7-13-2023

Increasing Retention and Knowledge Transfer Through Digital Storytelling and the Comics Medium: A Design Case

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INCREASING RETENTION AND KNOWLEDGE TRANSFER THROUGH DIGITAL
STORYTELLING AND THE COMICS MEDIUM: A DESIGN CASE

by

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A Dissertation Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Education

Major: Instruction and Curriculum Leadership

The University of Memphis

August 2023

Acknowledgments

My deepest appreciation to my professor and committee chair, Dr. Andrew Tawfik, for his inspiration and invaluable patience and feedback. I am also extremely grateful to my professor and defense committee member, Dr. Craig Shepherd, for his intangible support, knowledge, and expertise. Additionally, this endeavor would not have been possible without the generous support from the MacArthur Foundation.

I am also grateful to my classmates and cohort members for their continuous moral support through this endeavor. Additional thanks also go to the librarians and research assistants from the University of Memphis, who taught and guided me through research practices that will have a lasting impact.

I am eternally grateful to my wife, Tammy. For all the late nights, weekend sacrifices, and occasionally allowing me to whine and vent, her belief in me kept my determination and motivation strong throughout this journey. Lastly, I would be remiss not to thank my dogs, Eddie, and Dexter, who were always by my side or at my feet, keeping me company on late-night writing escapades and constant, loyal emotional support companions.

Abstract

Asynchronous multimedia learning is a common form of delivering training in the workforce industry, and organizations rely on a completion status to measure that training. However, measuring retention and knowledge transfer of new material rarely occurs during asynchronous learning. Grounded in the Visual Language Theory (VLT) and a delivery modality of digital storytelling (DST) suggest that sequential images presented as a visual narrative have higher degrees of retention. Thus, knowledge transfer occurs when learners relate to the narrative and visual applications when engaging with a comics approach to learning. From 2019-2022 a story emerged to design and develop an asynchronous digital storytelling comic narrative about simulation obstetrics training for distribution to 700 nurses in Bihar, India. Chapter 1 introduces digital storytelling and the use of comics in medical education. Chapter 2 explores the literature around visual language theory, digital storytelling, and andragogy in comics. Chapter 3 investigates the initial design beginning in 2018 with the implementation study, to the Simulation Educator Training redesign in 2019. A thorough needs assessment introduces Chapter 4 with learner and context analysis, exposing communication barriers, culture representation, character development, and technology challenges. The initial deployment and subsequent feedback survey in late 2019 resulted in a major redesign beginning in 2020. The following two years resulted in ten comic episodes with shorter seat time, more in-depth explanations of abstract concepts, and interactive scenarios to practice real-world situations. Chapter 5 concludes with lessons learned, opportunities, and closing with the results of a final study conducted in late 2021 and published in February 2022 in the International Journal of Environmental Research and Public Health, resulting in an 86% increase in retention.

Keywords: asynchronous learning, comic, comics narrative, digital storytelling, instructional design, visual language

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List of Abbreviations

AMANAT-Jyoti (Name of the program for the initial design of this Design Case)

Asynchronous Learning (eLearning)

Auxiliary Nurse Midwives (ANURSE MENTOR)

Face-to-Face Training (F2F

Human-Centered Design (HCD)

Hypercomics (interactive digital comic stories)

Instructional Designer (ID)

Instructional Design & Technology (IDT)

Leading Innovation in Quality-of-Care Education Development (LINQED)

Learning Management System (LMS)

Mobile Nurse Mentoring Team (MNURSE MENTORT)

Nursing Mentor (NURSE MENTOR)

Nurse Mentor Supervisors (NURSE MENTORS)

Objective Structured Clinical Examination (OSCE)

Respectful Maternity Care (RMC)

Scaled-up program from MNURSE MENTORT (AMANAT)

Simulation Educator Training (SIMULATION EDUCATOR TRAINING)

Simulation Facilitator Training (SIMULATION FACILITATOR TRAINING)

Subject Matter Experts (SMEs)

Theory of Multimedia Learning (TML)

University of California San Francisco (UCSF)

Visual Language Theory (VLT)

List of Definitions

Adult Learner. An adult learner is a person who is typically over the age of 25 and is involved in all forms of learning. Adult learners fall into a specific criterion of being experienced distinct from adolescent and child learners.

