categories to R2D2/C3PO model for further enhancement.

Summary

This chapter began with a discussion about the relation among accessibility, equity, and inclusion in online learning by analyzing legal frameworks, learners with disabilities, disability models, and accessibility needs and barriers. Accessibility provides access without barriers by designing and creating products, services, and environments that all people use (Baldwin & Ching, 2017; Lowenthal et al., 2021). Equity is defined as providing learners with what they need fairly and impartially (Baldwin & Ching, 2017), while inclusion is to provide a quality education meeting their diverse needs (Joshi, 2022). The UNCRPD, UK's Disability Discrimination Act and Equity Act, United States' ADA, and Rehabilitation Act are evident examples of legal frameworks and regulations discussed in the literature that exist to expand the rights of people with disabilities. The medical or social models of disabilities probably influenced these regulations. The medical model focuses on disability as a medical phenomenon that limits an individual (Bunbury, 2019), while the social model focuses on the social and environmental factors that influence the disability experience (Ferri & Giannoumis, 2014). Fifteen percent of the world's population reported some type of disability in 2011 (Acosta et al., 2020). Current statistics show that 75% of people with disabilities have more than one impairment due to illness or accidents (Miller, 2021). Among the adults who reported a disability in the last census in the United States, 13.7% said a physical or mobility disability, 10.8% a learning or cognitive disability, 5.9% a hearing disability, and 4.6% a visual disability. Based on current increases in adults reporting a disability, it is critical to understand the needs and barriers learners with disabilities face in online learning to provide successful accessible learning experiences by providing with access to platforms, consistent navigation, and usable and accessible content (Lowenthal et al., 2020). A step toward providing accessible experiences to learners might represent understanding existing guidelines, models, and frameworks that address accessibility.

This chapter continued with an introduction and expansion on accessibility guidelines such as WCAG and instructional design frameworks and models like UDL, QM, and R2D2/C3PO. There is an evident lack of a training system to provide proper training around accessibility concepts and practices for educators (Bai et al., 2019). Although WCAG is the most used document for universal accessibility (Sadness, 2021), and it is present in quality assurance frameworks as guidance (Lowenthal et al., 2021), it includes detailed technical guidelines that have evolved in complexity (Chee et al., 2022). It is vital to highlight that other frameworks and models address accessibility and expand on inclusion. In education, UDL principles are the most applied in the field for accessible online courses (Burgstahler, 2021) since it is evidence-based and it provides a broader perspective on inclusive learning than accessibility alone (Basham et al., 2016). Universal Design for Learning is mentioned in quality assurance frameworks, such as

QM. Quality Matters is one of the most recognized standards in quality assurance when designing quality online courses (Lowenthal et al., 2021), and it includes a specific section, General Standard 8, dedicated to accessibility and usability. However, challenges in the ease of language in some of these standards might be challenging for evaluators or educators (Lowenthal et al., 2020) and could leave educators and instructional designers with open questions when designing online courses. In the case of R2D2/C3PO instructional design model, and its original model R2D2, it provides educators with strategies for each quadrant and category to include active learning activities to encourage outcome-based education (Youngwanichsetha et al., 2019). Although there is limited research around R2D2 and R2D2/C3PO, Armstrong & Gale (2018) call for future research to add more categories to enhance this model. An example of possible enhancements is the integration of accommodations for students with diverse types of disabilities (Armstrong & Gale, 2025). These enhancements represent a new step toward providing educators with resources and strategies to design and create accessible, equitable, usable, and inclusive online learning. A discussion of the research method used in this study is presented in the following chapter.

Chapter 3: Research Method

The problem addressed in this study was that online educators and instructional designers experienced challenges with accessibility guidelines and their application when creating usable, accessible, and inclusive online courses due to limited and differing guidance at various levels (Baldwin & Ching, 2021; Lowenthal et al., 2021). Instructional design has a limited availability of model use research to enhance the field (Armstrong & Gale, 2018). The limited availability of model use research, along with the fast-paced growth of online learning, is creating many challenges for instructional designers and educators when designing and developing accessible content due to their lack of experience in accessibility and how to employ guidelines in practice (Acosta et al., 2020; Molanes-López et al., 2021).

The purpose of this qualitative design and development model use case study was to define the process of creating accessible learning activities to expand the validated research based R2D2/C3PO model to integrate accessibility strategies for each of the eight components of the existing model. The new updated model was validated during a focus group using the Nominal Group Technique (NGT) with expert instructional designers who have accessibility training and with accessibility experts who specialize in online environments. The purpose of this chapter is to discuss the research methodology and design used in the study and its appropriateness in relation to the study. This chapter includes a discussion about the population and sample, and the materials and instruments for the data collection. A review of how the data was collected and analyzed will follow. The chapter concludes with a discussion about the assumptions, limitations, delimitations, and ethical assurances for this study.

Research Methodology and Design

For this study, the selected methodology was qualitative research using a design and development model use case study. Qualitative research is a holistic approach to exploring an identified phenomenon in the field (Poggenpoel & Myburgh, 2006). Qualitative researchers use this method to explore the phenomenon around an individual's actions and experiences to understand their meanings and inner world (Bhangu et al., 2023; Johnson, 1997; Kekeya, 2021; Rose et al., 2021). Qualitative research is suitable when the researcher seeks to shift the focus away from an individual as a single unit and aims to understand in-depth, real-world issues with an impact on larger social, cultural, political, and economic structures (Bhangu et al., 2023; Chalmers & Cowdel, 2021; Chesebro & Borisoff, 2007). The goal of this study was to explore the perspectives of instructional designers, online educators, and accessibility experts about accessibility components and the recommendation of instructional strategies and activities to address accessibility in online courses. Qualitative research was appropriate because the need was to gain the practical perspectives and insights of instructional designers, online educators, and accessibility experts as opposed to external theories and practices (Tomita et al., 2021). Qualitative research was used to contemplate the phenomenon of understanding the perspectives of instructional designers, online educators, and accessibility experts regarding the needs of people with disabilities in online courses (Rose et al., 2021). Following an appropriate methodology, is vital for the researchers to identify the most suitable design.

A design and development model use case study was used to conduct this study. Design and development research (DDR) is a systematic but flexible method for improving educational research and producing contextual design guidelines (Kara & Cagiltay, 2020; Kapucu, 2019). DDR is defined as a systematic study of design, development, and evaluation processes to establish an empirical basis for creating instructional and non-instructional products and tools and new or enhanced models (Richey & Klein, 2007, 2014). Similarly, Alias and Hashin (2012) defined DDR as a method to explore a range of designed innovations, from artifacts to models, and less concrete aspects such as activities and curricula.

DDR research is divided into two categories: 1) research on products and tools and 2) research on the design and development of models (Kara & Cagiltay, 2020; Richey & Klein, 2007, 2014). Many studies focused on the first category, the design and development of technology-based products and tools (Richey & Klein, 2014), due to its pragmatism in testing the theory and validating the practicality of the results of a development (Yuyun et al., 2019). The second category, design and development of models, includes three phases—model development, model validation, and model use that can be implemented to guide the instructional design process (Richey & Klein, 2007, 2014). Only a few of instructional design models have been empirically tested or validated (i.e., Rapid Prototyping ID model, Kirkpatrick Evaluation Model, Gilbert's Behavioral Engineering Model, and Multiple Intelligence Design Model) (Roszkowski & Soven, 2010; Jones & Richey, 2000; Plass & Salisbusry, 2002; Tracey, 2009) due to limited research, a gap that many DDR studies are meant to address (Richey & Klein, 2014). Additionally, there is a need for further research to be conducted on design and development practices to make additional advancements in the instructional design practice (Alias & Hashim, 2012; Kapucu, 2019; Rickey & Klein, 2014). Model use design and development research was used for this study due to its characteristics of creating new knowledge and validating existing practices and models (Richey & Klein, 2014). This design and development model use case study focused on exploring and augmenting the R2D2/C3PO model

(Armstrong & Gales, 2018; 2025) to include accessibility recommendations and strategies for each model's component.

Having discussed the characteristics and benefits of DDR, it is relevant to expand on the use of a case study for this research. Researchers use case studies to investigate a contemporary phenomenon within a real-life context and when the boundaries between phenomenon and context may not be evident (Merrian & Tisdell, 2015; Yin, 2018). A case study can be conducted individually or in a group setting, varying from family, class, school, community, industry, and profession (Gilham, 2000). Through case studies, researchers can explore complex human experiences, describe events with deep analysis, and share details that can engage decision-makers and policymakers in creating or revising policies and processes to improve practices and make informed decisions (Kekeya, 2021). In addition to the advantages of case studies, researchers should consider risks such as time and support needs that can challenge the data collection and caution in findings to prevent readers from misunderstanding the settings and reach of the study (Kekeya, 2021). The focus of this study was to understand a real-world case by exploring the perspectives of instructional designers, online educators, and accessibility experts about accessibility components and instructional strategies in online learning. The evidence in a case study comes from two main sources: direct observations of events and interviews of people involved in the events (Yin, 2018). Therefore, the case study was the best choice for this research because interviews were a key component of this study to gather the perspectives of instructional designers, online educators, and accessibility experts.

Another significant aspect of discussing the research methodology and design for this study was the evaluation of alternative methodologies and designs. Although this study included a survey that gathered quantitative data as a ranking system to determine the accessibility components and elements that were to be included in the enhanced R2D2/C3PO, a complete quantitative methodology was deemed less appropriate for this study because the focus was to understand the participants' perspectives. Quantitative research tests objective theories by examining the relation among variables (Creswell, 2009). Rose et al. (2021) indicated that quantitative research is a method used to quantify the findings through numerical data that is analyzed using appropriate statistics.

There are two paradigms that researchers usually often subscribe to when conducting research. One is the positivist paradigm which is centered on a quantitative perspective that includes numerical aspects and variables (Bhangu et al. 2023). The other is the interpretivism paradigm that is established in qualitative research and implemented to seek the perspectives of the participants (Goldkuhl, 2012). A complete quantitative study was not appropriate because the goal was to gather qualitative data through interaction with instructional designers, online educators, and accessibility experts about the recommendations and needs of accessibility components in online courses through an updated model drafted from the literature review and their expert insights. The following section will expand on the population and sample for this study.

Population and Sample

Lepkowski (2008) defined population as a finite or infinite collection or aggregation of individuals or other elements from which individual units will be drawn. From a different perspective, Taylor (2008) augmented the definition to indicate that a population may be people, objects, events, or measurements of the people, objects, or events. A target population is all subjects possessing common characteristics that are being studied and from which the data will be used to make conclusions (Cox, 2008; Lepkowski, 2008; Taylor, 2008).

The target population for this study were instructional designers and accessibility experts in online settings in North America. Seventy percent of instructional designers hold a degree in instructional technology or a related field, where 43% work in higher education and 27% in corporations and other industries (DeVaughn & Stephaniak, 2020). In the United States, higher education institutions have a workforce of 13,000 instructional designers, with expected growth in the upcoming years (Nworie, 2022). Many industries, such as higher education, corporate, government, non-profit, military, and healthcare, holding roles and skills from course design, management, training, and support (Nworie, 2022) use instructional design extensively (Richey & Klein, 2014). From an accessibility standpoint, 62.9% of web accessibility practitioners who participated in a survey indicated that they are in North America, and 29.1% reported having a disability (Web Accessibility in Mind [WebAIM], 2021). The need for web accessibility specialists has increased from 21.8% in 2020 to 30.3% in 2022 in organizations considering professionals with certifications from the International Association of Accessibility Professionals (IAPP) and 23.4% of organizations already having IAPP-certified personnel (IAAP, 2022). The skills, characteristics, and expertise of the instructional design and accessibility professionals provided an ideal population for this study.

Drawing from the target population, the participant sample in the study consisted of six instructional designers and four accessibility experts. The main sampling frame included a personal network of instructional designers that I have worked for the past 10 years in higher education and corporate industry as same level peers. It is pertinent to indicate that the personal network had both instructional designers and accessibility experts or instructional designers with expertise in accessibility, but the sampling process yielded six instructional designers' participants and zero accessibility experts.

Sampling Techniques

The sampling technique for the study was purposeful sampling, using a criterion sample (Coyne, 1997; Palinkas et al., 2015). Purposeful sampling is widely used in qualitative research to identify and select information-rich cases and individuals or groups of individuals who are knowledgeable or experienced with a phenomenon of interest (Palinkas et al., 2015). In this design and development model use case study, a purposeful criterion sampling technique was employed since it aligns with the sampling approach used in design and development research advocated by Richey and Klein (2007). Therefore, the aim was to gather insights from experts, instructional designers who possess expertise in accessibility and accessibility experts, about the models and techniques they employ to integrate accessibility strategies when designing online courses to inform and expand the well-established R2D2/C3PO model to include accessibility options for each component. Having discussed the principal sampling technique for this study, it is appropriate to discuss alternate plans that were executed to secure the sample.

After not securing the sample from the personal networks, there were two additional plans executed for this study. The first plan was a snowball sampling with the inclusion criterion. Snowball sampling is a convenience sampling method where existing participants refer or recruit future subjects that meet the requirements, and it is used when it is challenging to access subjects with the characteristics or criteria (Naderifar et al., 2017). Snowball sampling is used by researchers to recruit more participants and reduce time and costs when assembling the group of participants (Leighton et al., 2021; Sadler et al., 2010). Although there were three referrals from existing participants, these referrals did not join the study. The second plan was an internet volunteer sample by posting on self-professional profile and contacting professional online networks (i.e., International Society for Technology in Education, Association for Talent

Development, International Association of Accessibility Professionals, among others) and instructional design and accessibility social network sites (i.e., LinkedIn and Facebook) to refer members to participate. Internet sampling can increase the appropriateness of each participant who can best inform the research question (Hamilton & Bowers, 2006; Hewson et al., 2016). The internet volunteer sample plan yielded four accessibility experts' participants.

Sample Size and Criterion

The sample size for this design and development study consisted of 10 experts from the personal networks and internet volunteer sample who met the inclusion criteria to participate in the study. Study feasibility factors such as cost, time, multiple data collection, and analysis challenges (Daniel, 2012) impacted the sample size proposed for the study, but contingency plans took place to support the data collection until saturation was reached. An iterative deductive and inductive analysis process took place within the data collected until no new information, themes, insights, or perspectives are found (Suri, 2011) to improve the research quality and credibility (Sebele-Mpofu & Serpa, 2020). Ten interviews were conducted to achieve the sample size. A code stopping criterion of two (2) interviews without new shared codes, themes, or emerging ideas were established before concluding that saturation was achieved (Francis et al., 2010; Hennink & Kaiser, 2022). For example, after five interviews, the stopping criterion was tested after each successive interview until two consecutive interviews were without new information (Francis et al., 2010).

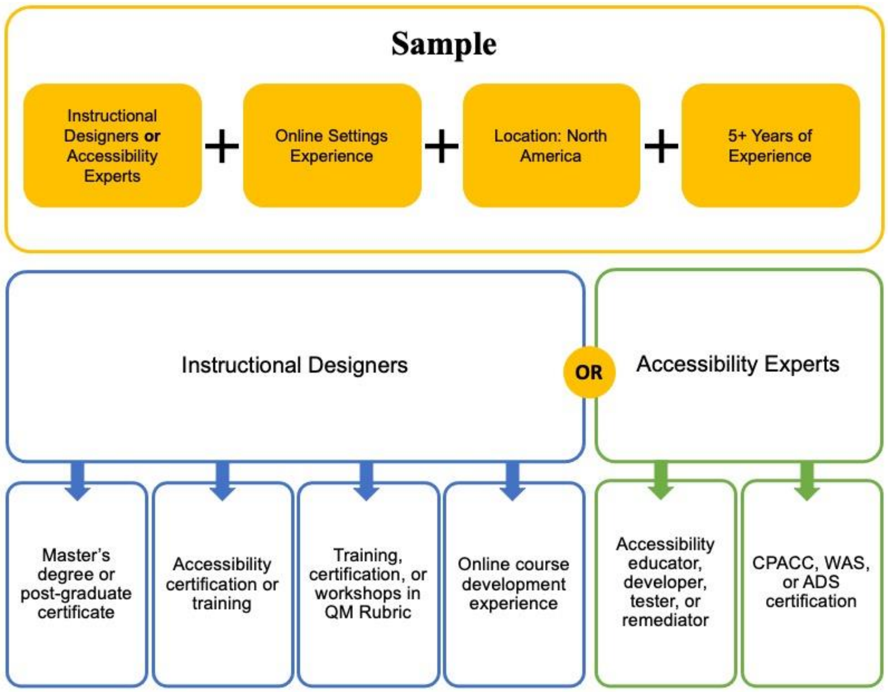
Inclusion Criteria. To address the research problem, purpose, and research questions of the study, inclusion criteria was implemented for research quality and identifying routes that maximized the possibilities of obtaining data (Coyne, 1997). Inclusion criteria enabled the opportunity to gather the perspectives and insights of participants who are experts in instructional design with expertise in accessibility and accessibility experts. The participants consisted of instructional designers and accessibility experts in online settings in North America with at least 5 years of experience. To participate in the study, participants met the specific eligibility criteria for their respective roles as (1) instructional designers or (2) accessibility experts.

Instructional Designers. Participants who were instructional designers met at least one of the requirements for each of the following categories: (a) a master's degree in instructional design, instructional systems technology, e-learning, learning design, educational technology, or a post-graduate certification in any of these programs, (b) accessibility certification or accessibility training provided by school, employer, or professional development organization, (c) training in Quality Matters (QM), QM certification courses or QM workshops, and (d) online course development experience in higher education, corporate, or military.

Accessibility Experts. Participants who were accessibility experts met at least one of the requirements for each of the following categories: (a) be an accessibility educator, developer, tester, or remediator, and (b) possess an International Association of Accessibility Professionals (IAAP) certification as Certified Professional in Accessibility Core Competencies (CPACC), Web Accessibility Specialist (WAS), or Accessible Document Specialist (ADS). It is critical to highlight that there were instructional designers who also were accessibility experts. The participants were relevant for the study because they played a role in the design and creation of online materials, including online learning courses accessed by learners with disabilities, which is critical in removing accessibility barriers faced by these learners. The criteria and eligibility of this study's participants are shown in Figure 2.

Figure 2

Sample Criterion



Participants Recruitment Overview

Following the Institutional Review Board (IRB) approval, participants were contacted. The process of contacting participants was broken down into the three strategies: personal networks, snowball, and internet recruitment, based on the sampling plans.

Networks. The first strategy was sending an email to ten individuals within the personal networks of instructional designers and accessibility experts to request their voluntarily participation as a possible candidate for the research study. A standard recruitment email with brief research information was sent to all people contacted. The standard email content included a brief description of the study, participants' criteria, time commitment, key points, and a recruitment survey link.

Snowball. The second strategy was for the snowball sample. Similarly to the network participation, in the snowball sample plan, participants referred by existing participants were contacted through email. Finally, the third recruitment strategy was the internet recruitment.

Internet Recruitment. Quantitative and qualitative research evolved from the researcher using the internet as research setting to using it as a recruitment tool (Im & Chee, 2004). In this study, internet recruitment strategies included posts on my professional profile and contacting instructional design and accessibility professional organizations and group support sites on social media requesting authorization to contact members and post the recruitment requests on the respective sites. Using social media platforms has become an increasing practice for researchers to contact and keep in touch with participants over time (Bathia-Lin et al., 2019). Social media posts included the researcher's name and contact information, a photo banner with the purpose of the study and a QR code with a link to the survey, and the full details within the body text of the post. Posting the contact information and authorization request to organizations and page moderators is a common practice and strategy for internet recruiting (Hamilton & Bowers, 2006). An advantage of using social media is that researchers can locate participants when other recruitment methods have failed, and social media is credited with finding an additional 16% of participants (Bathia-Lin et al., 2019).

Compensation. This study did not include a compensation in the original recruitment efforts. After not securing the full sample (10 participants) with the personal network and snowball sampling plans, a modification request was submitted to NU IRB to include a compensation of a $25 Amazon e-gift card for each participant. The requirements to receive the compensation was the completion of the individual semi-structure interview and the model accessibility enhancement questionnaire. The focus group participation was not required. The modification request was approved by the NU IRB and the recruitment materials, social media posts, and informed consent were updated. All ten participants that completed the two required steps received the $25 Amazon e-gift card.

Recruitment Summary. Once participants were selected, they received the Informed Consent and reassurance that their participation was voluntary to qualify them as participants. The informed consent served as a documentation of their approval to participate in the study. After participants selection and informed consent, the study started following a three-phase approach: Analysis, Design and Development, and Evaluation to guide the iterative data collection and analysis. A hybrid approach to data analysis was implemented in by using deductive and inductive analysis (Swain, 2018) following Braun and Clarke's (2007) six-step thematic analysis and a descriptive analysis (Armstrong & Gale 2018).

Phase 1: Analyze Overview

In the study, the data collection started in Phase 1: Analysis with a document analysis of the R2D2/C3PO model and accessibility research articles from the literature review. The document analysis was conducted through a deductive thematic analysis using a predetermined list of codes that emerged from the research problem, conceptual framework, and research questions (van Putten et al., 2022) to identify accessibility strategies for the model enhancement to remove barriers for learners with disabilities. Documents such as the R2D2/C3PO model, research studies, and articles were be uploaded to Phase 1 Data Analysis folder in NVivo to document the progress of codes and themes through all phases. The data collection continued through individual semi-structured interviews with participants to discuss the model enhancement to integrate the accessibility strategies and components to each of the R2D2/C3PO components.

Phases 2: Design and Develop Overview

Interviews from Phase 1 overlapped with Phase 2 since the notes and transcripts from the interview were analyzed in Phase 2. Interview notes and transcripts were uploaded to NVivo in Phase 2 Data Analysis folder and analyzed using inductive thematic analysis to generate codes and categories emerging from the data. The data collected and the codes from Phases 1 and 2 were used to complete the first draft of the model enhancement.

Phase 3: Evaluation Overview

After the first draft model enhancement in Phase 2, a model accessibility enhancement questionnaire was sent in Phase 3 to participants with open-ended questions and a four category Ranking Scale from 1 (not important) to 4 (very important) to rank the proposed accessibility strategies to remove barriers for learners with disabilities in online learning. The last step of data collection was a focus group with four participants experts using the NGT as a method for model validation and finalization. The data collected through the study is securely stored in a cloud storage service with password protection and two-factor authentication as an additional layer of data protection.

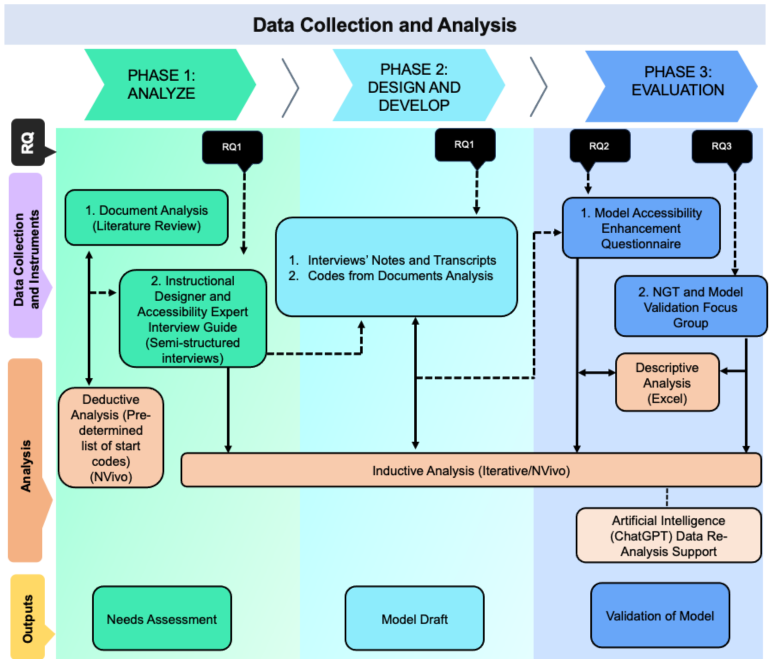
Materials or Instrumentation

According to Kekeya (2021), in qualitative studies, qualitative strategies are used to gather rich descriptive data of participant's lived experiences to enhance the understanding of the study inquiry. In qualitative research case studies, despite using protocols, the researcher is the person who gathers the information through multiple strategies that include document analysis, interviewing participants, and observations, among others (Creswell, 2009; Merriam & Tisdell, 2015). An important part of materials and instrumentation collection in qualitative studies is to ensure there is trustworthiness of the study by addressing transferability.

Transferability is the process of providing the findings of a study in useful and clear way for other researchers to judge and apply to similar or other contexts (Kekeya, 2021). It is a measure to ensure trustworthiness by providing researchers with sufficient knowledge to make the appropriate judgements of the applicability of the study to transfer to their specific study (Hancock et al., 2016). In this study, several actions were taken to address transferability concerns. First, including an extensive literature review to ensure external validity (Alias & Hashim, 2012). Second, a thick and clear description of the case, phenomena, sample, and fieldwork is presented to readers for them to decide whether the prevailing information is similar to their scenario or context (Kekeya, 2021; Shenton, 2004). Third, a thick and rich description of the findings is available through clear analysis and the availability of an audit trail by keeping record of the data collected (Benson, 2002). Lastly, the use of purposeful sampling through criterion sampling assured a rich description of participants' perspectives of the phenomenon (Alias & Hashim, 2012). Along with the importance of transferability measures, a thick analysis of each material and instrumentation is provided so the study can be replicated. For this study, document analysis, R2D2/C3PO model, semi-structured interviews with interview notes and transcripts, model accessibility enhancement questionnaire, focus group, and model validation protocol were used as instruments and foundation materials through the three-phase (Analyze, Design and Develop, and Evaluate) iterative process as previously shown in Figure 1 in Chapter 1.

Figure 1

Data Collection and Analysis Phases



***Research Questions**
RQ1: How did instructional designers and accessibility experts believe the R2D2/C3PO model can be expanded to integrate accessibility components?
RQ2: How did instructional designers and accessibility experts believe the updated R2D2/C3POA model can be used to remove barriers for learners with disability in online synchronous and asynchronous learning?
RQ3: What components of the updated R2D2/C3POA model did instructional designers and accessibility experts believe are best practices for implementing online courses, which are accessible to all students?

Document Analysis

Document analysis is a form of qualitative data collection by analyzing original and primary sources of materials to answer research questions in case studies (Kekeya, 2021). The data collection process started through a document analysis as part of the literature review process. Existing research from Acosta et al. (2020), Aquino and BuShell (2020), Baldwin and Ching (2021), Molanes-López et al. (2021), Murphy et al. (2019), Orellana et al. (2022), and Rodrigo and Tabuenca (2020), among others, discussed the need, challenges, and barriers faced by learners with disabilities. These studies also addressed strategies to promote accessible, equitable, and inclusive online learning experiences following standards and best practices from Web Content Accessibility Guidelines (WCAG), Universal Design for Learning (UDL), and Quality Matters. Through the document analysis using a predetermined list of codes that emerged from the research problem, conceptual framework, and research questions, the data collected was used as part of the enhancements to the R2D2/C3PO model.

R2D2/C3PO Model

The R2D2/C3PO model was the foundation material for this study. The original form of this model, R2D2, was created by Bonk and Zhang (2006) and enhanced and validated by Armstrong and Gale (2018) to the R2D2/C3PO. The review of this model started by breaking down each component, instructional strategies, and tools included in the existing model. Following the breakdown, a draft of recommended accessibility strategies for each component were included. These accessibility strategies were generated from the predetermined list of codes, the literature review, and the input from instructional designers and accessibility experts during the semi-structured interviews as part of the enhanced R2D2/C3PO/A. The R2D2/C3PO model was key for the semi-structured interview questions with the participants. On the other hand, the enhanced R2D2/C3PO/A model was key for the model accessibility enhancement questionnaire conducted with the instructional design and accessibility experts. Before the semi-structured interviews, participants received a summary explaining the R2D2 and R2D2/C3PO models to help them familiarize themselves with the model.

Semi-Structured Interviews Using an Instructional Designer and Accessibility Expert Interview Guide

Design and development researchers rely on interviews to collect data and clearly understand events and participants' thoughts and beliefs (Richey & Klein, 2007). Interviews may be conducted face-to-face, via video, or telephone with a general length of 30-90 minutes consisting of open-ended questions to allow participants to speak freely to gather in-depth data (Chalmers & Cowdell, 2021). A semi-structured interview using an Instructional Designer and

Accessibility Expert Interview Guide (Appendix A) was used to conduct participant interviews in this study by drafting a set of questions to guide the interviewer in the conversation (Kekeya, 2021).

Guide Protocol. The Instructional Designer and Accessibility Expert Interview guide included an introduction section where participants were informed about time and expectations, and a reassurance of their voluntary participation. The guide included general questions to discuss the participant's background. The next segment was to present the R2D2 and R2D2/C3PO models to participants. However, the model was shared with them before the interview process to help them familiarize with R2D2 and R2D2/C3PO.

Following the model introductions, the interview started by prompting questions to participants. The Instructional Designer and Accessibility Expert Interview Guide included several questions to gather information from participants around accessibility strategies for each of the eight components. The questions focused on accessibility strategies, impact on learners with disabilities, tools, and additional learning strategies that could remove barriers for learners with disabilities. The purpose of conducting a semi-structure interview using the guide was to address Research Question 1: How did instructional designers and accessibility experts believe the R2D2/C3PO model can be expanded to integrate accessibility components?

Peer Scrutiny. The questions on the guide did undergo through an expert peer scrutiny process to ensure credibility by determining the questions appropriateness and relevancy to the research questions (Shenton, 2004). The peer expert credentials include a Doctorate in Philosophy, more than 10 years of experience in instructional design, adjunct faculty in higher education, exhaustive training in accessibility standards and practices, provide accessibility training to more than 50 instructional designers, lead and implemented accessibility strategies at an organization level, and advocate of diversity, equity, and inclusion.

Semi-structured interviews allow researchers to draw the same core information from each participant while having the flexibility to probe more information while following the participants rather than leading the conversation (Belotto, 2018; Tomita et al., 2021). To align with Chalmers and Cowdell's (2021) parameters, semi-structured interviews in this study were through Zoom, a video conferencing tool, for 30 to 60 minutes. Interviews were recorded and transcribed using Zoom. The data collected from the semi-structured interviews, the interview notes, and transcripts contributed to enhance the R2D2/C3PO to R2D2/C3PO/A. The R2D2/C3PO/A enhancement included accessibility strategies for a post-interview and pre-focus group model accessibility enhancement questionnaire.

Model Accessibility Enhancement Questionnaire

The model accessibility enhancement questionnaire was created after the document analysis of the literature review and the responses to the questions in the Instructional Designer and Accessibility Expert Interview Guide (Appendix A) collected in the semi-structure interviews. The model accessibility enhancement questionnaire was emailed to all ten participants to review the suggested accessibility strategies for each enhanced R2D2/C3PO/A component. The survey concept was used in this study in alignment with its prominent use in many design and development research studies to collect a wide range of data, including evaluation information (Richey & Klein, 2007). Participants were asked to rank the accessibility strategies for each component using a four-category Ranking Scale (from not important (1) to very important (4) (Armstrong & Gale, 2018; Borch et al., 2012) and open-ended questions to write down additional ideas as they completed the accessibility strategies review. The questionnaire was conducted using Qualtrics, an online survey tool, to gather empirical data to support the creation of an enhanced model (Tracey, 2009). The R2D2/C3PO/A model draft with options for accessibility was updated to reflect strategies ranked in the model accessibility enhancement questionnaire and sent to participants prior to the focus group and model validation session. The model accessibility enhancement questionnaire served as a data collection method to address Research Question 2: How did instructional designers and accessibility experts believe the updated R2D2/C3PO/A model can be used to remove barriers for learners with disabilities in online synchronous and asynchronous learning? The questionnaire also undergo through the external expert peer scrutiny. The peer that participated in the interview guide scrutiny also conducted a scrutiny of the questionnaire. However, a second expert, also an instructional designer with a doctorate degree and more than 10 years of experience, conducted the scrutiny for the questionnaire to achieve the highest relevancy and quality. The model accessibility enhancement questionnaire initiated Phase 3 (Evaluation), leading to the focus group and model validation.

Focus Group and Model Validation

Focus groups are a supportive environment to help participants express and understand their views (Kara & Cagialtay, 2020). A researcher moderates focus groups and brings participants together for a group discussion that lasts 1 to 2 hours (Chalmers & Cowdell, 2021). Although an optimum size for focus group is six to 12 participants (Bloomberg, 2023), focus groups can work with as few as three to five participants (Armstrong & Gale, 2018; Fern, 1982; Gill et al., 2008). In this study, four participants experts participated in the virtual focus group through Zoom. The participants for this focus group were selected randomly from the original sample who completed the interview and model accessibility enhancement questionnaire.

The purpose of the focus group was to serve as the process for the internal model validation of the enhanced R2D2/C3PO/A model. Internal model validation often occurs in earlier stages of development and is a process that focuses on the integrity of the model to support each component and the relationship between the components and the process (Richey, 2005). A Ranking Scale survey (from not important (1) to very important (4) to rank the accessibility strategies for each component and the NGT five-step process was administered during the focus group (Armstrong & Gale, 2018). The NGT is extensively used in education, health, and other fields as an efficient method that gives equal opportunities to participants (experts) to generate ideas and reach a consensus (Burgin, 2023; Mohamad et al., 2023; Verheijden et al., 2023). The NGT was implemented in the study as a structured process because it resembled the generation of discussion and facilitated the vote using a Ranking Scale to rank accessibility strategies for each of the R2D2/C3PO components to conform the R2D2/C3PO/A model (Mohamad et al., 2023; Colombani et al., 2022).

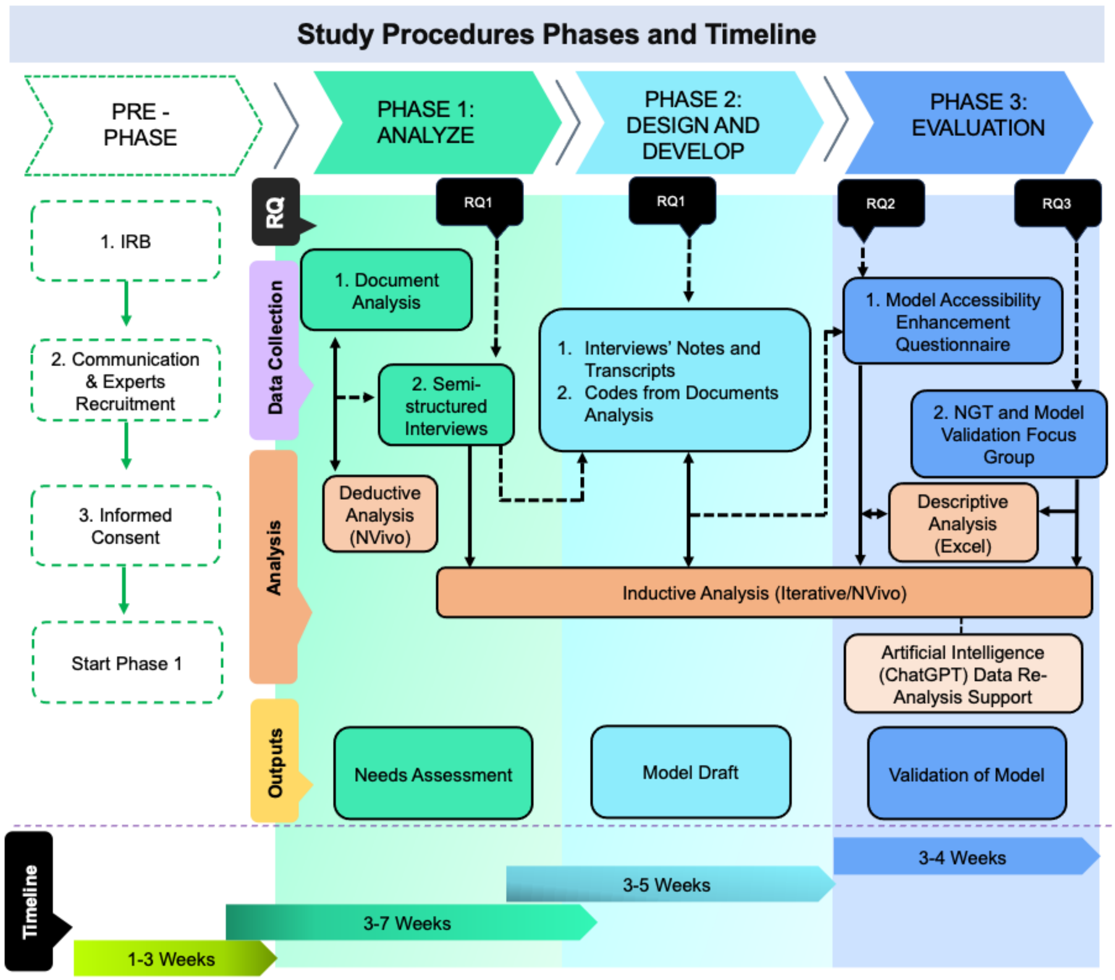
In this study, Armstrong and Gale (2018) NGT's procedure was used. Armstrong and Gale (2018) used a survey and the NGT five-step process with instructional design experts to validate two models. The NGT five-step consists of participants meeting one another, generating ideas based on previous work reviews, sharing ideas with the group, discussing ideas, and voting and ranking items based on questions about the model (Armstrong & Gale, 2018). As part of the discussion, participants were asked to complete a Ranking Scale survey to rank the accessibility strategies of the R2D2/C3PO/A model from 1 (not important) to 4 (very important) (Armstrong & Gale, 2018, Burgin, 2023; Chan et al., 2023; Colombani et al., 2022; Mohamad et al., 2023). The survey was created after the data collected from the literature review, semi-structured interview, the model accessibility enhancement questionnaire, and the discussion from the NGT during the focus group. Dr. Ann Armstrong who counts with Dale Carnegie Endorsement to run focus groups and over 400 hours of training facilitated the focus group. The focus group was digitally recorded and transcribed through Zoom. The data collected through the focus group and internal validation addressed Research Question 3: What components of the updated R2D2/C3PO/A model did instructional designers and accessibility experts believe are best practices for implementing online courses which are accessible to all learners?

Study Procedures

This section provides a description of the study procedure, and the steps conducted for recruitment and data collection. As introduced in Chapter 1, this study followed an iterative three-phase system: Analyze (Phase 1), Design and Develop (Phase 2), and Evaluate (Phase 3). Additionally, in alignment and compliance with National University's Institutional Review Board (NU IRB) guidelines, all necessary forms to conduct the qualitative design and development model use case study were submitted to pursue approval prior to recruitment. The description of the study procedure consists of the communication and recruitment process and the iterative three-phase for data collection, analysis, output and timeline as shown in Figure 3.

Figure 3

Study Procedure Phases and Timeline



***Research Questions**

RQ1: How did instructional designers and accessibility experts believe the R2D2/C3PO model can be expanded to integrate accessibility components?
RQ2: How did instructional designers and accessibility experts believe the updated R2D2/C3POA model can be used to remove barriers for learners with disability in online synchronous and asynchronous learning?
RQ3: What components of the updated R2D2/C3POA model did instructional designers and accessibility experts believe are best practices for implementing online courses, which are accessible to all students?

Communication and Recruitment Process

The communication and recruitment process started after the permission was granted from the NU IRB. Participants were emailed a standard message that included the research information, study description, key points, and a recruitment survey. The recruitment survey was created in Qualtrics. The survey asked participants for their name, last name, phone number (optional), email (required), location (region), role, highest degree level attained, type of degree, years of experience, certifications, training, and professional development in the field of accessibility.

The communication process started by sending the standard email to people within the personal networks and requesting their voluntarily participation. This process was replicated for the people contacted through the snowball. The candidates from the internet volunteer sample technique accessed the survey through social media posts. After selecting the participants that met the criteria for the study, a participation confirmation email was sent. The participation confirmation message included a link to the researcher's scheduling system (Doodle), where participants selected the day and time for the semi-structured interviews that aligned with their schedule and the informed consent. The communication process occurred in a timeframe of 1-3 weeks.

Phase 1: Analyze

The Analysis phase consisted of a document analysis as part of the literature review. Through the literature review, an analysis of the R2D2/C3PO model and accessibility research studies and articles that discuss existing guidelines and quality assurance frameworks (WCAG, ULD, and QM) to identify accessibility strategies for online learning was conducted. The literature review articles were uploaded to the qualitative data analysis software NVivo to start the analysis process. A folder for each phase was created on NVivo to create a codebook per phase and to compare the progress of codes through each phase. A predetermined list of codes emerging from the research problem, conceptual framework, and research questions uploaded to NVivo and used to conduct a thematic analysis of the documents (van Putten et al., 2022).

Semi-structured interviews with participants using the Instructional Designer and Accessibility Expert Interview Guide were also conducted during Phase 1. Participants had prior access to Doodle, a scheduling system, to select the date and time from the researcher's schedule. Before starting the interviews, participants received information that explained the R2D2 and

R2D2/C3PO to help them familiarize with the model. Semi-structured interviews conducted through Zoom had an average duration of 30 to 60-minutes. These interviews were recorded and transcribed using Zoom. Although participants were notified about the recording through the informed consent, they were asked for their acknowledgement to be recorded at the beginning of the interview. Participants received the transcripts from their interviews for a member check. After the semi-structured interviews, the data collected from the interaction, transcript, and notes were used to conduct an iterative inductive thematic analysis. The interview notes and transcripts were uploaded to NVivo to a new Phase 2 folder. The analyzed data was used in the Design and Develop phase to produce the first R2D2/C3PO/A model draft. Phase 1 average duration was 3 to 7 weeks. Elements in Phase 2 overlapped with Phase 1 since the data analysis was conducted after each interview.

Phase 2: Design and Develop

The Design and Develop phase focused on the enhancement of the R2D2/C3PO model. The data collected from the literature review, the predetermined list of start codes, and the initial set of themes and subthemes were used to enhance the model. Additionally, the enhancement process used the themes generated through the inductive thematic analysis of the transcripts and notes from the semi-structured interviews using the Instructional Designer and Accessibility Expert Interview Guide with participants' perspectives on how they believed the model could be expanded to integrate accessibility components. The interview notes and transcripts were uploaded to Phase 2 folder in NVivo to conduct the inductive analysis and to generate the codes, categories, and themes. The R2D2/C3PO enhancement consisted of adding accessibility components from the literature review and the input from instructional designers and accessibility experts during the semi-structured interviews to create the R2D2/C3PO/A. This enhancement was used to continue the iterative process of the study through Phase 3. Phase 2 had a duration of 3 to 5 weeks.

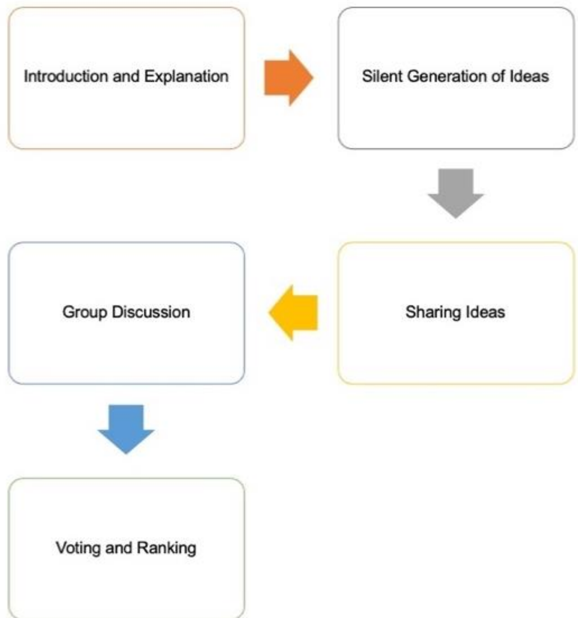
Phase 3: Evaluate

The Evaluation phase consisted of an iterative process for the model review and validation. This phase included two data collection methods as part of the iterative process. First, participants received through email the new R2D2/C3PO/A model and a model accessibility enhancement questionnaire with open-ended questions and a Ranking Scale from 1 (not important) to 4 (very important) (Armstrong & Gale, 2018; Borch et al., 2012). Participants used the questionnaire to review the accessibility components in the R2D2/C3PO/A model to rank the strategies that can remove barriers for learners with disabilities and provided comments and ideas for improvements before the focus group. The responses to the open-ended questions were uploaded to Phase 3 folder in NVivo to conduct the inductive thematic analysis. A descriptive analysis of the survey was performed using Excel to determine the survey's average, mean, mode, standard deviation, and median of the Ranking results. After evaluating the survey with the expert responses, the model R2D2/C3PO/A was updated based on the participants' feedback for accessibility strategies.

After the completion of the questionnaire and data analysis, the focus group was scheduled, and the updated model was sent to participants 3 days prior to the meeting as part of the iterative process. The focus group was conducted on Zoom and facilitated by Dr. Ann Armstrong who counts with Dale Carnegie Endorsement to run focus groups and over 400 hours of training. The researcher supported in the moderation and transcription of ideas during the focus group session. The session lasted 90 minutes and was recorded and transcribed by Zoom. The NGT was used for model validation and finalization, as shown in Figure 4.

Figure 4

Nominal Group Technique Steps



Nominal Group Technique. The NGT steps were completed by following Armstrong and Gale (2018):

1. **Introduction and explanation**: The session started with an introduction of presenters and participants, purpose, agenda, and procedures for the meeting. This section was 10 minutes.
2. **Silent generation of ideas**: Participants had 10 minutes of quiet time to reflect on the R2D3/C3POA model and generate ideas for what accessibility strategies should be added to each component. To allow for an anonymous brainstorming process, individual Word document links were shared with participants through Microsoft 365 to brainstorm and write their generated ideas.
3. **Sharing ideas**: Participants were be asked to share out-loud a single idea for each of the R2D2/C3PO/A model components generated during Step 2. Each participant had 3 to 5

minutes to share their ideas without interruption. Participants ideas were typed on-screen using a PowerPoint Slide by the researcher as they were presented.

4. **Group discussion**: During group discussion, cross talk was allowed among participants to discuss, combine similar ideas, and argue proposed ideas or accessibility strategies for each model component. This segment lasted 25-30 minutes. Notes were taken on-screen in a new PowerPoint Slide to preserve previous data and to share new suggestions with participants.
5. **Voting and ranking:** The reviewed suggestions were presented to the group on-screen from the PowerPoint slide used in the group discussion to finalize enhancements. Participants voted anonymously on each suggestion (Colombani et al., 2022) using the poll survey tool from Zoom. This segment lasted 10-15 minutes.

The data collected from the focus group notes, recordings, transcripts, validation, and generation of ideas document was used to conduct an inductive thematic analysis for the qualitative data and a descriptive analysis for the Ranking and voting. The notes, transcripts, and generation of ideas were analyzed in NVivo, and the data was uploaded to Phase 3 folder. The descriptive analysis was conducted in Excel.

To ensure the study's trustworthiness, a member checking process was implemented to confirm the results are in order and to enhance the credibility and dependability of the interpretations (Shenton, 2004; van Putten et al., 2022). Participants received a summary of the focus group 3 days after the session for their check and to confirm the integrity of the focus group summary and the analysis of the accessibility strategies ranking. Participants had 2 days after receiving the summary to provide a member check; otherwise, the summary was presumed valid, and no changes were performed. Morgan and Ravitch (2018) described trustworthiness as the researcher's decisions and procedures to ensure the quality of a study. The results and participants' feedback will be used to finalize the model. Phase 3 is expected to last 3-4 weeks.

Data Analysis

In qualitative research, the data analysis process consists of processing, refining, and structuring raw data in a form that is appropriate for researchers to make decisions and conclusions (Madondo, 2021). The data is presented in a series of phases to help the reader see how each phase leads to another through a complete data analysis process (Cresswell, 2009; Swain, 2018). In this study, the data analysis consisted of an iterative process integrated into each of the study phases: Analyze (Phase 1), Design and Develop (Phase 2), and Evaluate (Phase 3). NVivo, a qualitative analysis software, was used to facilitate the analysis process where a folder for each phase was created to conduct the hybrid and iterative analysis process and to demonstrate the progression of codes and themes through the phases (Swain, 2018). A hybrid approach to data analysis was implemented by using deductive and inductive analysis (Banwell et al., 2023; Swain, 2018) following Braun and Clarke's (2006) six-step thematic analysis and a descriptive analysis (Armstrong & Gale 2018). These three-phase process combined the iteration between data collection methods and the data analysis process by using multiple sources of data collection and data analysis methods aligned to each to address triangulation.

Triangulation is a combination of data collection and analysis methods that also addresses issues or concerns of trustworthiness in qualitative research studies (Bloomberg & Volpe, 2019; Given, 2008). Given (2008) indicated that triangulation, or a multimethod approach, is a strategy to minimize biases or other deficiencies in the study that could be caused by using single methods and allow researchers to understand and interpret the phenomena. Flick (2007) established that using various methods also promotes the quality of qualitative research.

Triangulation is key in design and development research to address each key aspect of a study and to prevent bias that could open questions on the findings (Richey & Klein, 2007). Hence, the benefits of using multiple data collection methods are evident.

Phase 1: Analyze

A hybrid approach of deductive and inductive thematic analysis was implemented in Phase 1 (Banwell et al., 2023; Swain, 2018). A deductive analysis was conducted using a predetermined list of start codes emerging from the research problem, conceptual framework, and research questions (Armstrong & Gale, 2018; Banwell et al., 2023; Swain, 2018; van Putten et al., 2022). After the deductive analysis, an inductive analysis was conducted following Braun and Clarke's (2006) six-step thematic analysis. The data analysis method was implemented based on the data collection and instrumentation method.

Document Analysis. Phase 1 started with a document analysis of the literature review by analyze articles, research studies, and the R2D2 and R2D2/C3PO models using a deductive analysis with a predetermined list of start codes (Armstrong & Gale, 2018; Banwell et al., 2023; Swain, 2018; van Putten et al., 2022). A document analysis involves a detailed examination of significant documents in various areas, including their interpretations, effects, and uses (Wharton, 2006). The research studies, articles, and the R2D2 and R2D2/C3PO model were uploaded to NVivo to Phase 1 folder to conduct the deductive analysis. The content was coded using the predetermined list of start codes. Adopting a deductive analysis helps in producing codes relative to a pre-specified conceptual framework or codebook to complete an "analyst-driven" analysis that will allow for a subsequent interpretation (Byrne, 2021; Fereday & Muir-Cochrane, 2006).

Semi-structured Interviews Using an Instructional Designer and Accessibility Expert Interview Guide. Semi-structured interviews using an Instructional Designer and Accessibility Expert Interview Guide occurred during Phase 1. The interviews were recorded and transcribed verbatim by Zoom. A member-checking process took place where participants received a copy of the transcription 3 to 4 days after the interview for verification and validation to ensure trustworthiness. Participants were asked to validate the transcription within a 4 days' timeframe after receiving the transcript; otherwise, no revisions were made. An inductive thematic analysis was used to analyze the data collected from the semi-structured interviews which also reflected the notes and transcriptions. Notes and transcriptions analysis started as they were occurring in Phase 1 and extended to Phase 2.

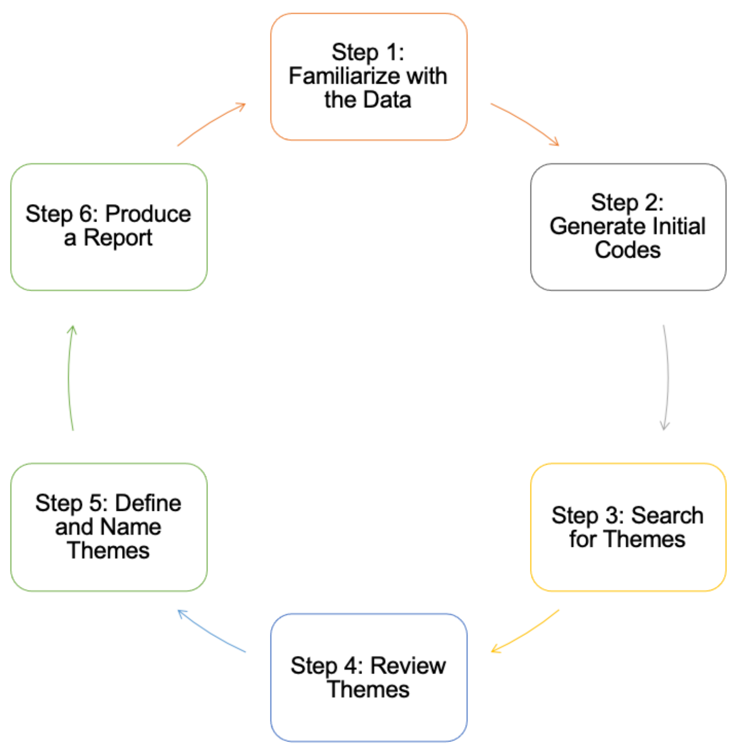
Phase 2: Design and Develop

Phase 2 was established as a design and develop phase, where the main output were the first draft of R2D2/C3PO/A model. The model draft was completed from the document analysis and semi-structured interviews and the codes and themes generated through the deductive and inductive analysis. The analysis of the data collected from the semi-structured interviews notes and transcriptions was conducted during Phase 2, but the iterative analysis overlapped with Phase 1.

Interview Notes and Transcripts. An iterative inductive analysis was conducted for interview notes and transcripts during Phases 1 and 2. The interview notes and transcripts were uploaded to Phase 2 folder in NVivo to conduct the data-driven analysis. The inductive analysis was used as a process to analyze qualitative data in detail from the semi-structured interviews to derive concepts or themes guided by specific objectives or questions (Swain, 2018; Thomas, 2006). Braun and Clarke (2006) defined themes as something important about the data in relation to the research question that represents some level of patterned response or meaning within the data set. Contrary to deductive analysis, which uses a conceptual framework, in inductive analysis, the researcher works exclusively with the content of the data collected from the participants' experiences (Azungah, 2018; Byrne, 2021). In this study, Braun and Clarke's (2006) six-step thematic analysis was used to achieve the inductive thematic analysis of the data, as shown in Figure 5.

Figure 5

Six-Steps Thematic Analysis



Six-Steps Thematic Analysis. The first step of Braun and Clarke's (2006) six-steps thematic analysis is familiarizing with data. In this step, the researcher needs to immerse in the data to familiarize with the depth of the content through repeated reading and searching for meanings and patterns (Braun & Clarke, 2006; Byrne, 2021). The second step is generating initial codes. The production of initial codes is when the researcher works systematically through the data set by giving full and equal attention to each data item to identify interesting aspects that will form repeated patterns or themes and by taking notes throughout the texts (Braun & Clarke, 2006). The third step is searching for themes. After completing the initial codes, it is key to sort the codes into potential themes and classify them as main themes and subthemes (Braun & Clarke, 2006). The fourth step is reviewing themes. This step involves refining and narrowing down the themes of the coded data extracts, followed by a theme review at the entire data set level to achieve a relation between the themes and the questions (Braun & Clarke, 2006). The fifth step of the thematic analysis is defining and naming themes. This step includes defining and further redefining the themes used in the analysis by conducting and writing an analysis of each theme (Braun & Clarke, 2006). The final step in Braun and Clarke's (2006) thematic analysis is producing a report. In this step, it is critical to include data extracts as part of the analysis to demonstrate the prevalence of the theme (Braun & Clarke, 2006; Byrne, 2021). It is worth highlighting that the deductive and the six-steps thematic analyses for the inductive analysis are iterative processes that repeated throughout the phases. The output of Phase 2: Design and Develop mainly fed from the data and analysis conducted in Phases 1 and 2 to produce the enhancements to the R2D2/C3PO model.

Phase 3: Evaluate

Phase 3 also had a hybrid approach to data analysis. A descriptive analysis and an inductive analysis were used iteratively during this phase. Inductive analysis was used following the same parameters and guidance from Braun and Clarke's (2006) six-step thematic analysis for qualitative data collected in the Module Accessibility Enhancement questionnaire and in the

NGT and model validation focus group session. For the voting and ranking elements of both data collection methods, a descriptive analysis was used (Armstrong & Gale, 2018).

Model Accessibility Enhancement Questionnaire. After the initial step of model enhancement created in Phase 2, participants received in Phase 3 a model accessibility enhancement questionnaire with open-ended questions and a Ranking Scale from 1 (not important) to 4 (very important) to rank the accessibility components in the R2D2/C3PO/A model. The ranking data collected through the model accessibility enhancement questionnaire was analyzed using a descriptive analysis in Excel to determine the survey's average, mean, mode, standard deviation, and median of the results (Armstrong & Gale 2018). Schwandt (2007) defined descriptive analysis as the mathematical techniques using measures such as mean, mode, and standard deviation to organize, display, and summarize numerical data sets. The data collected from the open-ended questions was uploaded to NVivo to conduct the analysis. An inductive thematic analysis was used to analyze the open-ended questions. Armstrong and Gale (2018) employed a descriptive analysis using Excel to generate the average, mean, mode, and standard deviation of the model accessibility enhancement questionnaire and thematic analysis for the comment sections of the surveys. For this study, the ranking data was added an Excel spreadsheet to reflect the analysis process of the model accessibility enhancement questionnaire in Phase 3: Evaluation.

Focus Group and Model Use Validation. The focus group using NGT and the model use validation process occurred in a single session in Phase 3: Evaluation. The focus group was recorded and transcribed verbatim through Zoom. Focus group participants received a summary of the focus group 3 days after the session for a member-check to ensure trustworthiness. Participants had 4 days after receiving the summary to validate the information; otherwise, no revisions were made, and the summary remained as produced. An NGT strategy was used for the focus group, and a Ranking Scale survey was used for the model validation for participants to rank the accessibility strategies. The transcriptions and notes from the focus groups, and the silent generation of ideas documents used by participants was uploaded to Phase 3 folder in NVivo for the qualitative analysis. Two data analysis methods were used to analyze the data collected through the focus group and model validation. Following Braun and Clarke's (2006) six-steps thematic analysis, an inductive thematic analysis was used for the data collected from the focus group and transcripts and the silent generation of ideas. A descriptive analysis was used for the model validation using Excel to determine the survey's average, mean, mode, standard deviation, and median (Armstrong & Gale, 2018).

Themes Cross-Analysis. A manual themes cross-analysis was conducted for the qualitative data generated in all data collection methods. The themes cross-analysis served as a method to identify the strength of themes and subthemes, and their occurrence among all data collections. After conducting all the analysis in NVivo, artificial intelligence (ChatGPT) was used to support the data analysis process to identify research gaps and opportunities.

Assumptions

Assumptions are statements or underlying aspects of the research that are out of the researcher's control and are accepted as accurate without concrete proof but that are relevant to the study (Ellis & Levy, 2010; Simon, 2011; Vogt, 2005). Several assumptions were identified and applied to this research study. First, the research method and design influenced the study (Ellis & Levy, 2010). A design and development model use case study was assumed to be an appropriate research design because the R2D2/C3PO instructional design model was enhanced to add accessibility strategies and create a new model, the R2D2/C3PO/A. It was also assumed that participants answered the recruitment survey truthfully and were representatives of experts in the instructional design and accessibility field. The survey responses reflected all the questions for years of experience, location, degrees or certifications, training, and online course development experience or online accessibility. Another assumption was that participants completed an authentic model accessibility enhancement questionnaire and validation based on their expertise and training and not by observing personal preferences.

Limitations

Limitations are weaknesses often out of the researcher's control and associated with design and methodology characteristics that can impact the study (Bloomberg & Volpe, 2019; Theofanidis & Fountouki, 2018). This study was subject to various limitations. First, as a characteristic of qualitative research, the small sample prevented generalization. This limitation was addressed with triangulation until saturation was reached to reinforce the study's trustworthiness and comprehensively understand the phenomena. Transferability measures such as extensive literature review, thick and rich descriptions of the case, and purposeful sampling were taken to support the study's trustworthiness and the comprehension of the phenomena.

Second, the study was limited to instructional designers and accessibility experts rather than learners with disabilities as end users. However, the study was open to instructional designers and accessibility experts who experience a disability. This limitation suggests that the findings and the R2D2/C3PO model creation were relevant to instructional designers and accessibility experts developing online courses. Another limitation was scheduled updates to the Web Content Accessibility Guidelines and Quality Matters Rubric that could have impacted any proposed accessibility strategies. Part of the proposed accessibility strategies came from the literature review, and continuous monitoring occurred to identify any updates and new research about WCAG and QM accessibility strategies during Phase 2: Design and Development.

Delimitations

Delimitations in a study are limitations set by the researcher as the boundaries of their work, so objectives do not become impossible to achieve, therefore, the scope and delimitations are set and controlled by the researcher (Bloomberg & Volpe, 2019; Theofanidis & Fountouky, 2018). This study included three delimitations. First, participants were instructional designers and accessibility experts in North America with 5 or more years of online experience with specific criteria. The specific criterion for instructional designers were having a post-graduate degree or certification in the field, training or certification on accessibility and Quality Matters, and experience in online course development. The specific criterion for accessibility experts was having an IAAP certification and having experience as a tester, educator, developer, or remediator. The rationale for these delimitations were that instructional designers and accessibility experts in online course development were able to provide the data to address and answer the study's research questions to add accessibility strategies to the R2D2/C3PO instructional design model.

Second, the research questions focused on narrowing the experience of instructional designers and accessibility experts on creating accessible, equitable, and inclusive online learning for learners with disabilities by enhancing the R2D2/C3PO instructional model to the R2D2/C3PO/A. Model development and validation were pertinent to this design and development research study because it focused on a model use and process to enhance a model rather than demonstrating how the model works (Richey & Klein, 2007). Lastly, another delimitation was the guidelines and frameworks that were used in the study. WCAG, QM, and

UDL are the guidelines and frameworks used in the study to inform the common standards, guidelines, and practices for accessible, equitable, and inclusive online learners. The Portable Document Format Universal Accessibility (PDF/UA) standard were excluded from the study. The rationale for this delimitation was that PDF/UA is a standard that mainly addresses the features and functions of portable document formats (PDF) to be technically accessible (PDF/UA Foundation, 2023) rather than the overall accessibility of online learning.

Ethical Assurances

In qualitative research, researchers should conduct the study to minimize the potential harm to participants due to its emergent and flexible design by protecting participants' rights and confidentiality (Bloomberg & Volpe, 2019). This study required National University's IRB approval before contacting possible participants and conducting the research study. Before seeking IRB approval, the required online training course about conducting research studies with human subjects were completed as part of the NU's program and dissertation phase requirements. The communication process started after receiving IRB approval.

An email was sent to potential participants from the personal networks to request their voluntarily participation. The email included a brief description of the study, criteria, time commitment, recruitment survey link, and a voluntary participation statement. The participation statement reassured potential participants that their participation was voluntary, not linked to their current employers and that declining participation was not going to impact their employment since the participation status ere not to be shared with other subjects. Although there could have been a previous work relationship between possible participants and the researcher, the relationship did not involve supervisory roles from researcher to participants. After not securing the full sample with the personal networks, a snowball sampling with inclusion criteria and an internet volunteer sample were be implemented until saturation was reached. The email communication to participants recruited through these two options also included the voluntary participation statement.

Participants that formed the study's final sample received an Informed Consent Letter through email. The study's information and purpose were disclosed to the participants through the Informed Consent. Additionally, it included specifications about the voluntary participation and the right to withdraw from the study at any moment without penalty. The informed consent also had an explanation of benefits, activities, privacy, confidentiality, data protection, risks, potential risks of a breach, compensation details, and the researcher's contact information.

Confidentiality is the researcher's obligation and ethical duty to safeguard entrusted information and to protect participants' identity to avoid negative repercussions (Turcotte-Tremblay & Mc Sween-Cadieux, 2018). Identifiable information was not disclosed to anyone nor included in the results and discussion to grant participants anonymity. Participants were assigned an identifier code as experts and their field (i.e., ID01, AE01). Additionally, to protect participants' privacy and confidentiality, the data collected has been secured in a cloud storage service with password protection and two-factor authentication. The data were saved in this secured location for 5 years after the research completion and will be deleted and destroyed at the five-year mark.

The researcher's role in design and development research studies is more diverse when compared to traditional research due to critical methodological aspects unique to DDR (Alias & Hashim, 2012; Richey & Klein, 2014). In many DDR studies, the researcher is the designer and developer, which is common and unavoidable due to the practical constraints of studying real-life design projects such as model development (Richey & Klein, 2014). Adding to the body of knowledge was pursued in this study by enhancing the R2D2/C3PO model to include accessibility strategies for each component to create the new R2D2/C3PO/A. Additionally, there was a potential bias due to prior knowledge in the instructional design and accessibility fields and possible connections with experts.

Despite the risks of bias due to prior knowledge, bringing previous experiences allows the opportunity to focus on the participants' meaning rather than exact words and understand how accessibility practices emerge in online learning (Alvarado-Alcántar & Keeley, 2020). It is vital to highlight that the role of the instructional designer researcher is comparable to the role of the participant observer in qualitative research (Richey & Klein, 2014). However, special attention to instrument design, data collection, and triangulation of multiple data sources were considered to address any concerns about the study's trustworthiness. Additionally, reflective journaling took place throughout the research process. Self-reflective journaling is a strategy researchers use to facilitate critical self-reflection to examine personal assumptions or goals or to clarify systems and subjective beliefs that can impact the research process, design, methods, and approaches taken (Ortlipp, 2008).

Summary

This chapter presented the methodology for this study. A qualitative methodology with a design and development model use case study was used to explore the perspectives of instructional designers and accessibility experts to include accessibility components and strategies to enhance the R2D2/C3PO model and augment it to a new R2D2/C3PO/A model. It is critical to define instructional designers and accessibility experts in online settings as the population for this study, since they played a key role in augmenting the model. In the United States alone, instructional designers form a workforce of 13,000 people, while the need for accessibility experts continues to grow (IAAP, 2022; Nworie, 2022). Purposeful sampling was used in this design and development research to narrow the population and to explore models or techniques used by experts while conducting the study in numerous settings (Richey & Klein, 2007). However, due to unexpected challenges, two additional plans were executed to secure the five to 10 instructional designers' and accessibility experts' samples using a snowball and an internet volunteer sample.

This chapter also presented the data collection methods, study process, and data analysis as iterative in three phases (Analysis, Design and Development, and Evaluation) to address the research questions. Multiple data collection and analysis methods were used throughout the phases to address the research question, triangulation, and trustworthiness. In Phase 1, a document analysis was part of the literature review using a deductive analysis with a predetermined list of codes that emerged from the research problem, conceptual framework, and research questions to identify various accessibility strategies for each model component and contribute to the augmented model, the R2D2/C3PO/A. Additionally, semi-structured interviews using an interview guide were conducted with participants before the initial model enhancement, and the data collected were analyzed through Braun and Clarke's (2006) six-step inductive thematic analysis.

The model enhancement started during Phase 2: Design and Development. Participants reviewed the first update of the enhanced model through a model accessibility enhancement questionnaire in Phase 3. The data collected through the survey was analyzed through a descriptive analysis, and additional updates were conducted before the focus group. It is key to highlight that the focus group was the last data collection method where participants shared ideas and strategies and completed a model validation ranking the accessibility strategies. Inductive and descriptive analyses were used to analyze the data of the focus group and model validations to produce the final updates to enhance R2D2/C3PO/A.

This chapter also discussed the study's assumptions, limitations, delimitations, and ethical assurances. It is worth noting that DDR and a model use case study were assumed appropriate due to the scope of the study to enhance the R2D2/C3PO model and augment it by adding accessibility strategies following the assumptions that participants were true experts and that they conducted an authentic model review and validation. The three main limitations of this study were the small sample that prevented generalization, the use of experts as participants rather than people with disabilities, and updates to existing guidelines and frameworks. Despite these limitations, some strategies to minimize the impact included addressing the small sample with triangulation and saturation while keeping the study relevant to experts in the field. However, there was a probability that some experts experienced a disability. Additionally, transferability measures such as extensive literature review, thick and rich descriptions of the case, and purposeful sampling were taken to support any trustworthiness concerns.

Similarly, setting up delimitations to establish boundaries to manage the work appropriately was key. This study delimitations were a focused sample by using a purposeful sampling with criterion, the use of research questions to narrow the experience of experts and using accessibility guidelines and frameworks pertinent to online settings while not using PDF/UA due to its focus on accessible documents. Lastly, this chapter considered the ethical assurances to minimize potential harm to participants by seeking IRB approval, acquiring the required training, and establishing security measures to protect participant's privacy. The next chapter will introduce and expand on the study findings.

Chapter 4: Findings

The problem addressed in this study was that online educators and instructional designers experience challenges with accessibility guidelines and their application when creating usable, accessible, and inclusive online courses due to limited and differing guidance at various levels (Baldwin & Ching, 2021; Lowenthal et al., 2021). Instructional design has a limited availability of model use research to enhance the field (Armstrong & Gale, 2018). The limited availability of model use research, along with the fast-paced growth of online learning, is creating many challenges for instructional designers and educators when designing and developing accessible content due to their lack of experience in accessibility and how to employ guidelines in practice (Acosta et al., 2020; Molanes-López et al., 2021).

The purpose of this qualitative design and development model use case study was to define the process of creating accessible learning activities to expand the validated research-based R2D2/C3PO model to integrate accessibility strategies for each of the eight components of the existing model. This chapter includes the results of this qualitative design and development model use case study that explored the perspectives of instructional designers, online educators, and accessibility experts about accessibility components and gathered recommendations for instructional strategies and activities to address accessibility in online courses.

The study explored the perspectives of 10 participants, consisting of six experts in instructional design and four accessibility experts. All participants have over 5 years of experience in online learning or environments. Participants shared their practical perspectives regarding the needs of people with disabilities in online learning and provided insights on expanding the validated R2D2/C3PO model. The study's trustworthiness and the data findings were implemented based on credibility, transferability, dependability, and confirmability. This chapter also includes the results of this study throughout the three phases: (1) Analysis, (2) design and development, and (3) evaluation, their relation to the research question, and an explanation of findings. Lastly, the chapter concludes with a summary of key findings.

Trustworthiness of the Data

A critical component determining the extent researchers take to achieve high-quality qualitative research is trustworthiness. Morgan and Ravitch (2018) described trustworthiness as the researcher's decisions and procedures to ensure the quality of a study. Researchers must provide detailed descriptions of the process they embark on from the methodology, design, data collection, and analysis, allowing readers to understand how researchers accounted for trustworthiness (Bloomberg & Volpe, 2019; Given, 2008). In this study, the trustworthiness of the data was determined by using multiple data collection and analysis methods through a thick and topic-focused document analysis of the literature review, a three-phase iterative process to achieve triangulation, peer scrutiny, member checking, journaling, and reflective practice, and a strict and organized research process throughout the phases. The trustworthiness criteria are credibility, dependability, confirmability, and transferability.

Credibility

Credibility represents the truth of findings, how accurate and consistent they are, and how they align with reality (Amankwaa, 2016; Conelly, 2016; Shenton, 2004; Söderholm, 2024). In other words, it demonstrates the consistency between the researcher's interpretation and the truthful perspective shared by the participants' responses that are believable by readers (Bloomberg & Volpe, 2019; Morrow, 2005; Nowel et al., 2017). Researchers can address credibility using reflections, prolonged engagement, triangulation, and member checks (Söderholm, 2024). In this study, several strategies were implemented to promote credibility.

Data Collection and Triangulation. The study included a three-phase process: (1) Analysis, (2) design and development, and (3) evaluation. Each phase involved multiple data collection and data analysis methods throughout an iterative process. Using various data collection methods and sources to gather information supports the consistency and the opportunity to achieve triangulation to recognize patterns in the data (Söderholm, 2024). At the early stages of phase 1 (Analysis), a thick and robust document analysis of the literature review was conducted to identify potential accessibility strategies to enhance the R2D2/C3PO model. A deductive thematic analysis of the research articles using a predetermined list of start codes was conducted in NVivo.

In phase 1, qualitative individual semi-structured interviews were conducted with participants through Zoom for 1 hour to establish the initial conversation and gather their perspectives on practices and accessibility strategies to enhance each model component and ensure accessibility in online learning. During Phase 2 (Design and development), the interview transcripts were reviewed and analyzed in NVivo following Braun and Clarke's (2006) six-step thematic analysis for an inductive thematic analysis of the data. The first draft of the R2D2/C3PO/A model was created after the interview analysis, and the model accessibility enhancement questionnaire was developed.

In Phase 3 (Evaluation), the model accessibility enhancement questionnaire was deployed to participants. All participants completed the questionnaire. Braun and Clark's six-step thematic analysis was followed for the inductive analysis in NVivo for the qualitative data of the open-ended questions. The quantitative data of the ranking, from 1 (not important) to 4 (very important), of accessibility strategies for each component was conducted in Excel using a descriptive analysis. Lastly, the R2D2/C3PO/A model was updated to reflect the results from the questionnaire, and four participants selected randomly from the existing sample were engaged in a 1-hour focus group using the Nominal Group Technique (NGT) to rank from 1 to 4 and validate the strategies using the poll option from Zoom. The NGT consisted of an introduction, silent generation of ideas, sharing ideas, group discussion, voting and ranking, and conclusion. After the session, the qualitative data from the silent generation of ideas, sharing ideas, and group discussion were analyzed in NVivo following Braun and Clark's six-step thematic analysis. The quantitative data for the voting and ranking was analyzed using a descriptive analysis in Excel.

Peer Scrutiny. The peer scrutiny involved seeking feedback from colleagues and experts in the instructional design field to ensure the credibility of the data collection methods and prevent biases or presumptions. For interviews, the Instructional Designer and Accessibility Expert Interview guide was reviewed by an instructional design expert. The expert feedback helped reformulate some questions to ensure clarity and alignment to Research Question 1: How do instructional designers and accessibility experts believe the R2D2/C3PO model can be expanded to integrate accessibility components?

The model accessibility enhancement questionnaire also passed through peer scrutiny to ensure alignment with Research Question 2: How do instructional designers and accessibility experts believe the updated R2D2/C3PO/A model can be used to remove barriers for learners with disability in online synchronous and asynchronous learning? The instructional design expert conducted the peer scrutiny of this instrument, and the feedback was implemented. However, a second instructional design expert conducted a final questionnaire review to ensure an additional layer of credibility. Once the input from both instructional designers was implemented, the questionnaire was released to participants for completion.

Member Checking. The member checking is to return transcripts to participants to confirm the interpretations or findings and ensure that their perspectives are represented accurately (Söderholm, 2024). Participants in this study received the transcripts for the semi-structured interviews and the focus group, along with a summary of the focus group discussion. Comments were allowed, but no alterations. Their remarks were reconfirmed with the recordings and notes taken throughout the interview process to ensure the meaning of their perspective was accurately represented and not altered in post-revisions.

ChatGPT Data Analysis Support. Artificial intelligence (AI) is a way to support and aid data analysis by generating insightful interpretations, identifying research gaps and opportunities, providing succinct summaries from collected data, and discovering patterns and outliers that could go unnoticed (Chuckwuere, 2024). ChatGPT was used as part of the data analysis process after the qualitative inductive analysis in NVivo. The purpose was to compare the research analysis by discovering new patterns, outliers, or themes not identified by the researcher and to ensure the researcher's biases did not influence how participants' perspectives were documented or represented. Transcripts and qualitative data from the questionnaire's open-ended questions were uploaded to ChatGPT, where a prompt was provided to create a table of themes focusing on accessibility strategies with four columns that include a theme number in order of strength, theme names, description, and the number of times referenced in the transcript. A second prompt was provided to request the addition of participants' excerpts from the interview. The outputs provided material that supported the researcher in identifying new patterns, outliers, or errors produced by the ChatGPT. Other AI tools from Zoom were used to identify critical points from recordings and compare session-documented summaries with the next steps.

Other strategies that contributed to the study's credibility were the robust data organization and analysis by phases in NVivo and conducting the focus group using the validated NGT process. The NGT focus group was moderated by Dr. Ann Armstrong, National University faculty and dissertation chair, with the co-moderation of the research. Integrating the experts' inputs and perspectives and including robust strategies and methods enhance the credibility and rigor of the study's findings and conclusions, opening the path for its transferability.

Transferability

Transferability is the process of showing through a thick description that research findings are applicable in other contexts or sites through a thorough description from the researcher while maintaining the uniqueness and richness of its content (Amankwaa, 2016; Bloomberg & Volpe, 2019; Nowell et al., 2017). Detailed explanations of how the research was conducted and who the participants were help readers comprehend how findings may apply to similar situations (Söderholm, 2024). Researchers established that purposeful sampling, clarity in writing, detailed information, and thick description are techniques and methods to achieve transferability (Bloomberg & Volpe, 2019; Given, 2008).

This study used a purposeful criterion sampling technique as a first option. This technique helped in recruiting instructional design experts. However, to secure accessibility experts as part of the sample, two additional plans were executed: first, the snowball sampling with the inclusion criterion followed by an internet volunteer sapling.

Additionally, the study included a rigorous three-phase process with multiple data collection and data analysis methods thoroughly documented and established in each phase. The process included clear communication with participants at the end of each phase, including the next steps and expectations established in the informed consent. Lastly, this study provides detailed descriptions of the results and findings in the following section to provide others with context to follow the detailed phase and iterative process, which supports the study's dependability.

Dependability

Dependability is where the data collected is dependable, answers the research questions, and the findings are consistent over time, allowing other researchers to repeat the process (Amankwaa, 2016; Conelly, 2016; Bloomberg & Volpe, 2019; Morgan & Ravitch, 2018; Morrow, 2005). Researchers must document the process in detail following a logical order to allow for prototyping practices by other researchers (Bloomberg & Volpe, 2019; Nowel et al., 2017; Shenton, 2004). Different strategies for dependability are field notes, journaling and reflection, and an audit trail. In this study, dependability was secured through rigorous data collection and analysis procedures, member checks, and keeping a record of all the information following the three-phase approach that helped to achieve the study's confirmability.

Confirmability

Confirmability establishes the connection between the data and the researcher's interpretation or conclusions since this information must be derived from the data collection and the researcher's interpretations rather than being influenced by personal biases or presumptions (Bloomberg & Volpe, 2019; Nowell et al., 2017; Shenton, 2004; Söderholm, 2024). A researcher can achieve confirmability through audit trails, clear documentation, journaling, and data analysis through themes and categories (Amankwaa, 2016). The informed consent provided specific criteria and expectations for participants in all phases and data collection methods, including the time invested in each element. Participants selected their interview availability directly from the researcher's calendar through Doodle. The availability selection by participants was replicated for the focus group using Doodle's voting system to accomplish a consensus.

All live interactions with participants (semi-structured interviews and focus groups) were recorded and transcribed, and participants had the opportunity to conduct a member check of the transcripts. After each data collection method, the R2D2/C3PO/A model was updated in Phases 2 and 3 and made available to participants before the next iteration (data collection). The three-phase process is detailed enough for other researchers to understand how the process was conducted, the decisions made in this research, and the results.

Results

Results are a key component of research studies since its disclosure must balance the beneficence and respect for participants autonomy and research transparency (Passmore et al. 2023). This section provides a brief description of the participants demographics and qualifications required to be part of the study. The results are discussed by research question broken down into the study's phases and the themes that emerged from each data collection method. The section concludes with a themes cross-analysis table that show the final themes for this study and the overview of their relation to the research questions.

Participant Demographics

The results from this study reflect the perspectives of instructional designers and accessibility experts about accessibility components and the instructional strategies and learning activities they recommended to address accessibility in online courses. Ten experts participated in this qualitative design and development research (DDR) model use case study, six instructional design experts (ID01-ID06) and four accessibility experts (AE01-AE04). All ten participants participated in the individual semi-structured interviews conducted in Phase 1 and the model accessibility enhancement questionnaire in Phase 2. From the existing participants, a group of four participants (P1-P4) was volunteered to participate in a focus group and NGT in Phase 3 to rank and validate the new accessibility model. Table 1 references a brief demographic for each participant type and identifier.

Table 1

Participants Demographics

Expert Participant	Identifier	Role	Industry	Certifications (QM or IAAP)
Instructional Design	ID01	Instructional Design Manager	Higher Education and Corporate	Applying the QM Rubric
Instructional Design	ID02	Senior Instructional Designer	Higher Education and Corporate	Applying the QM Rubric
Instructional Design	ID03	Senior Instructional Designer	Higher Education	Applying the QM Rubric
Instructional Design	ID04	Senior Instructional Designer	Higher Education	Applying the QM Rubric
Instructional Design	ID05	Senior Instructional Designer	Higher Education	Applying the QM Rubric
Instructional Design	ID06	Senior Instructional Designer	Higher Education and Corporate	Applying the QM Rubric
Accessibility	AE01	Accessibility Remediator	Not Applicable	Web Accessibility Specialist (WAS)
Accessibility	AE02	Accessibility Educator or Trainer	Not Applicable	Certified Professional in Accessibility Core Competencies (CPACC)
Accessibility	AE03	Accessibility Educator or Trainer	Not Applicable	Certified Professional in Accessibility Core Competencies (CPACC) AND Accessible Document Specialists (ADS)

Accessibility	AE04	Accessibility Remediator	Not Applicable	Accessible Document Specialist (ADS)

ID01. Participant ID01 is an Instructional Design Manager in Higher Education and Corporate who was responsible for applying the QM Rubric and building and implementing accessibility strategies in online courses. Participant ID01 conducts project management tasks of instructional design projects. Participant ID01 said "We produce online training materials and online course content about accessibility. We test and measure the number of barriers in our courses as we create them, and we make sure to do manual testing to be sure, to remove any barriers that our courses may have."

ID02. Participant ID02 has a dual role as a Senior Instructional Designer and Instructional Desing Process Manager in Higher Education and Corporate who was responsible for applying the QM Rubric and building and implementing accessibility strategies in online courses. Participant ID02 said "I ensure that courses are using general accessibility principles. We implement close caption, transcribe videos and audio, and ensure we have alt text on images and color contrast for visibility…"

ID03. Participant ID03 is an Instructional Designer and Educational Technologist in Higher Education who was responsible of implementing the QM Rubric and assessing accessibility content. This participant has experience in learning differences and neurodiversity. Participant ID03 said "I review courses for accessible content and that they meet 508 guidelines and the instructional design standards like Quality Matters."

ID04. Participant ID04 is an Instructional Design Manager in Higher Education and K-12 literacy responsible of assessing and implementing accessibility in online courses. Participant ID04 said "We are currently working to migrate our platform from a not accessible state to mitigate it to something that is accessible. We collaborate with the accessibility team to make it accessible for students."

ID05. Participant ID05 is an Instructional Designer and Associate Digital Academic Designer in Higher Education and K-12 responsible of designing accessible online courses and curriculum activities. Participant ID05 said "We ensure our software is accessible, for example, that the visual elements have audio and text for students, as well as keyboard accessibility. We want to make sure that all of our courses are accessible for students."

ID06. Participant ID06 is a Senior Instructional Designer responsible of developing implementing the QM rubric and accessibility practices in online learning in Higher Education and corporate. Participant ID06 said "Part of the service I provide is to make everything we develop accessible. I also create awareness on faculty, so they are aware of not accessible items."

AE01. Participant AE01 is an accessibility expert and remediator certified as a Web Accessibility Specialist (WAS) with the International Association of Accessibility Professionals (IAAP). Participant AE01 is responsible for ensuring accessibility compliance by conducting keyboard accessibility testing, general accessibility testing before and after implementation. Participant AE01 said "I primarily work in technology, for example, things like keyboard accessibility, time limit extensions, user notifications. I assist with technology with assistive technology strategy and recommendations. I also do documentations like voluntary product report, accessibility reports, and knowledge on accessibility related laws related to industry standards."

AE02. Participant AE02 is an accessibility specialist and educator certified in IAAP as a Certified Professional in Accessibility Core Competencies (CPACC) whom also has experience as an instructional designer responsible of ensuring accessibility practices and compliance in online courses in a community college. Participant AE02 said "I support faculty on getting started in the beginning and getting them on board to make their content better and more accessible for everyone. I do a lot of training and try to get them to see the why. When I begin my trainings, I go over the laws and show how people with disabilities are using technology, so they have equal access."

AE03. Participant AE03 is an accessibility expert and educator certified in IAAP as a CPACC and Accessibility Document Specialist (ADS). Participant AE03 work in a digital accessibility organization as a training consultant who is also responsible for conducting online trainings about accessibility. Participant AE03 said "I am primarily an instructor delivering the trainings but also developing new content on accessibility, for example, creating accessible presentations. I also update our accessibility trainings for better structure."

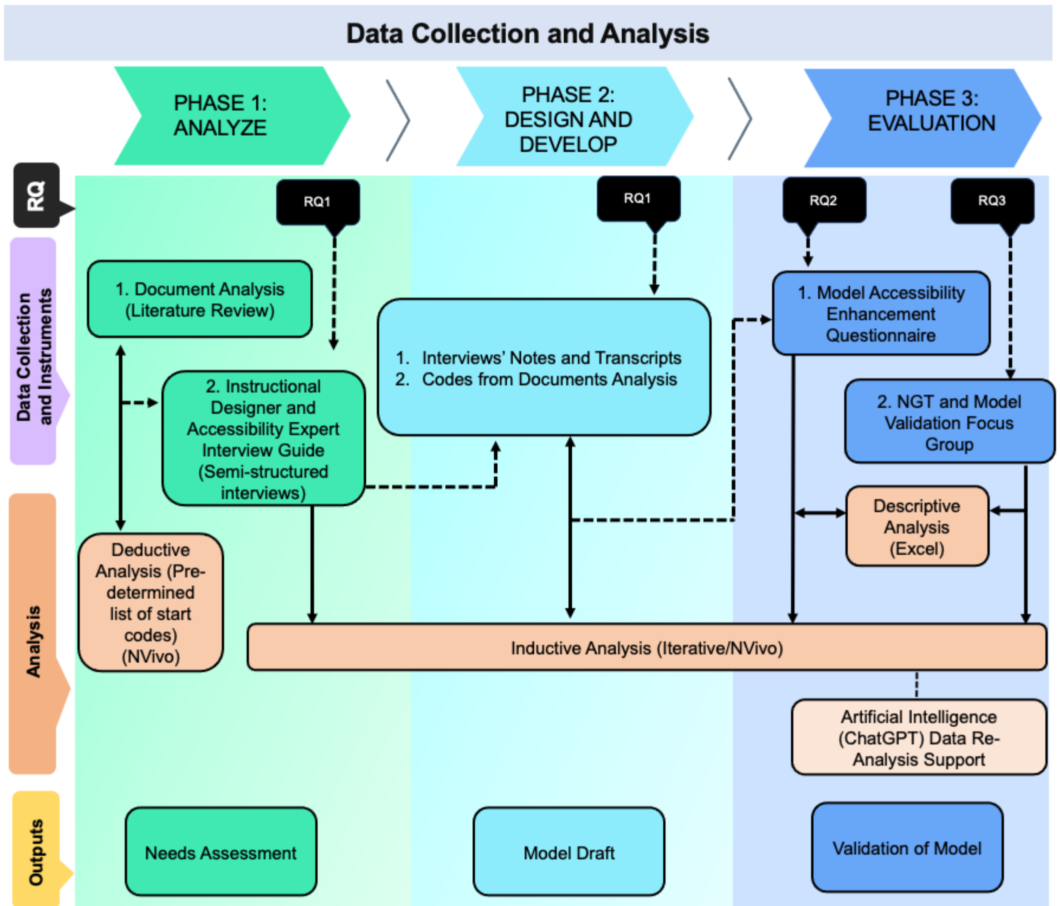
AE04. Participant AE04 is an accessibility expert and remediator specialist certified in IAAP as an Accessible Document Specialist (ADS) who owns a business for document remediation and online teaching. Participant AE04 said "I conduct document remediation to making documents screen reader accessible. I'm also an online teacher, sometimes on-on-one with deaf students, and other times creating courses that are posted online to be watched asynchronously. Some of these courses are designed for a specific disability group or just designed for general public but accessible."

The research questions conveyed the problem and purpose of the study, which was to explore the perspectives of instructional designers and accessibility experts on accessibility components and the recommended strategies to address accessibility in online courses. The research questions focused on expanding the R2D2/C3PO to include accessibility strategies for each component and the augmented model's validation process based on the experience of instructional designers and accessibility experts. The study was conducted through an iterative three-phase process: 1) Analysis, 2) design and development, and 3) evaluation. The iterative process in each phase included data collection and analysis and was aligned with a research question (RQ). As previously depicted in Chapter 1 Figure 1 Data Collection and Analysis Phases, the RQs are addressed as follows on each of the phases and by data collection method:

- RQ1: How do instructional designers and accessibility experts believe the R2D2/C3PO model? is addressed in phases 1 and 2.
- RQ2: How do instructional designers and accessibility experts believe the updated R2D2/C3PO/A model can be used to remove barriers for learners with disability in online synchronous and asynchronous learning? is addressed in Phase 3
- RQ3: What components of the updated R2D2/C3PO/A model do instructional designers and accessibility experts believe are best practices for implementing online courses, which are accessible to all students? Is addressed in Phase 3.

Figure 1

Data Collection and Analysis Phases



***Research Questions**
RQ1: How did instructional designers and accessibility experts believe the R2D2/C3PO model can be expanded to integrate accessibility components?
RQ2: How did instructional designers and accessibility experts believe the updated R2D2/C3POA model can be used to remove barriers for learners with disability in online synchronous and asynchronous learning?
RQ3: What components of the updated R2D2/C3POA model did instructional designers and accessibility experts believe are best practices for implementing online courses, which are accessible to all students?

Research Question 1: Phases 1 and 2

How do instructional designers and accessibility experts believe the R2D2/C3PO model can be expanded to integrate accessibility components? The answer to this RQ began with a detailed analysis of peer reviewed research books and articles related to the topic. Following that analysis and before the interviews, all participants were exposed through email to the eight components of the R2D2/C3PO model, which were also described and displayed throughout the interview process. Participants had the opportunity to share their expertise and perspectives on accessibility and instructional strategies for each of the eight components. After completing all interviews, the transcripts were emailed to participants for a member check.

Phase 1: Analysis. Phase 1 included a document analysis of the literature review research articles. Several research articles that discussed the R2D2/C3PO model, accessibility strategies and guidelines, Quality Matters, and Universal Design for Learning were selected for a deductive thematic analysis in NVivo using a predetermined list of start codes. The predetermined list of start codes emerged from the literature review, conceptual framework, and research questions and were pre-uploaded to NVivo's Phase 1 folder along with the research articles. Table 2 displays the research articles and the predetermined list of start codes. The strategies presented in the research articles contributed to the initial draft of the R2D2/C3PO model enhancement (R2D2/C3PO/A), along with the strategies that emerged from the interviews and themes.