Design Case. A design case is defined by Boling (2010) as "a vehicle for the dissemination of precedent, direct or vicarious experience of existing designs stored as episodic memory" (p. 2). It is a detailed, in-depth description of design decisions, moves, and artifacts that encompass a design. While design cases may call upon research and theory to inform design decisions, the procedure is foregrounded (Boling, 2010; Howard, 2011).

Visual Sequential Narrative. Analogous to the way that sequential words take on grammatical roles that embed within the constituent structure in sentences, sequential images take on narrative roles that embed within the constituent structure of visual narratives (Cohn, 2013).

Comicboarding. The comicboarding method leverages known plot formats, interaction styles, and character development for comics to assist stakeholders with generative ideas who may have limited experience in creative brainstorming (Moraveji et al., 2007).

Digital Storytelling. Digital storytelling is a multimedia product consisting of still images or segments of video containing background music or voice-over narrative (Robin, 2006).

Human-Centered Design. Human-centered design is a problem-solving technique that puts real people at the center of the development process, enabling designers to create realistic experiences that resonate with the audience's needs.

Action Mapping. A streamlined process to design an efficient way to involve stakeholders effectively, especially when the project has already begun (Moore, 2008)

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CHAPTER 1: INTRODUCTION

According to the World Health Organization (WHO), as of 2019, the neonatal mortality rate is 39%, mainly due to malnutrition. An international effort between PRONTO International and CARE India developed a multi-day face-to-face (F2F) simulation training program. The training educated regional adult nurse learners in the proper care of mothers and delivery of babies to reduce infant mortality rates in the poverty region of Bihar, India. After training, participants would become nurse facilitators in their home regions and transfer the knowledge to other nurses. This design case highlights how an interactive comic was developed in a digital storytelling format to augment the F2F training.

Visual Language Theory, Images that Communicate and Implications for Retention

Medical research and technology are constantly evolving, and new techniques and treatments are emerging at a rapid pace (Yang et al., 2022). Therefore, continuing medical education is critical for healthcare professionals to stay current with new developments and provide the best possible care with the latest advancements in evidence-based treatments in medical science and technology (Szarko et al., 2022). Asynchronous learning enables medical communities to keep up with that pace, allowing training delivery anywhere at any time and location. Asynchronous self-paced learning, or eLearning, is a training and development approach used in many organizations with a geographically dispersed adult workforce audience.

There are various modalities to support medical education, such as recorded lectured or selected readings provided in an online medium. While these may be beneficial, they need more interactivity and contextualization central to constructivist learning principles. One way to further support enhanced learning outcomes is by applying visual language theory (VLT) within these online formats, especially as it applies to digital storytelling. The main argument of VLT is

that visual communication is organized using the same schematic structures and principles as written languages. These same structures and principles are applied to drawing or making pictures. Both are natural, intrinsic human abilities for expressing thoughts and are structured, processed and developed similarly (Cohn, 2014). Cohn argues that our capabilities to speak, use body language gestures, and draw pictures share an equal communication architecture. As it applies to using comics to enhance medical education, the aesthetics, and visual tone in digital storytelling are thus like other languages where symbols and elements have meaning, and those symbols and elements arranged in patterns communicate a message, inform, instruct, or educate (Cohn, 2013). The picture superiority effect (Hockley, 2008) refers to pictures and their associations benefiting from deeper and more conceptual affordance processing. Combining these understandings forms a theoretical framework that guides this design case by applying a human-centered design approach to ensure the content and cultural style of the comic modules are accessible, representative, and relatable to the Nurse Supervisors.

Digital Storytelling and Medical Education

Digital storytelling is a popular medium used for instruction in the classroom from early childhood through adult education. Within healthcare, concepts such as empathy and well-being are central to the practice, and the nuances of these topics require more work to capture in other mediums. Indeed, comics - which juxtapose text and images - have been used to educate the public and patients about health conditions for years. In adult audiences, comics have been used to teach topics including immunization (Muzumdar, 2016), HIV and STD prevention (Willis et al., 2018), childhood developmental milestones (Rosas-Blum et al., 2018), infertility (Murali & Venkatesan, 2021), IUDs (Sridhar et al., 2017), follow-up care in the emergency room (Hanson et al., 2017), and stroke (Furuno & Sasajima, 2015).