Table 2

Literature Review Analysis: Start Codes

Article Title	Year	Author	Predetermined Start Codes
Techniques for the publication of accessible multimedia content on the web	2020	Acosta et al.	• Accessibility challenges and barriers • Accessibility compliance reviews or checks • Accessible, flexible, and inclusive online learning • Instructional design models and frameworks • Lack of experience in accessibility guidelines

			• Learners with disabilities challenges and needs • Minimizing unaddressed barriers • Online accessibility strategies and best practices • Usability of learning materials and learning environments • Web accessibility standards or guidelines
Device usage and accessible technology needs for post traditional students in the e-Learning environment	2020	Aquino & BuShell	• Accessibility challenges and barriers • Accessible, flexible, and inclusive online learning • Instructional design models and frameworks
R2D2/C3PO video conferencing instructional strategies and learning activities: Expert validated research instructional design	2025	Armstrong & Gale	• Instructional design model enhancements • Online learning or courses
Accessibility in online courses: A review of national and statewide evaluation instruments	2021	Baldwin & Ching	• Accessibility compliance reviews or checks • Accessible online courses • Accessible, flexible, and inclusive online learning • Instructional design models and frameworks • Learners with disabilities challenges and needs • Online accessibility strategies and best practices • Usability of learning materials and learning environments • WCAG • Web accessibility standards or guidelines

More to do than can ever be done: Reconciling library online learning objects with WCAG 2.1 standards for accessibility	2022	Chee et al.	• Accessibility challenges and barriers • Accessibility compliance reviews or checks • Accessible, flexible, and inclusive online learning • Lack of experience in accessibility guidelines • Learners with disabilities challenges and needs • Minimizing unaddressed barriers • Online accessibility strategies and best practices • Usability of learning materials and learning environments • WCAG
A working model for complying with accessibility guidelines for online learning	2016	Cifuentes et al.	• Accessibility challenges and barriers • Accessible online courses • Accessible, flexible, and inclusive online learning • Instructional design models and frameworks • Learners with disabilities challenges and needs • Online accessibility strategies and best practices • Web accessibility standards or guidelines
Navigating the ADA accessibility requirements and legal pitfalls in online education	2021	King & Pitrowski	• Accessibility compliance reviews or checks • Online accessibility strategies and best practices • Web accessibility standards or guidelines

Moving toward a universally accessible web: Web accessibility and education	2019	Kurt. S.	• Accessibility challenges and barriers • Accessibility compliance reviews or checks • Accessible, flexible, and inclusive online learning • Learners with disabilities challenges and needs • Online accessibility strategies and best practices • WCAG • Web accessibility standards or guidelines
Creating accessible and inclusive online learning moving beyond compliance and broadening the discussion	2020	Lowenthal et al.	• Accessibility challenges and barriers • Accessibility compliance reviews or checks • Accessible online courses • Accessible, flexible, and inclusive online learning • Instructional design models and frameworks • Learners with disabilities challenges and needs • Online accessibility strategies and best practices • Quality of online education • Usability of learning materials and learning environments • WCAG
Accessibility in online course design	2019	Moorefield-Lang*	• Instructional design models and frameworks • Online accessibility strategies and best practices

Identifying challenges and benefits of online education for students with a psychiatric disability	2019	Murphy et al.	• Accessibility challenges and barriers • Instructional design models and frameworks • Learners with disabilities challenges and needs
Universal Design for Learning in rehabilitation education: Meeting the needs for equal access to electronic course resources and online learning	2018	Oswald et al.	• Accessible online courses • Instructional design models and frameworks. Online accessibility strategies and best practices
Inclusive e-Learning - towards an integrated system design	2017	Patzer & Pinkwart	• Accessibility challenges and barriers • Instructional design models and frameworks • WCAG
Learning ecologies in online students with disabilities	2020	Rodrigo & Tabuenca	• Learners with disabilities challenges and needs
Teaching tip promoting inclusive online learning for students with disabilities in information systems course	2022	Wu et al.	• Accessible online courses • Accessible, flexible, and inclusive online learning • Instructional design models and frameworks • Lack of experience in accessibility guidelines • Learners with disabilities challenges and needs • Online accessibility strategies and best practices

Following the document analysis, individual semi-structured interviews were conducted with all participants: six instructional design experts and four accessibility experts. The interviews were conducted for an average of 60 minutes through Zoom following the Instructional Designer and Accessibility Expert Interview Guide (see Appendix A). The goal of the semi-structured interviews was to address Research Question 1.

Phase 2: Design and Development. Phase 2 involved the data analysis of the semi-structured interview transcripts to continue the iterative process and to draft the R2D2/C3PO/A model to include the accessibility and learning strategies gathered from the experts' perspectives. In this phase, the process to answer Research Question 1 continued. Transcripts were uploaded to NVivo's Phase 2 folder for an inductive analysis following Braun and Clarke's six-step thematic analysis:

1. Familiarize with the data by reading the transcript multiple times and watching the recording.
2. Generate initial codes by going through the transcripts
3. Search for themes by identifying codes that follow a pattern
4. Review themes by combining repeated themes and breaking down themes into subthemes when needed (e.g., type of accessibility strategies).
5. Define and name themes after identifying and breaking down the subthemes.
6. Produce a report by collecting participant's excerpts to support the research process and data analysis.

Table 3 displays the themes and subthemes from the interviews during this phase. A total of six themes were established based on strength of those that received input from five or more participants (50% or more). Subthemes emerged from the themes as more focused inputs and strategies. The subthemes served as key points to set the accessibility and instructional strategies to enhance the R2D2/C3PO model into the R2D2/C3PO/A to include these strategies for each component and answer Research Question 1.

Table 3

Themes and Subthemes from Semi-structured Interviews

Theme and Subthemes	Participant Responses	Percentage of Participants	Description
Theme 01: Conduct technical accessibility testing	10/10	100%	Strategies and tools to ensure technical compliance and usability of learning materials with technology in online settings and its functionality with assistive technology.
Subtheme 01: Accessibility testing and tools	9/10	90%	Prompts the urgency of conducting accessibility checks and using accessible tools to ensure higher quality and accessibility.
Subtheme 02: Test for functionality with assistive technologies	8/10	80%	Highlights the importance of conducting testing with assistive technologies to check for accessibility.
Theme 02: Strategies for visual and multimedia accessibility	10/10	100%	Emphasizes using and implementing key accessibility strategies to make visual and multimedia elements accessible for synchronous and asynchronous learning experiences.
Subtheme 01: Closed captions for live videos or recordings	10/10	100%	Strategies and steps to ensure the accessibility of videos, recordings, and any time-based media that is shared in online learning by implementing closed captions.
Subtheme 02: Describe complex graphics or components	9/10	90%	Strategies to ensure accessibility of complex graphics like infographics and other components like virtual tours, whiteboards, and other elements that might require additional descriptions.
Subtheme 03: Color contrast and styling	9/10	90%	Strategies for elements that need key color contrast and specific styling to ensure its accessibility.

Subtheme 04: Transcripts for elements with audio	7/10	70%	Elements needed to ensure accessibility of elements like video and audio.
Subtheme 05: Alternative text or description for images	7/10	70%	Strategies and challenges of images and how to ensure their accessibility so all learners can access them.
Subtheme 06: Creating accessible presentations	6/10	60%	Best practices and strategies to create and share accessible presentations with learners.
Subtheme 07: Give user control over time-based media	4/10	40%	Ways to grant learners control over various time-based media.
Theme 03: Digital document accessibility	10/10	100%	Includes strategies and practices to make documents accessible and better options to share with learners, and challenges that some forms of documents might bring to learners.
Subtheme 01: Create a proper heading structure	7/10	70%	Discuss the need for proper document headings and other elements to improve navigation, readability, and functionality with assistive technologies.
Subtheme 02: Challenges in PDF accessibility	6/10	60%	Discusses the expert concerns about the challenges that come with PDF documents in online environments.
Subtheme 03: Making accessible links	5/10	50%	Strategies to ensure links are accessible and functional.
Subtheme 04: Content readability	5/10	50%	Highlights key aspects of why content readability is important for learner understanding.
Theme 04: Learners with disabilities challenges and needs	10/10	100%	Challenges and needs of diverse learners with disabilities and methods to reach and engage learners based on their needs
Subtheme 01: Challenges for learners with disabilities	10/10	100%	Discussed several challenges faced by learners with a disability, along with their responsibility in disclosing a disability and the stigmas created around these groups of learners.
Subtheme 02: Learners with	10/10	100%	Discusses the needs of learners with

disabilities needs			disabilities and how to better guide faculty by providing options by disability group.
Theme 05: Frameworks and model enhancement needs	8/10	80%	Provide highlights on the need for framework and model enhancements to improve accessibility.
Subtheme 01: R2D2 C3PO model enhancement	7/10	70%	Participants input on enhancements for accessibility of the model and its reach to impact all learners.
Theme 06: Learning activities and instructional strategies	5/10	50%	Key learning and instructional strategies to reinforce and enhance accessible online learning experiences suitable for all learners, including learners with various disabilities.
Subtheme 01: Provide multiple methods of materials or assessment	10/10	100%	Discusses the key aspects and strategies of providing learners various options to access the content and submit their work, allowing a significant reach and impact.
Subtheme 02: Give detailed rubrics criteria and instructions for learners	10/10	100%	Gathers the critical aspects and strategies to provide learners with clear guidance to achieve an inclusive experience that will benefit all learners.
Subtheme 03: Preparation and planning by faculty	10/10	100%	Discuss various ways and strategies to help faculty plan ahead of time and prepare to create accessible online content and learning activities
Subtheme 04: Accessible methods for feedback and coaching	9/10	90%	Experts discuss various methods to ensure feedback and coaching elements are accessible.
Subtheme 05: Use inclusion and cultural sensitivity practices	8/10	80%	Experts discuss the importance of inclusiveness and cultural sensitivity in learning practices and strategies to grant more accessible experiences.
Subtheme 06: Enhance interactions between learners and instructors	7/10	70%	Discusses ways to support activities interactions from learner to learner and learners to instructors
Subtheme 07: Using institutional resources for disability	7/10	70%	Guidance on using institutional resources available to ensure accessibility of online learning.

Subtheme 08: Using third-party resources in live courses	7/10	70%	Experts express their concerns and strategies for using third-party resources appropriately in online courses.
Subtheme 09: Give flexibility to learners	6/10	60%	Highlights the importance of giving flexibility to learners for success.
Subtheme 10: Provide pre-content and prework ahead of time	6/10	60%	Essentials of sharing with learners content ahead of time to ensure appropriate understanding
Subtheme 11: Explore the accessibility of polls or questionnaires	6/10	60%	Experts discuss various concerns and steps to ensure your polls or questionnaires are as accessible as possible.

Throughout the individual semi-structured interview, participants were asked about the eight R2D2/C3PO components and what accessibility strategies they would recommend making each component learning activity accessible. Additionally, they were prompted to determine what type of learners with disabilities would benefit from these strategies, how the learning strategies could be enhanced to address accessibility concerns, and what tools they would suggest, among others (Appendix A). Semi-structured interviews were ideal for this study because they allowed for drawing the core information from each participant while having the flexibility to probe more information and prompt new questions following participants' inputs (Tomita et al., 2021). Participants' inputs for accessibility and instructional strategies for the RD2D/C3PO model are available among each of the themes included in Table 3.

Theme 01: Conduct Technical Accessibility Testing. Ten out of ten participants (100%) mentioned this theme as part of their discussion in the interviews. The focus of this theme was on strategies and tools to ensure the technical compliance and usability of learning materials with assistive technology (e.g., screen readers, sticks, magnifiers, keyboards, etc.). This section presents excerpts from some of the instructional design (ID) and accessibility experts (AE) participants.

Participant AE01 said "The keyboard, pretty good test. So, if a student says I'm having problems with this survey or I'm having issues building this out, believe them. They might be like, oh, hover over this thing for an explanation of what this acronym is. And so, if you're using a keyboard, you will not get that information. So just kind of be mindful of that."

Participant AE02 said "What I have done is we have Blackboard A11y, which checks the accessibility… it checks the accessibility of the content on our learning management platform. And what I have done with that is I have used it to run different, reports to see where the issues mainly are."

Participant AE03 said "Be really detailed with manuals as PDFs and Word documents. I would not expect every instructor to be a document specialist, but I would expect them to make sure the documents they share are accessible, … and making sure that the technical access to any of these materials is provided so that learners with assistive technologies won't encounter a blocker of any sort of barrier..."

"And then, for Microsoft in particular use that check accessibility button, do a thorough review with that automated stuff. But then there's a lot more of manual components to review, which would take time to learn as a skill…"

Participant AE04 said "Smart graphics on PowerPoint is terribly inaccessible. It's really pretty, but you can't read them with screen readers very easily. They get very disorganized."

Participant ID01 said "So, if you had all of the components in a PowerPoint, you could run an accessibility test on a PowerPoint… to make sure that everything in the presentation itself is accessible. That's how I would do it… And yeah, so basic things like that and make sure everything can be, you know, keyboard accessible."

Participant ID02 said "WCAG, they have some tools on their site that instructional designers can use that are nice. And then there's now also built-in tools, in Word and PowerPoint that you can use … we actually have an internal tool that we've developed that will scan an entire course for accessibility issues, and then, like push out a whole list of things with links to the pages to fix, which is really neat and helpful."

Participant ID03 said "Use color contrast software. We are very fortunate that, at this point, there are really a number of color contrast tools that examine a document and can provide suggestions… [also] if you are going to provide links to YouTube or Ted Talk, [ensure] they are descriptive and not just the URL."

Participant ID04 said "If there's a screen reader, use it."

Participant ID05 said "Definitely, we want to make sure that it's keyboard accessible. So, we want to make sure that students who have difficulties navigating the activities they're able to do so with keyboards… If we have text, we want to make sure that we have an audio button for students to be able to click and follow the text and then also have an alt text image for students to be able to see. You know. What's the purpose of this image? Does it help or sustain the content? And what kind of support it provides for them."

Participant ID06 said "Another common error that you want to look for is tabbing through the PowerPoint and making sure that it's going in order of the information presented. If there are objects, you want to make sure those are in order as they are being presented."

Theme 02: Strategies for Visual and Multimedia Accessibility. Ten out of ten (100%) experts mentioned this theme as part of the interviews. The focus of this theme was on implementing key accessibility strategies (e.g., alternative text, image descriptions, closed captions, color contrast, transcripts, etc.) to make visual and multimedia elements accessible for learners. This section presents excerpts from some of the instructional design (ID) and accessibility experts (AE) participants.

Participant AE01 said "I still recommend captions or a transcript if somebody is trying to use video. The easiest would be to let the students know if there are captions available or if there are no captions. If there are no captions, there might be some additional information or a summary of what the video is about."

Participant AE02 said "So actually, it's really this came to my attention maybe about 2 years ago, where, you know, we were so focused on making sure we added captions. That was like the biggest thing for videos is adding captions… And so, there was a faculty member teaching anatomy and physiology. So, in her videos, she was saying, right, here's this. And this is where it takes you. And it wasn't very descriptive. And so, the captions were not helpful, because it was saying, hey, here it is right here. And over here is this."

Participant AE03 said "At synchronous lectures, I would definitely be encouraging instructors to consider how they are presenting their lectures, speaking at a reasonable pace, and having access to captioning. Ideally live human captioning, but at the very least, automated captioning. Now, having the confirming the accuracy of those captions after sending them, describing relevant visuals on the slide."

Participant AE04 said "If I'm looking at, say, a graph, for instance, and I have to read the graph and tell you statistics about it, answer my 3 or 4 little questions with it. I typically will write a very short alt text that says this is ABC and see this location for long description. So, then my blind user can go to that long description and get all the information that's in that infographics."

Participant ID02 said "You would want the alt text to capture that if the image is purely decorative, you would want to ensure that you're not including all text because that's just going to add to their cognitive load. They don't need that. So, if it's just for decorative purposes, skip it. But for anything that's including information that the students need something short. I think I want to say that it's like fewer than 40 characters…"

"With things like animations. I would make sure that there were like no flashing or auto play features enabled to make them more accessible."

Participant ID03 said "For videos, there is one more thing that you have to consider that students can and have control over the play and replay of the video and also, nowadays, some tools would offer speed options so students can adapt the video to the speed of their understanding… Depending on what is more comfortable for the user."

Participant ID04 said "That's one where you can fall into that trap where color is the only thing that's providing meaning. And so that's where I would advise that make sure whenever you're creating a graph, make sure that the color alone isn't providing the meaning."

Participant ID05 said, "And that if there's any activity like animations and things like that, give the student the opportunity to be able to stop and play where needed. So that way if they have any issues understanding, they could always go back and kind of go back and reread or revisit what they don't understand. So that way they have the opportunity to kind of own that part of hitting play or stop where necessary."

Participant ID06 said "…for any slides, like if there are slides being presented, we want to provide the learners with the PowerPoint slides and ensuring that the PowerPoint slides are written in an accessible manner, meaning if there's any images that there's an alternative version or a description, depending on how detailed the images."

Theme 03: Digital Document Accessibility. Ten out of ten (100%) participants mentioned this theme as part of the interviews. The focus of this theme was on including strategies and practices to make documents accessible, along with some challenges experienced by learners. This section presents excerpts from some of the instructional design (ID) and accessibility experts (AE) participants.

Participant AE01 said "PDFs, actually are less accessible, particularly for people who use screen readers. I know that can be very difficult, especially in a K to 12 or younger setting, because some schools have differences in funding, or they might not be able to remediate the PDFs. But that is something useful to know, especially if a student has something on file, such as in the US context, they would usually have an IEP, which is the Individualized Education Plan…"

Participant AE02 said "Make sure that if you have students who are lower on the cognitive scale, then make sure that you're not using $5 words. Make sure you keep it simple. We don't want to make it over-complicated, and sometimes we can't do that, especially if we're teaching at a higher level."

Participant AE03 said "If we're thinking about the documents we create, if we're thinking about like the Word documents as the base document that most instructors might be turning to, I would definitely make sure that we have headings that are programmatic, meaning that they are interactive. So, if you open the navigation pane under your review panel, I think, in Word you can actually see the headings you have created because you can actually navigate between them."

Participant AE04 said "So I would not recommend using Words for creating forms, PDFs with blocks, InDesign with text boxes and tooltips… it causes trouble for attention issues because of focus issues because there was so much on the page. They cause issues for low vision because the print was too small. They cause issues for the blind because they use tables to format them. They cause issues or low vision because when they move them up, they moved stuff around. So, if you're going to create good templates, which are important, use the right software Word, not it."

Participant ID01 said "…title all those structures and make sure all the downloadable links have accessible hyperlink descriptions. And then, if you're using a document like Word, for example, make sure to use styles instead of, you know, font sizes. Things like that would be really important."

Participant ID02 said "What I would recommend for it is keeping things very streamlined, organized, and like as brief as possible. So having bullet points out for key concepts that students can look at rather than full long paragraphs."

Participant ID05 said "You want to make sure that the hyperlink is where you want students to go directly. So, for example, if you want students to go to the critical incident, you will add that little hyperlink to that title so that way, they know that they're going to access it, access it."

Participant ID06 said "It can help to break those up a little bit with headers and make sections out of it. Often, they're just like a page of a bunch of text, so breaking up the text a little bit kind of help for readability for students."

Theme 04: Learners with Disabilities, Challenges and Needs. Ten out of ten participants (100%) mentioned this theme as part of the interviews. This theme highlighted the challenges and needs of diverse learners and the discussion of methods to reach and engage learners based on their needs. Two subthemes emerged from this theme. This section presents excerpts from some of the participants.

Participant AE01 said "There's a lot of disability stigma. The easiest example would be things like wearing glasses. You have an impairment. Do people with glasses necessarily say I'm disabled? No. Right. But in an important sense, they are. If you take the glasses away, it's very difficult. you can see in most cases, but you might not be able to see client detail, or you might have to move the screen or resize it...but there's so much stigma around disability that it plays into that, especially for neurodivergent, which I'm sort of using as a term to include anything from ADHD to autism to different learning styles. You know, one learning style may be primarily visual, one might be primarily written, some people like to take notes or just have the act of writing, helping them remember, and some people are very meticulous note-takers. some people are not, and as I've said, it tends to also impact more than just a very specific segment of people."

Participant AE02 said "People with like anxiety or social, cognitive those we really want to make sure that we're thinking of at the same time, it can it can negatively impact them, but we can also make it a positive impact as well by not, you know, calling them out, making sure that, we set them up for success instead of failure in those situations, kind of thinking, like ahead of time, giving them like, hey, here's the activity that we're going to be doing. Start thinking on things that might be because people who have anxiety really do struggle on the spot. And so, we want to make sure that we're setting them up for success and not for failure."

Participant AE03 said "I mean, virtual tours, if they were actually digitally accessible, would be great, but they are not currently. They're usually this thing where you, like, give a virtual tour to a student, and a blind student is going to look at it and be like, cool, blank page. I don't think I would remove virtual tours as much as the ideal would be to make virtual tours technically accessible because I think they're a robust tool for sighted learners… Peer coaching is so important, but it's also so anxiety-provoking. So, I would provide a lot of scaffolding, and I think I would expand on the definition of what scaffolding means."

Participant AE04 said "Smart graphics on PowerPoint is terribly inaccessible. It's really pretty, but you can't read them with screen readers very easily. They get very disorganized."

Participant ID03 said "It is a similar situation with coaching that the environment created, be it face-to-face or virtual, that the environment is safe. You are going to get a lot more out of your students in terms of participation engagement if they feel safe to do so. And sometimes instructors find that kind of difficult and challenging. And they feel they need to control the environment, and that is that makes the environment stressful overloads students memory, ability to understand, concepts."

Participant ID04 said "But also have to take into consideration that some students will not pick up on your body language at all. Some students may not even benefit from any of these things because they can't. They just don't won't see them. So, I would look into it."

Participant ID05 said "Yeah, I definitely see the issue with using emojis to promote motivation. So, if you have students that have a visual impairment, that might be something that they are not able to perceive unless it has some kind of audio or tells them an emoji with a smiley face. So, I think that one is the one that brought it. You know, came to me right away."

Participant ID06 said "You think drawing tools and presenting back to the entire group in the main room or in small groups in breakout sessions that would present a lot of challenges. So, I feel like that would really need to be talked through, depending on what the presentation is and what they're drawing like, that really would need to be taught through in detail whether that would be multimedia could be done instead."

Theme 05: Frameworks and Model Enhancement Needs. Eight out of ten participants (80%) mentioned this theme as part of their discussion in the interviews. This theme highlighted the need for framework and model enhancements to improve accessibility. A subtheme emerged from this theme. This section presents excerpts from some of the participants.

Participant AE02 said "I think having resources for them, making sure that they know, okay, for word documents, … these are, like, the biggest hits that you need to make sure that you're doing. Make sure that there are headings, make sure that, things are in line. Make sure you're using the styles inside of Word to make sure that the navigation all falls through. So that way, I think having resources is a great way to make sure that this is effective. Maybe a rubric…I think it is a fantastic model. I'm excited about that model."

Participant AE03 said "What does cognitive apprenticeship mean? That would be the first thing I would have I would be like explain what that is to find what it is. I think with. Yeah, I was just going to say, I think with, some of these, it's, it's quite clear what they're saying it is, but like the actual accessibility of what they're providing as strategies is something that could be improved upon with more clarity for each of these examples… I would change the word conviviality because that's not an accessible word. But that aside, I hear feedback. It's a tough word, even if this is your first language. Honestly, it's a word I haven't encountered before today, and it's like, I think I know what it means, but what does it really mean kind of thing?"

Participant AE04 said "There's an awful lot of information in this… But I feel like a professor who knows his material, his content is going to be a little overwhelmed by it…Sometimes, if things are broken down into disability groups, that can make it easier to absorb. So maybe they'll say, okay, I have a whole bunch of kids with ADHD. Let me work on the things that make it easier for the ADHD crowd. Oh, I have one student this semester. All right. Let me work on the things that make it easier for deaf people. And then, you know, the ADHD stuff is already done because I did that last semester."

Participant ID02 said "I think, including like a checklist and like that kind of like pre-education element of being able to talk to us or fellow instructional designers, or anybody about like the why and the how just giving people that context is really important. A checklist is great and really helpful for reducing cognitive load for the designer and kind of giving them more of an opportunity to make things more accessible."

Participant ID05 said "Yeah, so this is usually the high level or issue for our instructional designers. It's making sure that those visual elements are accessible. So, one of the things is, you know, be aware of Quality Matters and what is required for each of the elements."

Participant ID06 said "I think making it more available and providing it as a model to follow would be good, and providing examples of each of those things that are listed, if there are examples provided, demonstrating that, how it can be done would be good."

Theme 06: Learning Activities and Instructional Strategies. Ten out of ten (100%) participants mentioned this theme as part of the interviews. The focus of this theme was on key learning and instructional strategies to reinforce accessible online learning experiences that can benefit all learners, including learners with various disabilities. This section presents excerpts from some of the instructional design (ID) and accessibility experts (AE) participants.

Participant AE01 said "I was very sort of writing based on spoken, people with a lot of anxiety. I also avoid things like in-person or on-camera. So just having the sort of multiple approaches there, I think would drastically help. And just asking, hey, you know, here are the options. Just let me know which one would be most convenient or most useful for you."

Participant AE02 said "I think just making sure, like with the case studies and all of that, everything they're having to use to develop is accessible for them. I think that's the biggest thing, and it depends on the disability. So that's why we need to make sure that there are different activities that they can choose from or have, like an alternate plan, like if the only activity that they're going to do is an online roleplay. There's just no way to make that accessible for someone who has vision impairments, for example, then there has to be another alternate activity with the same outcomes. And so, I recommend having several different learning activities that they can choose from. Of course, not everybody's going to do that."

Participant AE03 said "And on that note, just providing the space for students to engage in different ways. So maybe one student wants to provide a vocal reflection, and maybe another one wants to provide a written reflection, all in that same shared space. So, you give the student the opportunity to speak aloud through a pair share and then open group discussion."

Participant AE04 said "The other thing I would suggest is be careful what third-party apps you use. If you start downloading lots of free Add-ons to your browser, some of those are accessible, and some of those are not. Be sure to check in with your admin department to purchase software or software-related items. Talk to your I.T because they can perhaps help you to find something that's already at the university that you didn't realize was there."

Participant ID01 said "Yeah, live session can be absolutely more challenging. I would provide the materials before the live session. So, people with accessibility need to have the information at hand so they could prepare for what's going to happen. And very important in that preloaded information, you should definitely include an agenda and stay true to the process of the lecture."

Participant ID02 said "I would mostly like want to talk or just kind of give a heads up regarding being culturally sensitive and inclusive. These, you know, all of these things, I think. You know, on at face value. You're like, yeah, that's all great, and that all makes sense. But you do have to consider your audience and how you know how you and just be considerate of the differences among the people attending, and how you know even with the best intentions, you might inadvertently shut down some students and their participation if you misgender them or you know, if culturally, there's like a word or an emoji, or something that means something different like that."

"With a lot of them, I would probably go for an alternative version that was text-based and easily read by a screen reader and used, you know, descriptive but concise explanations of any visual representations."

Participant ID03 said "So, if it is a video that has been created by the instructor, with a demonstration, it will provide an alternative. A cheat sheet or a, Pdf or document in which you have the process the steps, and they can follow along."

Participant ID04 said "I see time represented a couple of instances here. I know from my own teaching experience as well as collaborating with faculty members, and them being unsure of how to provide extended time. But make sure that there is especially for a quiz. If your quiz is timed, make sure that you know how to provide extended time in the system for students."

Participant ID05 said "I think one of the things that we normally typically miss is when we add pictures either, you know, or videos, or any picture or video elements that we're trying to bring. It's to be aware of, which is something that it's not usually considered. It's important to be aware of how you say it. For example, be inclusive. I guess that's what it is. Be inclusive and make sure that somehow somebody can be identified, but also be aware that some of the images can hurt or be received incorrectly from the user."

"I think one of the things that the faculty, or the teacher or the instructor can do when providing the specific doing the work. Provide specific guidelines and let them put into that either, whether it's a rubric or instructions to make sure and give that information. Student, make sure that it's accessible."

Participant ID06 said "I would be very careful with emojis and GIFs or GIFs and all of those things. Because what may mean one thing to one person may mean something else to someone else, especially if there's, like a dual language situation. And when you cut when it comes down to idioms, they're very different between even different geographical regions that use the same language."

Artificial Intelligence Integration for Analysis. The integration of artificial intelligence, ChatGPT, was used in this step to gain a deeper understanding of the data to re-analyze the transcripts and identify possible themes, patterns, and outliers that could have been missed or overlooked through the manual analysis in NVivo. However, due to a previous familiarization with the data by reading transcripts multiple times, watching the recording, and reviewing notes, there were some gaps or instances of misinformation present in ChatGPT outputs.

Summary of Research Question 1 Results. After conducting the thematic analysis using the participants' responses to the interview questions, the R2D2/C3PO/A model was drafted (Appendix B) to include a column with accessibility and learning strategies to address Research Question 1. Table 4 displays the accessibility strategies added to each of the R2D2/C3PO/A components based on theme strength and prioritizing those that achieved a 50% or more of participants responses. These strategies formed the drafted model shared with participants before completing the model accessibility enhancement questionnaire.

Table 4

R2D2/C3PO/A Accessibility Strategies Draft 1

R2D2/C3PO/A Model Component	Accessibility and Learning Strategies
1. Read/ Listening/ Viewing	a. Include transcripts for any audio (podcasts) and videos in a downloadable format. Add descriptive transcripts (e.g., explanation of a scene or formula) for any visuals on slides or videos. b. Include alternative text and descriptions for visuals (such as images, infographics, and GIFs) and provide a summary for complex images. c. Include accurate closed captions for all videos. d. Enable live captions and coordinate with the Office of Disabilities for interpreters in live synchronous sessions. e. Use accessibility tools (e.g., Microsoft Accessibility Checker, Adobe Accessibility Checker, Color Contrast Analyzers, etc.) for automated accessibility checks. Conduct manual checks in addition. f. Provide multiple methods for learners to access the content and to complete their activities (e.g., alternative options to existing activities and methods). Share materials with learners ahead of time. g. Use heading structures (H1 to H6) for proper navigation, content understanding, and proper readability. h. Ensure keyboard navigation and functionality for all activities (e.g., video players, interactive media, etc.) and provide the user control over multimedia (e.g., video play, pause, stop). i. Ensure proper color contrast between background and content (apply to content, images, links, etc.) j. Minimize the use of Adobe PDF documents due to accessibility challenges and remediation costs.
2. Reflect/ Writing/ Sharing	a. Provide learners with multiple formats and methods to complete activities (e.g., alternative versions of existing formats, two options to complete an activity, create practice quizzes before any primary assessment, etc.).

b. Include transcriptions and captions for synchronous events (e.g., breakout rooms, live sessions) or coordinate for transcribers or interpreters.
c. Allow for flexibility by providing additional time for discussions and activity completion for those who need it.
d. Provide clear instructions and details of sessions, quizzes, interactions, and activities (e.g., details about a quiz such as the number of questions, choices, sentences, or if they include pictures, audio clips, etc.).
e. Use institutional accessibility resources (e.g., transcribers, sign language interpreters, Braille printers, etc.).
f. Send content ahead in advance (e.g., links to videos that will be displayed in synchronous sessions, slides, pre-reading).
g. Group learners by ability (low, mid, high) to improve collaboration.
h. Ensure technologies are accessible or work with assistive technologies where learners can control the environment (e.g., keyboard, screen readers, read-out-loud, etc.).

3. Display

a. Include alternative text or transcriptions for images, diagrams, and graphs. Use proper terminology for text-based descriptions with content for all relevant visuals (synchronous or asynchronous).
b. Provide detailed descriptions for complex visuals. For example, describe tables, drawings, virtual worlds, and tours as they occur.
c. Have accurate transcripts and closed captions for video and audio files, coordinate live transcribers, or include audio descriptions for an elevated level of accessibility. If using videos in synchronous sessions, share the videos with accurate captions and transcripts before the session.
d. Ensure color contrast for course components (links, images, text, virtual backgrounds, etc.), and avoid using color or images as the single method for meaning.
e. Test links for functionality, set up links as descriptive links (e.g., the name of the target instead of "Click Here" or the full URL), and use standard formatting (underlined, visual difference to stand out, etc.).
f. Promote accessibility awareness at the institutional level and among your learners by using inclusive and culture-sensitive language and encouraging learners to include alternative text, descriptions, transcripts, and captions in their work.

g. Give learners complete control over multimedia (e.g., play, pause, and stop at any time), and do not use auto-play or flashing/blinking.

4. Doing the Work

a. Include multiple formats or methods (e.g., transcript, summary, a cheat sheet with steps or processes) and activities (e.g., ungraded practice for complex activities, asynchronous group paper collaboration instead of synchronous collaboration, etc.).
b. Add clear rubric criteria with an explanation of the activity, and share ground rules on learners creating accessible content by adding alt text, descriptions, and transcripts.
c. Provide clear instructions, expectations, and steps for multimedia completion and engagement.
d. Have interpreters and captions for live sessions (whole class and small groups) and record sessions.
e. Provide clear explanations and descriptions of elements such as math problems and anything visual (e.g., anything created on the whiteboard, PowerPoint slides, etc.).
f. Provide accessible material ahead of time. If learners are presenting, request their presentation to be shared before the session and provide it to other students.
g. Establish various levels of accommodations through institutional resources (e.g., Office of Disabilities).
h. Provide time-based accommodations to give people time to process.
i. Ensure the readability level by using headers to break content and vocabulary knowledge.
j. Provide accessible tools for learners to use to create their works

5. Coaching

a. Provide multiple ways to coach learners' needs or preferences (e.g., email, messaging apps, learning management system, office hours virtual/in-person, video chats, recorded sessions along with a transcript).
b. Share an agenda or clear guidelines before a coaching session to clarify each item or expectation and how much time they will spend.
c. Arrange for interpreters (e.g., sign language) for synchronous coaching sessions.
d. Include clear feedback to guide learners. Do not rely on colors, images, or shapes as the only source of meaning (e.g., do not use green to represent correct).

6. Conviviality	a. Use and encourage clear, inclusive language that reflects cultural sensitivity (e.g., describe participants or scenarios in sessions, etc.). b. Resist stereotypes and be inclusive in visual and audio materials. c. Provide clear descriptions of emojis, GIFs, and other visual material that might mean something different for learners. Visuals should not be the only way to convey information. d. Establish ground rules for behaviors and accessibility awareness for both instructors and learners. e. Add multiple check-ins throughout the session to keep learners engaged. f. Make engagement strategies optional, not required. g. Allow responses through the chat feature and include time and long pauses for questions.
7. Critical Incident Technique (CIT)	a. Use accessible online forms to collect feedback instead of using Microsoft Word or Adobe PDF documents to gather feedback due to accessibility challenges. b. Ensure all materials are accessible with assistive technologies (e.g., keyboard accessibility to navigate and interact with the materials). c. Provide multiple formats or alternative ways to complete the activity (e.g., open discussion forums, written reflection, etc.). d. Questions are in an inclusive format with both specific and open-ended questions that account for the emotional aspects of the interaction. e. Provide expectations to learners ahead of time (e.g., type of polls, chats, number of poll activities, etc.). f. Use descriptive links. g. Conduct follow-up polls after the event or session for synchronous events polls to allow time for reflection. h. Conduct automated and manual accessibility checks.
8. Planning/ Organization	a. Run accessibility checks on all your materials to ensure accessibility and that they are usable with assistive technologies (e.g., keyboard, screen readers, etc.). You can create a checklist to review for accessibility. b. Plan for captions and transcripts in all videos and transcripts for audio only (podcasts). c. Ensure enough color contrast in all your materials and that crucial information does not rely only on color to convey meaning. d. Start with accessibility in mind when designing a course. Create accessible templates that you can use.

e. Plan for alt text on all images and evaluate the context to ensure accurate information.
f. Coordinate with institution resources for professional development funds and access to resources (e.g., accessible tools, textbook companies, etc.).
g. Plan for multiple ways for learners to access the content and submit their work.
h. Plan heading structure in documents and web pages to allow for better navigation and understanding.
i. Include a syllabus with clear expectations, participation, organization of content, and objectives

---

Research Question 2: Phase 3

How do instructional designers and accessibility experts believe the updated R2D2/C3PO/A model can be used to remove barriers for learners with disability in online synchronous and asynchronous learning? The answer to this RQ began in Phase 3 through the data collection and analysis of the model accessibility enhancement questionnaire (Appendix C). Participants received the draft of the R2D2/C3PO/A model through email. All 10 participants received a link to the model accessibility enhancement questionnaire in Qualtrics during Phase 3, which was to be completed 5 days after receiving the email communication.

Phase 3: Evaluation. Part of Phase 3 included the model accessibility enhancement questionnaire. The questionnaire was built through the iterative process during phases 2 and 3 using a ranking scale from 1 (not important) to 4 (important) to rank the accessibility strategies for each model component. The questionnaire also included open-ended questions to gather participants' input and address Research Question 2. All 10 participants responded to the questionnaire (Appendix D). The data analysis for the questionnaire was analyzed using two methods: 1) a descriptive analysis through Excel to define the mean, mode, average, and standard deviation of the ranking results, and 2) an inductive analysis following Braun and

Clarke's six-step thematic analysis for the open-ended questions qualitative data. The qualitative data was uploaded to NVivo so that the inductive analysis could be conducted. Table 5 displays a summary of the model accessibility enhancement questionnaire results. Strategies that achieved a mean and average of 3 or more remained part of the second draft of the model, while those that achieved less than three were removed.

Table 5

Model Accessibility Enhancement Questionnaire Summary Results

R2D2/C3PO/A Model Component	AVG	MEAN	MODE	SD
Component 1: Read/ Listening/ Viewing Strategies				
a. Include transcripts for any audio (podcasts) and videos in a downloadable format. These include descriptive transcripts (e.g., explanation of a scene or formula) for any visuals on slides or videos.	3.8	3.8	4	0.42
b. Include alternative text and descriptions for visuals (such as images, infographics, and GIFs) and provide a summary for complex images.	3.8	3.8	4	0.63
c. Include accurate closed captions for all videos.	3.9	3.9	4	0.32
d. Enable live captions and coordinate with the Office of Disabilities for interpreters in live synchronous sessions.	3.6	3.6	4	0.52
e. Use accessibility tools (e.g., Microsoft Accessibility Checker, Adobe Accessibility Checker, Color Contrast Analyzers, etc.) for automated accessibility checks. Conduct manual checks in addition.	3.5	3.5	4	0.71
f. Provide multiple methods for learners to access the content and to complete their activities (e.g., alternative options to existing activities and methods). Share materials with learners ahead of time.	3.2	3.2	4	0.79
g. Use heading structures (H1 to H6) for proper navigation, content understanding, and proper readability.	4	4	4	0.00
h. Ensure keyboard navigation and functionality for all activities (e.g., video players, interactive media, etc.) and provide the user control over multimedia (e.g., video play, pause, stop).	3.9	3.9	4	0.32

i. Ensure proper color contrast between background and content (apply to content, images, links, etc.)	3.5	3.5	4	0.71
j. Minimize the use of Adobe PDF documents due to accessibility challenges and remediation costs.	3.1	3.1	3	0.74
Component 2: Reflect/ Writing/ Sharing Strategies				
a. Provide learners with multiple formats and methods to complete activities (e.g., alternative versions of existing formats, two options to complete an activity, create practice quizzes before any primary assessment, etc.).	3.2	3.2	4	0.79
b. Include transcriptions and captions for synchronous events (e.g., breakout rooms, live sessions) or coordinate for transcribers or interpreters.	3.5	3.5	4	0.71
c. Allow for flexibility by providing additional time for discussions and activity completion for those who need it.	3.8	3.8	4	0.42
d. Provide clear instructions and details of sessions, quizzes, interactions, and activities (e.g., details about a quiz such as the number of questions, choices, sentences, or if they include pictures, audio clips, etc.).	3.8	3.8	4	0.42
e. Use institutional accessibility resources (e.g., transcribers, sign language interpreters, Braille printers, etc.).	3.6	3.6	4	0.52
f. Send content ahead in advance (e.g., links to videos that will be displayed in synchronous sessions, slides, pre-reading).	3.2	3.2	3	0.79
g. Group learners by ability (low, mid, high) to improve collaboration.	2	2	1	1.05
h. Ensure technologies are accessible or work with assistive technologies where learners can control the environment (e.g., keyboard, screen readers, read-out-loud, etc.).	3.7	3.7	4	0.48
Component 3 Display Strategies				
a. Include alternative text or transcriptions for images, diagrams, and graphs. Use proper terminology for text-based descriptions with content for all relevant visuals (synchronous or asynchronous).	3.8	3.8	4	0.42
b. Provide detailed descriptions for complex visuals. For example, describe tables, drawings, virtual worlds, and tours as they occur.	3.7	3.7	4	0.67

c. Have accurate transcripts and closed captions for video and audio files, coordinate live transcribers, or include audio descriptions for an elevated level of accessibility. If using videos in synchronous sessions, share the videos with accurate captions and transcripts before the session.	3.9	3.9	4	0.32
d. Ensure color contrast for course components (links, images, text, virtual backgrounds, etc.), and avoid using color or images as the single method for meaning.	3.8	3.8	4	0.42
e. Test links for functionality, set up links as descriptive links (e.g., the name of the target instead of "Click Here" or the full URL), and use standard formatting (underlined, visual difference to stand out, etc.).	3.9	3.9	4	0.32
f. Promote accessibility awareness at the institutional level and among your learners by using inclusive and culture-sensitive language and encouraging learners to include alternative text, descriptions, transcripts, and captions in their work.	3.9	3.9	4	0.32
g. Give learners complete control over multimedia (e.g., play, pause, and stop at any time), and do not use auto-play or flashing/blinking.	4	4	4	0.00
Component 4 Doing the Work Strategies				
a. Include multiple formats or methods (e.g., transcript, summary, a cheat sheet with steps or processes) and activities (e.g., ungraded practice for complex activities, asynchronous group paper collaboration instead of synchronous collaboration, etc.).	3.4	3.4	4	0.699
b. Add clear rubric criteria with an explanation of the activity, and share ground rules on learners creating accessible content by adding alt text, descriptions, and transcripts.	3.7	3.7	4	0.483
c. Provide clear instructions, expectations, and steps for multimedia completion and engagement.	3.6	3.6	4	0.699
d. Have interpreters and captions for live sessions (whole class and small groups) and record sessions.	3.4	3.4	4	0.70
e. Provide clear explanations and descriptions of elements such as math problems and anything visual (e.g., anything created on the whiteboard, PowerPoint slides, etc.).	3.7	3.7	4	0.67
f. Provide accessible material ahead of time. If learners are presenting, request their presentation to	2.8	2.8	2	0.92

be shared before the session and provide it to other students.				
g. Establish various levels of accommodations through institutional resources (e.g., Office of Disabilities).	3.8	3.8	4	0.42
h. Provide time-based accommodations to give people time to process.	3.6	3.6	4	0.52
i. Ensure the readability level by using headers to break content and vocabulary knowledge.	3.5	3.5	4	0.71
j. Provide accessible tools for learners to use to create their works.	3.6	3.6	4	0.70
Component 5 Coaching Strategies				
a. Provide multiple ways to coach for learners' needs or preferences (e.g., email, messaging apps, learning management system, office hours virtual/in-person, video chats, recorded sessions along with a transcript).	3.4	3.4	4	0.70
b. Share an agenda or clear guidelines before a coaching session to clarify each item or expectation and how much time they will spend.	3.5	3.5	4	0.85
c. Arrange for interpreters (e.g., sign language) for synchronous coaching sessions.	3.7	3.7	4	0.48
d. Include clear feedback to guide learners. Do not rely on colors, images, or shapes as the only source of meaning (e.g., do not use green to represent correct).	3.6	3.6	4	0.52
Component 6 Conviviality Strategies				
a. Use and encourage clear, inclusive language that reflects cultural sensitivity (e.g., describe participants or scenarios in sessions, etc.).	3.5	3.5	4	0.71
b. Resist stereotypes and be inclusive in visual and audio materials.	3.3	3.3	4	0.82
c. Provide clear descriptions of emojis, GIFs, and other visual material that might mean something different for learners. Visuals should not be the only way to convey information.	3.3	3.3	4	0.82
d. Establish ground rules for behaviors and accessibility awareness for both instructors and learners.	3.8	3.8	4	0.42
e. Add multiple check-ins throughout the session to keep learners engaged.	3.5	3.5	4	0.71
f. Make engagement strategies optional, not required.	2.8	2.8	3	0.63

g. Allow responses through the chat feature and include time and long pauses for questions.	3.2	3.2	3	0.79
Component 7 Critical Incident Technique Strategies				
a. Use accessible online forms to collect feedback instead of using Microsoft Word or Adobe PDF documents to gather feedback due to accessibility challenges.	3.4	3.4	4	0.70
b. Ensure all materials are accessible with assistive technologies (e.g., keyboard accessibility to navigate and interact with the materials).	3.9	3.9	4	0.32
c. Provide multiple formats or alternative ways to complete the activity (e.g., open discussion forums, written reflection, etc.).	3.2	3.2	4	0.92
d. Questions are in an inclusive format with both specific and open-ended questions that account for the emotional aspects of the interaction.	3.2	3.2	3	0.79
e. Provide expectations to learners ahead of time (e.g., type of polls, chats, number of poll activities, etc.).	3.4	3.4	4	0.84
f. Use descriptive links.	4	4	4	0.00
g. Conduct follow-up polls after the event or session for synchronous events polls to allow time for reflection.	2.8	2.8	3	0.92
h. Conduct automated and manual accessibility checks.	3.9	3.9	4	0.32
Component 8 Planning and Organization Strategies				
a. Run accessibility checks on all your materials to ensure accessibility and that they are usable with assistive technologies (e.g., keyboard, screen readers, etc.). You can create a checklist to review for accessibility.	3.7	3.7	4	0.67
b. Plan for captions and transcripts in all videos and transcripts for audio only (podcasts).	3.9	3.9	4	0.32
c. Ensure enough color contrast in all your materials and that crucial information does not rely only on color to convey meaning.	3.8	3.8	4	0.42
d. Start with accessibility in mind when designing a course. Create accessible templates that you can use.	4	4	4	0.00
e. Plan for alt text on all images and evaluate the context to ensure accurate information.	3.7	3.7	4	0.67

f. Coordinate with institution resources for professional development funds and access to resources (e.g., accessible tools, textbook companies, etc.).	3.9	3.9	4	0.32
g. Plan for multiple ways for learners to access the content and submit their work.	3.3	3.3	4	0.95
h. Plan heading structure in documents and webpages to allow for better navigation and understanding.	4	4	4	0.00
i. Include a syllabus with clear expectations, participation, organization of content, and objectives.	3.9	3.9	4	0.32

The qualitative data from the open-ended questions was exported from Qualtrics and uploaded to the Phase 3 folder in NVivo to conduct the inductive analysis following Braun and Clarke's six-step thematic analysis.

Table 6 displays the themes and subthemes that emerged from the open-ended questions in the model accessibility enhancement questionnaire during this phase. Five themes were established based on strength of those that received input from five or more participants (50% or more). Subthemes emerged from some themes as a more focused input. The subthemes provided additional insight to update further the accessibility and instructional strategies to continue enhancing the R2D2/C3PO/A and to answer Research Question 2. Some themes and subthemes were consistent and repeated from the interview themes. Those repeated have the same theme number and have an asterisk as an identification mark (*).

Table 6

Themes and Subthemes from Questionnaire

Theme and Subthemes	Participant Responses	Percentage of Participants	Description
Theme 07: Removing barriers with R2D2/C3PO/A	10/10	100%	Participants' input on how the R2D2/C3PO/A model is helping to remove barriers for learners

			with disabilities through existing or new strategies and discussion on how the existing components of the model draft meet the needs of learners with disabilities.
***Theme 04: Learners with disabilities challenges and needs**	9/10	90%	Provides key aspects for creating inclusive and accessible experiences that meet the needs of learners with disabilities along with challenges faced by them.
Subtheme 01: Communication with learners	5/10	50%	Methods to communicate with learners to share information and to request information.
Subtheme 02: Inclusion	4/10	40%	Strategies to manage and provide inclusion.
Subtheme 03: Needs of learners with disabilities	4/10	40%	Strategies to address the needs of learners with disabilities.
***Theme 06: Learning activities and instructional strategies**	9/10	90%	Provides learners' input to existing or needed learning activities and strategies at component levels.
Subtheme 01: Learning Activities at the Components Level	9/10	90%	Discuss learning activities that can support the accessibility of the R2D2/C3PO/A model accessibility. These are structured at a component level.
Subtheme 02: Provide multiple methods for materials at component levels	7/10	70%	Discuss the importance of multiple methods or ways to learning through various components.
Subtheme 03: Set up Clear Instructions and Expectations	5/10	50%	Highlights the key to providing clear instructions and expectations to learners.
Theme 08: Accessible strategies for course design and structure	8/10	80%	Discuss various ways to create accessible course design and structure.

Subtheme 01: Multimedia and visual accessibility	7/10	70%	Highlights the key aspects of multimedia and visual accessibility for online environments.
Subtheme 02: Readability	4/10	40%	Discusses methods to improve the readability experience.
***Theme 01: Conduct Technical Accessibility Testing**	5/10	50%	Includes various ways for accessibility checks and testing.

The open-ended questions gathered participants' inputs on additional accessibility strategies, learning activities, and components' improvements to accommodate learners with disabilities better. Additionally, participants were able to provide further feedback on how the enhanced R2D2/C3PO/A removes barriers for learners with disabilities and overarching strategies that should be applied across all components. To conclude, participants also shared additional suggestions on improving the accessibility of the model's learning activities for all learners, including those with disabilities. Participants' inputs throughout the qualitative data collected on the questionnaire are available among the themes.

Theme 07: Removing Barriers with R2D2/C3PO/A. Ten out of ten participants (100%) mentioned this theme as part of their responses to the questionnaire's open-ended questions. This theme focused on participants' input on how the R2D2/C3PO/A model is helping to remove barriers for learners with disabilities. This section presents excerpts from some of the participants.

Participant AE01 said "Nothing will be 100% accessible to all learners, but the considerations of Perceivable, Operable, Understandable, and Robust (from Web Content Accessibility Guidelines) are throughout. Education and awareness about existing guidelines and best-practice tools might also be helpful in certain areas of the instructional model: while tools change, it would help establish a cadence for checking in on resources and tools, what those tools can/cannot do, and what is regarded as good and useful tools by disabled communities."

Participant AE02 said "Following the accessibility best practices will allow for more student understanding and success."

Participant AE03 said "The enhanced model can remove barriers by recognizing the diversity of access needs learners have and honoring multiple methods of learning, engagement, and growth by disabled learners. By not only recognizing this diversity but by structuring the options needed to support this diversity, online synchronous and asynchronous learning can be a more flexible environment that meets students based on their access needs instead of based on assumed capacity."

Participant AE04 said "It can give a clear model to instructors so they can focus on their content area."

Participant ID01 said "Providing this rubric will educate and help instructors to be aware of the options they can provide… This is a great model and should be distributed to private, corporate, and public education settings."

Participant ID02 said "It is a very thorough tool that appears to take a variety of learners with disabilities, including invisible disabilities, into consideration. This can only improve learning outcomes for a greater number of learners online and asynchronously."

Participant ID03 said "It may offer a more comprehensive and thorough approach to accessibility in teaching and learning."

Participant ID04 said "The enhanced model takes all students into account and takes the emphasis off solely visual or audio components (both in content and live sessions) and accounts for the need for transcription, closed captions, and alternatives for synchronous and asynchronous learning activities and content. It also now emphasizes digital readability (headings, contrast, and screen reader access) …"

Participant ID05 said "The R2D2/C3PO/A model enhances online synchronous and asynchronous learning for students with disabilities by promoting diverse content representation and fostering an inclusive environment through tailored communication and collaboration. This approach ensures adaptability and support effectively."

Participant ID06 said "If this resource is followed when designing a course, then students with visual, auditory, and cognitive differences will succeed to their full capacities, and the other student populations will also benefit from the improved course design. It provides a plan and expectations for course designers to follow so accommodation components are not missed."

Theme 04*: Learners with Disabilities, Challenges and Needs. Nine out of ten participants (90%) mentioned this theme as part of their responses to the questionnaire's open-ended questions. This theme focused on providing key aspects for creating inclusive and accessible experiences that meet the needs of learners with disabilities and is repeated from the themes that emerged from the individual semi-structured interviews. Three subthemes emerged from this theme in the questionnaire. This section presents excerpts from some of the participants.

Participant AE01 said "If the institution has existing resources - even discounted licenses or even a newsletter internal to the institution for teacher/coach training, etc - use them. If not, argue for them as much as possible so resources and educator awareness are strengthened. Improving resources for everyone is the "curb cut effect" and often impacts people who aren't disabled as well (i.e., captions also helping those who speak multiple languages or have a lot of ambient noise around them)."

Participant AE02 said "Keep in mind anxiety and other disorders that can hinder understanding of concepts."

Participant AE03 said "One thing that stood out was the emphasis on interpreters. Interpreters are necessary for some learners, and that should always be a priority for the learners that need it. Instructors are also, however, responsible for hiring interpreters only when necessary. If no students in a class need the interpreter, do NOT hire an interpreter (especially for sign language) - doing so removes interpreters from the limited pool of professionals available. Especially for content that is not recorded and does not plan to be shared outside of the immediate learning community. Prioritize the incorporation of accurate captioning over interpreters unless, again, there are learners who are sign language users or may even be primarily fluent in spoken languages outside of the primary course language."

Participant ID01 said "Incorporate more diversity in teaching examples and analogies."

Participant ID02 said "Encouragement and attention to inclusive language, cultural sensitivity, and consideration should be applied across all components. I would like to see more inclusion or perhaps just mention of learners with chronic illnesses, which are often invisible."

Participant ID04 said "Be sure questions asked are inclusive of the experience everyone would have had, not just those without accommodations."

Participant ID05 said "Additionally, regular feedback from learners with disabilities can help identify barriers and inform adaptations."

Theme 06*: Learning Activities and Instructional Strategies. Nine out of ten participants (90%) mentioned this theme as part of their responses to the questionnaire's open-ended questions. This theme focused on providing inputs from learners to existing or needed learning activities and strategies at component levels and it is repeated from the themes that emerged from the semi-structured interviews. Three subthemes emerged from this theme in the questionnaire. This section presents excerpts from some of the participants.

Participant AE01 said "Have multiple methods of engagement whenever possible, because otherwise conviviality and working together can be taken over by the loudest vocal person in the group, instead of everyone in the group being able to participate."

"WebAIM Million project as a reference; the "curb cut" effect can be used to give examples of designing for multiple audiences (for example, people who use captions on videos aren't always the same people who identify as disabled, partly due to stigma, but also because captions are useful for things like ambient noise like vacuums, construction, or anything like that; also captions and transcripts are useful for learners who concentrate on the words/language and can look up unfamiliar words, or who may have difficulty distinguishing speech patterns."

Participant AE02 said "Adding in animations or videos that will support content, adding in competency-based learning for some units or lessons, peer evaluations, lots of check-ins that include reflection or practice of concepts, clear expectations and continuous feedback, and having activities that are anonymous or quick check-ins."

Participant AE03 said "Include information about the length of materials (word count, minutes, etc.), provide content notes for materials that could be emotionally difficult to process for any number of reasons, offer an opportunity for learner input into agenda or guidelines before coaching sessions to collaboratively establish use of coaching time, create time-accommodations for responding to discussions and concepts occurring in the moment at a later time without penalty or judgment, prepare plain language alternative explanations of concepts and materials from the course, and the content presented in multiple ways should be equitable forms of access."

Participant ID01 said "Provide audio feedback in addition to written feedback, allow mobile devices for dictation, provide examples that are thorough and complete, provide immediate feedback (automated), and encourage new delivery methods and explore options appropriate to the specific accommodations."

Participant ID02 said "Include glossaries or tooltips for complex terms, abbreviations, or jargon to help learners who may struggle with technical language or unfamiliar vocabulary, design an icebreaker activity that invites students to give a brief introduction or history of their name, whether bestowed by family, self-selected, or otherwise, this activity is a great way to help the instructor and students learn each other's names, offering multiple methods of completion, and asking learners for feedback on activities and how to improve their user experiences."

Participant ID03 said "Ensure the length of the writing assigned is appropriate with the time allotted to complete the task, make sure students understand the expectations of tasks and assignments, set clear expectations for group works with guidelines for conflict resolution, and incorporate reflections and tie them to lessons learned in conviviality."

Participant ID04 said "Encourage submission of at least one draft to obtain feedback, consider what AI strategies, if any, could be used to help complete work, clear and concise course policies, along with clear and concise consequence, use a variety of materials, not just readings or just videos. Make sure there is diversity in voices being shared as well."

Participant ID05 said "Consider incorporating customizable learning paths that allow learners to engage with content at their own pace and preferred method, whether through text, video, or interactive elements."

Participant ID06 said "Allow group work to be conducted asynchronously when needed - do not require synchronous group work when possible. Provide just-in-time areas for gathering student feedback on course design as the course progresses, instead of saving for the conclusion of the course."

Theme 08: Accessible Strategies for Course Design and Structure. Eight out of ten participants (80%) mentioned this theme as part of their responses to the questionnaire's open-ended questions. This theme focused on participants' input on how the R2D2/C3PO/A model is helping to remove barriers for learners with disabilities. Two subthemes emerged from this theme. This section presents excerpts from some of the participants.

Participant AE01 said "… avoiding flickering etc. (between 3 flashes and 25 frames/flashes per second) can help avoid health issues like migraine, dizziness, and epileptic triggers. So, for me, this is even MORE crucial because it can cause physical harm to the learners."

Participant AE02 said "Making sure words in videos are also described, and [that] the course itself is in a logical structure to minimize confusion."

Participant AE03 said "Offer plain language and/or easy-read versions of display opportunities when possible. Plan for enough time to build accessibility into your course, both individually and when relying on institutional resources… Practice/refine the visual descriptions of all displays before presenting to learners."

Participant ID01 said "Incorporate more HTML pages instead of PDF if possible, ensure all displays are responsive on mobile devices, and use accessible coding for HTML forms."

Participant ID02 said "Noise-free options (ability to remove music or ambient sounds) in recorded material for auditory processing disorders, customizable text options (ability to change font color, size, type; option to enable dyslexia friendly fonts), and [other] customizable options for the user."

Participant ID03 said "Include reading aloud as an option to check understanding of instructions, consider allowing dark/light mode, and ensure font and font sizes are easy to read."

Participant ID04 said "Be consistent in design. Do not switch formatting and heading structure from week to week."

Participant ID06 said "In instructor-created or institution-created written content, check the order of information provided, group information with clear heading and sub-heading titles, and record all synchronous presentations and lectures to be shared with students needing to re-review."

Theme 01*: Conduct Technical Accessibility Testing. Five out of ten participants (50%) mentioned this theme as part of their responses to the questionnaire's open-ended questions. This theme focused on using various methods for accessibility checks and testing and is repeated from the themes that emerged from the individual semi-structured interviews. This section presents excerpts from some of the participants.

Participant AE02 said "Having a checklist or guide when creating the course and activities to keep accessibility in mind."

Participant ID01 said "Allow various platforms and check responsiveness on multiple formats."

Participant ID02 said "Do user experience testing; ask volunteers to screen record their experiences and narrate any issues or frustrations they experience."

Participant ID04 said "Build in time to practice or troubleshoot with technology before the official session so that time can be spent on coaching goals vs tech issues."

Summary of Research Question 2 Results. After conducting the inductive analysis following Braun and Clarke's thematic analysis using the participants' responses to the model accessibility enhancement questionnaire, the second draft of the R2D2/C3PO/A model was completed (Appendix E). The model was updated based on the themes and subthemes strength from the questionnaire. The accessibility and learning strategies were updated in the model's new accessibility column and to address Research Question 2. After this update and analysis, it was possible to proceed with the focus group, the final data collection method aimed to answer Research Question 3.

Research Question 3: Phase 3

What components of the updated R2D2/C3PO/A model do instructional designers and accessibility experts believe are best practices for implementing online courses, which are accessible to all students? The answer to this RQ was completed in Phase 3 through the data collection and analysis of the focus group and NGT (Appendix F) to rank the accessibility strategies with a selected group of experts. The email invitation to participate in the focus group and the updated model were sent to the six randomly selected participants, along with a link to the Doodle poll to choose from the options for the best date and time to conduct the focus group. After not receiving confirmation from some participants, the invitation was extended to the remaining four participants. Five participants confirmed their participation; however, only four attended the session.

Phase 3: Evaluation. The last part of Phase 3 included the focus group and NGT to rank the strategies and validate the mode. Before the focus group, the five confirmed participants received the updated R2D2/C3PO/A model through email. The focus group, conducted through Zoom and moderated by Dr. Ann Armstrong and co-moderated by the researcher, followed the

Nominal Group Technique (NGT) and lasted 90 minutes. Similarly to the model accessibility enhancement questionnaire, the data analysis for the focus group was analyzed using two methods: 1) a descriptive analysis through Excel to define the mean, mode, average, and standard deviation of the voting and ranking results, and 2) an inductive analysis following Braun and Clarke's six-step thematic analysis for the qualitative data shared through the sharing ideas and group discussion sections. The qualitative data was uploaded to NVivo Phase 3 for the inductive analysis. Table 7 summarizes the results of the focus group and the NGT.

Table 7

Focus Group Voting and Ranking Summary Results

R2D2/C3PO/A Model Component	AVG	MEAN	MODE	SD
Component 1: Read/ Listening/ Viewing Strategies				
a. Include transcripts for any audio (podcasts) and videos in a downloadable format. These include descriptive transcripts (e.g., explanation of a scene or formula) for any visuals on slides or videos.	4	4	4	0
b. Include alternative text and descriptions for visuals (such as images, infographics, and GIFs) and provide a summary for complex images.	3.75	3.75	4	0.5
c. Include accurate closed captions for all videos.	4	4	4	0
d. Enable live captions and coordinate with the Office of Disabilities for interpreters in live synchronous sessions. Interpreters should be scheduled only when necessary.	3.5	3.5	3	0.57
e. Use accessibility tools (e.g., Microsoft Accessibility Checker, Adobe Accessibility Checker, Color Contrast Analyzers, etc.) for automated accessibility checks. Conduct manual checks in addition.	3.5	3.5	4	0.57
f. Provide multiple methods for learners to access the content and to complete their activities (e.g., alternative written options to existing activities and methods such as multimedia, case studies, questionnaires, etc.). Share materials or pre-reading content (glossaries, tooltips, guided templates) with learners ahead of time. *	2.75	2.75	3	0.5

g. Use heading structures (H1 to H6) for proper navigation, content understanding, and proper readability.	4	4	4	0
h. Ensure keyboard navigation and functionality for all activities (e.g., video players, interactive media, etc.), provide font size and line height adjustments, and provide the user control over multimedia (e.g., video play, pause, stop).	4	4	4	0
i. Ensure proper color contrast between background and content (apply to content, images, links, etc.).	4	4	4	0
j. Minimize the use of Adobe PDF documents due to accessibility challenges and remediation costs and ensure reading materials from original sources.	3.25	3.25	3	0.5
Component 2: Reflect/ writing/ sharing Strategies				
a. Provide learners with multiple formats and methods to complete activities (e.g., alternative versions of existing formats, two options to complete an activity, create practice quizzes before any primary assessment, use social media engagement, creative compositions, personal reflections, flexible journaling, sentence starters, etc.).	3.25	3.25	3	0.5
b. Include transcriptions and captions for synchronous events (e.g., breakout rooms, live sessions) or coordinate for transcribers or interpreters when needed.	3.75	3.75	4	0.5
c. Allow for flexibility by providing additional time for discussions and activity completion for those who need it.	3.25	3.25	3	0.5
d. Provide clear instructions and details of sessions, quizzes, interactions, and activities (e.g., details about a quiz such as the number of questions, choices, sentences, or if they include pictures, audio clips, etc.).	3.75	3.75	4	0.5
e. Use institutional accessibility resources (e.g., transcribers, sign language interpreters (when needed, Braille printer, etc.).	3.75	3.75	4	0.5
f. Send content ahead in advance (e.g., links to videos that will be displayed in synchronous sessions, slides, pre-reading) to allow learners to take notes.	3	3	3	0.81
g. Ensure technologies are accessible or work with assistive technologies where learners can control	4	4	4	0

the environment (e.g., keyboard, screen readers, read-out-loud, volume controls, etc.).				
h. Leverage Artificial Intelligence to support accommodations (e.g., writing, scanning sources and citations, provide alt text, break down ideas of simplifying language). *	2.75	2.75	3	0.5
i. Provide graphic organizing to help plan for writing and include readability checkers (e.g., Grammarly) to help learners phrase their ideas. *	2.5	2.5	2	0.57
Component 3 Display Strategies				
a. Include alternative text or transcriptions for images, diagrams, and graphs. Use proper terminology for text-based descriptions with content for all relevant visuals (synchronous or asynchronous).	4	4	4	0.000
b. Provide detailed descriptions for complex visuals. For example, describe tables, drawings, virtual worlds, and tours as they occur.	3.5	3.5	4	1.000
c. Have accurate transcripts and closed captions for video and audio files, coordinate live transcribers when needed, or include audio descriptions for an elevated level of accessibility. If using videos in synchronous sessions, share the videos with accurate captions and transcripts before the session.	3.75	3.75	4	0.500
d. Ensure color contrast for course components (links, images, text, virtual backgrounds, etc.), and avoid using color or images as the single method for meaning.	4	4	4	0.000
e. Test links for functionality, set up links as descriptive links (e.g., the name of the target instead of "Click Here" or the full URL), and use standard formatting (underlined, visual difference to stand out, etc.).	4	4	4	0.000
f. Promote accessibility awareness at the institutional level and among your learners by using inclusive and culture-sensitive language and encouraging learners to include alternative text, descriptions, transcripts, and captions, and avoid flashing or flickering images in their work.	3.75	3.75	4	0.500
g. Give learners complete control over multimedia and content (e.g., volume, play, pause, stop at any time, options to view and hide content), and do not use no auto-play or flashing/blinking.	3.75	3.75	4	0.500

h. Minimize the use of decorative visuals that are not meaningful or relevant to the content.	3	3	3	0.816
Component 4 Doing the Work Strategies				
a. Include multiple formats or methods (e.g., transcript, summary, a cheat sheet with steps or processes, audio and video submissions) and activities (e.g., ungraded practice for complex activities, asynchronous group paper collaboration instead of synchronous collaboration, fieldwork experience, scenarios, problem-based activities, literature reviews, visual and written creations, etc.).	3.5	3.5	4	0.577
b. Add clear rubric criteria with an explanation of the activity, and share ground rules on learners creating accessible content by adding alt text, descriptions, and transcripts.	4	4	4	0.000
c. Provide clear instructions, expectations, and steps for multimedia completion and engagement.	3.5	3.5	3	0.577
d. Have interpreters (when needed) and captions for live sessions (whole class and small groups) and record sessions.	3.5	3.5	4	0.577
e. Provide clear explanations and descriptions of elements such as math problems and anything visual (e.g., anything created on the whiteboard, PowerPoint slides, etc.).	3.5	3.5	4	0.577
f. Establish various levels of accommodations through institutional resources (e.g., Office of Disabilities).	3.75	3.75	4	0.500
g. Provide time-based accommodations to give people time to process.	3.25	3.25	4	0.957
h. Ensure the readability level by using headers to break and organize content and vocabulary knowledge.	3.5	3.5	4	0.577
i. Provide accessible tools and customization options (i.e., font, size, style, colors, context, etc.) for learners to use to complete content and assignments.	3.25	3.25	4	0.957
j. Encourage learners to use resources available from institutions that will support their journey (e.g., writing centers, communication, etc.)	3.5	3.5	3	0.577
Component 5 Coaching Strategies				

a. Provide multiple ways to coach for learners' needs or preferences (e.g., email, messaging apps, peer mentoring and evaluations, learning management system, office hours virtual/in-person, video chats, recorded sessions along with a transcript).	3.25	3.25	3	0.500
b. Share an agenda or clear guidelines before a coaching session to clarify each item or expectation and how much time they will spend.	3.75	3.75	4	0.500
c. Arrange for interpreters (e.g., sign language) for synchronous coaching sessions when needed.	3.5	3.5	3	0.577
d. Include clear feedback to guide learners. Do not rely on colors, images, or shapes as the only source of meaning (e.g., do not use green to represent correct)	4	4	4	0.000
e. Provide learners with enough time for reflection.	3.5	3.5	4	0.577
Component 6 Conviviality Strategies				
a. Provide multiple methods of engagement for learners to enable participation and create time accommodations for their responses.	3.25	3.25	3	0.500
b. Use and encourage clear, inclusive language that reflects cultural sensitivity (e.g., describe participants or scenarios in sessions, call learners by their name with accurate pronunciation, etc.).	4	4	4	0.000
c. Resist stereotypes and be inclusive in visual and audio materials.	3.75	3.75	4	0.500
d. Provide clear descriptions of emojis, GIFs, and other visual material that might mean something different for learners. Visuals should not be the only way to convey information.	3	3	2	1.155
e. Establish ground rules for behaviors and accessibility awareness for both instructors and learners.	3.5	3.5	3	0.577
f. Add multiple check-ins throughout the session to keep learners engaged.	3	3	3	0.816
g. Allow responses through the chat feature and include time and long pauses for questions.	3	3	3	0.816
h. Include open discussions with time accommodation as a method of engagement for learners to ask questions of each other, for friendly connections, and discuss lessons learned.	3.5	3.5	3	0.577
Component 7 Critical Incident Technique Strategies				

a. Use accessible online forms to collect feedback instead of using Microsoft Word or Adobe PDF documents to gather feedback due to accessibility challenges.	4	4	4	0.000
b. Ensure all materials are accessible with assistive technologies (e.g., keyboard accessibility to navigate and interact with the materials).	4	4	4	0.000
c. Provide multiple formats or alternative ways to complete the activity (e.g., open discussion forums, written reflection, etc.).	3.25	3.25	3	0.500
d. Questions are in an inclusive format with both specific and open-ended questions that account for emotional aspects of the interaction.	3.25	3.25	3	0.500
e. Provide expectations to learners ahead of time (e.g., type of polls, chats, number of poll activities, etc.).	3.75	3.75	4	0.500
f. Use descriptive links.	4	4	4	0.000
g. Conduct automated and manual accessibility checks.	3.75	3.75	4	0.500
h. Include multiple check-ins for feedback throughout the course to gather feedback on activities and user experience improvement.	3.75	3.75	4	0.500
Component 8 Planning and Organization Strategies				
a. Run accessibility checks on all your materials to ensure accessibility and that they are usable with assistive technologies (e.g., keyboard, screen readers, etc.). You can create a checklist to review for accessibility.	4	4	4	0.000
b. Plan for captions and transcripts in all videos and transcripts for audio only (podcasts) and include guidelines for learners on video/audio time length.	4	4	4	0.000
c. Ensure enough color contrast in all your materials and that crucial information does not rely only on color to convey meaning (e.g., marking required fields). Consider color contrast in synchronous sessions and prevent virtual backgrounds or clothes that can cause a flickering screen.	4	4	4	0.000
d. Start with accessibility in mind when designing a course. Create accessible templates that you can use.	4	4	4	0.000
e. Plan for alt text on all images and evaluate the context to ensure accurate information.	4	4	4	0.000

f. Coordinate with institution resources for professional development funds and access to resources (e.g., accessible tools, textbook companies, etc.), leverage the accessibility tools and features from the LMS, and plan for support staff accommodation.	3.75	3.75	4	0.500
g. Plan multiple ways for learners to access the content and submit their work.	3.5	3.5	4	0.577
h. Plan heading structure in documents and webpages to allow for better navigation and understanding.	4	4	4	0.000
i. Include a syllabus with clear expectations, participation, organization of content, and objectives.	3.75	3.75	4	0.500
j. Provide learners with guided tips to organize time and the space to share their own timelines based on their needs or perceptions.	3.5	3.5	4	1.000

The qualitative data from the sharing ideas and group discussion was extracted from the transcript and uploaded to the Phase 3 folder in NVivo to conduct the inductive analysis following Braun and Clarke's six-step thematic analysis.

Table 8 displays the themes and subthemes that emerged from the focus in this phase. Four themes were established based on those that received input from two or more participants (50% or more). Additionally, subthemes emerged from some themes as a more focused input. The subthemes provided additional insight to finalize the R2D2/C3PO/A model and to answer Research Question 3. Some themes and subthemes were consistent and repeated from the interviews and questionnaire themes. Those repeated have the same theme number and have an asterisk as an identification mark (*).

Table 8

Themes and Subthemes from Focus Group and NGT

Theme and Subthemes	Participant Responses	Percentage of Participants	Description
***Theme 06: Learning activities and instructional strategies**	4/4	100%	Discussion of activities and strategies to integrate and promote accessibility in online courses.
Subtheme 01: Using institutional resources	3/4	75%	Discuss various ways to leverage institutional resources to support accessibility and learners, and ways for learners to benefit from these resources.
Subtheme 02: Learner needs and engagement	2/4	50%	Focuses on the needs and approaches to engage learners in the accessibility and inclusion process.
Theme 09: Give user control over media and content	4/4	100%	Discuss strategies to give users control over multimedia and the content they access.
Theme 10: Leverage artificial intelligence for accommodations	4/4	100%	Discuss the use of AI as an alternative to address accommodations and better support the learner's experience and engagement.
***Theme 02: Strategies for Visual and Multimedia Accessibility**	3/4	75%	Discuss various ways to create accessible course design and structure.
Subtheme 01: Video Accessibility	2/4	50%	Highlights the key aspects of video accessibility.

The focus group's sharing ideas and discussion sections gathered participants' inputs on the R2D2/C3PO/A model and the accessibility strategies. It allowed participants to share a new idea per each component and a group discussion to defend, expand, or argue other participants' strategies. Participants' inputs throughout the qualitative data collected on these sections of the focus group are available among the themes.

Theme 06*: Learning Activities and Instructional Strategies. Four out of four participants (100%) mentioned this theme as part of their responses to sharing ideas and group discussion during the focus group and NGT. This theme focused on the discussion of activities and strategies for integrating and promoting accessibility in online courses and is repeated from the themes that emerged in previous data collection methods. Two subthemes emerged from this theme. This section presents excerpts from some of the participants.

Participant 1 said "Be sure to confirm accommodations and attendance of support staff, and include that in the overall planning, encourage active participation from all users and use inclusive language while providing instructions, and encourage active participation from all users and use inclusive language while providing instructions."

Participant 2 said "Send content ahead in advance (e.g., links to videos that will be displayed in synchronous sessions, slides, pre-reading).."

Participant 4 said "[Tools] It'll recognize like if you're heading levels aren't set up correctly. I don't know if it does, color contrast. I know it used to do like if your image didn't have alt text, though I don't know that it would recognize if it was like, oh, this is a decorative image versus. This is something you need to provide all text for, but it would at least flag it if you didn't check the box, for it being all text or not."

Participant 3 said "I see Canvas [LMS] calls it "you do it" universal design online, content, inspection tool. Then they have an element called You Fix It, which scans the entire course for accessibility issues, then pushes out a report, and then you can check off the ones you did that you addressed. And then save any for, like, a future revision."

Theme 09: Give User Control Over Media and Content. Four out of four participants (100%) mentioned this theme as part of their responses to sharing ideas and group discussion during the focus group and NGT. This theme focused on discussions for strategies to allow users to have control over multimedia and the content they access. This section presents excerpts from some of the participants.

Participant 1 said "When giving learners complete control over multimedia, confirm and ensure that proper tools are present for learners to access the content (i.e., software such as JAWS, or ergonomic mouse, etc.)… it could be looked at in different ways like it could be the platform itself, where they customize it, so that the fonts are always the same size, or you know, the colors are always the same. So, if they have color blindness, or you know other conditions, they could do that also. Maybe customization options in terms of like providing context…"

Participant 2 said "Give learners complete control over multimedia (e.g., volume, play, pause, and stop at any time) and do not use no auto-play or flashing/blinking. [Also], font type/size-hard return vs. spacing vs. use of line breaks."

Participant 3 said "Allow users to not only adjust font size and style but also modify font characteristics like letter spacing, line height, and stroke thickness, adapting text visibility to individual needs. Offer dyslexia-friendly fonts as well as options for larger spacing for improved readability. Possibly, offer a simplified or "layered" display mode where users can hide or reveal content incrementally, minimizing distractions and helping those with cognitive disabilities process information in smaller, manageable chunks."

Theme 10: Leverage Artificial Intelligence for Accommodations. Four out of four participants (100%) mentioned this theme as part of their responses to sharing ideas and group discussion during the focus group and NGT. This theme focused on participants' ideas to use

Artificial Intelligence (AI) as an alternative to address accommodations and better support the learners' experiences and engagement. This section presents excerpts from some of the participants.

Participant 1 said "…but even in the read and listening, none of us mentioned AI. And I think AI could play a huge role with reading and listening, and all of these… I think it might be helpful to incorporate a little bit of the AI, the role of AI in supporting accommodation, accessibility in reading and writing…"

Participant 2 said "… in terms of artificial intelligence because it could potentially be leveraged, for example, to provide alternative text that works for complex images, complex tables. However, obviously, this must be run by the expert, the SME, and consider that for a generative AI, making sure that the sources, right, the citations, etc. are appropriate, and in that, probably establish trusted generative AI tools that have been tested for issues."

Participant 3 said "Yeah, I think you could also mention to learners that if they're struggling with complex ideas or very technical ideas, you could leverage AI to break that down into you know, to kind of rephrase it for a different education level or age group."

Participant 4 said "Well, in doing the work. Do you just need to say, in general, set parameters on how AI can be used because…Provide accessible tools for learners to use to complete assignments. Does that need to be elaborated upon to say? Use AI sparingly. Use AI for only these things, but not this much…"

Theme 02*: Strategies for Visual and Multimedia Accessibility. Three out of four participants (75%) mentioned this theme as part of their responses to sharing ideas and group discussion during the focus group and NGT. This theme focused on discussing various ways to create accessible course design and structure and is repeated from the themes that emerged in previous data collection methods. One subtheme emerged from this theme through the focus group. This section presents excerpts from some of the participants.

Participant 2 said "I think that short videos are always the best option in general. As long as they are focused and provide the content that you need. Truth be told that, we are consumers of TikTok, where consumers are YouTube shorts. I believe in providing that. So yeah, I would say that longer videos can be used, but you can also chunk those videos in chapters…"

Participant 3 said "You can also provide, you know, kind of an introductory context to those longer videos to say, this is optional viewing. But here's why I selected it. Here's why I like it…Watch from this timestamp to this one because it makes a really good point about X, and that can, you know, at least get them looking at the most important part."

Participant 4 said "I just say, if there's a transcript, I would skim the transcript versus watch the video. You can't really skim a video, but you can transcript and be like, oh, let me see if I can go find that for additional context…"

Summary of Research Question 3 Results. After conducting the inductive analysis following Braun and Clarke's thematic analysis using the qualitative data from the focus group and NGT and the voting and ranking, the final update to the R2D2/C3PO/A model was completed (Appendix H). After the focus group, participants received a summary and transcript of the focus group session. A cross-analysis of themes among all three phases was conducted to identify the themes' evidence across all data sources and to establish the final themes for the study.

Themes Qualitative Cross-Analysis

Table 9 includes a cross-analysis of the qualitative data collected throughout the individual semi-structured interviews with participants in Phase 1, the model accessibility enhancement questionnaire deployed to all participants in Phase 3, and the Focus Group and NGT in Phase 3. All 10 participants participated in the individual semi-structured interviews and model accessibility enhancement questionnaire. A random selection of participants was conducted to participate in the focus group and NGT—four participants assisted to the focus group and NGT session. The data includes the number of participants that contributed to the theme on each data collection instrument. A detailed cross-analysis follows in Table 9 that includes the final themes for the study and their relation to the research questions.

Table 9 includes six columns. The first column displays the list of final themes and subthemes for the study. After conducting the cross-analysis, some themes from the individual data collection methods were consolidated with subthemes that emerged earlier in the analysis with a significant strength. Columns 2 to 4 display the number of participants that discussed this theme on each of the data collection methods from the total of participants on each. The fifth column display the number of times the themes emerged across all data sources. The sixth column display the research questions that were addressed with each theme.

Table 9

Final Themes and Cross-Analysis

Themes	Participant Responses			Evidenced in All Data Sources	Themes Link to Research Questions
	Semi-Structured Interviews	Model Accessibility Enhancement Questionnaire	Focus Group and NGT		
Theme 01: Conduct technical accessibility testing	10/10	5/10	0/4	No (2/3)	RQs 1 & 2
ST 01: Accessibility testing and tools	9/10	0/10	0/4	No (1/3)	
ST 02: Test for functionality with assistive technologies	8/10	0/10	0/4	No (1/3)	

Theme 02: Strategies for visual and multimedia accessibility*	10/10	0/10	3/4	No (2/3)	RQs 1 & 3
ST 01: Alternative text or description for images	7/10	0/10	0/4	No (1/3)	
ST 02: Closed captions for live videos or recordings	10/10	0/10	0/4	No (1/3)	
ST 03: Color contrast and styling	9/10	0/10	0/4	No (1/3)	
ST 04: Creating accessible presentations	6/10	0/10	0/4	No (1/3)	
ST 05: Describe complex graphics or components	9/10	0/10	0/4	No (1/3)	
ST 06: Give user control over time-based media	4/10	0/10	4/4	No (2/3)	
ST 07: Transcripts for elements with audio	7/10	0/10	0/4	No (1/3)	
Theme 03: Digital document accessibility	10/10	0/10	0/4	No (1/3)	RQs 1
ST 01: Create proper heading structure	7/10	0/10	0/4	No (1/3)	
ST 02: Challenges in PDF accessibility	6/10	0/10	0/4	No (1/3)	
ST 03: Making accessible links	5/10	0/10	0/4	No (1/3)	
ST 04: Content readability*	5/10	0/10	0/4	No (1/3)	
Theme 04: Learners with disabilities challenges and needs	10/10	9/10	0/4	No (2/3)	RQs 1 & 2
ST 01: Challenges for learners with disabilities	10/10	0/10	0/4	No (1/3)	
ST 02: Learners with disabilities needs	10/10	4/10	0/4	No (2/3)	

ST 03: Communication to learners	0/10	5/10	2/4	No (2/3)	
ST 04: Inclusion	0/10	4/10	0/4	No (1/3)	
Theme 05: Frameworks and model enhancement needs	8/10	0/10	0/4	No (1/3)	RQ 1
ST 01: R2D2/C3PO Model Enhancement	7/10	0/10	0/4	No (1/3)	
Theme 06: Learning activities and instructional strategies	10/10	9/10	4/4	**Yes**	RQs 1, 2, 3
ST 01: Give Flexibility to Learners	6/10	0/10	0/4	No (1/3)	
ST 02: Use Inclusion and Culture Sensitivity Practices	8/10	0/10	0/4	No (1/3)	
ST 03: Provide Multiple Methods of Materials or Assessment	10/10	7/10	0/4	No (2/3)	
ST 04: Provide Pre-Content and Prework Ahead of Time	6/10	0/10	0/4	No (1/3)	
ST 05: Enhance Interactions Between Learners and Instructors	7/10	0/10	0/4	No (1/3)	
ST 06: Give Detailed Rubrics Criteria and Instructions for Learners	10/10	5/10	0/4	No (2/3)	
ST 07: Preparation and Planning by Faculty	10/10	0/10	0/4	No (1/3)	
ST 08: Using Institutional Resources for Disability	7/10	0/10	3/4	No (2/3)	
ST 09: Accessible Methods for Feedback and Coaching	9/10	0/10	0/4	No (1/3)	

ST 10: Using Third-Party Resources in Live Courses	7/10	0/10	0/4	No (1/3)	
ST 11: Explore the Accessibility of Pools or Questionnaires	6/10	0/10	0/4	No (1/3)	
ST 12: Learning Activities at the Components Level	0/10	9/10	0/4	No (1/3)	
Theme 07: Removing barriers with R2D2/C3PO/A	0/10	10/10	0/4	No (1/3)	RQs 2
Theme 08: Leverage Artificial Intelligence for Accommodations	0/10	0/10	4/4	No (1/3)	RQs 3

This section presented the results of the overall study throughout each of the iterative phases. The output of Phase 3 and the study was the updated and validated R2D2/C3PO/A model (Appendix H). The following section will discuss the evaluation of findings and the presentation of the final R2D2/C3PO/A model.

Evaluation of the Findings

This qualitative design and development model use case study defined the process of creating accessible learning activities. It expanded the validated research-based R2D2/C3PO instructional design model by integrating accessibility strategies to the eight components and augmented it to the R2D2/C3PO/A. The problem addressed in this study was that online educators and instructional designers experience challenges with accessibility guidelines and their application when creating usable, accessible, and inclusive online courses due to limited and differing guidance at various levels (Baldwin & Ching, 2021; Lowenthal et al., 2021). The study started with a document analysis of the literature review. Through the document analysis, several accessibility challenges, needs, and strategies were identified for the disability groups.

These findings from the literature in Acosta et al. (2020), Baldwin and Chin (2021), Che et al. (2022), Cifuentes et al. (2019), Kurt (2019), Lowenthal et al. (2020), Murphy (2019), Rodrigo and Tabuenca (2020), and Wu He et al. (2022) aligned with the experts' perspectives throughout the data collection interactions. Table 10 displays accessibility strategies that emerged from the document analysis of the literature review and the themes that emerged from the study to address these strategies.

Table 10

Accessibility Challenges, Needs, and Strategies Per Disability Group

Disability group	Challenges or needs	Strategies	Themes from the Study
Elderly (Age)	Challenges accessing multimedia published online	Elders might benefit from strategies directed to all other groups.	Theme 04: Learners with disabilities challenges and needs
Hearing (partially and fully)	The absence of captions, textual transcriptions, or sign language causes exclusion	**Closed captions (synchronous and asynchronous)** • Transcriptions of the dialogue in which speakers are identified • Include sound effects or information needed to understand their content. **Clean audio** • An audio channel that separately contains the spoken dialogue of non-voice information. **Sign language** • Uses facial expressions, combinations of hand and arm movements, or body positions to convey meaning. **Text video descriptions** • Textual descriptions of all audio sounds and significant visual information	Theme 02: Strategies for visual and multimedia accessibility Theme 04: Learners with disabilities challenges and needs

		Transcriptions (synchronous and asynchronous) • Text that contains the dialogue, the identification of the characters involved, and the content	
Vision (complete, partial, glaucoma, etc.)	Scanned documents cause challenges due to cut-off text or poor contrast between the background color and text. Some visual learners (e.g., low vision or eye fatigue) might need magnification software for a customizable visual experience.	**Audio descriptions** • Descriptions added to the soundtrack containing essential visual details **Text video descriptions** • Textual descriptions of all audio sounds and significant visual information **Transcriptions** • Text that includes the dialogue, character identification, and the content **Alternative text (alt text)** • Describe images to those who are unable to see them. **Color contrast** • Allows optimal visual perception of content for all users (e.g., those with low vision, those looking at a screen in bright sunlight) **Link text** (Contextual links) • It benefits learners in terms of clarity when navigating between pages. **Navigational structure** • It helps with comprehension, which is particularly important for screen reader users. **Web zoom** • Ideally, the web browser's user should be able to resize web text.	Theme 01: Conduct technical accessibility testing Theme 02: Strategies for visual and multimedia accessibility* Theme 03: Digital document accessibility Theme 04: Learners with disabilities challenges and needs
Physical and Mobility	Users need support with assistive technology and	**Assistive technology** • Enable navigation for	Theme 01: Conduct technical accessibility

	devices that adjust to their needs.	assistive technology (keyboard, joysticks, mouse, etc.) **Supportive software** • Including virtual keyboards, voice recognition, speech-to-text, etc. **Flexibility** • Provide time accommodations to complete activities (oral or writing),	testing Theme 04: Learners with disabilities challenges and needs Theme 06: Learning activities and instructional strategies
Seizures and photosensitivity	Flashing content can elicit seizures in users with photosensitive epilepsy.	**Blinking and Flashing** • Avoid using rapidly blinking or flashing content	Theme 04: Learners with disabilities challenges and needs

Table 10 shows the alignment of the needs and strategies per disability group consistently with Themes 1, 2, 3, 4, and 6. In contrast, the data of participants' perspectives reveal Themes 5, 7, and 8 are not directly aligned with the literature. Theme 5: Frameworks and model enhancement needs and Theme 7: Removing barriers with R2D2/C3PO/A, emerged from the specificity of the R2D2/C3PO model enhancement and how the enhanced R2D2/C3PO/A could remove barriers for learners with disabilities. Theme 8: Leveraging AI for accommodations emerged from collaborating ideas throughout the focus group and NGT as a novel approach from participants to incorporate artificial intelligence to assist with online learning accessibility.

All themes in this study came from the perspectives of instructional designers and accessibility experts to answer the three research questions and to expand and validate the instructional design model. Participants shared their perspectives on accessibility strategies to expand the model and ways to improve learning activities to ensure an inclusive learning experience for all learners and learners within disability groups. Participants engaged through a multi-phase iterative process where they shared their perspectives through individual semi-structured interviews, the model accessibility enhancement questionnaire, and focus group and NGT. The participants' perspectives and results provided a layer of input to the document analysis of the literature review that supported the creation of the themes and the answers to the research questions.

Research Question 1

Research Question 1 was: How do instructional designers and accessibility experts believe the R2D2/C3PO model can be expanded to integrate accessibility components? All 10 participants participated in the individual semi-structured interviews conducted through Zoom following the Instructional Designer and Accessibility Expert Interview Guide (Appendix A). Throughout these interviews, participants shared their perspectives and accessibility strategies to enhance and augment the R2D2/C3PO model into the R2D2/C3PO/A. The core of the strategies focused on testing for technical accessibility, adding accessibility to visuals and multimedia, making digital documents accessible, and learning activities and instructional strategies—experts' discussions about the challenges and needs of learners with disabilities aligned with the literature. For example, Acosta et al. (2020), Baldwin and Chin (2021), Chee et al. (2022), and Cifuentes et al. (2019), among others, highlighted the primary need for including closed captions or transcripts for time-based media such as videos. The study's results agree with the literature, where 100% of participants highlighted the need for accurate and descriptive closed captions for live videos or recordings.

In comparison, 70% agreed that transcripts are needed for elements with audio. However, additional approaches emerged from their perspectives to enhance the models by focusing on the learner's emotional aspect, cultural sensitivity, flexibility, and awareness. These findings were not broadly found in the literature, except for Murphy (2019) and Rodrigo and Tabuenca (2020), which included specific discussions about the emotional impact of online courses on learners with disabilities. Despite the area of expertise among participants (instructional design and accessibility experts), they concurred on several strategies to be included for each component, as depicted in Table 4, previously displayed in the results section.

Research Question 2

Research Question 2 was: How do instructional designers and accessibility experts believe the updated R2D2/C3PO/A model can be used to remove barriers for learners with disabilities in online synchronous and asynchronous learning? All 10 participants completed the questionnaire conducted through Qualtrics. In the questionnaire, participants voted and ranked the strategies from 1 (not important) to 4 (very important), which were included in the first draft of the enhanced R2D2/C3PO/A. All strategies presented in the first draft of the model that received an average ranking of three or more remained in the second draft. The strategies that received a ranking average of less than three were removed from the second draft of the R2D2/C3PO/A. The strategies that received less than three rankings were:

- **Component 2: Reflect/ Writing/ Sharing Strategies.**
    - Group learners by ability (low, mid, high) to improve collaboration.
- **Component 4 Doing the Work Strategies**
    - Provide accessible material ahead of time. If learners are presenting, request their presentation to be shared before the session and provide it to other students.
- **Component 6 Conviviality Strategies**
    - Make engagement strategies optional, not required.
- **Component 7 Critical Incident Technique Strategies**

  - Conduct follow-up polls after the event or session for synchronous events polls to allow time for reflection.

These results somewhat align with the literature since no evidence of these strategies was found in the document analysis of the literature review. From the questionnaire's open-ended questions, several themes were repeated from those that emerged from the interviews, and new themes emerged from participants' responses. The themes that repeated were:

- Theme 01: Conduct technical accessibility testing
- Theme 04: Learners with disabilities challenges and needs
- Theme 06: Learning activities and instructional strategies

The new themes were Theme 07: Removing barriers with R2D2/C3POA, and Theme 08: Accessible strategies for course design and structure. In regards to the benefits of using the enhanced R2D2/C3PO/A model to remove barriers, the findings align with Armstrong and Gale (2025), who highlighted the importance of adding accessibility to the technology for teachers and students along with training and support mechanisms for its adoption. Additionally, Armstrong and Gale pointed out that the R2D2/C3PO model provides instructional designers, educators, and instructors, among others, with a guide to design, develop, implement, and evaluate authentic learning activities. Regarding Theme 08, several articles in the literature align with the participant's perspectives. For example, participant ID04 stated, "Be consistent in design. Do not switch formatting and heading structure from week to week." In the literature review, Chee et al. (2022), King and Piotrowski (2021), Moorefield (2019), and Oswald (2018) talked about the importance of navigation through descriptive links, use of headers, order of reading, and consistency in layouts and design. Participant AE02 said, "Making sure words in videos are also described." In the literature, Chee et al. (2022) highlighted that video-only learning objects should be presented with an audio file or text content that describes the visual action. After addressing the RQ2 and updating the R2D2/C3PO/A enhanced model to reflect the questionnaire results, the focus group and NGT session were conducted to address RQ3.