In formal health education settings, comics have been used among medical students (Tsao & Yu, 2016), nursing students (Anand et al., 2018), and psychology students (Joshi et al., 2019) to teach concrete topics such as an overview of neurotransmitters (Joshi et al., 2015) or basic anatomy (Kim et al., 2017), as well as more abstract emotional concepts like empathy (McNicol, 2017; Ronan & Czerwiec, 2020; Tsao & Yu, 2016). The unique format of comics has been shown to increase the retention of information (Hanson et al., 2017; Kim et al., 2017) and allow for deeper comprehension (Rapp, 2011). In contrast to a more didactic learning approach, comics as a medium transcend time and space and present opportunities for creative perspectives in storytelling. A scene can indicate that time or space is divided with durations of time and dimensions of space defined by the location contents than by the scene alone (McCloud, 1994, p. 99). Comics can convey nuanced concepts to communicate complex ideas about health, exploring emotional and social issues while allowing readers to see themselves in learning representations. Comics allow for a deeper understanding of developing empathy beyond that which can be achieved through textbook readings alone (Anand et al., 2018; Green & Myers, 2010; McNicol, 2017; Tsao & Yu, 2016).

Initial Design Problem of Practice

Adult learners participating in organizational training are often given asynchronous compliance-driven topics with completion metrics as the driver (Warner, 2019). Those who participate in face-to-face training benefit from collaboration, but research shows that lasting retention fades over time, yet little evidence supports retention measurement (Masters, 2020). In both asynchronous and synchronous learning, organizations are constantly looking for innovative solutions to increase the retention of information and the transfer of knowledge among employees and effectively measure knowledge retention (Steil et al., 2020). In the Initial Design

of this design case discussed in Chapter 3, adult nurse learners, primarily women, participated in simulation train-the-trainer workshops to become nurse facilitators to train other nurses. Approximately 700 adult female nurses from Bihar, India, attend multi-day simulation training programs to become nurse facilitators. Once trained, these nurses return to their home clinics to disseminate the information to other nurses as facilitators of the same simulation. Additionally, this is a low-resource and low-literacy region, and simulation facilitators use various techniques during training to ensure retention instead of required reading or attending lectures. However, with the Initial Design video training approach, within a few months after attending simulation training, the nurses would revert to pre-training practices with no consistency in procedures and the regression of knowledge retention (Ghosh et al., 2019).

Designers can engage learners to think critically visually with instructional digital storytelling. Indeed, it has been argued that "stories are the most natural and powerful formalism for storing and describing experiential knowledge that is essential to problem-solving." (Jonassen & Hernandez-Serrano, 2002, p. 76). At the same time, there are many debates about what specific aspects of digital storytelling led to increased motivation, engagement, interactivity, retention, and more. There needs to be more guidance about applying VLT elements within digital storytelling, especially for diverse audiences. In line with this gap, this design case describes the challenges and solutions following a three-year supplemental asynchronous training that implemented a series of interactive digital stories designed as a visual narrative using the comic medium.

This design case highlights the history of a learning design where the goal was to assess the Initial Design results and Redesign an innovative asynchronous approach that would be sustainable and scale to a broader audience. The Initial Design simulation training funded by the

Gates Foundation was successful but had leveled off the core objective of reducing infant mortality rates. Stakeholder feedback from PRONTO International, headquartered at the University of San Francisco, CARE India, and the School of Nursing at the University of Utah prompted an investigation into an innovative solution to increase simulation facilitator skills and knowledge retention further. This design case focuses on the Redesign and Final Design discussed in detail in Chapter 4. The Redesign proposed two asynchronous interactive modules and supplemental printed performance support materials in the form of comic books in both English and Hindi to be accessed before attending simulation training. Stakeholder and redesign learner survey feedback led to the Final design of ten episodic comic modules accessed after attending face-to-face simulation training, followed by reflective coaching.

Final Design Deliverable

The final deliverable for this design case was ten asynchronous interactive digital storytelling comic episodes that begin with Episode 1: The Origin Story. The following eight episodes introduced topics on how to Simulation Educator Training up a simulation scenario, facilitating skills, teamwork, and communication skills. In addition, abstract concepts taught an understanding of safe learning space, empathy, and self-efficacy. The digital story is presented through the ongoing struggles between a protagonist teaching sound training methods and an antagonist committed to disrupting simulation training. The final tenth episode rekindled a broken relationship between the protagonist, Super Divya, and the antagonist, Professor Agni, and left the learner anticipating future stories.