Research Question 3

Research Question 3 was: What components of the updated R2D2/C3PO/A model do instructional designers and accessibility experts believe are best practices for implementing online courses, which are accessible to all students? After the survey, the four participants in the focus group and the NGT session received the updated R2D2/C3PO/A model. Through the focus group and NGT session, all participants shared ideas about existing or new strategies for each component. The strategies were discussed during the group discussion, and updates were made live. The four participants voted and ranked the components strategies from 1 (not important) to 4 (very important) using the Zoom poll feature to validate and finalize the model. The strategies that received a three or higher-ranking average remained in the final R2D2/C3PO/A model. Various strategies received an average ranking of less than three; however, they continued to be part of the model due to their innovation and contribution towards meeting the accessible needs of learners, and many participants ranked these strategies as important (3). The following strategies that received less than three in the focus group and NGT but that remained in the model are the following:

- **Component 1 Read/ Listening/ Viewing Strategies**
    - Provide multiple methods for learners to access the content and to complete their activities (e.g., alternative written options to existing activities and methods such as multimedia, case studies, questionnaires, etc.). Share materials or pre-reading

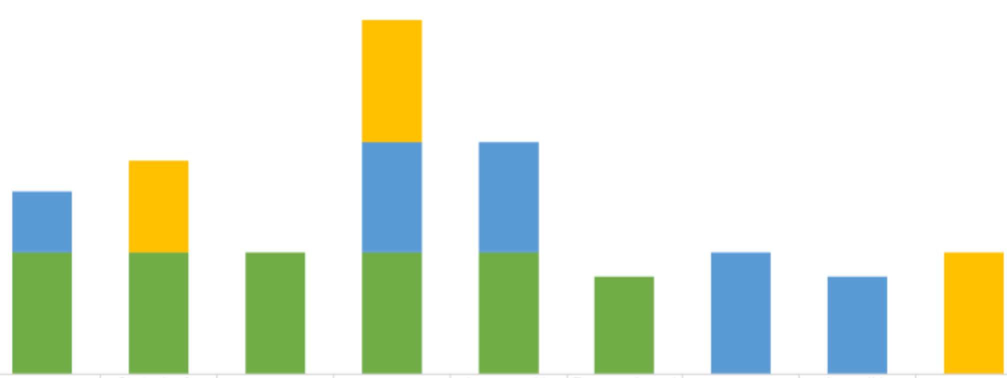
content (glossaries, tooltips, guided templates) with learners ahead of time. (Average = 2.75)

- **Component 2 Reflect/ Writing/ Sharing Strategies**
  - Leverage Artificial Intelligence to support accommodations (e.g., writing, scanning sources and citations, provide alt text, break down ideas of simplifying language). (Average = 2.75)
  - Provide graphic organizing to help plan for writing and include readability checkers (e.g., Grammarly) to help learners phrase their ideas. (Average = 2.5)

The model ranking and validation align with the existing research process, as depicted by Armstrong and Gale (2018, 2025). From a theme's perspective, two of the four themes that emerged from the sharing ideas and group discussion were repeated from previous data collections. For example, Theme 02: strategies for visual and multimedia accessibility were repeated from the interviews. Theme 06: Learning activities and instructional strategies were repeated from the interviews and questionnaire, as shown in Figure 6.

Figure 6

Themes Cross-Analysis by Data Collection



	Conduct Technical Accessibility Testing	Strategies for Visual and Multimedia Accessibility	Digital Document Accessibility	Learning Activities and Instructional Strategies	Learners with Disabilities Challenges and Needs	Frameworks and Model Enhancement Needs	Removing barriers with R2D2/C3POA	Accessible Strategies for Course Design and Structure	Leverage Artificial Intelligence for Accommodations
Focus Group	0%	75%	0%	100%	0%	0%	0%	0%	100%
Questionnaire	50%	0%	0%	90%	90%	0%	100%	80%	0%
Interviews	100%	100%	100%	100%	100%	80%	0%	0%	0%

This section discussed the evaluation of findings from the study's data collection and analysis. A summary of accessibility challenges, needs, and strategies was provided per disability group from the literature and participant's inputs to support the R2D2/C3PO/A model. Additionally, the results and their interpretation, considering the existing research and conceptual framework, were discussed through the research questions. The following section summarizes the findings presented in this chapter.

Summary

Chapter 4 included a review of the problem and purpose of this qualitative design and development model use case study. Within the chapter, a summary of participants, their demographics, and perspectives were also included. Chapter 4 also reassured the study's trustworthiness through credibility, transferability, dependability, and confirmability. Multiple data collection and analysis strategies were used to ensure the study's trustworthiness. Additional strategies implemented included thick topic-focused document analysis through the literature review. This study also included a three-phase iterative process to reinforce trustworthiness through triangulation, peer scrutiny, member checking, journaling, and reflective practice. This chapter also presented various phases of data analysis.

NVivo was used to conduct the qualitative data coding and thematic analysis. Excel was used to analyze the questionnaire and focus group data to rank the strategies. A descriptive analysis was performed through Excel. Chapter 4 also included the inclusion of artificial intelligence and ChatGPT for data analysis support and insightful interpretation and to identify research gaps and opportunities. ChatGPT was used as a novel approach and tempered to recent trends in using this computer program. A presentation of the study's results followed the data analysis.

The study's results were presented by research questions (RQ) and broken down into their respective phase in the iterative process. In Phase 1, a document analysis was conducted using a predetermined list of start codes to address RQ1. Following the document analysis, in Phase 2, a thematic analysis was performed for the interviews. Six themes and several subthemes emerged at this stage, revealing the perspectives of participants and their insights on accessibility and instructional strategies. Some of the strategies focused on conducting technical accessibility testing, and strategies for visual and multimedia accessibility, among others. A draft of the model was generated, and the process continued to answer the following research question.

RQ2 was addressed in Phase 3 through the model accessibility enhancement questionnaire, where participants ranked the strategies presented in the model from 1 (not important) to 4 (very important), with an opportunity to provide additional insights through the open-ended questions. Five themes emerged from the questionnaire; some were repeated from the previous phase, and some were new. For example, the theme removing barriers with R2D2/C3PO/A collected the participants' perspectives on how the enhanced model can help to remove barriers for learners with disabilities. After the questionnaire, a second draft of the model was generated to continue to the following stages of Phase 3 and to address the following research question.

RQ3 was also addressed through the iterative process in Phase 3. A focus group and NGT were conducted with a group of experts, who shared their ideas about the updated model. After sharing ideas, a group discussion occurred, and participants followed to vote and rank the strategies from the second draft of the model. Four themes emerged at this stage. Two themes repeated from previous data collection methods and phases, and two new themes emerged. The use of artificial intelligence to support accessibility emerged through the discussion, and a new theme emerged: leveraging artificial intelligence for accommodations. After the thematic analysis for each phase, a cross-analysis was conducted. After the cross-analysis, the study presented eight final themes.

The chapter concludes with an evaluation of the findings. A table of accessibility challenges, needs, and strategies per disability group was included as collected from the document analysis and participants' perspectives. The findings of this study sought to address the research question and support the use of the enhanced model to remove barriers for learners with disabilities. The next chapter reviews the problem, purpose, research methodology, design, results, and limitations. Chapter 5 also discusses the analysis of the results and their contribution to the existing literature and framework, as depicted in Chapter 2. Finally, Chapter 5 will introduce the implications, recommendations of practice, and future research opportunities after this study.

Chapter 5: Implications, Recommendations, and Conclusions

Online educators and instructional designers experience challenges with accessibility guidelines and their application when creating usable, accessible, and inclusive online courses due to limited and differing guidance at various levels (Baldwin & Ching, 2021; Lowenthal et al., 2021). Instructional design has a limited availability of model use research to enhance the field (Armstrong & Gale, 2018). The limited availability of model use research, along with the fast-paced growth of online learning, is creating many challenges for instructional designers and educators when designing and developing accessible content due to their lack of experience in accessibility and how to employ guidelines in practice (Acosta et al., 2020; Molanes-López et al., 2021). The purpose of this qualitative design and development model use case study was to define the process of creating accessible learning activities to expand the validated research-based R2D2/C3PO model to integrate accessibility strategies for each of the eight components of the existing model.

This study used a qualitative methodology design and development research (DDR) model use case study to explore the perspectives of instructional designers, online educators, and accessibility experts. Experts' perspectives were sought about the accessibility3 of the model components. The experts' recommendations included accessibility and instructional strategies and activities to address accessibility in online courses by enhancing the R2D2/C3PO instructional design model. Design and development research systematically studies design, development, and evaluation processes to establish an empirical basis for creating instructional and non-instructional products and tools and new or enhanced models (Richey & Klein, 2007, 2014). Using a design and development model use case study allowed the exploration of the experts' perspectives through an iterative process of multiple data collection methods and analysis on various phases to support the R2D2/C3PO/A model development and validation.

In Phase 1: Analysis, a document analysis was conducted from the literature review, followed by individual semi-structured interviews with participants. In Phase 2: Design and Development, an inductive thematic analysis following Braun and Clarke's six-step thematic analysis was conducted, and the first draft of the R2D2/C3PO/A model was generated. In Phase 3: Evaluation, all experts participated in the model accessibility enhancement questionnaire to rank the strategies in the R2D2/C3PO/A from 1 (not important) to 4 (very important). A descriptive analysis using Excel was conducted for the ranking, while a thematic analysis was conducted for the open-ended questions responses. The model was updated to reflect the changes generated from the questionnaire. Lastly, a focus group and Nominal Group Technique (NGT) were conducted with four expert participants to rank the strategies following the same questionnaire ranking system and validate the model. For data analysis, a thematic analysis using NVivo and a descriptive analysis using Excel was conducted for the ranking and voting.

The findings from his study allowed the enhancement of the R2D2/C3PO instructional design model to add accessibility and instructional strategies to each of the model components, hence adding to the body of knowledge with a new model, the R2D2/C3PO/A. Experts provided their perspectives based on their real-world experience and training, creating accessible online learning materials and courses to remove barriers for learners with disabilities. Conducting the study through a multi-phase iterative process allowed multiple data collection methods and analysis to achieve a rich and informed model that will benefit instructional designers, online educators, and accessibility experts when creating accessible, usable, and inclusive online courses.

A limitation of this study was the small sample size of six instructional designers and four accessibility experts. Despite meeting the original intention of recruiting up to 10 participants for this study, the distribution of roles was 60% instructional designers and 40% accessibility experts. A distribution of 50/50 may have added additional insights and a balanced voting and ranking process. The sample size limitation was addressed through data triangulation by using multiple methods for data collection, peer scrutiny, and member checks. The data collection occurred in a 9-week timeframe distributed throughout the phases.

Interviews in Phase 1 took 7 weeks with 10 participants, an increase of 4 weeks from the original proposed timeline. Ten participants were selected to secure the minimum (5) set of experts and to achieve data saturation. Following the interviews, the questionnaire in Phase 3 took 1 week from the email communication to the deadline for participants to complete the questionnaire. All ten participants completed the questionnaire.

The last step in Phase 3, focus group and NGT, took 1 week from the scheduled time to completion. The focus group and NGT event session lasted 90 minutes on a single day. Five participants were selected to participate in the focus group; however, only four participants attended, still meeting the desired range of participants for a focus group in this study. Although some sources established that an optimum size for a focus group is six to 12 participants (Bloomberg, 2023), a focus group can be performed and be effective with as few as three participants (Armstrong & Gale, 2018; Fern, 1982; Gill et al., 2008). The total time of data collection in Phase 3 averaged 2 weeks.

A second limitation was that the study was limited to instructional designers and accessibility experts rather than learners with disabilities as end users. However, several participants disclosed experiencing a disability. Although some participants disclosed a disability and parted from the assumption of improving the possibility of specific needs for learners with disabilities, the focus of this study and its result are relevant to instructional designers and accessibility experts developing online courses. Hence, the focus of the study is appropriate for the problem and purpose of this study.

Another limitation is scheduled updates to the Web Content Accessibility Guidelines and Quality Matters Rubric during the study. These updates could have impacted any proposed accessibility strategies. However, the proposed accessibility strategies came from the literature review and the experts' perspectives. Through Phase 2: Design and development, continuous monitoring occurred to identify any updates and new research about Web Content Accessibility Guidelines (WCAG) and Quality Matters (QM) accessibility strategies to address any concerns of the strategies from the document analysis. Regarding the experts' perspectives, the study proceeded with the assumption that participants were familiar with the updates since they were critical knowledge for their respective roles as instructional designers and accessibility experts and met the criteria for the study.

A purposive sampling using a criterion sample was used to identify participants who met the inclusion criteria. Several candidates were identified through a personal network. Six participants instructional designers were secured through this plan. However, two additional plans were executed to secure a larger sample: 1) snowball sampling, yielding zero results, and 2) internet volunteer sampling, yielding four accessibility experts as participants. The expertise of each participant led to in-depth interviews on the research topics, the instructional design model, and the accessibility and instructional strategies. Results mirrored an in-depth discussion and informed practices to include accessibility and instructional strategies to each R2D2/C3PO model component. The data were derived from the individual semi-structured interviews, the model accessibility enhancement questionnaire, and the focus group and NGT session conducted via Zoom meeting. The data collected from participants revealed their expertise and input towards the model enhancement and its expected positive impact on removing barriers for learners with disabilities.

Chapter 5 continues with a discussion of the implication of this research in the context of the research problem, purpose, and conceptual framework. The implications include a discussion by research questions and themes and provide insights on the impressions in various contexts. The chapter also includes several recommendations on how this model could be used in various settings and the model validation process. Lastly, this chapter concludes with recommendations for future research.

Implications

Understanding the perspectives of instructional designers and accessibility experts to remove barriers for learners with disabilities in online learning was critical to providing a comprehensive model with accessibility practices. The data collected provided a deeper understanding of the experts' perspectives on challenges faced by learners with disabilities in online learning. The data also offered in-depth recommendations to create a model that supports educators in creating more accessible online courses without the granular knowledge of accessibility guidelines and standards, which can include complex technical language and differing guidance at various levels. The data analysis and findings provided a thematic consistency throughout the phases that resulted in the enhanced model within the context of the conceptual framework.

Accessibility, equity, and inclusion imply from their definitions that courses should ensure equitable access and content without barriers encompassing fairness and impartiality

(Baldwin & Ching, 2021) for all learners regardless of their ability to access high-quality education (Aryeh-Adjei et al., 2023). This study and its findings also highlight from the context of conceptual frameworks the value of WCAG, Universal Design for Learning (UDL), and QM as established frameworks and standards alongside practical instructional design models like the R2D2/C3PO to create accessible and equitable learning environments.

The data collected, and findings of this study support the enhanced R2D2/C3PO/A model that could benefit learners with disabilities by providing instructional designers, online educators, and accessibility experts within the field of online education with an enhanced instructional design model with comprehensive accessibility strategies. The revised R2D2/C3PO/A model promotes the creation of inclusive online courses. This section discusses the implications of the results by research questions.

Research Question 1

How do instructional designers and accessibility experts believe the R2D2/C3PO model can be expanded to integrate accessibility components? Several key themes evolved from the data collected through the individual semi-structured interviews to address RQ1, providing valuable insights on the best practices and strategies to enhance the R2D2/C3PO model to integrate accessible experiences for learners with disabilities. The findings highlighted the importance of technical accessibility testing, strategies for visual components, the challenges and needs of learners with disabilities, and key learning strategies to include all learners. Most findings are consistent with the literature (Acosta et al., 2020; Baldwin & Ching, 2021; Lowenthal et al, 2020; Rodrigo & Tabuenca, 2020), except for approaches that stress focusing on learner's emotional aspect, cultural sensitivity, flexibility, and awareness that are not broadly available in the literature. The findings revealed the key perspectives to enhance the R2D2/C3PO model through six themes.

Conduct Technical Accessibility Testing. This theme emerged as a central theme among participants. The findings suggest that conducting accessibility testing of the materials and content created is key for delivering accessible online courses. Two subthemes emerged, focusing on testing tools and testing for functionalities through assistive technologies. As Participant ID05 stated "Definitely, we want to make sure that it's keyboard accessible. So, we want to make sure that students who have difficulties navigating the activities they're able to do so with keyboards…" This perspective reflects a significant step to ensure proper navigation for learners, increasing their opportunities for better interaction and completion of a material. Proper navigation and testing are highlighted throughout the literature and are present in frameworks such as WCAG, UDL, and QM. For example, Rodrigo and Tabuenca (2020) pointed out that learners with physical and mobility disabilities rely on their ability to manage keyboard and mouse devices, reinforcing the importance of this theme to conduct proper accessibility testing of learning materials.

Strategies for Visual and Multimedia Accessibility. As a central theme among participants, this theme focuses on key strategies to ensure the accessibility of visual and multimedia materials. Seven subthemes emerged from this theme, generally covering the strategies needed to enhance the model components, including visuals. For example, alternative text, closed caption, color contrast, accessible presentations, user control over time-based media, and transcripts are among the strategies highlighted through this theme. Participant AE01 said, "I still recommend captions or a transcript if somebody is trying to use video. The easiest would be to let the students know if there are captions available or if there are no captions. If there are no captions, there might be some additional information or a summary of what the video is about." This finding is consistent with the literature that pointed out that some strategies to support learners with visual disabilities are transcripts, closed captions, and user control of media, among others (Rodrigo & Tabuenca, 2020; W3C, 2017). Similarly, mentioning closed captions, for example, is also present in frameworks such as UDL and WCAG. For instance, in UDL, this theme aligns with the principle of multiple ways of representation, which is to provide the course content in more than one format (Baldwin & Ching, 2021).

Digital Document Accessibility. This theme emerged from 100% of participants. Four subthemes emerged from this theme, providing a more granular input. The four themes focused on creating proper heading structure, challenges in PDF accessibility, making accessible links, and content readability are the central focus of this theme. Participant ID06 said, "It can help to break those up a little bit with headers and make sections out of it. Often, they're just like a page of a bunch of text, so breaking up the text a little bit kind of help for readability for students." In the literature review, Rodrigo and Tabuenca (2020) mentioned the importance of headings, link text, and labels as essential in supporting the needs of learners with learning disabilities. From a conceptual framework standpoint, elements within this theme align with UDL, WCAG, and QM. For example, WCAG's understandable principle requires making the content readable and comprehensible for all users at the appropriate reading level and making it appear and work in predictable ways (Kurt, 2019).

Learners with Disabilities Challenges and Needs. Like previous themes addressing RQ1, this theme was discussed by 100% of participants and emerged as a critical factor of the need to engage learners based on their needs. Two subthemes emerged from this theme, focusing on challenges for learners with disabilities and learners with disabilities needs. Participant ID04 said, "But also have to take into consideration that some students will not pick up on your body language at all. Some students may not even benefit from any of these things because they can't. They just don't won't see them. So, I would look into it." These findings align with the literature review and conceptual framework on accessibility, equity, and inclusion around the discussion on the lack of clarity about directions (Rao et al., 2015). However, most of the existing literature focuses on technological aspects rather than learner-to-learner or learner-to-instructor interactions.

Frameworks and Model Enhancement Needs. This theme emerged from the conversations with 80% of the participants. The theme highlights the need for framework and model enhancements to improve accessibility. A single subtheme, R2D2/C3PO model enhancement, emerged from this theme. Participant ID02 said "I think, including like a checklist and like that kind of like pre-education element of being able to talk to us or fellow instructional designers, or anybody about like the why and the how just giving people that context is really important. A checklist is great and really helpful for reducing cognitive load for the designer and kind of giving them more of an opportunity to make things more accessible." This theme is consistent with the literature where Armstrong and Gale (2018) called for model components or categories enhancement in the R2D2/C3PO model, which is also part of this study's conceptual framework.

Learning Activities and Instructional Strategies. This theme emerged from conversations with 50% of the participants, and it is centered on key learning and instructional strategies to enhance accessible online learning experiences for all learners. A significant number (11) of subthemes emerged from this theme, focusing on specific strategies to support all learners, including those with disabilities. For example, several participants called for alternative versions or multiple methods. Participant AE01 said, "…so just having the sort of multiple approaches there, I think, would drastically help. And just asking, hey, you know, here are the options. Just let me know which one would be most convenient or most useful for you." Participants AE02, AE03, ID02, and ID03 also highlighted the importance of having multiple methods (alternative versions) for learning materials. This subtheme is consistent with the literature and conceptual framework. For example, consistency is found within WCAG's perceivable principle by providing alternatives to the content, such as alternative text, captions, transcripts, and sufficient contrast, and making the content available to assistive technologies (Kurt, 2019). Additionally, there is consistency with UDL's multiple means of representation principle by providing course content in more than one format using a variety of methods and strategies (Baldwin & Ching, 2021; Coombs, 2010; Lowenthal et al., 2020), for example, explaining a concept through a video while providing a descriptive text transcript.

Research Question 2

How do instructional designers and accessibility experts believe the updated R2D2/C3PO/A model can be used to remove barriers for learners with disability in online synchronous and asynchronous learning? Five themes emerged from the data collected through the model accessibility enhancement questionnaire to address RQ2, providing valuable insights through the open-ended questions and ranking the proposed strategies in the first draft of the R2D2/C3PO/A model. From the five themes that emerged at this stage, three themes were repeated from the individual semi-structured interviews. Two new themes emerged from the questionnaire's open-ended questions. Most findings are consistent with the literature, including the ranking and validation process used by Armstrong and Gale (2018). The findings revealed the key themes to continue the R2D2/C3PO/A model enhancement and the creation of the second draft.

Removing Barriers with R2D2/C3PO/A. All 10 participants (100%) contributed to this theme. Participants highlighted how the R2D2/C3PO/A model will help to remove barriers for learners with disabilities. As noted by Participant AE04, "[R2D2/C3PO/A] can give a clear model to instructors so they can focus on their content area." Additionally, *Participant I*D01 said, "Providing this rubric will educate and help instructors to be aware of the options they can provide… This is a great model and should be distributed to private, corporate, and public education settings." This theme embodies a new addition to the literature and conceptual framework since it provides new perspectives on an enhanced model. On a scale of 1 (not important) to 4 (very important), the average ranking of strategies among participants was 3.5, except for four strategies spread through various components that received less than three (3) scores. It is not clear why these strategies did not receive better ranks, but it might be influenced by each participant's individual experience, priorities, role description, and industry. The influence of participants' experience is a reflection of qualitative research methodology since it seeks to explore an individual's actions and experiences to understand their inner world (Bhangu et al., 2023; Rose et al., 2021).

Learners with Disabilities Challenges and Needs. Learners with disabilities challenges, and needs was mentioned by nine participants (90%) in the questionnaire open-ended questions. Three subthemes emerged from this theme. Learners with disabilities challenges and needs theme was repeated from the themes that emerged from the semi-structured interviews. The three subthemes expanded from the original creation of the theme to add value to communication with learners, inclusion, and the needs of learners with disabilities. As previously mentioned, although the existing literature mainly focuses on technical and design aspects, there are mentions of flexibility in online learning as an advantage (Kotera et al., 2019) and issues with communications as a key barrier (Rao et al., 2015). As *Participant* ID02 said, "Encouragement and attention to inclusive language, cultural sensitivity, and consideration should be applied across all components. I would like to see more inclusion or perhaps just mention of learners with chronic illnesses, which are often invisible." This perspective adds to existing research that calls for interactions and communication as barriers. For example, in the study conducted by Murphy et al. (2019), participants with mental disabilities pointed to a lack of in-person contact with faculty and difficulty concentrating and focusing as key online challenges. This theme helps expand the possibility of critical learning activities and strategies to ensure a more inclusive experience.

Learning Activities and Instructional Strategies. Learning activities and instructional strategies was also mentioned by nine participants (90%) in the open-ended questions. Three subthemes emerged from this theme. Learning activities and instructional strategies theme was also repeated from the themes that emerged from the semi-structured interviews. However, the three subthemes focused on learning activities at the component level, providing multiple methods for materials on each component and setting up clear instructions and expectations for learners. For example, for the Planning and Organization component, Participant AE01 said, "If the institution has existing resources - even discounted licenses or even a newsletter internal to the institution for teacher/coach training, etc. - use them..." For the CIT component, *Participant* ID04 said, "Be sure questions asked are inclusive of the experience everyone would have had, not just those without accommodations." Similarly to the previous instance of this theme, it is supported by the literature; however, it provides a new perspective within the context of the R2D2/C3PO/A model.

Accessible Strategies for Course Design and Structure. This theme emerged from the input of eight participants (80%) in the open-ended questions. Through this theme, participants discussed various ways to create accessible course design and structure. This theme is new at this stage, and two subthemes emerged from this theme. However, one of the themes that emerged, multimedia and visual accessibility, aligns with a key theme from the individual semi-structured interviews. This alignment displays a critical need for the accessibility of visual materials, as pointed out by all participants throughout the study. *Participant* AE02 said**,** "Making sure words in videos are also described, and [that] the course itself is in a logical structure to minimize confusion." This theme strongly aligns with three of the four principles in WCAG: Perceivable, operable, and understandable, as depicted in the conceptual framework and literature review. All people must perceive the content through alternatives such as captions, transcripts, and availability through assistive technologies, among others (Kurt, 2019). Users should be able to navigate, find, and interact with content (Baldwin & Ching, 2021), and the content must be readable and comprehensible for all users while working in predictable ways (Kurt, 2019). An accessible course design and structure is also highlighted in QM General Standard 8: Accessibility and Usability.

Conduct Technical Accessibility Testing. Conducting technical accessibility testing was the last theme that emerged from the open-ended questions in the model accessibility enhancement questionnaire. This theme focuses on including various ways to check accessibility and test. Although this theme emerged first in the interviews, at this stage, the theme was supported by five of ten participants (50%), and no subthemes unfolded. The repetition of these theme from the individual semi-structured interviews, revalidates the importance of conducting technical accessibility testing of course materials. *Participant* ID04 said**,** "Build in time to practice or troubleshoot with technology before the official session so that time can be spent on coaching goals vs tech issues." Conducting technical accessibility testing will help with removing significant barriers in online environments. As depicted in the literature, course navigation is a significant barrier that prevents learners who use assistive technologies from accessing and properly navigating the content (Lord & Stein, 2018; Lowenthal et al., 2021; Oswald et al., 2018). Another significant barrier within course navigation pointed out in the literature is broken links and buttons, which disrupt the experience of all learners, especially learners with disabilities (Kyudong et al., 2019).

Research Question 3

What components of the updated R2D2/C3PO/A model do instructional designers and accessibility experts believe are best practices for implementing online courses, which are accessible to all students? The focus group and NGT aimed to rank the strategies, validate the model, and consequently answer RQ3. The focus group and NGT process is consistent with existing research on these procedures, as used by Armstrong and Gale (2018). The NGT discussion consisted of the following:

1. **Silent generation of ideas:** Quiet time to reflect on the model and generate ideas for accessibility strategies that should be added or modified.
2. **Sharing ideas:** Sharing out loud one idea per component (new or reworded).
3. **Group discussion:** Crosstalk opportunity to discuss, combine similar ideas, and argue proposed ideas.
4. **Voting and ranking:** Anonymous vote and ranking of finalized strategies.

Four themes emerged from the qualitative data collected through the focus group, and NGT conducted with four experts in Phase 3. Two of the four themes that emerged at this stage were repeated from previous data collection, and two were new. However, one of the new themes (Give user control over media and content) was strongly present in an earlier data collection theme but as a subtheme. The findings revealed the key themes to finalize and validate the R2D2/C3PO/A model.

Learning Activities and Instructional Strategies. Learning activities and instructional strategies is a theme that is repeated from previous data collection methods. All focus group participants (100%) provided insights for this theme, focusing on activities and strategies to integrate and promote accessibility in online courses. Two subthemes unfolded from this theme: Using institutional resources and learners' needs and engagement. Discuss various ways to create accessible course design and structure. Participant 1 said, "Be sure to confirm accommodations and attendance of support staff, and include that in the overall planning, encourage active participation from all users and use inclusive language while providing instructions, and encourage active participation from all users and use inclusive language while providing instructions." From this perspective, this theme also aligns with the literature that highlights that achieving accessibility, equity, and inclusion is a collaborative effort that involves several resources and stakeholders like institutions, educators, and instructional designers (Coleman & Berge, 2018; Radovan & Perdih, 2016).

Give User Control Over Media and Content. This theme emerged from the focus group and NGT session, with all four participants (100%) engaging in discussions on providing learners control over media and content. This theme did not generate additional subthemes. As Participant 2 said, "Give learners complete control over multimedia (e.g., volume, play, pause, and stop at any time) and do not use no auto-play or flashing/blinking. [Also], font type/size-hard return vs. spacing vs. use of line breaks." This theme is consistent with the literature and conceptual framework for user controls as accessibility strategies. Rodrigo and Tabuenca (2020) highlighted that strategies to support learners with visual disabilities include enabling players to adjust caption size and complete control of media. Although this theme emerged as a new theme at this stage, it was present in previous data collection methods as a strong subtheme due to its relation with visual and multimedia strategies. Despite being a new theme, due to its strength as a subtheme, it remained a subtheme under the theme strategies for visual and multimedia accessibility after the final themes and cross-analysis for the study.

Leverage Artificial Intelligence for Accommodations. This theme emerged as a novel discussion on using artificial intelligence to address accommodations and better support the learners' experience and engagement. All four participants (100%) contributed to the discussion of this theme and suggested adding AI as part of the strategies in the R2D2/C3PO/A model. Participant 1 said, "…but even in the read and listening, none of us mentioned AI. And I think AI could play a huge role with reading and listening, and all of these… I think it might be helpful to incorporate a little bit of the AI, the role of AI in supporting accommodation, accessibility in reading and writing…" Participants also discussed setting up parameters when integrating AI. *Participant 4* said**, "**Well, in doing the work. Do you just need to say, in general, set parameters on how AI can be used because…Provide accessible tools for learners to use to complete assignments. Does that need to be elaborated upon to say? Use AI sparingly. Use AI for only these things, but not this much…" This theme and discussion can be categorized as a new contribution to the literature and conceptual framework topics, since the mention of artificial intelligence in supporting accessibility was not present in the literature review conducted as part of this study.

Strategies for Visual and Multimedia Accessibility. Strategies for visual and multimedia accessibility is a theme that is repeated from previous data collection methods. Three of four participants (75%) discussed various ways to create accessible course design and structure to enhance the R2D2/C3PO/A model. The subtheme video accessibility emerged as a strong single subtheme. Participant 3 said, "You can also provide, you know, kind of an introductory context to those longer videos to say, this is optional viewing. But here's why I selected it. Here's why I like it…" As a theme in two of the four data collection methods, it is consistent with the literature and conceptual framework. There is a general perspective that learners with disabilities experience various challenges online, including multimedia and audio descriptions, among others. (Koch et al., 2018; Miller, 2021; Murphy et al., 2019; Rodrigo & Tabuenca, 2020). Acosta et al. (2020) conducted a study to propose techniques for authors of digital content with a specific focus on multimedia content for the web. The discussion from the literature and participants' inputs around strategies for visual and multimedia accessibility make this theme a critical aspect applicable to the design and development of accessible, equitable, and inclusive online learning.

After the NGT protocol, participants proceeded to rank the accessibility strategies and validate the model. On a scale of 1 (not important) to 4 (very important), the average ranking of strategies among the focus group participants was 3.6, except for three strategies spread through various components that received a score of less than 3. An example of one of the strategies that did not meet the minimum score of 3 is Leveraging artificial intelligence to support accommodations, with an average of 2.75. It is unclear why these strategies did not receive better ranks. Still, similarly to the ranking process in the questionnaires in Phase 2, it might be influenced by each participant's individual experience, priorities, role description, and industry. However, these strategies continued to be part of the model due to their innovation and contribution towards meeting the needs of learners with disabilities. Many participants ranked these strategies with at least a 3 (important).

Summary of Implications

The results of this study are consistent with existing research, as depicted in the literature review, on accessibility, equity, inclusion, WCAG, ULD, QM, and the R2D2/C3PO instructional design model. Participants' perspectives on integrating accessibility into each component of the R2D2/C3PO model through this research address a critical gap in current instructional design practices. The findings underscore the importance of using flexible and inclusive strategies that accommodate the diverse needs of learners, particularly those with disabilities. A factor that might have influenced the interpretation of these findings is the researcher's experience in the instructional design field and the topic of digital accessibility. However, this possible influence was mitigated by using artificial intelligence (AI) through ChatGPT to cross-comparison the manual analysis conducted in NVivo to identify gaps and opportunities. The conclusive findings support creating the enhanced R2D2/C3PO/A instructional design model as a comprehensive model with accessibility practices for several contexts. Eight final themes were key in enhancing the R2D2/C3PO/A model and answering the research questions. The following list includes the final themes and their alignment with the research questions.

1. Conduct technical accessibility testing (RQ1 & RQ2)
2. Strategies for visual and multimedia accessibility (RQ1 & RQ3)
3. Digital document accessibility (RQ1)

4. Learners with disabilities challenges and needs (RQ1 & RQ2)
5. Frameworks and model enhancement needs (RQ1)
6. Learning activities and instructional strategies (RQ1, RQ2, RQ3)
7. Removing barriers with R2D2/C3PO/A (RQ2)
8. Leverage Artificial Intelligence for Accommodations (RQ3)

The implications of this research extend to various educational contexts, including K-12 education and corporate training environments. The R2D2/C3PO/A model can help institutions meet the needs of an increasingly diverse student population by embedding accessibility into each phase of the learning design process. The model emphasizes the importance of flexibility in content delivery, supporting learners with a wide range of needs and preferences. Additionally, the findings support the inclusion of institutions as key stakeholders in supporting educators in creating accessible online courses through faculty development, crucial departments like IT, and offices like Student Accessibility Services or Student Disability Centers, among others. This study includes several recommendations for practice for the integration and implementation of the R2D2/C3PO/A model into the course development workflow.

Recommendations for Practice

Based on the results of this qualitative design and development model use case study with instructional design and accessibility experts, four recommendations for practice are also supported by the existing literature. The first recommendation is for institutions and organizations' education departments to develop a role-specific accessibility toolkit supported by the R2D2/C3PO/A model. The second recommendation is to facilitate ongoing professional learning communities. The third recommendation is to integrate accessibility milestones into the workflow. The fourth recommendation is to embed continuous course evaluations. These recommendations encompass an integration for practice for the R2D2/C3PO/A instructional model in phases, as presented in Figure 7. The framework includes four phases: 1) Research and analyze, 2) connect and collaborate, 3) design and develop, and 4) implement and evaluate. The framework allows the implementation of all phases in order or requires Phases 3 and 4, with the opportunity of adding Phases 1 and 2 based on resource availability.

Figure 7

R2D2/C3PO/A Instructional Design Model Integration to Framework

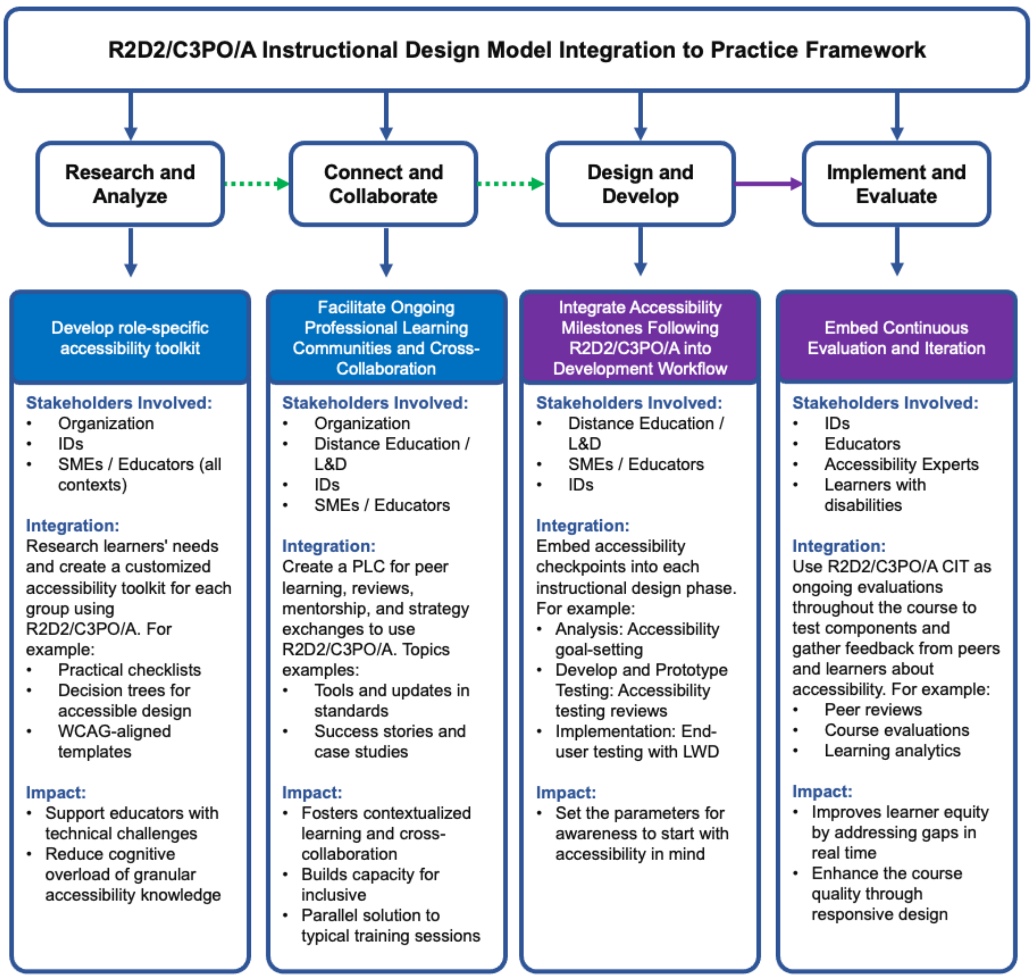


Table 11 provides the R2D2/C3PO/A implementation alignment sample. The table presents the eight model components aligned with some instructional strategies, learning activities, and accessibility strategies. The first column includes each of the model components. Column 2 includes instructional strategies for each component followed by a column with accessibility strategies. Column 4 includes learning activities, online or offline, for each component. Column 5 includes accessibility strategies to address possible barriers of these learning activities. A complete guidance on strategies is available in the final enhanced and validated R2D2/C3PO/A model (Appendix H).

Table 11

R2D2/C3PO/A Implementation Alignment Sample

Model Components	**Instructional Strategies**	**Accessibility**	**Learning Activities (Online or Offline)**	**Accessibility**
Read/ Listening/ Viewing	Synchronous expert lectures and presentations/	Include accurate captions and transcripts; Slides are screen reader accessible; Enable chat feature for questions	Reading materials	Accessible documents (HTML, Word); Allow user control to adjust font and styles; Provide audio version
	Live demonstrations	Describe actions verbally; Use high contrast visuals	Listening to audio podcasts	Include transcripts; Summaries; Alternative text formats
Reflect/ Writing/ Sharing	Time allocated before, after, and during the web conferencing session for reflection	Provide flexible time accommodations and clear instructions; Share accessible content ahead	Keep reflection journals	Allow for multiple formats and methods (text, audio, video)
	Provide "silent time" for deep reflection	Allow multiple methods to engage (audio, notes, visual maps)	Create visual representations	Lead by example with accessible design practices (alt text for visuals, color contrast, descriptions, etc.)
	Pair shares / Small group or focus group discussion	Provide accessible collaboration tools Provide structured discussion prompts and clear instructions	Online quizzes	Ensure quizzes are keyboard accessible; Allow extra time for accommodations; Use accessible tools for quizzes

Display	Demonstrations (process steps, concept maps, logic steps)	Provide detailed walkthroughs descriptions	Visual representations (pictures, diagrams, multimedia/videos, etc.)	Provide alternative text or description of visuals in writing
	Instructor "live video" based feedback	Provide closed captions and written summaries		
Doing the Work	Case studies	Provide audio versions and transcripts	Collaborative group project	Provide alternatives for asynchronous participation and collaboration
	Assessments	Ensure screen reader compatibility Provide clear instructions	Practice	Allow multiple methods (written, video, audio) to demonstrate practice
Coaching	Interactive feedback	Provide feedback in multiple formats (text, audio recording with transcript, email, messaging apps)	Breakout sessions for peer coaching	Share an agenda or clear guidelines before a coaching session to clarify each item or expectation and how much time they will spend.
Conviviality	Use Emojis to promote motivation, friendliness, enthusiasm, and humor	Provide clear descriptions of emojis, GIFs, and other visual material that might mean something different for learners. Visuals should not be the only way to convey information.	Ask questions in live sessions and use the Chat feature for answers	Allow responses through the chat feature and include time and long pauses for questions.
	Ground Rules to encourage collaboration, cooperation, and trust	Establish ground rules for behaviors and accessibility awareness for both instructors and learners.	Inject appropriate humor, sharing cartoons, avatars, etc.	Provide alternative text or description for visuals; Use and encourage clear, inclusive language that reflects cultural sensitivity; Resist stereotypes and be inclusive in visual and audio materials.

Critical Incident Technique	Use CIT for immediate student feedback between instructional events	Provide multiple formats or alternative ways to complete the activity (e.g., open discussion forums, written reflection, etc.).	Students can make single or multiple-choice anonymous responses through Zoom Poll feature	Provide expectations to learners ahead of time (e.g., type of polls, chats, number of poll activities, etc.).
Planning and Organization	PowerPoint slides	Images have alternative text; Slides are screen-reader and keyboard accessible	Participant manual or journals	Manuals include clear heading structures; Images or charts include alternative text or descriptions

Recommendation 1: Develop a Role-Specific Accessibility Toolkit Supported by R2D2/C3PO/A

The need to develop a role-specific accessibility toolkit supported by the R2D2/C3PO/A model has been identified. As Participant AE02 said, "I think having resources for them, making sure that they know, okay, for word documents, … these are, like, the biggest hits that you need to make sure that you're doing. Make sure that there are headings, make sure that, things are in line. Make sure you're using the styles inside of Word to make sure that the navigation all falls through. So that way, I think having resources is a great way to make sure that this is effective. Maybe a rubric…" Developing a role-specific accessibility toolkit is part of Phase 1: Research and analysis in the R2D2/C3PO/A Instructional Design Model Integration for Practice framework. Stakeholders that should be involved at this stage are the institutions or organizations, instructional designers, subject matter experts, and educators in various contexts (K-12, higher education, corporate, military, among others.).

This practice integration involves researching learners with disabilities needs and creating a customized accessibility toolkit for each stakeholder group (ID professionals, faculty, corporate trainers, military instructors, and K-12 educators) using R2D2/C3PO/A. This effort can start at an institutional or organizational level and be facilitated by instructional design teams or lead educators. Examples of the integration include checklists or rubrics, decision trees for accessible design, and WCAG-aligned templates. Implementing this practice will support educators who face deep technical challenges in accessibility standards. The availability of a toolkit can also support reducing cognitive overload and guide the implementation without requiring granular accessibility knowledge.

Recommendation 2: Facilitate Ongoing Professional Learning Communities and Cross-Collaboration Teams

The need to facilitate ongoing professional learning communities (PLC) and cross-collaboration teams has been identified. As Participant AE01 said, "Nothing will be 100% accessible to all learners, but the considerations of Perceivable, Operable, Understandable, and Robust (from Web Content Accessibility Guidelines) are throughout. Education and awareness about existing guidelines and best-practice tools might also be helpful in certain areas of the instructional model: while tools change, it would help establish a cadence for checking in on resources and tools, what those tools can/cannot do, and what is regarded as good and useful tools by disabled communities." Facilitating ongoing professional learning communities and cross-collaboration is part of Phase 2: Connect and collaborate in the R2D2/C3PO/A Instructional Design Model Integration for Practice framework. At this stage, stakeholders that should be involved are institutions or organizations, distance education or learning and development teams, instructional designers, subject matter experts, or educators.

This practice integration involves the creation of professional learning communities that cultivate a space of peer learning, reviews, mentorship, and strategy exchange segmented by context (e.g., Higher education, military, etc.). The topics that can be covered are challenges and solutions in accessible design, case studies, success stories, tools available, and updates in standards or regulations (WCAG, QM, Section 508, European Accessibility Act, etc.). Participant AE02 added, "If the institution has existing resources - even discounted licenses or even a newsletter internal to the institution for teacher/coach training, etc. - use them. If not, argue for them as much as possible so resources and educator awareness are strengthened. Improving resources for everyone is the "curb cut effect" and often impacts people who aren't disabled as well."

A community of learning can be an alternative or addition to faculty training sessions. The impact of this practice is to foster understanding and cross-collaboration that builds the institution or organization's capacity for inclusive design. For example, higher education will encourage instructional designers to partner with faculty during course design and development. In corporate, it will help to align learning and development specialists with department leads, human resources, and IT teams to develop accessible training paths.

Recommendation 3: Integrate Accessibility Milestones Following R2D2/C3PO/A into Course Development Workflow

The need to integrate accessibility milestones using R2D2/C3PO/A into course development workflow has been identified. As Participant AE02 said "Having a checklist or guide when creating the course and activities to keep accessibility in mind." Integrating accessibility milestones into course development workflow is part of Phase 3: Design and develop in the R2D2/C3PO/A Instructional Design Model Integration for Practice framework. At this stage, the stakeholders who should be involved are distance education or learning and development teams, subject matter experts or educators, and instructional designers. The integration consists of embedding accessibility checkpoints into each phase of instructional design (e.g., ADDIE). For example, in an analysis phase, set up accessibility goals or end-user testing with learners with disabilities during an implementation phase. This recommendation will impact the practice by setting parameters for awareness to engage course creators to start with accessibility in mind through a continuous and measurable process of the design and development workflow.

Recommendation 4: Embed Continuous Evaluation and Iteration

The need for embedding continuous evaluation and iteration using R2D2/C3PO/A into course development workflow has been identified. Participant ID05 said, "Additionally, regular feedback from learners with disabilities can help identify barriers and inform adaptations." Participant ID02 added, "Do user experience testing; ask volunteers to screen record their experiences and narrate any issues or frustrations they experience." Embedding continuous evaluation and iteration is part of Phase 4: Implement and evaluate in the R2D2/C3PO/A Instructional Design Model Integration for Practice framework. At this stage, the stakeholders that should be involved are instructional designers, educators, accessibility experts, and learners with disabilities. The integration of this practice consists of using the R2D2/C3PO/A Critical Incident Technique (CIT) component by using formative and summative ongoing evaluations (before and throughout the course) to test components and gather feedback from peers and learners with disabilities about accessibility functionalities and barriers in real-time. For example, conduct peer reviews by peer instructors, add course evaluations for learner's feedback, and use learning analytics data to analyze the learners' behaviors.

Summary of Recommendations for Practice

These recommendations provide a framework that includes key stakeholders and actionable steps and strategies to integrate the R2D2/C3PO/A to create accessible, equitable, and inclusive online courses. By providing resources to stakeholders through toolkits, facilitating professional communities, integrating accessibility milestones, and embedding continuous evaluations, educators can be equipped with essential awareness to improve learning experiences for learners with disabilities. Incorporating these recommendations can help mitigate barriers for learners with disabilities. These recommendations are evidence-based and supported by this study's findings and existing literature. As previously stated, these recommended practices are adaptable to various contexts, such as K-12, higher education, corporate, and military, to address the needs of learners with disabilities. This study shows positive insights from participants about the enhanced R2D2/C3PO/A instructional design model and its benefit in designing more accessible courses. The following section discusses recommendations for future research.

Recommendations for Future Research

This qualitative design and development model use case study was designed to define the process of creating accessible learning activities to expand the validated research-based R2D2/C3PO model to integrate accessibility strategies for each of the eight components of the existing model. This study focused on exploring the perspectives of instructional designers, online educators, and accessibility experts about the accessibility of the model components to enhance and validate the R2D2/C3PO/A instructional design model. Recommendations for future research originated from the findings and implications of this study.

The first recommendation for future research is to conduct a qualitative design and development case study to design and develop an online course using R2D2/C3PO/A instructional design model accessibility strategies. Using a design and development case study through learner-centered research could help to gather the perspectives of learners with disabilities to evaluate whether these strategies meaningfully reduce barriers in online courses. This recommendation is to expand the findings and implications of this study by providing experts with a comprehensive model with accessibility strategies to accommodate the needs of learners through flexible and inclusive strategies. Additionally, research could investigate and expand into which model components (e.g., Read, Display, Coaching) most effectively support the needs of diverse learners.

A limitation of this study was that it was only available to instructional designers and accessibility experts instead of learners with disabilities as end users. Future research can address this limitation by providing a direct validation from end users based on their needs, which could lead to future model enhancement iterations. Gathering the perspective and experience of learners with disabilities aligns with the recommendation for practice to embed continuous evaluations and iterations to courses to receive learners' feedback.

The second recommendation for future research is to conduct a qualitative multi-case study to investigate the effectiveness of the enhanced R2D2/C3PO/A across multiple contexts and sectors (e.g., K-12, corporate, military). The study could explore the perspective of instructors and learners across these sectors. The enhanced model includes the experts' perspectives for accessibility strategies, making the exploration of its practical application and learners' outcomes across various educational and training settings a pivotal contribution to the model use research. Some key aspects would be to understand the effectiveness of the R2D2/C3PO/A model to improve accessibility and learner outcomes in varied instructional design settings and to explore what contextual adaptions are needed for specific sectors. Additionally, it would be meaningful to understand the implications of using artificial intelligence (AI) in supporting accessibility implementation strategies. This recommendation also aligns with this study's implications and recommendation for practice to integrate accessibility milestones in the course development workflow and the integration of continuous evaluations and iterations throughout the course.

The third recommendation is to evaluate the impact of professional development grounded in the R2D2/C3PO/A instructional design model. The R2D2/C3PO/A is an expert validated model that provides a framework for professional development. The problem, purpose, framework, literature review, and findings of this study established that online educators and instructional designers face challenges in creating usable, accessible, and inclusive online learnings due to limited and differing guidance. Future research can focus on using R2D2/C3PO/A as ground to create a professional development program to introduce participants to standards and how to apply the model's accessibility strategies effectively across each phase of a course design.

A quasi-experimental study is recommended for this third recommendation since it provides real-world applicability that aligns with educational and professional settings since random assignment to experimental and control groups is not favorable. This recommendation could help with identifying gaps between accessibility knowledge and implementation. An example of a professional development opportunities is a professional learning community focusing on designing one online course module using the R2D2/C3PO/A model. This research recommendation aligns with the recommendations for practice on facilitating professional learning communities and cross-collaboration in institutions and organizations.

Conclusions

The perspective of instructional designers, online educators, and accessibility experts to define the process of creating accessible learning activities and to expand the validated research-based R2D2/C3PO model to integrate accessibility strategies for each of the eight components was explored in this qualitative design and development model use case study. Experts contributed accessibility and learning strategies to remove barriers for learners with disabilities to enhance the model and to provide educators with a comprehensive model that support diverse learners. Using a qualitative methodology was ideal for understanding the perspectives of the experts regarding the needs of people with disabilities (Rose et al., 2021). Design and development research was used since it allows the evaluation process to establish an empirical basis for creating instructional and non-instructional products, tools, or enhanced models (Richey & Klein, 2007, 2014).

Instructional designers and accessibility in online settings in North America were the target population of this study. Six participants were selected from a personal network through purposeful sampling using a criterion sample as the first plan for this study. However, two additional plans were executed to secure the sample. A snowball sampling with the inclusion criterion was executed, but led to no participants. The last plan was an internet volunteer sample, helping to grant four additional participants for a total of 10 participants in the study (ID=6, AE=4). After securing the sample, the multi-phase study was conducted through an iterative data collection and analysis process.

Phase 1: Analysis included a document analysis of the literature review to identify research-based strategies for accessibility. A deductive thematic analysis of the literature was conducted in NVivo using a predetermined list of start codes that derived from the problem, purpose, research questions, and conceptual framework. A needs assessment was conducted to determine the accessibility strategies to support the model enhancement. This phase also included individual semi-structured interviews with the expert participants.

Phase 2: Design and Development included the analysis of the individual semi-structured interviews. An inductive thematic analysis following Braun and Clarke's (2006) six step thematic analysis using NVivo was conducted to identify themes. The first model draft was created in Phase 2.

Phase 3: Evaluation included the model accessibility enhancement questionnaire for participants to rank the accessibility strategies from 1 (not important) to 4 (very important) and open-ended questions to provide additional. A descriptive analysis was conducted using Excel to determine the mean, the mode, and standard deviation of the ranking. An inductive thematic analysis using NVivo was conducted to identify themes. A second draft of the model was created. The last step was a focus group and NGT session with four participants to rank the strategies and validate the model. A descriptive analysis using Excel was conducted for the ranking process, while an inductive thematic analysis was conducted to identify themes from the NGT discussion. The output of this phase was the validated enhanced R2D2/C3PO/A instructional design model.

After conducting all the phases analysis, a thematic cross-analysis among all phases was conducted to establish the final themes of this study. A total of eight themes were established: 1) Conduct technical accessibility testing, 2) strategies for visual and multimedia accessibility, 3) digital document accessibility, 4) learners with disabilities challenges and needs, 5) frameworks and model enhancements needs, 6) learning activities and instructional strategies, 7) removing barriers with R2D2/C3PO/A, and 8) leverage artificial intelligence for accommodations. It is important to highlight that ChatGPT was used to conduct a cross-comparison of the manual analysis conducted in NVivo to identify any gaps in the interpretation and findings and to define areas of opportunity.

The data analysis of the qualitative data was consistent with the literature in the areas of technical accessibility, detailed descriptions, user control, and flexibility in online learning, which was also reflected throughout the ranking and validation of the strategies. However, the findings also expanded in the focus of conducting accessibility testing, using resources available to ensure accessibility, and a special focus on human, emotional, and cultural sensitivity when designing and developing online courses. Additionally, the findings highlighted the crucial aspect of understanding essential guidelines and frameworks oriented toward the creation of accessible online courses and providing learners with clear instructions and guidance in their courses. Participants in the focus group prompted the conversation on using AI to support accessibility efforts in course development.

The study revealed that participants supported the enhancement of the R2D2/C3PO model and validation of the enhanced R2D2/C3PO/A. Participants believed that the model could remove barriers by recognizing the diversity of access and needs that learners have through multiple methods of learning, engagement, and growth. This model provides instructors, educators, and designers with a comprehensive and clear guideline from creating awareness to implementing accessibility strategies. *Participant* ID01 highlighted the model's applicability through various context and sectors from corporate, to public and private education settings. Furthermore, organizations, institutions, instructional designers, and educators should take a lead role by creating role specific accessibility toolkits, facilitating ongoing professional learning communities, and integrating accessibility milestones into the course development workflow for effective implementation of the R2D2/C3PO/A to remove barriers for learners with disabilities in online learning.

References

Acosta, T., Zambrano-Miranda, J., & Lujan-Mora, S. (2020). Techniques for the publication of accessible multimedia content on the web. *IEEE Access, Access, IEEE, 8*, 55300–55322. https://doi.org/10.1109/ACCESS.2020.2981326

ADA.gov. (2024, April 8). *Fact sheet: New rule on the accessibility of web Content and mobile apps provided by state and local governments*. https://www.ada.gov/resources/2024-03-08-web-rule/

Alajarmeh, N. (2022). Evaluating the accessibility of public health websites: An exploratory cross-country study. *Universal Access in the Information Society, 21*(3), 771–789. https://doi.org/10.1007/s10209-020-00788-7

Alias, N. A., Hashim, S. (2012). Design and development research in instructional technology. *Instructional technology research, design, and development. Lessons from the field*. https://doi.org/10.4018/978-1-61350-198-6.ch001. IGI Global.

Alvarado-Alcantar, R., & Keeley, R. (2020). Students with specific learning disabilities' experiences with instructional materials and programs in a blended high school history classroom: A phenomenological study of accessibility. *Journal of Online Learning Research, 6*(3), 201–220.

American Bar Association. (2015). *Convention on the rights of persons with disabilities*. https://www.americanbar.org/advocacy/governmental_legislative_work/priorities_policy/promoting_international_rule_law/conventionontherightsofpersonswithdisabilities/

Aquino, K. C., & BuShell, S. (2020). Device usage and accessible technology needs for post-traditional students in the e-learning environment. *Journal of Continuing Higher Education, 68*(2), 101–116. https://doi.org/10.1080/07377363.2020.1759313

Ara, J., & Sik-Lanyi, C. (2023). AccGuideLiner: Towards a modelling approach of web accessibility requirements following WCAG 2.2. *2023 IEEE International Conference on Smart Information Systems and Technologies (SIST), Smart Information Systems and Technologies (SIST), 2023 IEEE International Conference On,* 10–15. https://doi.org/10.1109/SIST58284.2023.10223541

Armstrong, A., & Gale, A. J. (2018). Online learning design and implementation models. *Quarterly Review of Distance Education, 19*(1), 27–45

Armstrong, A. (2016). Constructivist instructional strategies for synchronous web conferencing: Synchronous constructivist instructional strategies for the 21st century. In D. H. Eberwein (Ed.), *Advocacy for change in educational culture*. Nova Science Publishers, Inc.

Armstrong, A., & Gale, A. J. (2025). R2D2/C3PO Video Conferencing Instructional Strategies and Learning Activities: Expert Validated Research Instructional Design Model. In M. Khosrow-Pour, D.B.A. (Ed.), *Encyclopedia of Information Science and Technology, Sixth Edition*. Advance online publication. https://doi.org/10.4018/978-1-6684-7366-5.ch002

Aryeh-Adjei, A., Ussher, Y. A. A., & Kutame, L. C. (2023). Students with special needs online learning experiences during the Covid-19 pandemic at the University of Ghana. *Clearing House, 96*(2), 61–69. https://doi.org/10.1080/00098655.2023.2168598

Azungah, T. (2018). Qualitative research: Deductive and inductive approaches to data analysis. *Qualitative Research Journal (Emerald Group Publishing Limited), 18*(4), 383–400. https://doi.org/10.1108/QRJ-D-18-00035

Bai, A., Stray, V., & Mork, H. (2019). What methods software teams prefer when testing web accessibility. *Advances in Human-Computer Interaction*, 1–14. https://doi.org/10.1155/2019/3271475

Baldwin, S., Ching, Y.-H., & Hsu, Y.-C. (2017). Online course design in higher education: A review of national and statewide evaluation instruments. *TechTrends: Linking Research and Practice to Improve LearningA Publication of the Association for Educational Communications & Technology*, 1–12. https://doi.org/10.1007/s11528-017-0215-z

Baldwin, S. J., & Ching, Y.-H. (2021). Accessibility in online courses: a review of national and statewide evaluation instruments. *TechTrends: Linking Research and Practice to Improve Learning A Publication of the Association for Educational Communications & Technology, 65*(5), 731–742. https://doi.org/10.1007/s11528-021-00624-6

Banwell, E., Qualter, P., & Humphrey, N. (2023). Barriers and facilitators to training delivery and subsequent implementation of a localized child and adolescent mental health initiative: A qualitative content analysis. *BMC Medical Education, 23*(1), 1–15. https://doi.org/10.1186/s12909-023-04238-9

Bhangu. S., Provost, F., & Caduff, C. (2023). Introduction to qualitative research methods – Part I. *Perspectives in Clinical Research, 14*(1), 39–42. https://doi.org/10.4103/picr.picr_253_22

Basham, J. D., Smith, S. J., & Satter, A. L. (2016). Universal Design for Learning: Scanning for alignment in k-12 blended and fully online learning materials. *Journal of Special Education Technology, 31*(3), 147–155.

Batanero, C., de-Marcos, L., Holvikivi, J., Hilera, J. R., & Oton, S. (2019). Effects of new supportive technologies for blind and deaf engineering students in online learning. *IEEE Transactions on Education, Education, IEEE Transactions on, IEEE Trans. Educ, 62*(4), 270–277. https://doi.org/10.1109/TE.2019.2899545

Belotto, M. J. (2018). Data analysis methods for qualitative research: Managing the challenges of coding, interrater reliability, and thematic analysis. *Revista Brasileira de Enfermagem, 71*, 2622–2633.

Benson, A. D. (2002). Using online learning to meet workforce demand. *Quarterly Review of Distance Education, 3*(4), 443–452.

Bhatia-Lin, A., Boon-Dooley, A., Roberts, M. K., Pronai, C., Fisher, D., Parker, L., Engstrom, A., Ingraham, L., & Darnell, D. (2019). Ethical and regulatory considerations for using social media platforms to locate and track research participants. *American Journal of Bioethics, 19*(6), 47–61. https://doi.org/10.1080/15265161.2019.1602176

Bin Mubayrik, H. F. A., & Al-Mutairi, N. M. H. (2022). Responding to the COVID-19 pandemic with the R2D2 teaching model: An organizing aid for online higher education learners. *Education Research International*, 1–7. https://doi.org/10.1155/2022/6775052

Blanchfield, L., & Brown, C. (2015). *The United Nations Convention on the Rights of Persons with Disabilities: Issues in the U.S. ratification debate*. https://sgp.fas.org/crs/misc/R42749.pdf

Bloomberg, L. D., & Volpe, M. (2019). *Completing your qualitative dissertation: A road map from beginning to end* (4th ed.). Sage Publications, Ltd.

Bloomberg, L. (2023). *Completing your qualitative dissertation: A road map from beginning to end* (5th ed.). Sage Publishing.

Bonk, C., & Zhang, K. (2006). Introducing the R2D2 model: Online learning for the diverse learners of this world. *Distance Education*, *27*(2), 249–264. https://doi.org/10.1080/01587910600789670

Borch, K. B., Ekelund, U., Brage, S., & Lund, E. (2012). Criterion validity of a 10-category scale for ranking physical activity in Norwegian women. *The International Journal of Behavioral Nutrition and Physical Activity, 9*. https://doi.org/10.1186/1479-5868-9-2

Brault, M.W. (.2012). Americans with disabilities: 2010. *Current populations report*, 70–131. https://www2.census.gov/library/publications/2012/demo/p70-131.pdf.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bunbury, S. (2019). Unconscious bias and the medical model: How the social model may hold the key to transformative thinking about disability discrimination. *International Journal of Discrimination and the Law, 19*(1), 26–47. https://doi.org/10.1177/1358229118820742

Burgin, X. D. (2023). Use of technology by Ecuadorian teachers: An exploratory study about gender roles. *Journal of International Women's Studies, 25*(4), COV14.

Burgstahler, S. (2021). *Designing online learning to be accessible to students with disabilities*. 2021 Conference on Research in Equitable and Sustained Participation in Engineering, Computing, and Technology (RESPECT), Research in Equitable and Sustained Participation in Engineering, Computing, and Technology (RESPECT), 2021 Conference On, 1–2.

Byrne, D. (2022). A worked example of Braun and Clarke's approach to reflexive thematic analysis. *Quality & Quantity: International Journal of Methodology, 56*(3), 1391–1412. https://doi.org/10.1007/s11135-021-01182-y

Centers for Disease Control and Prevention. (2020). *Disability impacts all of us*. https://www.cdc.gov/ncbddd/disabilityandhealth/infographic-disability-impacts-all.html

Chalmers, J., & Cowdell, F. (2021). What are quantitative and qualitative research methods? A brief introduction. *Dermatological Nursing, 20*(2), 45–48.

Chan, C. A., Chou, E., LaDisa, A. G., Mehta, A., Zelenski, A., & Longtin, K. (2023). Using nominal group technique to determine skills that applied improvisation can teach health profession education learners. *PEC Innovation, 3*. https://doi.org/10.1016/j.pecinn.2023.100194

Charmatz, M. (2020). Harvard settles web access complaint. *Disability Compliance for Higher Education, 25*(10), 1–7. https://doi.org/10.1002/dhe.30836

Chee, M., Davidian, Z., & Weaver, K. D. (2022). More to do than can ever be done: Reconciling library online learning objects with WCAG 2.1 standards for accessibility. *Journal of Web Librarianship, 16*(2), 87–119.

Chesebro, J., & Borisoff, D. (2007). What makes qualitative research qualitative? *Qualitative Research Reports in Communication, 8*(1), 3–14. https://doi.org/10.1080/17459430701617846.

Cifuentes, L., Janney, A., Guerra, L., & Weir, J. (2016). A working model for complying with accessibility guidelines for online learning. *TechTrends: Linking Research & Practice to Improve Learning, 60*(6), 557–564. https://doi.org/10.1007/s11528-016-0086-8

Coleman, M., & Berge, Z. L. (2018). A review of accessibility in online higher education. *Online Journal of Distance Learning Administration, 21*(1).

Colombani, F., Encrenaz, G., Sibé, M., Quintard, B., Ravaud, A., & Saillour-Glénisson, F. (2022). Development of an evidence-based reference framework for care coordination with a focus on the micro level of integrated care: A mixed method design study combining scoping review of reviews and nominal group technique. *Health Policy, 126*(3), 245–261. https://doi.org/10.1016/j.healthpol.2022.01.003

Connelly, L. M. (2016). Trustworthiness in qualitative research. *Medsurg Nursing: Official Journal of the Academy of Medical-Surgical Nurses, 25*(6), 435–436.

Coombs, N. (2010). *Making online teaching accessible: Inclusive course design for students with disabilities*. Jossey-Bass.

Cox, B. (2008). Target population. In Lavrakas, P. J. (Ed.), *Encyclopedia of survey research methods* (Vol. 0, p. 876). Sage Publications, Inc. https://doi.org/10.4135/9781412963947.n571

Coyne, I. T. (1997). Sampling in qualitative research. Purposeful and theoretical sampling: Merging or clear boundaries? *Journal of Advanced Nursing, 26*(3), 623–630.

Cremin, K. M. (2016). What does access to justice require? -Overcoming barriers to invoke the United Nations Convention on the Rights of Persons with Disabilities. *Frontiers of Law in China, 11*(2), 280–322. https://doi.org/10.3868/s050-005-016-0017-7

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design* (4th ed.). Sage Publications, Inc.

Creswell, J. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Sage Publications, Inc.

Cygan, H., & Bejster, M. (2021). From the classroom to the virtual world: Faculty response to COVID-19. *Journal of Nursing Education*, *60*(9), 509. https://doi.org/10.3928/01484834-20210708-04

Daniel, J. (2012). *Sampling essentials: Practical guidelines for making sampling choices.* SAGE Publications, Inc., https://doi.org/10.4135/9781452272047

DeVaughn, P., & Stefaniak, J. (2020). An exploration of how learning design and educational technology programs prepare instructional designers to evaluate in practice. *Educational Technology Research & Development, 68*(6), 3299–3326. https://doi.org/10.1007/s11423-020-09823-z

Ellis, T., & Levy, Y. (2010). A guide for novice researchers: Design and development research methods. *InSITE Conference*.

Erickson, M. J., & Larwin, K. H. (2016). The potential impact of online/distance education for students with disabilities in higher education. *International Journal of Evaluation and Research in Education, 5*(1), 76-81.

Fajardo-Flores, S. B., Gaytan-Lugo, L. S., Santana-Mancilla, P. C., & Rodriguez-Ortiz, M. A. (2021). Accessibility assessment for online education tools: Towards accessible principles for a Mexican university. *EAI Endorsed Transactions on E-Learning, 21*, 1–11. https://doi.org/10.4108/eai.17-2-2021.168720

Feingold, L. (2017). Digital accessibility and the quest for online equality. *Journal of Internet Law, 21*(4), 3–12.

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International Journal of Qualitative Methods*, 5. https://doi.org/10.1177/160940690600500107

Fern, E. F. (1982). The use of focus groups for idea generation: The effects of group size, acquaintanceship, and moderator on response quantity and quality. *Journal of Marketing Research, 19*(1), 1–13. https://doi.org/10.2307/3151525

Ferri, D., & Giannoumis, G. A. (2014). A Revaluation of the cultural dimension of disability policy in the European Union: The impact of digitization and web accessibility. *Behavioral Sciences & the Law, 32*(1), 33–51. https://doi.org/10.1002/bsl.2102

Flick, U. (2007). *Managing quality in qualitative research*. Sage Publications, Ltd.

Francis, J. J., Johnston, M., Robertson, C., Glidewell, L., Entwistle, V., Eccles, M. P., & Grimshaw, J.M. (2010). What is an adequate sample size? Operationalizing data saturation for theory-based interview studies. *Psychology & Health, 25*(10), 1229–1245. https://doi.org/10.1080/08870440903194015

Gill, P., Stewart, K., Treasure, E., & Chadwick, B. (2008). Methods of data collection in qualitative research: interviews and focus groups. *British Dental Journal, 204*(6), 291–295. https://doi.org/10.1038/bdj.2008.192

Gillham, B. (2000). *Case study research methods*. Bloomsbury Publishing Plc.

Given, L. M. (2008). *The SAGE encyclopedia of qualitative research methods* (Vols. 1-0). SAGE Publications, Inc.

Goering, S. (2010). Revisiting the relevance of the social model of disability. *American Journal of Bioethics, 10*(1), 54–55. https://doi.org/10.1080/15265160903460913

Goldkuhl, G. (2012). Pragmatism vs interpretivism in qualitative information systems research. *European Journal of Information Systems, 21*(2), 135–146. https://doi.org/10.1057/ejis.2011.54

Gregory, R. L., Rockinson-Szapkiw, A. J., & Cook, V. S. (2020). Community college faculty perceptions of the Quality Matters[TM] rubric. *Online Learning Journal (OLJ), 24*(2), 128. https://doi.org/10.24059/olj.v24i2.2052

Haegele, J. A., & Hodge, S. (2016). Disability discourse: Overview and critiques of the medical and social models. *Quest (00336297), 68*(2), 193–206. https://doi.org/10.1080/00336297.2016.1143849

Hamilton, R. J., & Bowers, B. J. (2006). Internet recruitment and e-mail interviews in qualitative studies. *Qualitative Health Research, 16*(6), 821–835. https://doi.org/10.1177/1049732306287599

Hancock, M. E., Amankwaa, L., Revell, M. A., & Mueller, D. (2016). Focus group data saturation: A new approach to data analysis. *The Qualitative Report, 21*(11), 2124-2130.

He, W., Zha, S., Watson, S., & He, Y. (2022). Promoting inclusive online learning for students with disabilities in information systems courses. *Journal of Information Systems Education, 33*(1), 7–14.

Hennink, M., & Kaiser, B. N. (2021). Sample sizes for saturation in qualitative research: A systematic review of empirical tests. *Social Science & Medicine*. https://doi.org/10.1016/j.socscimed.2021.114523

Hewson, C., Vogel, C., & Laurent, D. (2016). *Internet research methods*. SAGE Publications, Ltd. https://doi.org/10.4135/9781473920804

Hoard, B., Stefaniak, J., Baaki, J., & Draper, D. (2019). The influence of multimedia development knowledge and workplace pressures on the design decisions of the instructional designer. *Educational Technology Research and Development: A Bi-Monthly Publication of the Association for Educational Communications & Technology, 67*(6), 1479–1505.

Im, E., & Chee, W. (2004). Recruitment of research participants through the Internet. *CIN: Computers, Informatics, Nursing, 22*(5), 289–297.

Imenda, S. (2014). Is there a conceptual difference between theoretical and conceptual frameworks? *Sosyal Bilimler Dergisi/Journal of Social Sciences, 38*(2), 185–195.

Ingavélez-Guerra, P., Otón-Tortosa, S., Hilera-González, J., & Sánchez-Gordón, M. (2021). The use of accessibility metadata in e-learning environments: A systematic literature review. *Universal Access in the Information Society: International Journal*, *22*(2), 445–461. https://doi.org/10.1007/s10209-021-00851-x

International Association of Accessibility Professionals. (2022). *State of digital accessibility*. https://www.accessibilityassociation.org/s/about

Jabareen, Y. (2009). Building a conceptual framework: Philosophy, definitions, and procedure. *International Journal of Qualitative Methods, 8*(4), 49–62. https://doi.org/10.1177/160940690900800406

Johnson, R. B. (1997). Examining the validity structure of qualitative research. *Education, 118*(2), 282–292.

Johnson, N., Seaman, J., & Poulin, R. (2022). Defining different modes of learning: Resolving confusion and contention through consensus. *Online Learning, 26*(3), 91–110. https://doi.org/10.24059/olj.v26i3.3565

Jones, T. S., & Richey, R. C. (2000). Rapid prototyping in action: A developmental study. *Educational Technology Research and Development, 48(2)*, 63–80.

Joshi, D. D. (2022). Exploring barriers to the right to inclusive education in rural Nepal. *Human Rights Brief, 25*(1), 1–12.

Kaatz, K. W. (2021). The joy of quality assurance: Evaluating faculty quality assurance training at a medium-size university in the west. *Journal of Educators Online, 18*(2), 53–65.

Kafia, E., Ibrahimi, S., & Ibrahimi, E. (2023). Inclusive education and its fundamental characteristics: A reflection on the evidence-based approach. *Journal of Pharmacy & Bioallied Sciences, 15*(1), 9–14. https://doi.org/10.4103/jpbs.jpbs_82_23

Kapucu, M. S. (2019). Students' experiences of design-based research in science applications course: A design and development research. *International Journal of Progressive Education, 15*(5), 70–91. https://doi.org/10.29329/ijpe.2019.212.6

Kara, N., & Cagiltay, K. (2020). Smart toys for preschool children: A design and development research. *Electronic Commerce Research and Applications, 39*. https://doi.org/10.1016/j.elerap.2019.100909

Kekeya, J. (2021). Qualitative case study research design: the commonalities and differences between collective, intrinsic, and instrumental case studies. *Contemporary PNG Studies, 36*, 28–37.

King, C., & Piotrowski, C. (2021). Navigating the ADA accessibility requirements and legal pitfalls in online education. *College Student Journal, 55*(2), 127.

Koch, L. C., Lo, W.-J., Mamiseishvili, K., Lee, D., Hill, J., & Rumrill, P. D. (2018). The effect of learning disabilities, attention deficit hyperactivity disorder, and psychiatric disabilities on three-year persistence outcomes at four-year higher education institutions. *Journal of Vocational Rehabilitation, 48*(3), 359–367. https://doi.org/10.3233/JVR-180944

Kotera, Y., Green, P., Hutchinson, L., Shaw, P., Bowskill, N., & Cockerill, V. (2019). Towards another kind of borderlessness: Online students with disabilities. *Distance Education, 40*(2), 170–186. https://doi.org/10.1080/01587919.2019.1600369

Krittika, K., & Shimray, S. R. (2025). Accessibility evaluation of top 25 QS-ranked world universities and top 25 QS-ranked Indian universities using WCAG 2.2: a comparative study. *Universal Access in the Information Society: International Journal,* 1–14. https://doi.org/10.1007/s10209-025-01218-2

Kurt, S. (2019). Moving toward a universally accessible web: Web accessibility and education. *Assistive Technology, 31*(4), 199–208. https://doi.org/10.1080/10400435.2017.1414086

Kyudong, P., Hyo-Jeong, S., & Hyunjin, C. (2019). Digital equity and accessible MOOCs: Accessibility evaluations of mobile MOOCs for learners with visual impairments. *Australasian Journal of Educational Technology*, *35*(6), 48–63. https://doi.org/10.14742/ajet.5521

Lassi, N. (2022). Remote learning and parent depression during the COVID-19 pandemic. *Educational Research Quarterly, 46*(2), 39–68.

Lebenicnik, M., Pitt, I., & Starcic, A. I. (2020). Optimal multimedia combination for students with dyslexia. *Advances in Methodology & Statistics / Metodoloski Zvezki*, *17*(2), 30–48.

Leighton, K., Kardong-Edgren, S., Schneidereith, T., & Foisy-Doll, C. (2021). Using social media and snowball sampling as an alternative recruitment strategy for research. *Clinical Simulation in Nursing, 55*, 37–42. https://doi.org/10.1016/j.ecns.2021.03.006

Lepkowski, J. (2008). Population. In Lavrakas, P. J. (Ed.) (2008). *Encyclopedia of survey research methods* (Vols. 1-0). Sage Publications, Inc. https://doi.org/10.4135/9781412963947

Lord, J. E., & Stein, M. A. (2018). Pursuing inclusive higher education in Egypt and beyond through the Convention on the Rights of Persons with Disabilities. *Social Inclusion, 6*(4), 230–240. https://doi.org/10.17645/si.v6i4.1709

Lowenthal, P. R., Humphrey, M., Conley, Q., Dunlap, J. C., Greear, K., Lowenthal, A., & Giacumo, L. A. (2020). Creating accessible and inclusive online learning: Moving beyond compliance and broadening the discussion. *Quarterly Review of Distance Education*, *21*(2), 1–21.

Lowenthal, P. R., Smith, C., Lomellini, A., & Greear, K. (2021). Accessible online learning: An analysis of online quality assurance frameworks. *Quarterly Review of Distance Education, 22*(2), 15–29.

Madondo, S. (2021). *Data analysis and methods of qualitative research: Emerging research and opportunities*. IGI Global. https://doi.org/10.4018/978-1-7998-8549-8

Malaquias, C. (2022). Unrealised promises and hollow claims: Australia's failure to enact its international obligations under the CRPD for the education of students with disability. *Australian Journal of Education (Sage Publications Ltd.), 66*(3), 235–250. https://doi.org/10.1177/00049441221127454

Martin, F., Kumar, S., & She, L. (2021). Examining higher education instructor perceptions of roles and competencies in online teaching. *Online Learning, 25*(4), 267–295. https://doi.org/10.24059/olj.v25i4.2570

Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative research: A guide to design and implementation*. John Wiley & Sons, Inc.

Miller, S. 2021. *Designing accessible learning content: A practical guide to applying best-practice accessibility standards to L&D resources*. Kogan Page.

Mohamad, I. Z., Mohd Fadzil, A. H., & Roslizam, H. (2023). Combination of M-learning with problem-based learning: Teaching activities for mathematics teachers. *International Journal of Interactive Mobile Technologies (IJIM), 17*, 4–19.

Molanes-Lopez, E. M., Rodriguez-Ascaso, A., Leton, E., & Perez-Martin, J. (2021). Assessment of video accessibility by students of a MOOC on digital materials for all. *IEEE Access, Access, IEEE, 9*, 72357–72367.

Moore, J. L., Dickson-Deane, C., & Galyen, K. (2011). e-Learning, online learning, and distance learning environments: Are they the same? *The Internet and Higher Education, 14*(2), 129–135. https://doi.org/10.1016/j.iheduc.2010.10.001

Moorefield-Lang, H. (2019). Accessibility in online course design. *Library Technology Reports, 55*(4), 14–16.

Morgan, D., & Ravitch, S. (2018). Trustworthiness. In B. Frey (Ed.), *The SAGE encyclopedia of educational research, measurement, and evaluation* (Vol. 1). SAGE Publications, Inc.

Murphy, A., Malenczak, D., & Ghajar, M. (2019). Identifying challenges and benefits of online education for students with a psychiatric disability. *Journal of Postsecondary Education & Disability, 32*(4), 395–409.

Naderifar, M., Goli, H., & Ghaljaie, F. (2017). Snowball sampling: A purposeful method of sampling in qualitative research. *Strides in Development of Medical Education, 14*(3). https://doi.org/10.5812/sdme.67670

Nantongo, P. S. (2019). Framing heuristics in inclusive education: The case of Uganda's preservice teacher education programme. *African Journal of Disability, 8*, 1–10. https://doi.org/10.4102/ajod.v8i0.611

National Association of the Deaf. (2019). *National Association of the Deaf announces landmark settlement with Harvard to improve online accessibility*. https://www.nad.org/2019/11/27/nad-announces-landmark-settlement-with-harvard-to-improve-online-accessibility/

Nworie, J. (2022). The increasing quest for instructional designers and technologists in higher education and corporate settings. *Contemporary Educational Technology, 14*(1), 1–20. https://doi.org/10.30935/cedtech/11481

Olivares Garita, C., Brenes Sánchez, V., & Valverde Marín, E. (2020). R2D2: An effective model to incorporate ICTs in the EFL classroom? *Actualidades Investigativas en Educación, 20*(1), 1–32. https://doi.org/10.15517/aie.v20i1.40098

Orellana, A., Arguello, G., & Kanzki-Veloso, E. (2022). Online presentations with PowerPoint present live real-time automated captions and subtitles: Perceptions of faculty and administrators. *Online Learning, 26*(2), 34–51. https://doi.org/10.24059/olj.v26i2.2763

Ortlipp, M. (2008). Keeping and using reflective journals in the qualitative research process. *The Qualitative Report, 13*(4), 695.

O'Shea, A., & Kaplan, A. (2018). Disability identity and use of services among college students with psychiatric disabilities. *Qualitative Psychology, 5*(3), 358–379. https://doi.org/10.1037/qup0000099

Oswald, G. R., Nathan Adams, R. D., & Hiles, J. A. (2018). Universal Design for Learning in rehabilitation education: Meeting the needs for equal access to electronic course resources and online learning. *Journal of Applied Rehabilitation Counseling, 49*(1), 19–22. https://doi.org/10.1891/0047-2220.49.1.19

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research, 42*(5), 533–544. https://doi.org/10.1007/s10488-013-0528-y

Passmore, S. R., Longhurst, C., Gerbitz, A., Green-Harris, G., Norris, N., & Edwards, D. F. (2023). "I Want to Know Everything...": The Return of Research Results and the Importance of Transparency in the Acceptability of Lumbar Punctures for African American Older Adults. *Journal of Alzheimer's Disease, 95*(2), 663–675. https://doi.org/10.3233/JAD-230275

Patzer, Y., & Pinkwart, N. (2017). Inclusive E-learning - towards an integrated system design. *Studies in Health Technology and Informatics, 242*, 878–885. https://doi.org/10.3233/978-1-61499-798-6-878

PDF/UA Foundation. (2023). *Why PDF/UA*. https://pdfua.foundation/en/why-pdf-ua/

Plass, J. L., & Salisbusry, M. W. (2002). A living-systems design model for web-based knowledge management systems. *Educational Technology Research and Development, 50*(1), 35–57.

Poggenpoel, M., & Myburgh, C. (2006). Obstacles in qualitative research: Possible solutions. *Education, 126*(2), 304.

Quality Matters. (2023). About. https://qualitymatters.org/about

Radovan, M., & Perdih, M. (2016). Developing guidelines for evaluating the adaptation of accessible web-based learning materials. *International Review of Research in Open & Distance Learning, 17*(4), 166–181. https://doi.org/10.19173/irrodl.v17i4.2463

Rao, K., Edelen-Smith, P., & Wailehua, C. (2015). Universal design for online courses: Applying principles to pedagogy. *Open Learning*, *30*(1), 35-52. https://doi.org/ 10.1080/02680513.2014.991300

Rao, K., & Tanners, A. (2011). Curb cuts in cyberspace: Universal instructional design for online courses. *Journal of Postsecondary Education and Disability, 2*4, 211–229.

Rice, M. F., & Ortiz, K. R. (2020). Perceptions of accessibility in online course materials: A survey of teachers from six virtual schools. *Journal of Online Learning Research, 6*(3), 245–264.

Rice, M. F., & Ortiz, K. R. (2021). Evaluating digital instructional materials for K-12 online and blended learning. *TechTrends: Linking Research and Practice to Improve Learning A Publication of the Association for Educational Communications & Technology, 65*(6), 977–992. https://doi.org/10.1007/s11528-021-00671-z

Richey, R. C. (2005). Validating instructional design and development models. In J. M. Spector, C. Ohrazda, A. Van Schaack, & D. A. Wiley (Eds.), *Innovations in instructional technology: Essays in honor of M. David Merrill* (pp. 171–185). Lawrence Erlbaum Associates Publishers.

Richey, R. C., & Klein, J. D. (2007). *Design and development research*. Lawrence Erlbaum Associates, Inc.

Richey, R.C., & Klein, J.D. (2014). Design and development research. In: Spector, J., Merrill, M., Elen, J., & Bishop, M. (Eds.) *Handbook of Research on Educational Communications and Technology*. Springer, New York, NY. https://doi.org/10.1007/978-1-4614-3185-5_12

Robinson, D. E., & Wizer, D. R. (2016). Universal Design for Learning and the Quality Matters guidelines for the design and implementation of online learning events. *International Journal of Technology in Teaching and Learning, 12*(1), 17–32.

Rodrigo, C., & Tabuenca, B. (2020). Ecologías de aprendizaje en estudiantes online con discapacidades. *Comunicar*, *28*(62), 53–65. https://doi.org/10.3916/C62-2020-05

Rose, R., Himangshu Das, Narayan, J., & Jament, J. (2021). Training in qualitative research methods for professionals working with persons with disabilities. *Disability, CBR & Inclusive Development, 32*(1), 130–149. https://doi.org/10.47985/dcidj.447

Roszkowski, M. J., & Soven, M. (2010). Did you learn something useful today? An analysis of how perceived utility relates to perceived learning and their predictiveness of satisfaction with training. *Performance Improvement Quarterly, 23*(2), 71–91.

Sadler, G. R., Lee, H.-C., Lim, R. S.-H., & Fullerton, J. (2010). Recruitment of hard-to-reach population subgroups via adaptations of the snowball sampling strategy. *Nursing & Health Sciences, 12*(3), 369–374. https://doi.org/10.1111/j.1442-2018.2010.00541.x

Samawi, F. S., & Al-kreimeen, R. A. (2022). Shifting to remote learning: Students' engagement and anticipating challenges: A review article. *Journal of Educators Online, 19*(2), 1–8.

Sánchez-Vásquez, F., Pérez-Arriaga, J. C., Vega, G. C., Luján-Mora, S., & Tortosa, S. O. (2022). Towards the implementation process of accessible virtual campuses in higher education institutions in Latin America. *Applied Sciences, 12*(11), 5470. https://doi.org/10.3390/app12115470

Sandnes, F. E. (2021). Is there an imbalance in the supply and demand for universal accessibility knowledge? Twenty years of UAIS papers viewed through the lens of WCAG. *Universal Access in the Information Society: International Journal*, 1–17. https://doi.org/10.1007/s10209-021-00834-y

Schwandt, T. A. (2007). Descriptive analysis. *The SAGE dictionary of qualitative inquiry* (Vols. 1-0). SAGE Publications, Inc., https://doi.org/10.4135/9781412986281

Sebele-Mpofu, F. Y., & Serpa, S. (2020). Saturation controversy in qualitative research: Complexities and underlying assumptions. A literature review. *Cogent Social Sciences, 6*(1), 1–15. https://doi.org/10.1080/23311886.2020.1838706

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information, 22*(2), 63–75. https://doi.org/0.3233/EFI-2004-22201

Simon, M. K., & Goes, J. (2012). *Dissertation and scholarly research: Recipes for success*. https://doi.org/10.13140/rg.2.1.5089.0960

Singleton, K., Evmenova, A., Jerome, M. K., & Clark, K. (2019). Integrating UDL strategies into the online course development process: Instructional designers' perspectives. *Online Learning, 23*(1), 206–235.

Silva Bampi, L. N., Guilhem, D., & Alves, E. D. (2010). Social model: A new approach of the disability theme. *Revista Latino-Americana de Enfermagem (RLAE), 18*(4), 816–823. https://doi.org/10.1590/S0104-11692010000400022

Suri, H. (2011). Purposeful sampling in qualitative research synthesis. *Qualitative Research Journal (RMIT Training Pty Ltd Trading as RMIT Publishing), 11*(2), 63–75. https://doi.org/10.3316/QRJ1102063

Swain, J. (2018). A hybrid approach to thematic analysis in qualitative research: Using a practical example. https://doi.org/10.4135/9781526435477

Taylor, S. (Ed.) (2008). Population. In Boslaugh, S. (Ed.). *Encyclopedia of epidemiology* (Vols. 1-2). SAGE Publications, Inc.

Theofanidis, D., & Fountouki, A. (2018). Limitations and delimitations in the research process. *Perioperative Nursing, 7*(3), 155–163. https://doi.org/10.5281/zenodo.2552022

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation*, 27(2), 237–246.

Tomita, K., Alangari, H., Zhu, M., Ergulec, F., Lachheb, A., & Boling, E. (2021). Challenges implementing qualitative research methods in a study of instructional design practice. *TechTrends: Linking Research & Practice to Improve Learning*, *65*(2), 144–151. https://doi.org/10.1007/s11528-020-00569-2

Tracey, M. W. (2009). Design and development research: A model validation case. *Educational Technology Research and Development, 57*, 553-571.

Turcotte-Tremblay, A.-M., & Mc Sween-Cadieux, E. (2018). A reflection on the challenge of protecting confidentiality of participants while disseminating research results locally. *BMC Medical Ethics, 19*(Suppl 1). https://doi.org/10.1186/s12910-018-0279-0

United Nations Treaty Collection. (2006). *Conventions on the Rights of Persons with Disabilities*. https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=IV-15&chapter=4&clang=_en

Verheijden, M., Giroldi, E., Eertwegh, V., Luijkx, M., Weijden, T., Bruin, A., & Timmerman, A. (2023). Identifying characteristics of a skilled communicator in the clinical encounter. *Medical Education, 57*(5), 418. https://doi.org/10.1111/medu.14953

Vogt, W. P. (Ed.) (2005). *Dictionary of statistics and methodology* (Vols. 1-0). SAGE Publications, Inc., https://doi.org/10.4135/9781412983907

van Putten, S., Blom, N., & Dibane, Z. (2022). Non-specialist primary school mathematics teachers' professional identity. *Africa Education Review, 19*(2), 141–160. https://doi.org/10.1080/18146627.2023.2225750

Wescott, H. N., MacLachlan, M., & Mannan, H. (2020). Disability inclusion and global development: a preliminary analysis of the United Nations partnership on the rights of persons with disabilities programme within the context of the Convention on the Rights of Persons with Disabilities and the sustainable development goals. *Disability, CBR & Inclusive Development, 31(4)*, 90–115. https://doi.org/10.47985/dcidj.397

Web Accessibility in Mind. (2021, January 26). Survey of *web accessibility practitioners #3 results.* https://webaim.org/projects/practitionersurvey3/

Wharton, C. (Ed.) (2006). Document analysis. *The SAGE Dictionary of Qualitative Inquiry* (Vols. 1-0). SAGE Publications, Ltd. https://doi.org/10.4135/9780857020116

World Wide Web Consortium. (2017). *Diverse abilities and barriers*. https://www.w3.org/WAI/people-use-web/abilities-barriers/

World Wide Web Consortium. (2023). *Web accessibility law and policies*. https://www.w3.org/WAI/policies/

Wright, R. (2018, August 1). Quality Matters: The implementation of a quality assurance program for a virtual campus at a state college in Florida. *Distance Learning, 15*(3), 41.

Yin, R. K. (2018). *Case Study Research and Applications: Design and Methods* (6th ed.). SAGE Publications, Inc.

Youngblood, N. E., Tirumala, L. N., & Galvez, R. A. (2018). Accessible media: The need to prepare students for creating accessible content. *Journalism and Mass Communication Educator, 73*(3), 334–345. https://doi.org/10.1177/1077695817714379

Youngwanichsetha, S., Phumdoung, S., Kritcharoen, S., Chunuan, S., & Kala, S. (2019). Application of the R2D2 model for active learning strategy in graduate midwifery course.