The curriculum followed an overriding Simulation Educator Training of objectives to drive the narrative: 1) establish a universal Simulation Educator Training of principles for nurse facilitators, 2) reinforce psychologically safe learning, 3) encourage shared feedback among

peers, and 4) empathy for the birthing mother at the forefront. The learner audience resides in a low-literacy region where careful thought was given to specific cultural, language, and environmental considerations. Because of the learning environment, instructional design decisions were often constrained and limited, yet they maintained the intention of engaging and immersing the learner in the fictional story. For example, the direct purpose of using real-life nurse facilitators as characters in the story made for the learners' direct connection and relatability. First, the learner could see themselves in the story, and secondly, recognizing a peer-influenced a tighter bond among the group and, in some instances, were seen as celebrities.

The Redesign, with a detailed front-end analysis, was fully supported, and the instructional design was solid. However, that design should have included several learner environments and cultural aspects, resulting in a total redesign. As indicated earlier, the learner region has low literacy. While the low fidelity of sequential visual narratives (comics) transcends universal languages (Hockley, 2008), the design process was challenging for stakeholders to brainstorm. Comicboarding was introduced as a participatory design method. The comicboarding method leverages known plot formats, interaction styles, and character development for comics to assist stakeholders with generative ideas who may have limited experience in creative brainstorming (Moraveji et al., 2007). Instructional designers reading this case may find the innovative execution of the comic medium inspiring for any future endeavor where increasing an adult learner's retention is a learning objective.

Purpose Statement

According to Howard (2011, p. 53), The motivation for a design case, particularly this one, is "How did the design come to be as is (Howard, 2011)?" Instead of evaluating a hypothesis of whether Nurse Facilitators remembered training better given a controlled

intervention, this design case is for instructional designers to build upon processes and workflows to direct future design schemas and applications (Svihla & Boling, 2020). This design case aims to rigorously document the process and decisions made during the design and development of the supplemental Super Divya comic series for nurses in simulation training to become better Nurse Facilitators. That is the insights, thought processes, and instructional design decisions instead of research questions and a quantitative study or a qualitative observation. In doing so, design cases give readers an extended look into what the designers experienced with a transparent view into initial brainstorming sessions, methodologies, development workflows, and in this case, adherence to artistic visual style decisions and the technology for distribution (Svihla & Boling, 2020). This design case thus serves as a form of knowledge-sharing and, consequently, knowledge-building, common to fields where instructional design is central practice (Svihla & Boling, 2020).

A vicarious look at existing research is thoroughly explored in Chapter 2. I go in-depth on existing research to show that comics in medical education are either collaborative, facilitated digital storytelling workshops or analog print comics for learning. However, there needs to be more research on asynchronous adult learning using comics. An in-depth narrative will kick off this design case in Chapter 3 by describing the project's origins from its Initial Design before I joined the project, the results from the Initial pilot study, Redesign efforts shifting from video-based training to an asynchronous interactive comic narrative, and the Final 10-episode design based on lessons learned from the redesign's survey feedback.

Chapter 4 will describe the Initial Design and subsequent study results and why that implementation did not meet expectations. The decision to develop an interactive comic was pitched for Redesign. Richard Mayer (2005) reinforced the interactive design with attention to

working memory, and Cohn (2013) anchored the design using sequential visual narratives that led to a major shift from the Initial Design. A detailed discussion in Chapter 4 will reveal the instructional design direction, how I led the process for culturally representative character development and environment decisions, and how including iterative learner and stakeholder feedback drove major design changes. Chapter 5 concludes this design case with the results of a final study conducted in late 2021 and published in February 2022 in the International Journal of Environmental Research and Public Health, resulting in an 86% retention of information. Finally, I share an in-depth discussion in Chapter 5 about lessons learned in designing instructional comics, specifically a comic series for medical education, opportunities missed, and considerations for future designs on how the benefits of leveraging digital storytelling in interactive ways using the comic medium will further increase retention and knowledge transfer.

CHAPTER TWO: LITERATURE REVIEW

Introduction

Practitioners in Learning and Development are often required to solve complex learning problems in various domains. These challenges include designing instruction for diverse audiences who are geographically dispersed and in different cultures. This chapter presents an overview of visual language theory and design considerations of the benefits of digital storytelling using the comic medium to reach diverse audiences within the medical education domain. Although there are many versions of how to define digital storytelling, most are synonymous with a simple definition of combining the art of storytelling that combines some mixture of graphics, images, text, and optional audio narration or music, to present information on a specific topic (Meadows, 2003). Digital storytelling is typically short-form video and focuses on a particular topic from specific perspectives (Robin, 2006). This distinction allows designers to understand the choices available for output modalities better.