International Journal of Nursing Education, 11(1), 115–118. https://doi.org/10.5958/0974-9357.2019.00022.9

Yuyun, M., Budi, M., Riandi, R., & Nuryani, R. (2019). Design development research approach in developing gel electrophoresis virtual laboratory to substitute real practicum. *Scientiae Educatia: Jurnal Pendidikan Sains, 8*(1), 64–75. https://doi.org/10.24235/sc.educatia.v8i1.3961

Appendix A

Instructional Designer and Accessibility Expert Interview Guide

Introduction

Thank you for participating in this study. The interview process is scheduled for a duration of 30 to 60 minutes. To stay true to what we discuss today, I would like to record our conversation with video and audio to assist with notetaking and transcriptions. The acknowledgment request was made through the Informed Consent, but if you continue to agree with the process, your consent will form part of the start of the recording.

Do you acknowledge and agree to be recorded in audio and video for the length of this conversation? [*Participant answer*]. Thank you. Participation in this study is voluntary, and your responses to the prompted questions will be kept confidential. The recordings will be deleted after the research process is completed. You are at risk of no harm, and your identity or any identifiable information or characteristic will not be recorded. Also, please be aware that you can withdraw from the process at any time.

You are participating in this interview because you identified yourself as an instructional designer/accessibility expert with experience, training, or certifications within the field of accessibility in online settings. This research aims to describe the model development and validation process to expand the validated, research-based R2D2/C3PO model to integrate accessibility options for each of the eight components of the existing model. The research is to gather from your expertise accessibility strategies and best practices to enhance the R2D2/C3PO instructional design model to include accessibility strategies to remove barriers for learners with disabilities.

Participant Background

1. Please share what is your current role at your workplace.
2. Departing from your current role, what are your main tasks or contributions toward aiming for accessible experiences for learners or people with disabilities?
3. How long have you been an [*Participant answer to question 1]* and implementing accessibility strategies?

R2D2 and R2D2/C3PO Model Introduction

R2D2/C3PO is an instructional design model created by Bonk and Zhang in 2006 and later enhanced by Armstrong in 2016 to provide educators with a tool to guide the design, development, implementation, and evaluation of online learning activities for learners of various learning styles. The original model includes four quadrants or components: (1) read, (2) reflect, (3) display, and (4) doing. It was later enhanced by Armstrong, who included four additional components: (5) coaching, (6) conviviality, (7) critical incident technique, and (8) planning by adding instructional strategies and tools for synchronous sessions.

Guide: Screenshare the model with participants for a brief section overview since the model was shared before the interview.

R2D2/C3PO Components and Accessibility Enhancements

We will review each of the eight components to identify accessibility strategies that will help educators using this instructional design model remove barriers learners with disabilities could experience through the components learning activities.

Read/Listening

1. What accessibility strategies would you recommend making to the read/listening component learning activities accessible?

    a. What type of learners with disabilities will benefit from these strategies?

2. *Instructional Designers*: Describe how these learning strategies can be enhanced to address accessibility concerns.
3. What tools or strategies would you suggest to instructors to provide a more accessible experience for the reading/listening component?

Reflect/Write/Sharing

1. What accessibility strategies or practices would you include or recommend making to the Reflect component learning activities accessible?
    a. What type of learners with disabilities will benefit from these strategies?
2. Some of the learning strategies in this component will occur in live/synchronous environments; please describe how live experiences can be enhanced to ensure they are accessible to learners with disabilities.
3. *Instructional Designers:* What tools or strategies would you suggest to instructors to provide a more accessible experience for the reflect component that includes synchronous and asynchronous experiences?

Display

1. What accessibility strategies would you recommend making to the display component learning activities accessible?
    a. What type of learners with disabilities will benefit from these strategies?
2. *Instructional Designers:* How would you expand or modify these strategies to assure accessibility for instructional strategies when content is displayed to learners?

Doing

1. In the doing component, some strategies include collaboration between learners; what type of accessibility strategies can enhance this experience to make it accessible?

    a. What type of learners with disabilities will benefit from these strategies?

2. What other accessibility strategies would you recommend for this component?

Coaching

1. What accessibility strategies would you recommend making to the coaching component learning activities accessible?
    a. What type of learners with disabilities will benefit from these strategies?
2. *Instructional Designers:* Describe other learning strategies and tools that could help instructors deliver a more accessible coaching experience for learners with disabilities.

Conviviality

1. Besides the accessibility strategies discussed to enhance similar learning activities as shown in conviviality, describe additional accessibility (or learning) strategies that instructors can implement to reinforce accessibility in collaboration scenarios.
    a. What type of learners with disabilities will benefit from these strategies?

Critical Incident Technique

1. What accessibility strategies would you recommend making to the Critical Incident Technique component to make it more accessible?
    a. What type of learners with disabilities will benefit from these strategies?
2. Describe the best form tools that will help instructors comply with accessibility.
3. Describe additional steps instructors can take to ensure an accessible learning experience for learners with disabilities when completing forms or polls.
4. *Instructional Designers*: Besides using forms or polls, what learning experiences can be implemented to gather feedback from learners with disabilities in a more accessible way?

Planning/Organization

a. What accessibility strategies would you recommend making to the Planning/organization component to make it more accessible, if any?
    a. What type of learners with disabilities will benefit from these strategies?
b. What strategies are must-haves for guides or manuals shared in online settings?

General Accessibility Needs

1. Describe any additional barriers or accessibility concerns in the R2D2/C3PO model that must be addressed.
2. What are your global accessibility recommendations to help overcome these barriers?
3. How can accessibility opportunities be maximized in an enhanced model?

Conclusion Script

Thank you for addressing our questions and participating in this interview process. As a reminder, the information provided will be kept confidential, but if you would like your responses removed from the data collection at any time, please notify me before the completion of the research. Thank you for your time.

Appendix B

R2D2/C3PO/A Model Draft Post Interview

R2D2/C3POA Components, Instructional Strategies/Learning Activities, Synchronous Tools, and Accessibility Strategies

R2D2/C3PO Component	*Instructional Strategies/ Learning Activities*	*Synchronous Web-Conferencing Tools*	*Accessibility Strategies and Learning Activities*
Read/ Listening/ Viewing	• Reading materials online or offline. • Creating participant manuals for each live synchronous event. • Listening to audio material (audio podcasts) online or offline. • Synchronous expert lectures/presentations/tutorials • "Live demonstrations" • Participant manuals as PDFs or Word Documents	• Downloadable participant manuals as PDF and/or Word files. • Downloadable audio podcast files. MP4 and Wave files are the most typical • Downloadable video/ multimedia files. MP4 and Wave files are the most typical streamed video. • Pictures using JPEG, PNG, and GIF files are most typical. • "Live" synchronous facilitator/faculty presentation/ demonstrations and lectures. • Facilitator/faculty tools include whiteboards, chats, application sharing, file transfer, share pods, screen sharing, PowerPoint slides, polls, and note boards for announcements, Q&A, and FAQs. • Print-based PDF and Word	a. Include transcripts for any audio (podcasts) and videos in a downloadable format. Add descriptive transcripts (e.g., explanation of a scene or formula) for any visuals on slides or videos. b. Include alternative text and descriptions for visuals (such as images, infographics, and GIFs) and provide a summary for complex images. c. Include accurate closed captions for all videos. d. Enable live captions and coordinate with the Office of Disabilities for interpreters in live synchronous sessions. e. Use accessibility tools (e.g., Microsoft Accessibility Checker, Adobe Accessibility Checker, Color Contrast Analyzers, etc.) for automated accessibility checks. Conduct manual checks in addition.

		files, as well as audio Podcast MP4 and Wave files, can be made available during the "live" web-conferencing session through Chat and File Share • Links to websites.	f. Provide multiple methods for learners to access the content and to complete their activities (e.g., alternative options to existing activities and methods). Share materials with learners ahead of time. g. Use heading structures (H1 to H6) for proper navigation, content understanding, and proper readability. h. Ensure keyboard navigation and functionality for all activities (e.g., video players, interactive media, etc.) and provide the user control over multimedia (e.g., video play, pause, stop). i. Ensure proper color contrast between background and content (apply to content, images, links, etc.) j. Minimize the use of Adobe PDF documents due to accessibility challenges and remediation costs.
Reflect/ writing/ sharing	• Time allocated before, after, and during the web conferencing session for reflection: ○ Prework, during synchronous event, between synchronous	• Downloadable participant manuals used to write reflections in PDF or Word doc format. • Downloadable journal in PDF or Word doc formats.	a. Provide learners with multiple formats and methods to complete activities (e.g., alternative versions of existing formats, two options to complete an activity, create

	events (multievent course)
	• Provide "silent time" for deep reflection
	• Write in-depth reflection papers covering:
	  o What was learned?
	  o How learned took place?
	  o How learning can be applied?
	• Keep Reflection Journals
	• Creative Reflective Visual Representations:
	  o Graphics, smart art, figures, models, tables
	• Pair shares
	• Small group discussion.
	• Focus group discussion.
	• Online role play.
	• Self-assessment.
	• Online quizzes.
	• Electronic portfolios for multi-session events
	• Practice
		• Chat pods used for sharing reflections with other participants.
		• Polls used to capture self-assessment and compare anonymously with other participants.
		• Online quizzes using polling and assessment features.
		• Main room presentations for group discussions, debates, mock trials, role play, practice with partners, and focus groups.
		• Breakout rooms used for small group discussions, debates, mock trials, role play, practice with partners, and focus groups.
			practice quizzes before any primary assessment, etc.).
			b. Include transcriptions and captions for synchronous events (e.g., breakout rooms, live sessions) or coordinate for transcribers or interpreters.
			c. Allow for flexibility by providing additional time for discussions and activity completion for those who need it.
			d. Provide clear instructions and details of sessions, quizzes, interactions, and activities (e.g., details about a quiz such as the number of questions, choices, sentences, or if they include pictures, audio clips, etc.).
			e. Use institutional accessibility resources (e.g., transcribers, sign language interpreters, Braille printer, etc.).
			f. Send content ahead in advance (e.g., links to videos that will be displayed in synchronous sessions, slides, pre-reading).
			g. Group learners by ability (low, mid, high) to improve collaboration.

			h. Ensure technologies are accessible or work with assistive technologies where learners can control the environment (e.g., keyboard, screen readers, read-out-loud, etc.).
Display	• Visual Representations include: ○ Pictures, diagrams, graphs, multimedia, video, charts, animations, flowcharts, YouTube videos, conceptual frameworks, models, virtual worlds, and mobile technologies. • Demonstrations include: ○ Process steps, concept maps, logic steps, real-world examples • Instructor "live" video-based feedback of work products and student work • Drawing • Virtual tours • Databases.	• Downloadable participant manuals with visual representations of key concepts in PDF or Word doc formats. • Video files in MP4, MOV, and WebM formats. • Streaming video using the Share feature. • Using drawing tools and presenting back to the entire group in the main room or small groups in breakout sessions. • Facilitator/faculty "live" presentation using a shared pod with a PowerPoint presentation with robust visuals to help explain concepts. • "Live" visual of the facilitator/faculty presenting or demonstrating "live," which enhances teacher presence. • "Live" visual of visiting	a. Include alternative text or transcriptions for images, diagrams, and graphs. Use proper terminology for text-based descriptions with content for all relevant visuals (synchronous or asynchronous). b. Provide detailed descriptions for complex visuals. For example, describe tables, drawings, virtual worlds, and tours as they occur. c. Have accurate transcripts and closed captions for video and audio files, coordinate live transcribers, or include audio descriptions for an elevated level of accessibility. If using videos in synchronous sessions, share the videos with accurate captions and transcripts before the session. d. Ensure color contrast for course components (links,

		experts presenting content through the Share feature. • Live videos of students presenting in the main room or breakout rooms. • Links to videos on YouTube, TED Talks, Khan Academy, etc. • Showing databases through the web-conferencing Share feature.	images, text, virtual backgrounds, etc.), and avoid using color or images as the single method for meaning. e. Test links for functionality, set up links as descriptive links (e.g., the name of the target instead of "Click Here" or the full URL), and use standard formatting (underlined, visual difference to stand out, etc.). f. Promote accessibility awareness at the institutional level and among your learners by using inclusive and culture-sensitive language and encouraging learners to include alternative text, descriptions, transcripts, and captions, in their work. g. Give learners complete control over multimedia (e.g., play, pause, and stop at any time) and do not use no auto-play or flashing/blinking.
Doing the Work	• Caselettes (short cases). • Case studies. • Practice. • Project-based learning. • Collaborative group paper, etc.	• Downloadable participant manuals with mini-cases, project, collaboration, and apprenticeship instructions in PDF and/or Word doc formats.	a. Include multiple formats or methods (e.g., transcript, summary, a cheat sheet with steps or processes) and activities (e.g., ungraded

	• Cognitive Apprenticeship • Assessment • Online role play • Gaming • Adaptive learning	• Live facilitator/faculty presentation, demonstration, and modeling for all activities. Time allocated for reflection and Questions and Answers (Q&As). • Using technology-based drawing tools and smart art, learners present projects, graphics, flowcharts, diagrams, pictures, project plans, and timelines, and then implementation plans consistent with their knowledge acquisition either in the main room, as pair shares, or in breakout rooms. • Breakout rooms with whiteboards and chat pods for individual and collaborative work. Polls available, when needed. • Breakout rooms for practice with partners or in larger groups, such as triads and quads. • "Live" individual or group presentations and role play in the main room. • Provide instructional games as well as fun icebreakers throughout the session.	practice for complex activities, asynchronous group paper collaboration instead of synchronous collaboration, etc.). b. Add clear rubric criteria with an explanation of the activity, and share ground rules on learners creating accessible content by adding alt text, descriptions, and transcripts. c. Provide clear instructions, expectations, and steps for multimedia completion and engagement. d. Have interpreters and captions for live sessions (whole class and small groups) and record sessions. e. Provide clear explanations and descriptions of elements such as math problems and anything visual (e.g., anything created on the whiteboard, PowerPoint slides etc.). f. Provide accessible material ahead of time. If learners are presenting, request their presentation to be shared before the session and provide it to other students. g. Establish various levels of

		• Provide custom learning experiences that address the learning needs of each individual student through providing just-in-time feedback, critiquing, and resources.	accommodations through institutional resources (e.g., Office of Disabilities). h. Provide time-based accommodations to give people time to process. i. Ensure the readability level by using headers to break content and vocabulary knowledge. j. Provide accessible tools for learners to use to create their works
Coaching	• Cognitive apprenticeships • Scaffolding • Interactive feedback	• Facilitator/ faculty feedback through "live" voice, chat, and private chat. • Peer coaching in breakouts and private chats.	a. Provide multiple ways to coach for learners' needs or preferences (e.g., email, messaging apps, learning management system, office hours virtual/in-person, video chats, recorded sessions along with a transcript). b. Share an agenda or clear guidelines before a coaching session to clarify each item or expectation and how much time they will spend. c. Arrange for interpreters (e.g., sign language) for synchronous coaching sessions. d. Include clear feedback to

			guide learners. Do not rely on colors, images, or shapes as the only source of meaning (e.g., do not use green to represent correct).
Conviviality	• Ground rules to encourage collaboration, cooperation, and trust • A fast start to ensure all participants can use the web conferencing tools • Practice good human relations principles • Call students by name • Smile when "Live" on camera • Provide positive, constructive criticism • Use emojis to promote motivation, friendliness, enthusiasm, and humor • Organizational consideration for instructor/facilitator workload and requirements for planning synchronous web-based video conferencing events.	• Participatory establishment of ground rules using "live" discussion, chats, whiteboard tools, and polls. • Remember, as an instructor, you are the visual. Smile. Body language should be relaxed, open, warm, and inviting. • Virtual background should be inviting and appropriate for the audience. • Begin in a friendly way. Start with a short story related to the topic or ask a question to engage the participants in the topic. • Remember the importance of each student's name and make sure to pronounce it correctly. If unsure, ask. • Use emojis to express emotions, such as like, surprise, love, speed up, slow down, applause, thumbs up, thumbs down, smiling, etc.	a. Use and encourage clear, inclusive language that reflects cultural sensitivity (e.g. describe participants or scenarios in sessions, etc.). b. Resist stereotypes and be inclusive in visual and audio materials. c. Provide clear descriptions of emojis, GIFs, and other visual material that might mean something different for learners. Visuals should not be the only way to convey information. d. Establish ground rules for behaviors and accessibility awareness for both instructors and learners. e. Add multiple check-ins throughout the session to keep learners engaged. f. Make engagement strategies optional, not required. g. Allow responses through the chat feature and include time

		• Inject appropriate humor, sharing cartoons, avatars, etc. • Ask questions. Let students answer through the Chat feature, Annotation feature on a Whiteboard of File Share, and through coming off mute and talking. • Institutions must recognize the increase in workload and planning needed for designing and implementing web-based video conferencing events and supply instructional designers, developers, teachers, and facilitators with the resources required.	and long pauses for questions.
Critical Incident Technique (CIT)	• Use CIT for immediate student feedback between instructional events. • Use other Kirkpatrick Level 1, reaction tools during or post the live event	• Downloadable form can be used in either PDF or Word doc formats and returned to the instructor after the session. • By using the Zoom Poll feature, students can make anonymous responses. • Questions can be asked using the White Board feature, and students allowed to anonymously post their responses. • Level 1, Kirkpatrick Reaction Evaluations can be made at the end of each web-conferencing	a. Use accessible online forms to collect feedback instead of using Microsoft Word or Adobe PDF documents to gather feedback due to accessibility challenges. b. Ensure all materials are accessible with assistive technologies (e.g., keyboard accessibility to navigate and interact with the materials). c. Provide multiple formats or alternative ways to complete the activity (e.g., open discussion forums, written reflection, etc.).

		session or an entire sequence. Tools can be downloadable PDFs or Word doc files, Excel worksheets, or using web-conferencing interactive Polling features. • Questions regarding student perceived usefulness, ease of use, and anxiety with technology can be asked.	d. Questions are in an inclusive format with both specific and open-ended questions that account for emotional aspects of the interaction. e. Provide expectations to learners ahead of time (e.g., type of polls, chats, number of poll activities, etc.). f. Use descriptive links. g. Conduct follow-up polls after the event or session for synchronous events polls to allow time for reflection. h. Conduct automated and manual accessibility checks.
Planning/ Organization	• Warm up • Fast start • Quick reference • Frequently Asked Questions (FAQ's) • Participant manual and/ or Journals • Facilitator/ trainer manual • PowerPoint slides • Pre-constructed whiteboards • Timeline for all activities • Time for reflection during event and between events. • Evaluation and assessments (both formative and summative)	• Warm up questions and/or activity visible as students sign into the web-based conference. • Fast Start introduces students to the web-based video conferencing features, tools, and functionality before delivery of content. • Quick Reference Guides and Frequently Asked Questions on how to use the web conferencing tools. • Participant manual containing content and exercises and reflections during the live session.	a. Run accessibility checks on all your materials to ensure accessibility and that they are usable with assistive technologies (e.g., keyboard, screen readers, etc.). You can create a checklist to review for accessibility. b. Plan for captions and transcripts in all videos and transcripts for audio only (podcasts). c. Ensure enough color contrast in all your materials and that crucial information does not rely only on color to convey

	• Participant journal for multi-session activities. • Facilitator/faculty manual with suggested timelines for all activities and instructions for use of web-based video conferencing software's features and functions. • Reflection time built into all events. • Polls and Assessments created in advance. • PowerPoint Slides uploaded in advance. • Graphics, figures, tables, frameworks, flow charts created and uploaded in advance. • Breakout sizes and number decided and set up in advance.	meaning. d. Start with accessibility in mind when designing a course. Create accessible templates that you can use. e. Plan for alt text on all images and evaluate the context to ensure accurate information. f. Coordinate with institution resources for professional development funds and access to resources (e.g., accessible tools, textbook companies, etc.). g. Plan for multiple ways for learners to access the content and submit their work. h. Plan heading structure in documents and webpages to allow for better navigation and understanding. i. Include a syllabus with clear expectations, participation, organization of content, and objectives

Source: This table is adapted from Armstrong (2014, 2016) and Armstrong and Gale (2018, 2025) and reprinted from Armstrong (2014) with permission from Nova Science Publishers.

Appendix C

Model Accessibility Enhancement Questionnaire: R2D2/C3POA

Introduction

Thank you for participating in the model accessibility enhancement questionnaire as part of the research study Addressing Accessibility Barriers in Online Learning: A DDR Model Use Study Augmenting the R2D2/C3PO Model. We are committed to enhancing the R2D2/C3PO model to include accessibility strategies for each of the eight components to remove barriers for learners with disabilities. This questionnaire will gather your feedback on accessibility strategies for each of the eight components collected through the literature review and individual interviews with participants. Your input will help us refine the model and develop an enhanced model.

- **Section 1:** Divided in three parts, this section includes each component, accessibility strategies, and learning activities, and a drop-down ranking system
- **Section 2:** Includes three open-ended questions for components feedback.
- **Section 3:** Includes general questions for additional feedback.

Expected time for completion: 10 to 20 minutes.

Privacy and Confidentiality Note

Please be assured that all data in this survey will be kept strictly confidential and will be used solely for this research project. Your responses will not be shared with third parties or used for purposes beyond this study. Additionally, we ask that you do not share any research study materials, including this questionnaire and the enhanced model draft, with anyone outside the study. This action helps us protect the integrity of the research and ensure that all feedback remains confidential.

Participant Information

- Name and Last name**
- Email address**

Section 1: Ranking Accessibility Strategies

For each R2D2/CPOA component listed, please rank the following accessibility strategies based on their importance in making instructional activities accessible to all learners, including those with disabilities. Use the ranking scale that goes from 1 (not important) to 4 (very important) through the drop-down options. You can review the full R2D2/C3POA model online or through the emailed Word file.

Note: Ranking questions might display or function differently on mobile devices.

Component 1: Read/ Listening/Viewing

c. Include transcripts for any audio (podcasts) and videos in a downloadable format. These include descriptive transcripts (e.g. explanation of a scene or formula) for any visuals on slides or videos. ****Ranking: [1] [2] [3] [4]****
d. Include alternative text and descriptions for visuals (such as images, infographics, and GIFs) and provide a summary for complex images. ****Ranking: [1] [2] [3] [4]****
e. Include accurate closed captions for all videos. ****Ranking: [1] [2] [3] [4]****
f. Enable live captions and coordinate with the Office of Disabilities for interpreters in live synchronous sessions. ****Ranking: [1] [2] [3] [4]****
g. Use accessibility tools (e.g., Microsoft Accessibility Checker, Adobe Accessibility Checker, Color Contrast Analyzers, etc.) for automated accessibility checks. Conduct manual checks in addition. ****Ranking: [1] [2] [3] [4]****

h. Provide multiple methods for learners to access the content and to complete their activities (e.g., alternative written options to existing activities and methods). Share materials with learners ahead of time. **Ranking: [1] [2] [3] [4]**

i. Use heading structures (H1 to H6) for proper navigation, content understanding, and proper readability. **Ranking: [1] [2] [3] [4]**

j. Ensure keyboard navigation and functionality for all activities (e.g., video players, interactive media, etc.) and provide the user control over multimedia (e.g., video play, pause, stop). **Ranking: [1] [2] [3] [4]**

k. Ensure proper color contrast between background and content (apply to content, images, links, etc.). **Ranking: [1] [2] [3] [4]**

l. Minimize the use of Adobe PDF documents due to accessibility challenges and remediation costs. **Ranking: [1] [2] [3] [4]**

Component 2: Reflect/Writing/Sharing

i. Provide learners with multiple formats and methods to complete activities (e.g., alternative versions of existing formats, two options to complete an activity, create practice quizzes before any primary assessment, etc.). **Ranking: [1] [2] [3] [4]**

j. Include transcriptions and captions for synchronous events (e.g., breakout rooms, live sessions) or coordinate for transcribers or interpreters. **Ranking: [1] [2] [3] [4]**

k. Allow for flexibility by providing additional time for discussions and activity completion for those who need it. **Ranking: [1] [2] [3] [4]**

l. Provide clear instructions and details of sessions, quizzes, interactions, and activities (e.g., details about a quiz such as the number of questions, choices, sentences, or if they include pictures, audio clips, etc.). **Ranking: [1] [2] [3] [4]**

m. Use institutional accessibility resources (e.g., transcribers, sign language interpreters, Braille printer, etc.). **Ranking: [1] [2] [3] [4]**

n. Send content ahead in advance (e.g., links to videos that will be displayed in synchronous sessions, slides, pre-reading). **Ranking: [1] [2] [3] [4]**

o. Group learners by ability (low, mid, high) to improve collaboration. **Ranking: [1] [2] [3] [4]**

p. Ensure technologies are accessible or work with assistive technologies where learners can control the environment (e.g., keyboard, screen readers, read-out-loud, etc.). **Ranking: [1] [2] [3] [4]**

Component 3: Display

h. Include alternative text or transcriptions for images, diagrams, and graphs. Use proper terminology for text-based descriptions with content for all relevant visuals (synchronous or asynchronous). **Ranking: [1] [2] [3] [4]**

i. Provide detailed descriptions for complex visuals. For example, describe tables, drawings, virtual worlds, and tours as they occur. **Ranking: [1] [2] [3] [4]**

j. Have accurate transcripts and closed captions for video and audio files, coordinate live transcribers, or include audio descriptions for an elevated level of accessibility. If using videos in synchronous sessions, share the videos with accurate captions and transcripts before the session. **Ranking: [1] [2] [3] [4]**

k. Ensure color contrast for course components (links, images, text, virtual backgrounds, etc.), and avoid using color or images as the single method for meaning. **Ranking: [1] [2] [3] [4]**

l. Test links for functionality, set up links as descriptive links (e.g., the name of the target instead of "Click Here" or the full URL), and use standard formatting (underlined, visual difference to stand out, etc.). **Ranking: [1] [2] [3] [4]**

m. Promote accessibility awareness at the institutional level and among your learners by using inclusive and culture-sensitive language and encouraging learners to include alternative text, descriptions, transcripts, and captions, in their work. **Ranking: [1] [2] [3] [4]**

n. Give learners complete control over multimedia (e.g., play, pause, and stop at any time) and do not use no auto-play or flashing/blinking. **Ranking: [1] [2] [3] [4]**

Component 4: Doing the Work

k. Include multiple formats or methods (e.g., transcript, summary, a cheat sheet with steps or processes) and activities (e.g., ungraded practice for complex activities, asynchronous group paper collaboration instead of synchronous collaboration, etc.). **Ranking: [1] [2] [3] [4]**

l. Add clear rubric criteria with an explanation of the activity, and share ground rules on learners creating accessible content by adding alt text, descriptions, and transcripts.

m. Provide clear instructions, expectations, and steps for multimedia completion and engagement. **Ranking: [1] [2] [3] [4]**

n. Have interpreters and captions for live sessions (whole class and small groups) and record sessions. **Ranking: [1] [2] [3] [4]**

o. Provide clear explanations and descriptions of elements such as math problems and anything visual (e.g., anything created on the whiteboard, PowerPoint slides etc.). **Ranking: [1] [2] [3] [4]**

p. Provide accessible material ahead of time. If learners are presenting, request their presentation be shared before the session and provide it to other students. **Ranking: [1] [2] [3] [4]**
q. Establish various levels of accommodations through institutional resources (e.g., Office of Disabilities). **Ranking: [1] [2] [3] [4]**
r. Provide time-based accommodations to give people time to process. **Ranking: [1] [2] [3] [4]**
s. Ensure the readability level by using headers to break and organize content and vocabulary knowledge. **Ranking: [1] [2] [3] [4]**
t. Provide accessible tools for learners to use to complete assignments. **Ranking: [1] [2] [3] [4]**

Component 5: Coaching

e. Provide multiple ways to coach for learners' needs or preferences (e.g., email, messaging apps, learning management system, office hours virtual/in-person, video chats, recorded sessions along with a transcript). **Ranking: [1] [2] [3] [4]**
f. Share an agenda or clear guidelines before a coaching session to clarify each item or expectation and how much time they will spend. **Ranking: [1] [2] [3] [4]**
g. Arrange for interpreters (e.g., sign language) for synchronous coaching sessions.
h. Include clear feedback to guide learners. Do not rely on colors, images, or shapes as the only source of meaning (e.g., do not use green to represent correct). **Ranking: [1] [2] [3] [4]**

Component 6: Conviviality

h. Use and encourage clear, inclusive language that reflects cultural sensitivity (e.g. describe participants or scenarios in sessions, etc.). **Ranking: [1] [2] [3] [4]**

i. Resist stereotypes and be inclusive in visual and audio materials. **Ranking: [1] [2] [3] [4]**

j. Provide clear descriptions of emojis, GIFs, and other visual material that might mean something different for learners. Visuals should not be the only way to convey information. **Ranking: [1] [2] [3] [4]**

k. Establish ground rules for behaviors and accessibility awareness for both instructors and learners. **Ranking: [1] [2] [3] [4]**

l. Add multiple check-ins throughout the session to keep learners engaged. **Ranking: [1] [2] [3] [4]**

m. Make engagement strategies optional, not required. **Ranking: [1] [2] [3] [4]**

n. Allow responses through the chat feature and include time and long pauses for questions. **Ranking: [1] [2] [3] [4]**

Component 7: CIT

i. Use accessible online forms to collect feedback instead of using Microsoft Word or Adobe PDF documents to gather feedback due to accessibility challenges. **Ranking: [1] [2] [3] [4]**

j. Ensure all materials are accessible with assistive technologies (e.g., keyboard accessibility to navigate and interact with the materials). **Ranking: [1] [2] [3] [4]**

k. Provide multiple formats or alternative ways to complete the activity (e.g., open discussion forums, written reflection, etc.). **Ranking: [1] [2] [3] [4]**

l. Questions are in an inclusive format with both specific and open-ended questions that account for emotional aspects of the interaction. **Ranking: [1] [2] [3] [4]**

m. Provide expectations to learners ahead of time (e.g., type of polls, chats, number of poll activities, etc.). **Ranking: [1] [2] [3] [4]**

n. Use descriptive links. **Ranking: [1] [2] [3] [4]**

o. Conduct follow-up polls after a synchronous session to allow time for reflection. **Ranking: [1] [2] [3] [4]**

p. Conduct automated and manual accessibility checks. **Ranking: [1] [2] [3] [4]**

Component 8: Planning and Organization

j. Run accessibility checks on all your materials to ensure accessibility and that they are usable with assistive technologies (e.g., keyboard, screen readers, etc.). You can create a checklist to review for accessibility. **Ranking: [1] [2] [3] [4]**

k. Plan for captions and transcripts in all videos and transcripts for audio only (podcasts). **Ranking: [1] [2] [3] [4]**

l. Ensure enough color contrast in all your materials and that crucial information does not rely only on color to convey meaning. Consider color contrast in synchronous sessions and prevent virtual backgrounds or clothes that can cause a flickering screen. **Ranking: [1] [2] [3] [4]**

m. Start with accessibility in mind when designing a course. Create accessible templates that you can use. **Ranking: [1] [2] [3] [4]**

n. Plan for alt text on all images and evaluate the context to ensure accurate information. **Ranking: [1] [2] [3] [4]**

o. Coordinate with institution resources for professional development funds and access to resources (e.g., accessible tools, textbook companies, etc.). **Ranking: [1] [2] [3] [4]**

p. Plan multiple ways for learners to access the content and submit their work. **Ranking: [1] [2] [3] [4]**

q. Plan heading structure in documents and webpages to allow for better navigation and understanding. **Ranking: [1] [2] [3] [4]**

r. Include a syllabus with clear expectations, participation, organization of content, and objectives. **Ranking: [1] [2] [3] [4]**

Section 2: Open-Ended Questions

Answer the following open-ended questions. This section includes three questions that you need to answer for each component in the provided text box area. All items are required.

Question 1

What additional accessibility strategies would you suggest for these components?

Component 1: Read/Listening, Viewing	[Entry text/answer box]
Component 2: Reflect/Writing/Sharing	[Entry text/answer box]
Component 3: Display	[Entry text/answer box]
Component 4: Doing the Work	[Entry text/answer box]
Component 5: Coaching	[Entry text/answer box]
Component 6: Conviviality	[Entry text/answer box]
Component 7: CIT	[Entry text/answer box]
Component 8: Planning and Organization	[Entry text/answer box]

Question 2

What learning activities would you include in these components to ensure an inclusive and accessible experience for all learners?

Component 1: Read/Listening, Viewing	[Entry text/answer box]
Component 2: Reflect/Writing/Sharing	[Entry text/answer box]
Component 3: Display	[Entry text/answer box]
Component 4: Doing the Work	[Entry text/answer box]
Component 5: Coaching	[Entry text/answer box]
Component 6: Conviviality	[Entry text/answer box]
Component 7: CIT	[Entry text/answer box]
Component 8: Planning and Organization	[Entry text/answer box]

Question 3

How can these components be improved to better accommodate diverse learners' needs?

Component 1: Read/Listening, Viewing	[Entry text/answer box]
Component 2: Reflect/Writing/Sharing	[Entry text/answer box]
Component 3: Display	[Entry text/answer box]
Component 4: Doing the Work	[Entry text/answer box]
Component 5: Coaching	[Entry text/answer box]
Component 6: Conviviality	[Entry text/answer box]
Component 7: CIT	[Entry text/answer box]
Component 8: Planning and Organization	[Entry text/answer box]

Section 3: General Enhanced Model Feedback

Enter your responses for each question to provide additional feedback. This section includes three questions, all of which are required.

1. How can the enhanced model, R2D2/C3POA, remove barriers for learners with disabilities in online synchronous and asynchronous learning? [Entry text/answer box]
2. Are there any overarching accessibility strategies or considerations that should be applied across all components of the **R2D2/C3POA** instructional design model? [Entry text/answer box]
3. Do you have any additional comments or suggestions on improving the accessibility of learning activities for all learners, including those with disabilities, in this model? [Entry text/answer box]

Conclusion

Thank you for your valuable input. Your feedback is essential in helping us enhance the model to create a more inclusive and accessible learning environment for all learners.

Appendix D

Accessibility Mode Enhancement Questionnaire Strategies Ranking Results

R2D2/C3POA Model	Participants										Scales				
Components	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	AVG	MEAN	MODE	SD	MDN
Component 1 Read/ Listening/Viewing Strategies															
a. Include transcripts for any audio (podcasts) and videos in a downloadable format. These include descriptive transcripts (e.g., explanation of a scene or formula) for any visuals on slides or videos.	4	3	4	4	4	4	3	4	4	4	3.8	3.8	4	0.42	4
b. Include alternative text and descriptions for visuals (such as images, infographics, and GIFs) and provide a summary for complex images.	4	4	4	4	4	4	2	4	4	4	3.8	3.8	4	0.63	4
c. Include accurate closed captions for all videos.	4	4	4	4	4	4	4	3	4	4	3.9	3.9	4	0.32	4
d. Enable live captions and coordinate with the Office of Disabilities for interpreters in live synchronous sessions.	4	3	4	3	4	4	3	4	3	4	3.6	3.6	4	0.52	4
e. Use accessibility tools (e.g., Microsoft Accessibility Checker, Adobe Accessibility Checker, Color Contrast Analyzers, etc.) for automated accessibility checks. Conduct manual checks in addition.	4	3	4	3	4	3	2	4	4	4	3.5	3.5	4	0.71	4

f. Provide multiple methods for learners to access the content and to complete their activities (e.g., alternative options to existing activities and methods). Share materials with learners ahead of time.	4	3	4	3	4	2	2	3	4	3	3.2	3.2	4	0.79	3
g. Use heading structures (H1 to H6) for proper navigation, content understanding, and proper readability.	4	4	4	4	4	4	4	4	4	4	4	4	4	0.00	4
h. Ensure keyboard navigation and functionality for all activities (e.g., video players, interactive media, etc.) and provide the user control over multimedia (e.g., video play, pause, stop).	4	4	4	4	4	3	4	4	4	4	3.9	3.9	4	0.32	4
i. Ensure proper color contrast between background and content (apply to content, images, links, etc.)	4	4	4	3	4	3	2	3	4	4	3.5	3.5	4	0.71	4
j. Minimize the use of Adobe PDF documents due to accessibility challenges and remediation costs.	3	3	3	3	4	3	2	4	4	2	3.1	3.1	3	0.74	3
Component 2 Reflect/ writing/ sharing															
Strategies															
a. Provide learners with multiple formats and methods to complete activities (e.g., alternative versions of existing formats, two options to complete an activity,	4	3	3	2	4	2	4	3	4	3	3.2	3.2	4	0.79	3

create practice quizzes before any primary assessment, etc.).															
b. Include transcriptions and captions for synchronous events (e.g., breakout rooms, live sessions) or coordinate for transcribers or interpreters.	4	3	4	4	4	3	2	4	4	3	3.5	3.5	4	0.71	4
c. Allow for flexibility by providing additional time for discussions and activity completion for those who need it.	4	3	4	4	4	4	4	4	4	3	3.8	3.8	4	0.42	4
d. Provide clear instructions and details of sessions, quizzes, interactions, and activities (e.g., details about a quiz such as the number of questions, choices, sentences, or if they include pictures, audio clips, etc.).	4	4	4	4	4	4	3	4	4	3	3.8	3.8	4	0.42	4
e. Use institutional accessibility resources (e.g., transcribers, sign language interpreters, Braille printer, etc.).	3	3	4	4	4	3	3	4	4	4	3.6	3.6	4	0.52	4
f. Send content ahead in advance (e.g., links to videos that will be displayed in synchronous sessions, slides, pre-reading).	3	4	4	3	4	2	2	3	4	3	3.2	3.2	3	0.79	3
g. Group learners by ability (low, mid, high) to improve collaboration.	2	1	3	2	4	1	1	2	3	1	2	2	1	1.05	2
h. Ensure technologies are accessible or work with assistive technologies where learners can	4	4	4	3	4	4	3	4	4	3	3.7	3.7	4	0.48	4

control the environment (e.g., keyboard, screen readers, read-out-loud, etc.).															
Component 3 Display Strategies															
a. Include alternative text or transcriptions for images, diagrams, and graphs. Use proper terminology for text-based descriptions with content for all relevant visuals (synchronous or asynchronous).	4	3	4	4	4	4	3	4	4	4	3.8	3.8	4	0.42	4
b. Provide detailed descriptions for complex visuals. For example, describe tables, drawings, virtual worlds, and tours as they occur.	4	3	4	4	4	4	2	4	4	4	3.7	3.7	4	0.67	4
c. Have accurate transcripts and closed captions for video and audio files, coordinate live transcribers, or include audio descriptions for an elevated level of accessibility. If using videos in synchronous sessions, share the videos with accurate captions and transcripts before the session.	4	4	4	4	4	4	4	3	4	4	3.9	3.9	4	0.32	4
d. Ensure color contrast for course components (links, images, text, virtual backgrounds, etc.), and avoid using color or images as the single method for meaning.	4	4	4	4	4	3	4	3	4	4	3.8	3.8	4	0.42	4

e. Test links for functionality, set up links as descriptive links (e.g., the name of the target instead of "Click Here" or the full URL), and use standard formatting (underlined, visual difference to stand out, etc.).	4	4	4	4	4	4	3	4	4	4	3.9	3.9	4	0.32	4
f. Promote accessibility awareness at the institutional level and among your learners by using inclusive and culture-sensitive language and encouraging learners to include alternative text, descriptions, transcripts, and captions, in their work.	4	4	4	4	4	3	4	4	4	4	3.9	3.9	4	0.32	4
g. Give learners complete control over multimedia (e.g., play, pause, and stop at any time) and do not use no auto-play or flashing/blinking.	4	4	4	4	4	4	4	4	4	4	4	4	4	0.00	4
Component 4 Doing the Work Strategies															
a. Include multiple formats or methods (e.g., transcript, summary, a cheat sheet with steps or processes) and activities (e.g., ungraded practice for complex activities, asynchronous group paper collaboration instead of synchronous collaboration, etc.).	4	3	3	2	4	3	4	3	4	4	3.4	3.4	4	0.69	3.5

b. Add clear rubric criteria with an explanation of the activity, and share ground rules on learners creating accessible content by adding alt text, descriptions, and transcripts.	3	4	4	3	4	4	4	4	4	3	3.7	3.7	4	0.48	4
c. Provide clear instructions, expectations, and steps for multimedia completion and engagement.	4	4	4	3	4	4	2	4	4	3	3.6	3.6	4	0.69	4
d. Have interpreters and captions for live sessions (whole class and small groups) and record sessions.	4	3	4	3	4	3	2	3	4	4	3.4	3.4	4	0.70	3.5
e. Provide clear explanations and descriptions of elements such as math problems and anything visual (e.g., anything created on the whiteboard, PowerPoint slides, etc.).	4	4	4	4	4	4	2	3	4	4	3.7	3.7	4	0.67	4
f. Provide accessible material ahead of time. If learners are presenting, request their presentation to be shared before the session and provide it to other students.	3	2	4	2	4	2	2	2	4	3	2.8	2.8	2	0.92	2.5
g. Establish various levels of accommodations through institutional resources (e.g., Office of Disabilities).	4	4	4	4	4	4	4	3	4	3	3.8	3.8	4	0.42	4
h. Provide time-based accommodations to give people time to process.	4	4	3	4	4	3	4	3	4	3	3.6	3.6	4	0.52	4

i. Ensure the readability level by using headers to break content and vocabulary knowledge.	2	4	4	4	4	3	3	3	4	4	3.5	3.5	4	0.71	4
j. Provide accessible tools for learners to use to create their works.	4	3	4	4	4	4	3	4	4	2	3.6	3.6	4	0.70	4
Component 5 Coaching Strategies															
a. Provide multiple ways to coach for learners' needs or preferences (e.g., email, messaging apps, learning management system, office hours virtual/in-person, video chats, recorded sessions along with a transcript).	3	3	3	4	4	4	3	4	4	2	3.4	3.4	4	0.70	3.5
b. Share an agenda or clear guidelines before a coaching session to clarify each item or expectation and how much time they will spend.	3	4	4	4	4	4	2	4	4	2	3.5	3.5	4	0.85	4
c. Arrange for interpreters (e.g., sign language) for synchronous coaching sessions.	4	4	4	3	4	4	3	4	3	4	3.7	3.7	4	0.48	4
d. Include clear feedback to guide learners. Do not rely on colors, images, or shapes as the only source of meaning (e.g., do not use green to represent correct).	3	4	4	4	4	3	4	3	4	3	3.6	3.6	4	0.52	4
Component 6 Conviviality Strategies															

a. Use and encourage clear, inclusive language that reflects cultural sensitivity (e.g., describe participants or scenarios in sessions, etc.).	3	4	4	4	4	3	4	2	4	3	3.5	3.5	4	0.71	4
b. Resist stereotypes and be inclusive in visual and audio materials.	3	4	4	4	4	3	2	2	4	3	3.3	3.3	4	0.82	3.5
c. Provide clear descriptions of emojis, GIFs, and other visual material that might mean something different for learners. Visuals should not be the only way to convey information.	3	4	3	4	4	4	2	2	4	3	3.3	3.3	4	0.82	3.5
d. Establish ground rules for behaviors and accessibility awareness for both instructors and learners.	3	4	4	4	4	4	3	4	4	4	3.8	3.8	4	0.42	4
e. Add multiple check-ins throughout the session to keep learners engaged.	3	3	4	4	4	4	2	3	4	4	3.5	3.5	4	0.71	4
f. Make engagement strategies optional, not required.	3	2	3	3	4	2	3	2	3	3	2.8	2.8	3	0.63	3
g. Allow responses through the chat feature and include time and long pauses for questions.	3	2	4	3	4	2	4	3	4	3	3.2	3.2	3	0.79	3
Component 7 Critical Incident Technique Strategies															
a. Use accessible online forms to collect feedback instead of using Microsoft Word or Adobe PDF	3	3	4	3	4	3	4	4	4	2	3.4	3.4	4	0.70	3.5

documents to gather feedback due to accessibility challenges.															
b. Ensure all materials are accessible with assistive technologies (e.g., keyboard accessibility to navigate and interact with the materials).	4	4	4	4	4	4	3	4	4	4	3.9	3.9	4	0.32	4
c. Provide multiple formats or alternative ways to complete the activity (e.g., open discussion forums, written reflection, etc.).	3	2	4	2	4	2	4	4	4	3	3.2	3.2	4	0.92	3.5
d. Questions are in an inclusive format with both specific and open-ended questions that account for emotional aspects of the interaction.	3	3	4	2	4	4	3	3	4	2	3.2	3.2	3	0.79	3
e. Provide expectations to learners ahead of time (e.g., type of polls, chats, number of poll activities, etc.).	3	3	4	4	4	4	2	4	4	2	3.4	3.4	4	0.84	4
f. Use descriptive links.	4	4	4	4	4	4	4	4	4	4	4	4	4	0.00	4
g. Conduct follow-up polls after the event or session for synchronous events polls to allow time for reflection.	3	2	3	3	3	3	1	4	4	2	2.8	2.8	3	0.92	3
h. Conduct automated and manual accessibility checks.	4	4	4	4	4	3	4	4	4	4	3.9	3.9	4	0.32	4
Component 8 Planning and Organization															
Strategies															
a. Run accessibility checks on all your materials to ensure accessibility and that they are	4	4	4	4	4	4	2	4	4	3	3.7	3.7	4	0.67	4

usable with assistive technologies (e.g., keyboard, screen readers, etc.). You can create a checklist to review for accessibility.															
b. Plan for captions and transcripts in all videos and transcripts for audio only (podcasts).	4	4	4	4	4	4	3	4	4	4	3.9	3.9	4	0.32	4
c. Ensure enough color contrast in all your materials and that crucial information does not rely only on color to convey meaning.	4	4	4	4	4	3	4	3	4	4	3.8	3.8	4	0.42	4
d. Start with accessibility in mind when designing a course. Create accessible templates that you can use.	4	4	4	4	4	4	4	4	4	4	4	4	4	0.00	4
e. Plan for alt text on all images and evaluate the context to ensure accurate information.	4	3	4	4	4	4	2	4	4	4	3.7	3.7	4	0.67	4
f. Coordinate with institution resources for professional development funds and access to resources (e.g., accessible tools, textbook companies, etc.).	4	4	4	4	4	3	4	4	4	4	3.9	3.9	4	0.32	4
g. Plan for multiple ways for learners to access the content and submit their work.	4	3	4	2	4	2	4	4	4	2	3.3	3.3	4	0.95	4
h. Plan heading structure in documents and webpages to allow for better navigation and understanding.	4	4	4	4	4	4	4	4	4	4	4	4	4	0.00	4

i. Include a syllabus with clear expectations, participation, organization of content, and objectives.	4	4	4	4	4	4	3	4	4	4	3.9	3.9	4	0.32	4

Appendix E

R2D2/C3PO/A Model Draft Post Questionnaire

R2D2/C3POA Components, Instructional Strategies/Learning Activities, Synchronous Tools, and Accessibility Strategies

R2D2/C3PO Component	*Instructional Strategies/ Learning Activities*	*Synchronous Web-Conferencing Tools*	*Accessibility Strategies and Learning Activities*
Read/ Listening/ Viewing	• Reading materials online or offline. • Creating participant manuals for each live synchronous event. • Listening to audio material (audio podcasts) online or offline. • Synchronous expert lectures/presentations/tutorials • "Live demonstrations" • Participant manuals as PDFs or Word Documents	• Downloadable participant manuals as PDF and/or Word files. • Downloadable audio podcast files. MP4 and Wave files are the most typical • Downloadable video/ multimedia files. MP4 and Wave files are the most typical streamed video. • Pictures using JPEG, PNG, and GIF files are most typical. • "Live" synchronous facilitator/faculty presentation/ demonstrations and lectures. • Facilitator/faculty tools include whiteboards, chats, application sharing, file transfer, share pods, screen sharing, PowerPoint slides, polls, and note boards for announcements, Q&A, and FAQs. • Print-based PDF and Word	a. Include transcripts for any audio (podcasts) and videos in a downloadable format. Add descriptive transcripts (e.g., explanation of a scene or formula) for any visuals on slides or videos. b. Include alternative text and descriptions for visuals (such as images, infographics, and GIFs) and provide a summary for complex images. c. Include accurate closed captions for all videos. d. Enable live captions and coordinate with the Office of Disabilities for interpreters in live synchronous sessions. Interpreters should be scheduled only when necessary. e. Use accessibility tools (e.g., Microsoft Accessibility Checker, Adobe Accessibility Checker, Color Contrast

	files, as well as audio Podcast MP4 and Wave files, can be made available during the "live" web-conferencing session through Chat and File Share • Links to websites.	Analyzers, etc.) for automated accessibility checks. Conduct manual checks in addition. f. Provide multiple methods for learners to access the content and to complete their activities (e.g., alternative options to existing activities and methods such as multimedia, case studies, questionnaires, etc.). Share materials or pre-reading content (glossaries, tooltips, guided templates) with learners ahead of time. g. Use heading structures (H1 to H6) for proper navigation, content understanding, and proper readability. h. Ensure keyboard navigation and functionality for all activities (e.g., video players, interactive media, etc.) and provide the user control over multimedia (e.g., video play, pause, stop). i. Ensure proper color contrast between background and content (apply to content, images, links, etc.) j. Minimize the use of Adobe PDF documents due to accessibility challenges and

			remediation costs.

Reflect/ writing/ sharing	• Time allocated before, after, and during the web conferencing session for reflection:
	  ○ Prework, during synchronous event, between synchronous events (multievent course)
	• Provide "silent time" for deep reflection
	• Write in-depth reflection papers covering:
	  ○ What was learned?
	  ○ How learned took place?
	  ○ How learning can be applied?
	• Keep Reflection Journals
	• Creative Reflective Visual Representations:
	  ○ Graphics, smart art, figures, models, tables
	• Pair shares
	• Small group discussion.
	• Focus group discussion.
	• Online role play.
	• Self-assessment.
	• Online quizzes.
	• Electronic portfolios for multi-session events
	• Practice
		• Downloadable participant manuals used to write reflections in PDF or Word doc format.
		• Downloadable journal in PDF or Word doc formats.
		• Chat pods used for sharing reflections with other participants.
		• Polls used to capture self-assessment and compare anonymously with other participants.
		• Online quizzes using polling and assessment features.
		• Main room presentations for group discussions, debates, mock trials, role play, practice with partners, and focus groups.
		• Breakout rooms used for small group discussions, debates, mock trials, role play, practice with partners, and focus groups.
			a. Provide learners with multiple formats and methods to complete activities (e.g., alternative versions of existing formats, two options to complete an activity, create practice quizzes before any primary assessment, use social media engagement, creative compositions, personal reflections, flexible journaling, sentence starters, etc.).
			b. Include transcriptions and captions for synchronous events (e.g., breakout rooms, live sessions) or coordinate for transcribers or interpreters.
			c. Allow for flexibility by providing additional time for discussions and activity completion for those who need it.
			d. Provide clear instructions and details of sessions, quizzes, interactions, and activities (e.g., details about a quiz such as the number of questions, choices, sentences, or if they

			include pictures, audio clips, etc.). e. Use institutional accessibility resources (e.g., transcribers, sign language interpreters when needed, Braille printer, etc.). f. Send content ahead in advance (e.g., links to videos that will be displayed in synchronous sessions, slides, pre-reading). g. Ensure technologies are accessible or work with assistive technologies where learners can control the environment (e.g., keyboard, screen readers, read-out-loud, volume controls, etc.).

Display	• Visual Representations include:
	  ○ Pictures, diagrams, graphs, multimedia, video, charts, animations, flowcharts, YouTube videos, conceptual frameworks, models, virtual worlds, and mobile technologies.
	• Demonstrations include:
	  ○ Process steps, concept maps, logic steps, real-world examples
		• Downloadable participant manuals with visual representations of key concepts in PDF or Word doc formats.
		• Video files in MP4, MOV, and WebM formats.
		• Streaming video using the Share feature.
		• Using drawing tools and presenting back to the entire group in the main room or small groups in breakout
			a. Include alternative text or transcriptions for images, diagrams, and graphs. Use proper terminology for text-based descriptions with content for all relevant visuals (synchronous or asynchronous).
			b. Provide detailed descriptions for complex visuals. For example, describe tables, drawings, virtual worlds, and tours as they occur.

	• Instructor "live" video-based feedback of work products and student work • Drawing • Virtual tours • Databases.	sessions. • Facilitator/faculty "live" presentation using a shared pod with a PowerPoint presentation with robust visuals to help explain concepts. • "Live" visual of the facilitator/faculty presenting or demonstrating "live," which enhances teacher presence. • "Live" visual of visiting experts presenting content through the Share feature. • Live videos of students presenting in the main room or breakout rooms. • Links to videos on YouTube, TED Talks, Khan Academy, etc. • Showing databases through the web-conferencing Share feature.	c. Have accurate transcripts and closed captions for video and audio files, coordinate live transcribers, or include audio descriptions for an elevated level of accessibility. If using videos in synchronous sessions, share the videos with accurate captions and transcripts before the session. d. Ensure color contrast for course components (links, images, text, virtual backgrounds, etc.), and avoid using color or images as the single method for meaning. e. Test links for functionality, set up links as descriptive links (e.g., the name of the target instead of "Click Here" or the full URL), and use standard formatting (underlined, visual difference to stand out, etc.). f. Promote accessibility awareness at the institutional level and among your learners by using inclusive and culture-sensitive language and encouraging learners to include alternative text, descriptions, transcripts, and captions, and avoid flashing

			or flickering images in their work. g. Give learners complete control over multimedia (e.g., volume, play, pause, and stop at any time) and do not use no auto-play or flashing/blinking.
Doing the Work	• Caselettes (short cases). • Case studies. • Practice. • Project-based learning. • Collaborative group paper, etc. • Cognitive Apprenticeship • Assessment • Online role play • Gaming • Adaptive learning	• Downloadable participant manuals with mini-cases, project, collaboration, and apprenticeship instructions in PDF and/or Word doc formats. • Live facilitator/faculty presentation, demonstration, and modeling for all activities. Time allocated for reflection and Questions and Answers (Q&As). • Using technology-based drawing tools and smart art, learners present projects, graphics, flowcharts, diagrams, pictures, project plans, and timelines, and then implementation plans consistent with their knowledge acquisition either in the main room, as pair shares, or in breakout rooms. • Breakout rooms with	a. Include multiple formats or methods (e.g., transcript, summary, a cheat sheet with steps or processes, audio and video submissions) and activities (e.g., ungraded practice for complex activities, asynchronous group paper collaboration instead of synchronous collaboration, field work experience, scenarios, problem-based activities, literature reviews, visual and written creations, etc.). b. Add clear rubric criteria with an explanation of the activity, and share ground rules on learners creating accessible content by adding alt text, descriptions, and transcripts. c. Provide clear instructions, expectations, and steps for

		whiteboards and chat pods for individual and collaborative work. Polls available, when needed. • Breakout rooms for practice with partners or in larger groups, such as triads and quads. • "Live" individual or group presentations and role play in the main room. • Provide instructional games as well as fun icebreakers throughout the session. • Provide custom learning experiences that address the learning needs of each individual student through providing just-in-time feedback, critiquing, and resources.	multimedia completion and engagement. d. Have interpreters (when needed) and captions for live sessions (whole class and small groups) and record sessions. e. Provide clear explanations and descriptions of elements such as math problems and anything visual (e.g., anything created on the whiteboard, PowerPoint slides etc.). f. Establish various levels of accommodations through institutional resources (e.g., Office of Disabilities). g. Provide time-based accommodations to give people time to process. h. Ensure the readability level by using headers to break content and vocabulary knowledge. i. Provide accessible tools for learners to use to create their works
Coaching	• Cognitive apprenticeships • Scaffolding • Interactive feedback	• Facilitator/ faculty feedback through "live" voice, chat, and private chat.	a. Provide multiple ways to coach for learners' needs or preferences (e.g., email,

		• Peer coaching in breakouts and private chats.	messaging apps, peer mentoring and evaluations, learning management system, office hours virtual/in-person, video chats, recorded sessions along with a transcript). b. Share an agenda or clear guidelines before a coaching session to clarify each item or expectation and how much time they will spend. c. Arrange for interpreters (e.g., sign language) for synchronous coaching sessions when needed. d. Include clear feedback to guide learners. Do not rely on colors, images, or shapes as the only source of meaning (e.g., do not use green to represent correct).
Conviviality	• Ground rules to encourage collaboration, cooperation, and trust • A fast start to ensure all participants can use the web conferencing tools • Practice good human relations principles • Call students by name • Smile when "Live" on camera	• Participatory establishment of ground rules using "live" discussion, chats, whiteboard tools, and polls. • Remember, as an instructor, you are the visual. Smile. Body language should be relaxed, open, warm, and inviting. • Virtual background should be inviting and appropriate for the	a. Provide multiple methods of engagement for learners to enable participation and create time accommodations for their response. b. Use and encourage clear, inclusive language that reflects cultural sensitivity (e.g. describe participants or scenarios in sessions, call

	• Provide positive, constructive criticism • Use emojis to promote motivation, friendliness, enthusiasm, and humor • Organizational consideration for instructor/facilitator workload and requirements for planning synchronous web-based video conferencing events.	audience. • Begin in a friendly way. Start with a short story related to the topic or ask a question to engage the participants in the topic. • Remember the importance of each student's name and make sure to pronounce it correctly. If unsure, ask. • Use emojis to express emotions, such as like, surprise, love, speed up, slow down, applause, thumbs up, thumbs down, smiling, etc. • Inject appropriate humor, sharing cartoons, avatars, etc. • Ask questions. Let students answer through the Chat feature, Annotation feature on a Whiteboard of File Share, and through coming off mute and talking. • Institutions must recognize the increase in workload and planning needed for designing and implementing web-based video conferencing events and supply instructional designers, developers, teachers, and facilitators with the resources required.	learners by their name with accurate pronunciation, etc.). c. Resist stereotypes and be inclusive in visual and audio materials. d. Provide clear descriptions of emojis, GIFs, and other visual material that might mean something different for learners. Visuals should not be the only way to convey information. e. Establish ground rules for behaviors and accessibility awareness for both instructors and learners. f. Add multiple check-ins throughout the session to keep learners engaged. g. Allow responses through the chat feature and include time and long pauses for questions. h. Include open discussions with time accommodation as a method of engagement for learners to ask questions of each other, for friendly connections, and discuss lessons learned.

Critical Incident Technique (CIT)	• Use CIT for immediate student feedback between instructional events. • Use other Kirkpatrick Level 1, reaction tools during or post the live event	• Downloadable form can be used in either PDF or Word doc formats and returned to the instructor after the session. • By using the Zoom Poll feature, students can make anonymous responses. • Questions can be asked using the White Board feature, and students allowed to anonymously post their responses. • Level 1, Kirkpatrick Reaction Evaluations can be made at the end of each web-conferencing session or an entire sequence. Tools can be downloadable PDFs or Word doc files, Excel worksheets, or using web-conferencing interactive Polling features. • Questions regarding student perceived usefulness, ease of use, and anxiety with technology can be asked.	a. Use accessible online forms to collect feedback instead of using Microsoft Word or Adobe PDF documents to gather feedback due to accessibility challenges. b. Ensure all materials are accessible with assistive technologies (e.g., keyboard accessibility to navigate and interact with the materials). c. Provide multiple formats or alternative ways to complete the activity (e.g., open discussion forums, written reflection, etc.). d. Questions are in an inclusive format with both specific and open-ended questions that account for emotional aspects of the interaction. e. Provide expectations to learners ahead of time (e.g., type of polls, chats, number of poll activities, etc.). f. Use descriptive links. g. Conduct automated and manual accessibility checks. h. Include multiple check-ins for feedback throughout the course to gather feedback on activities and user experience

			improvement.
Planning/ Organization	• Warm up • Fast start • Quick reference • Frequently Asked Questions (FAQ's) • Participant manual and/ or Journals • Facilitator/ trainer manual • PowerPoint slides • Pre-constructed whiteboards • Timeline for all activities • Time for reflection during event and between events. • Evaluation and assessments (both formative and summative)	• Warm up questions and/or activity visible as students sign into the web-based conference. • Fast Start introduces students to the web-based video conferencing features, tools, and functionality before delivery of content. • Quick Reference Guides and Frequently Asked Questions on how to use the web conferencing tools. • Participant manual containing content and exercises and reflections during the live session. • Participant journal for multi-session activities. • Facilitator/faculty manual with suggested timelines for all activities and instructions for use of web-based video conferencing software's features and functions. • Reflection time built into all events. • Polls and Assessments created in advance. • PowerPoint Slides uploaded in advance.	a. Run accessibility checks on all your materials to ensure accessibility and that they are usable with assistive technologies (e.g., keyboard, screen readers, etc.). You can create a checklist to review for accessibility. b. Plan for captions and transcripts in all videos and transcripts for audio only (podcasts). c. Ensure enough color contrast in all your materials and that crucial information does not rely only on color to convey meaning (e.g., marking required fields. Consider color contrast in synchronous sessions and prevent virtual backgrounds or clothes that can cause a flickering screen. d. Start with accessibility in mind when designing a course. Create accessible templates that you can use. e. Plan for alt text on all images and evaluate the context to ensure accurate information. f. Coordinate with institution resources for professional

	• Graphics, figures, tables, frameworks, flow charts created and uploaded in advance. • Breakout sizes and number decided and set up in advance.	development funds and access to resources (e.g., accessible tools, textbook companies, etc.). s. Plan for multiple ways for learners to access the content and submit their work. t. Plan heading structure in documents and webpages to allow for better navigation and understanding. u. Include a syllabus with clear expectations, participation, organization of content, and objectives. v. Provide learners guided tips to organize time and the space to share their own timeline based on their needs or perception.

Source: This table is adapted from Armstrong (2014, 2016) and Armstrong and Gale (2018, 2025) and reprinted from Armstrong (2014) with permission from Nova Science Publishers.

Appendix F

Focus Group Guidelines

Overview

The focus group will be conducted through Zoom and facilitated by Dr. Ann Armstrong, who counts with Dale Carnegie Endorsement to run focus groups and over 400 hours of training. I will support the moderation and transcription of ideas during the focus group session. The session will be recorded, and a transcript will be generated. The focus group will use a Nominal Group Technique for model validation and finalization.

Nominal Group Technique

1. **Introduction and explanation**: The session will start with an introduction, purpose, agenda, and procedures for the meeting. This section will be 5 minutes long.
2. **Silent generation of ideas**: Participants will have 10 minutes of quiet time to reflect on the R2D3/C3POA model and generate ideas for what accessibility strategies should be added to each component. They will be allowed to use a familiar tool such as Word or Google document to brainstorm and write their generated ideas to allow for an anonymous brainstorming process.
3. **Sharing ideas**: Participants will be asked to share out loud a single idea for each of the R2D2/C3POA model components generated during step 2. Each participant will have three to 5 minutes to share their ideas without interruption. Participants' ideas will be typed on-screen using a PowerPoint Slide by the researcher as they are presented.
4. **Group discussion**: During group discussion, cross talk will be allowed among participants to discuss, combine similar ideas, and argue proposed ideas or accessibility strategies for each model component. This segment will last 15-20 minutes. Notes will be

taken on-screen in a new PowerPoint Slide to preserve previous data and to share new suggestions with participants.

5. **Voting and ranking:** The suggestions from the PowerPoint slide reviewed in the group discussion will be presented to the group on-screen to finalize enhancements. Participants will vote anonymously on each suggestion using the poll survey tool from Zoom.

Conclusion

1. Thank the participants for sharing their experiences and perspectives.
2. Thank the moderator.
3. Discuss the next steps for participants: submission of silent generation of ideas and member check.
4. If time allowed, allowed 2-3 minutes for participants to ask questions of the moderator and researcher.

Appendix G

Focus Group and NGT Strategies Ranking Results

R2D2/C3POA Model	Participants				Scale				
Components	P1	P2	P3	P4	AVG	MEAN	MODE	SD	MDN
Component 1 Read/ Listening/Viewing Strategies									
a. Include transcripts for any audio (podcasts) and videos in a downloadable format. These include descriptive transcripts (e.g. explanation of a scene or formula) for any visuals on slides or videos.	4	4	4	4	4	4	4	0	4
b. Include alternative text and descriptions for visuals (such as images, infographics, and GIFs) and provide a summary for complex images.	4	4	3	4	3.75	3.75	4	0.5	4
c. Include accurate closed captions for all videos.	4	4	4	4	4	4	4	0	4
d. Enable live captions and coordinate with the Office of Disabilities for interpreters in live synchronous sessions. Interpreters should be scheduled only when necessary.	3	3	4	4	3.5	3.5	3	0.57	3.5
e. Use accessibility tools (e.g., Microsoft Accessibility	4	3	4	3	3.5	3.5	4	0.57	3.5

Checker, Adobe Accessibility Checker, Color Contrast Analyzers, etc.) for automated accessibility checks. Conduct manual checks in addition.									
f. Provide multiple methods for learners to access the content and to complete their activities (e.g., alternative written options to existing activities and methods such as multimedia, case studies, questionnaires, etc.). Share materials or pre-reading content (glossaries, tooltips, guided templates) with learners ahead of time.	3	2	3	3	2.75	2.75	3	0.5	3
g. Use heading structures (H1 to H6) for proper navigation, content understanding, and proper readability.	4	4	4	4	4	4	4	0	4
h. Ensure keyboard navigation and functionality for all activities (e.g., video players, interactive media, etc.), provide font size and line height adjustments, and provide the user control over multimedia (e.g., video play, pause, stop).	4	4	4	4	4	4	4	0	4

i. Ensure proper color contrast between background and content (apply to content, images, links, etc.).	4	4	4	4	4	4	4	0	4
j. Minimize the use of Adobe PDF documents due to accessibility challenges and remediation costs and ensure reading materials from original sources.	4	3	3	3	3.25	3.25	3	0.5	3
Component 2 Reflect/ Writing/ Sharing Strategies									
a. Provide learners with multiple formats and methods to complete activities (e.g., alternative versions of existing formats, two options to complete an activity, create practice quizzes before any primary assessment, use social media engagement, creative compositions, personal reflections, flexible journaling, sentence starters, etc.).	3	4	3	3	3.25	3.25	3	0.50	3
b. Include transcriptions and captions for synchronous events (e.g., breakout rooms, live sessions) or coordinate for transcribers or interpreters when needed.	4	4	3	4	3.75	3.75	4	0.50	4

c. Allow for flexibility by providing additional time for discussions and activity completion for those who need it.	3	3	3	4	3.25	3.25	3	0.50	3
d. Provide clear instructions and details of sessions, quizzes, interactions, and activities (e.g., details about a quiz such as the number of questions, choices, sentences, or if they include pictures, audio clips, etc.).	4	4	3	4	3.75	3.75	4	0.50	4
e. Use institutional accessibility resources (e.g., transcribers, sign language interpreters (when needed, Braille printer, etc.).	3	4	4	4	3.75	3.75	4	0.50	4
f. Send content ahead in advance (e.g., links to videos that will be displayed in synchronous sessions, slides, pre-reading) to allow learners to take notes.	4	3	2	3	3	3	3	0.81	3
g. Ensure technologies are accessible or work with assistive technologies where learners can control the environment (e.g., keyboard, screen readers, read-out-loud, volume controls, etc.).	4	4	4	4	4	4	4	0.00	4

h. Leverage Artificial Intelligence to support accommodations (e.g., writing, scanning sources and citations, provide alt text, break down ideas of simplifying language).	3	3	2	3	2.75	2.75	3	0.50	3.000
i. Provide graphic organizing to help plan for writing and include readability checkers (e.g., Grammarly) to help learners phrase their ideas.	2	3	2	3	2.5	2.5	2	0.577	2.5
Component 3 Display									
a. Include alternative text or transcriptions for images, diagrams, and graphs. Use proper terminology for text-based descriptions with content for all relevant visuals (synchronous or asynchronous).	4	4	4	4	4	4	4	0.00	4
b. Provide detailed descriptions for complex visuals. For example, describe tables, drawings, virtual worlds, and tours as they occur.	2	4	4	4	3.5	3.5	4	1.00	4
c. Have accurate transcripts and closed captions for video and audio files, coordinate live transcribers when needed, or	4	3	4	4	3.75	3.75	4	0.50	4

include audio descriptions for an elevated level of accessibility. If using videos in synchronous sessions, share the videos with accurate captions and transcripts before the session.									
d. Ensure color contrast for course components (links, images, text, virtual backgrounds, etc.), and avoid using color or images as the single method for meaning.	4	4	4	4	4	4	4	0.00	4
e. Test links for functionality, set up links as descriptive links (e.g., the name of the target instead of "Click Here" or the full URL), and use standard formatting (underlined, visual difference to stand out, etc.).	4	4	4	4	4	4	4	0.00	4
f. Promote accessibility awareness at the institutional level and among your learners by using inclusive and culture-sensitive language and encouraging learners to include alternative text, descriptions, transcripts, and captions, and avoid flashing or flickering images in their work.	4	4	3	4	3.75	3.75	4	0.50	4

g. Give learners complete control over multimedia and content (e.g., volume, play, pause, stop at any time, options to view and hide content) and do not use no auto-play or flashing/blinking.	3	4	4	4	3.75	3.75	4	0.50	4.000
h. Minimize the use of decorative visuals that are not meaningful or relevant to the content.	2	3	3	4	3	3	3	0.81	3
Component 4 Doing the Work Strategies									
a. Include multiple formats or methods (e.g., transcript, summary, a cheat sheet with steps or processes, audio and video submissions) and activities (e.g., ungraded practice for complex activities, asynchronous group paper collaboration instead of synchronous collaboration, field work experience, scenarios, problem-based activities, literature reviews, visual and written creations, etc.).	4	3	4	3	3.5	3.5	4	0.57	3.5
b. Add clear rubric criteria with an explanation of the	4	4	4	4	4	4	4	0.00	4

activity, and share ground rules on learners creating accessible content by adding alt text, descriptions, and transcripts.									
c. Provide clear instructions, expectations, and steps for multimedia completion and engagement.	3	3	4	4	3.5	3.5	3	0.57	3.5
d. Have interpreters (when needed) and captions for live sessions (whole class and small groups) and record sessions.	4	3	3	4	3.5	3.5	4	0.57	3.5
e. Provide clear explanations and descriptions of elements such as math problems and anything visual (e.g., anything created on the whiteboard, PowerPoint slides etc.).	4	3	3	4	3.5	3.5	4	0.57	3.5
f. Establish various levels of accommodations through institutional resources (e.g., Office of Disabilities).	4	4	3	4	3.75	3.75	4	0.50	4
g. Provide time-based accommodations to give people time to process.	4	3	2	4	3.25	3.25	4	0.95	3.5
h. Ensure the readability level by using headers to break and organize content and vocabulary knowledge.	4	3	3	4	3.5	3.5	4	0.57	3.5

i. Provide accessible tools and customization options (i.e., font, size, style, colors, context, etc.) for learners to use to complete content and assignments.	3	4	2	4	3.25	3.25	4	0.95	3.5
j. Encourage learners to use resources available from institutions that will support their journey (e.g., writing centers, communication, etc.)	3	4	3	4	3.5	3.5	3	0.57	3.5
Component 5 Coaching Strategies									
a. Provide multiple ways to coach for learners' needs or preferences (e.g., email, messaging apps, peer mentoring and evaluations, learning management system, office hours virtual/in-person, video chats, recorded sessions along with a transcript).	3	4	3	3	3.25	3.25	3	0.50	3
b. Share an agenda or clear guidelines before a coaching session to clarify each item or expectation and how much time they will spend.	3	4	4	4	3.75	3.75	4	0.50	4
c. Arrange for interpreters (e.g., sign language) for	3	4	3	4	3.5	3.5	3	0.57	3.5

synchronous coaching sessions when needed.									
d. Include clear feedback to guide learners. Do not rely on colors, images, or shapes as the only source of meaning (e.g., do not use green to represent correct)	4	4	4	4	4	4	4	0.00	4.000
e. Provide learners with enough time for reflection.	4	4	3	3	3.5	3.5	4	0.57	3.5
Component 6 Conviviality									
a. Provide multiple methods of engagement for learners to enable participation and create time accommodations for their response.	3	3	3	4	3.25	3.25	3	0.50	3
b. Use and encourage clear, inclusive language that reflects cultural sensitivity (e.g. describe participants or scenarios in sessions, call learners by their name with accurate pronunciation, etc.).	4	4	4	4	4	4	4	0.00	4
c. Resist stereotypes and be inclusive in visual and audio materials.	3	4	4	4	3.75	3.75	4	0.50	4
d. Provide clear descriptions of emojis, GIFs, and other visual material that might mean something different for	2	2	4	4	3	3	2	1.15	3

learners. Visuals should not be the only way to convey information.									
e. Establish ground rules for behaviors and accessibility awareness for both instructors and learners.	3	3	4	4	3.5	3.5	3	0.57	3.5
f. Add multiple check-ins throughout the session to keep learners engaged.	2	4	3	3	3	3	3	0.81	3
g. Allow responses through the chat feature and include time and long pauses for questions.	2	3	3	4	3	3	3	0.81	3
h. Include open discussions with time accommodation as a method of engagement for learners to ask questions of each other, for friendly connections, and discuss lessons learned.	3	4	3	4	3.5	3.5	3	0.57	3.5
Component 7 Critical Incident Technique Strategies									
a. Use accessible online forms to collect feedback instead of using Microsoft Word or Adobe PDF documents to gather feedback due to accessibility challenges.	4	4	4	4	4	4	4	0.00	4

b. Ensure all materials are accessible with assistive technologies (e.g., keyboard accessibility to navigate and interact with the materials).	4	4	4	4	4	4	4	0.00	4
c. Provide multiple formats or alternative ways to complete the activity (e.g., open discussion forums, written reflection, etc.).	3	4	3	3	3.25	3.25	3	0.50	3
d. Questions are in an inclusive format with both specific and open-ended questions that account for emotional aspects of the interaction.	3	4	3	3	3.25	3.25	3	0.50	3
e. Provide expectations to learners ahead of time (e.g., type of polls, chats, number of poll activities, etc.).	4	4	4	3	3.75	3.75	4	0.50	4
f. Use descriptive links.	4	4	4	4	4	4	4	0.00	4
g. Conduct automated and manual accessibility checks.	4	4	4	3	3.75	3.75	4	0.50	4
h. Include multiple check-ins for feedback throughout the course to gather feedback on activities and user experience improvement.	4	4	4	3	3.75	3.75	4	0.50	4
Component 8 Planning and Organization Strategies									

a. Run accessibility checks on all your materials to ensure accessibility and that they are usable with assistive technologies (e.g., keyboard, screen readers, etc.). You can create a checklist to review for accessibility.	4	4	4	4	4	4	4	0.00	4
b. Plan for captions and transcripts in all videos and transcripts for audio only (podcasts) and include guidelines for learners on video/audio time length.	4	4	4	4	4	4	4	0.00	4
c. Ensure enough color contrast in all your materials and that crucial information does not rely only on color to convey meaning (e.g., marking required fields). Consider color contrast in synchronous sessions and prevent virtual backgrounds or clothes that can cause a flickering screen.	4	4	4	4	4	4	4	0.00	4
d. Start with accessibility in mind when designing a course. Create accessible templates that you can use.	4	4	4	4	4	4	4	0.00	4
e. Plan for alt text on all images and evaluate the	4	4	4	4	4	4	4	0.00	4

context to ensure accurate information.									
f. Coordinate with institution resources for professional development funds and access to resources (e.g., accessible tools, textbook companies, etc.), leverage the accessibility tools and features from the LMS, and plan for support staff accommodation.	3	4	4	4	3.75	3.75	4	0.50	4
g. Plan multiple ways for learners to access the content and submit their work.	4	3	4	3	3.5	3.5	4	0.57	3.5
h. Plan heading structure in documents and webpages to allow for better navigation and understanding.	4	4	4	4	4	4	4	0.00	4
i. Include a syllabus with clear expectations, participation, organization of content, and objectives.	3	4	4	4	3.75	3.75	4	0.50	4
j. Provide learners guided tips to organize time and the space to share their own timeline based on their needs or perception.	4	2	4	4	3.5	3.5	4	1.00	4

Appendix H

R2D2/C3PO/A Final and Validated Model

R2D2/C3POA Components, Instructional Strategies/Learning Activities, Synchronous Tools, and Accessibility Strategies

R2D2/C3POComponent	*Instructional Strategies/ Learning Activities*	*Synchronous Web-Conferencing Tools*	*Accessibility Strategies and Learning Activities*
Read/ Listening/ Viewing	• Reading materials online or offline. • Creating participant manuals for each live synchronous event. • Listening to audio material (audio podcasts) online or offline. • Synchronous expert lectures/presentations/tutorials • "Live demonstrations" • Participant manuals as PDFs or Word Documents	• Downloadable participant manuals as PDF and/or Word files. • Downloadable audio podcast files. MP4 and Wave files are the most typical • Downloadable video/ multimedia files. MP4 and Wave files are the most typical streamed video. • Pictures using JPEG, PNG, and GIF files are most typical. • "Live" synchronous facilitator/faculty presentation/ demonstrations and lectures. • Facilitator/faculty tools include whiteboards, chats, application sharing, file transfer, share pods, screen sharing,	a. Include transcripts for any audio (podcasts) and videos in a downloadable format. These include descriptive transcripts (e.g. explanation of a scene or formula) for any visuals on slides or videos. b. Include alternative text and descriptions for visuals (such as images, infographics, and GIFs) and provide a summary for complex images. c. Include accurate closed captions for all videos. d. Enable live captions and coordinate with the Office of Disabilities for interpreters in live synchronous sessions. Interpreters should be scheduled only when necessary.

		PowerPoint slides, polls, and note boards for announcements, Q&A, and FAQs. • Print-based PDF and Word files, as well as audio Podcast MP4 and Wave files, can be made available during the "live" web-conferencing session through Chat and File Share • Links to websites.	e. Use accessibility tools (e.g., Microsoft Accessibility Checker, Adobe Accessibility Checker, Color Contrast Analyzers, etc.) for automated accessibility checks. Conduct manual checks in addition. f. *Provide multiple methods for learners to access the content and to complete their activities (e.g., alternative written options to existing activities and methods such as multimedia, case studies, questionnaires, etc.). Share materials or pre-reading content (glossaries, tooltips, guided templates) with learners ahead of time. g. Use heading structures (H1 to H6) for proper navigation, content understanding, and proper readability. h. Ensure keyboard navigation and functionality for all activities (e.g., video players, interactive

			media, etc.), provide font size and line height adjustments, and provide the user control over multimedia (e.g., video play, pause, stop). i. Ensure proper color contrast between background and content (apply to content, images, links, etc.). j. Minimize the use of Adobe PDF documents due to accessibility challenges and remediation costs and ensure reading materials from original sources.

Reflect/ Writing/ Sharing	• Time allocated before, after, and during the web conferencing session for reflection:
	  ○ Prework, during synchronous event, between synchronous events (multievent course)
	• Provide "silent time" for deep reflection
	• Write in-depth reflection papers covering:
	  ○ What was learned?
	  ○ How learned took place?
		• Downloadable participant manuals used to write reflections in PDF or Word doc format.
		• Downloadable journal in PDF or Word doc formats.
		• Chat pods used for sharing reflections with other participants.
		• Polls used to capture self-assessment and compare anonymously with other participants.
		• Online quizzes using
			a. Provide learners with multiple formats and methods to complete activities (e.g., alternative versions of existing formats, two options to complete an activity, create practice quizzes before any primary assessment, use social media engagement, creative compositions, personal reflections,

	o How learning can be applied? • Keep Reflection Journals • Creative Reflective Visual Representations: o Graphics, smart art, figures, models, tables • Pair shares • Small group discussion. • Focus group discussion. • Online role play. • Self-assessment. • Online quizzes. • Electronic portfolios for multi-session events • Practice	polling and assessment features. • Main room presentations for group discussions, debates, mock trials, role play, practice with partners, and focus groups. • Breakout rooms used for small group discussions, debates, mock trials, role play, practice with partners, and focus groups.	flexible journaling, sentence starters, etc.). b. Include transcriptions and captions for synchronous events (e.g., breakout rooms, live sessions) or coordinate for transcribers or interpreters when needed. c. Allow for flexibility by providing additional time for discussions and activity completion for those who need it. d. Provide clear instructions and details of sessions, quizzes, interactions, and activities (e.g., details about a quiz such as the number of questions, choices, sentences, or if they include pictures, audio clips, etc.). e. Use institutional accessibility resources (e.g., transcribers, sign language interpreters (when needed, Braille printer, etc.). f. Send content ahead in advance (e.g., links to videos that will be displayed in synchronous

			sessions, slides, pre-reading) to allow learners to take notes. g. Ensure technologies are accessible or work with assistive technologies where learners can control the environment (e.g., keyboard, screen readers, read-out-loud, volume controls, etc.). h. *Leverage Artificial Intelligence to support accommodations (e.g., writing, scanning sources and citations, provide alt text, break down ideas of simplifying language). i. *Provide graphic organizing to help plan for writing and include readability checkers (e.g., Grammarly) to help learners phrase their ideas.
Display	• Visual Representations include: ○ Pictures, diagrams, graphs, multimedia, video, charts, animations, flowcharts, YouTube videos, conceptual frameworks,	• Downloadable participant manuals with visual representations of key concepts in PDF or Word doc formats. • Video files in MP4, MOV, and WebM formats.	a. Include alternative text or transcriptions for images, diagrams, and graphs. Use proper terminology for text-based descriptions with content for all relevant visuals

	models, virtual worlds, and mobile technologies. • Demonstrations include: o Process steps, concept maps, logic steps, real-world examples • Instructor "live" video-based feedback of work products and student work • Drawing • Virtual tours • Databases.	• Streaming video using the Share feature. • Using drawing tools and presenting back to the entire group in the main room or small groups in breakout sessions. • Facilitator/faculty "live" presentation using a shared pod with a PowerPoint presentation with robust visuals to help explain concepts. • "Live" visual of the facilitator/faculty presenting or demonstrating "live," which enhances teacher presence. • "Live" visual of visiting experts presenting content through the Share feature. • Live videos of students presenting in the main room or breakout rooms. • Links to videos on YouTube, TED Talks, Khan Academy, etc. • Showing databases through the web-conferencing Share feature.	(synchronous or asynchronous). b. Provide detailed descriptions for complex visuals. For example, describe tables, drawings, virtual worlds, and tours as they occur. c. Have accurate transcripts and closed captions for video and audio files, coordinate live transcribers when needed, or include audio descriptions for an elevated level of accessibility. If using videos in synchronous sessions, share the videos with accurate captions and transcripts before the session. d. Ensure color contrast for course components (links, images, text, virtual backgrounds, etc.), and avoid using color or images as the single method for meaning. e. Test links for functionality, set up links as descriptive links (e.g., the name of the target

			instead of "Click Here" or the full URL), and use standard formatting (underlined, visual difference to stand out, etc.). f. Promote accessibility awareness at the institutional level and among your learners by using inclusive and culture-sensitive language and encouraging learners to include alternative text, descriptions, transcripts, and captions, and avoid flashing or flickering images in their work. g. Give learners complete control over multimedia and content (e.g., volume, play, pause, stop at any time, options to view and hide content) and do not use no auto-play or flashing/blinking. h. Minimize the use of decorative visuals that are not meaningful or relevant to the content.
Doing the Work	• Caselettes (short cases). • Case studies.	• Downloadable participant manuals with mini-cases,	a. Include multiple formats or methods (e.g.,

	• Practice. • Project-based learning. • Collaborative group paper, etc. • Cognitive Apprenticeship • Assessment • Online role play • Gaming • Adaptive learning	project, collaboration, and apprenticeship instructions in PDF and/or Word doc formats. • Live facilitator/faculty presentation, demonstration, and modeling for all activities. Time allocated for reflection and Questions and Answers (Q&As). • Using technology-based drawing tools and smart art, learners present projects, graphics, flowcharts, diagrams, pictures, project plans, and timelines, and then implementation plans consistent with their knowledge acquisition either in the main room, as pair shares, or in breakout rooms. • Breakout rooms with whiteboards and chat pods for individual and collaborative work. Polls available, when needed. • Breakout rooms for practice with partners or in larger groups, such as triads and quads.	transcript, summary, a cheat sheet with steps or processes, audio and video submissions) and activities (e.g., ungraded practice for complex activities, asynchronous group paper collaboration instead of synchronous collaboration, field work experience, scenarios, problem-based activities, literature reviews, visual and written creations, etc.). b. Add clear rubric criteria with an explanation of the activity, and share ground rules on learners creating accessible content by adding alt text, descriptions, and transcripts. c. Provide clear instructions, expectations, and steps for multimedia completion and engagement. d. Have interpreters (when needed) and captions for live sessions (whole class and small groups) and record sessions.

	• "Live" individual or group presentations and role play in the main room. • Provide instructional games as well as fun icebreakers throughout the session. • Provide custom learning experiences that address the learning needs of each individual student through providing just-in-time feedback, critiquing, and resources.	e. Provide clear explanations and descriptions of elements such as math problems and anything visual (e.g., anything created on the whiteboard, PowerPoint slides etc.). f. Establish various levels of accommodations through institutional resources (e.g., Office of Disabilities). g. Provide time-based accommodations to give people time to process. h. Ensure the readability level by using headers to break and organize content and vocabulary knowledge. i. Provide accessible tools and customization options (i.e., font, size, style, colors, context, etc.) for learners to use to complete content and assignments. j. Encourage learners to use resources available from institutions that will support their journey

			(e.g., writing centers, communication, etc.)
Coaching	• Cognitive apprenticeships • Scaffolding • Interactive feedback	• Facilitator/ faculty feedback through "live" voice, chat, and private chat. • Peer coaching in breakouts and private chats.	a. Provide multiple ways to coach for learners' needs or preferences (e.g., email, messaging apps, peer mentoring and evaluations, learning management system, office hours virtual/in-person, video chats, recorded sessions along with a transcript). b. Share an agenda or clear guidelines before a coaching session to clarify each item or expectation and how much time they will spend. c. Arrange for interpreters (e.g., sign language) for synchronous coaching sessions when needed. d. Include clear feedback to guide learners. Do not rely on colors, images, or shapes as the only source of meaning (e.g., do not use green to represent correct)

			e. Provide learners with enough time for reflection.
Conviviality	• Ground rules to encourage collaboration, cooperation, and trust • A fast start to ensure all participants can use the web conferencing tools • Practice good human relations principles • Call students by name • Smile when "Live" on camera • Provide positive, constructive criticism • Use emojis to promote motivation, friendliness, enthusiasm, and humor • Organizational consideration for instructor/facilitator workload and requirements for planning synchronous web-based video conferencing events.	• Participatory establishment of ground rules using "live" discussion, chats, whiteboard tools, and polls. • Remember, as an instructor, you are the visual. Smile. Body language should be relaxed, open, warm, and inviting. • Virtual background should be inviting and appropriate for the audience. • Begin in a friendly way. Start with a short story related to the topic or ask a question to engage the participants in the topic. • Remember the importance of each student's name and make sure to pronounce it correctly. If unsure, ask. • Use emojis to express emotions, such as like, surprise, love, speed up,	a. Provide multiple methods of engagement for learners to enable participation and create time accommodations for their response. b. Use and encourage clear, inclusive language that reflects cultural sensitivity (e.g. describe participants or scenarios in sessions, call learners by their name with accurate pronunciation, etc.). c. Resist stereotypes and be inclusive in visual and audio materials. d. Provide clear descriptions of emojis, GIFs, and other visual material that might mean something different for learners. Visuals should not be the only way to convey information. e. Establish ground rules for behaviors and accessibility awareness

		slow down, applause, thumbs up, thumbs down, smiling, etc. • Inject appropriate humor, sharing cartoons, avatars, etc. • Ask questions. Let students answer through the Chat feature, Annotation feature on a Whiteboard of File Share, and through coming off mute and talking. • Institutions must recognize the increase in workload and planning needed for designing and implementing web-based video conferencing events and supply instructional designers, developers, teachers, and facilitators with the resources required.	for both instructors and learners. f. Add multiple check-ins throughout the session to keep learners engaged. g. Allow responses through the chat feature and include time and long pauses for questions. h. Include open discussions with time accommodation as a method of engagement for learners to ask questions of each other, for friendly connections, and discuss lessons learned.
Critical Incident Technique (CIT)	• Use CIT for immediate student feedback between instructional events. • Use other Kirkpatrick Level 1, reaction tools during or post the live event	• Downloadable form can be used in either PDF or Word doc formats and returned to the instructor after the session. • By using the Zoom Poll feature, students can make anonymous responses.	a. Use accessible online forms to collect feedback instead of using Microsoft Word or Adobe PDF documents to gather feedback due to accessibility challenges. b. Ensure all materials are accessible with assistive

	• Questions can be asked using the White Board feature, and students allowed to anonymously post their responses. • Level 1, Kirkpatrick Reaction Evaluations can be made at the end of each web-conferencing session or an entire sequence. Tools can be downloadable PDFs or Word doc files, Excel worksheets, or using web-conferencing interactive Polling features. • Questions regarding student perceived usefulness, ease of use, and anxiety with technology can be asked.	technologies (e.g., keyboard accessibility to navigate and interact with the materials). c. Provide multiple formats or alternative ways to complete the activity (e.g., open discussion forums, written reflection, etc.). d. Questions are in an inclusive format with both specific and open-ended questions that account for emotional aspects of the interaction. e. Provide expectations to learners ahead of time (e.g., type of polls, chats, number of poll activities, etc.). f. Use descriptive links. g. Conduct automated and manual accessibility checks. h. Include multiple check-ins for feedback throughout the course to gather feedback on activities and user experience improvement.

Planning/ Organization	• Warm up • Fast start • Quick reference • Frequently Asked Questions (FAQ's) • Participant manual and/ or Journals • Facilitator/ trainer manual • PowerPoint slides • Pre-constructed whiteboards • Timeline for all activities • Time for reflection during event and between events. • Evaluation and assessments (both formative and summative)	• Warm up questions and/or activity visible as students sign into the web-based conference. • Fast Start introduces students to the web-based video conferencing features, tools, and functionality before delivery of content. • Quick Reference Guides and Frequently Asked Questions on how to use the web conferencing tools. • Participant manual containing content and exercises and reflections during the live session. • Participant journal for multi-session activities. • Facilitator/faculty manual with suggested timelines for all activities and instructions for use of web-based video conferencing software's features and functions. • Reflection time built into all events. • Polls and Assessments created in advance.	a. Run accessibility checks on all your materials to ensure accessibility and that they are usable with assistive technologies (e.g., keyboard, screen readers, etc.). You can create a checklist to review for accessibility. b. Plan for captions and transcripts in all videos and transcripts for audio only (podcasts) and include guidelines for learners on video/audio time length. c. Ensure enough color contrast in all your materials and that crucial information does not rely only on color to convey meaning (e.g., marking required fields). Consider color contrast in synchronous sessions and prevent virtual backgrounds or clothes that can cause a flickering screen. d. Start with accessibility in mind when designing a course. Create accessible

	• PowerPoint Slides uploaded in advance. • Graphics, figures, tables, frameworks, flow charts created and uploaded in advance. • Breakout sizes and number decided and set up in advance.	templates that you can use. e. Plan for alt text on all images and evaluate the context to ensure accurate information. f. Coordinate with institution resources for professional development funds and access to resources (e.g., accessible tools, textbook companies, etc.), leverage the accessibility tools and features from the LMS, and plan for support staff accommodation. g. Plan multiple ways for learners to access the content and submit their work. h. Plan heading structure in documents and webpages to allow for better navigation and understanding. i. Include a syllabus with clear expectations, participation, organization of content, and objectives. j. Provide learners guided tips to organize time and

	the space to share their own timeline based on their needs or perception

*The strategies marked with an asterisk scored below 3 in the average and mean in the final focus group for model validation and ranking. However, they continue to be part of the model due to its innovation and contribution towards meeting the accessible needs of learners and 3 of 4 participants rank these strategies as important.

Source: This table is adapted from Armstrong (2014, 2016) and Armstrong and Gale (2018, 2025) and reprinted from Armstrong (2014) with permission from Nova Science Publishers.