Researchers and educators have often conceived digital storytelling as how to produce stories in a digitized format (Robin, 2016). However, very little research has considered digital storytelling in other forms and how to embed elements of the visual language theory through means such as the comic medium. As this review will reflect, the current research also shows the visible benefits of comics as a medium to increase engagement and retention (Hanson et al., 2017; Kim et al., 2017). Through the lens of the Visual Language Theory (Cohn, 2014) and the principles of digital storytelling, the delivery of interactive instructional comics can engage learners with meaningful and relatable stories and increase retention to influence behavior change ultimately (Cohn, 2014; Mayer & Moreno, 1997; Robin, 2016). Informed by the visual language theory, a modified approach to the principles of DST is well-suited for instructional

designers to deliver interactive comic-based instruction to increase the retention of information for learners. With a solid understanding of these principles and the constructs of visual language narratives, educational comics encourage meaningful engagement and memorable experiences, especially in areas of healthcare.

Visual Language Theory, Images, and Implications for Retention

As educators explore addressing these health disparities, they leverage technologies to convey complex ideas. One design approach is through the lens of Visual Language Theory. Neil Cohn's work on the Visual Language Theory (VLT) explores the structure of individual images and sequential images on how existing knowledge of our memories provides our minds with the information to make sense of what we see (Cohn, 2012). The main argument of VLT is that graphic communication is organized using the same structures and principles as language. These same structures and principles are applied to drawing or making pictures. Both are natural, intrinsic human abilities for expressing thoughts and are structured, processed and developed similarly (Cohn, 2014). Cohn argues that our ability to speak, use body language gestures, and draw pictures share an equal communication architecture. It should be noted that understanding the theoretical model of Visual Language Theory is the beginning of graphic communication in the context of this design case (see Chapter 3), including digital storytelling and sequential narrative art (sections that follow).

The tenets of the Visual Language Theory have their roots within cognitive psychology and related literature. As visual language is the output of expression of structures, the 1980s psychologist Vera John-Steiner suggests that ideas are first formed in the mind as schemas and structures as a process of visual thinking:

"The representation of knowledge in the form of structures in motion; the study of relationships of these forms and structures; the flow of images as pictures, diagrams, explanatory models, orchestrated paintings of immense ideas, and simple gestures; work with schemes and structures of the mind" (John-Steiner, 1997, p. 109).

The schemes and structures John-Steiner references can compare the cognitive form of *drawing* to the cognitive structure of *language,* where both systems rely on storing schemas in memory that connect when *reading* pictures (Cohn, 2014). Conventional schematic knowledge representations that reflect recognizable patterns are the same approach one employs as they recognize patterns in writing (Wilkins et al., 1997).

Beyond mere expression, the Visual Language Theory suggests that visual communication is a structure with rules and grammar of graphic elements that make up the visual language (Cohn, 2013). Like any language, some symbols and elements have meaning, arranged in patterns forming a visible narrative structure to communicate complex message systems (Cohn, 2013). In a later paper, Cohn recognizes that these visual languages prominently appear in comics and that this paradigm includes all aspects of graphics and drawn information (Cohn, 2018). For example, consider the following sentence, 'the rich aroma of a warm beverage filled the air with an inviting mood although it was a dreary and cold autumn day,' can be visualized without text that follows the same grammatical structure with a sequence of images that visualize a cold autumn day, the warm beverage as the subject, and a character's facial expression setting the mood (Figure 1).

Figure 1

Image Sequence of a Tree, a Warm Beverage, and a Person Enjoying the Beverage.

The human ability to express or produce ideas falls into one of three modalities: sound (verbal; hearing), moving (signing, body), and graphic (visual representation). Other modalities are used to interpret or understand concepts and ideas (Cohn, 2012). For example, in Image 1, the aroma of coffee is interpreted by smell. Visual language is parallel with verbal language as the primary ability to express ideas and concepts through a system of a grammatical structure consisting of three underlining components:

1. Modality – sounds, bodily, visual-graphic

2. Meaning – an expression of modality

3. Grammar – rules, and constraints for sequential expression of meaning

Additionally, languages have two main traits that are systematic and combinatorial. All components (modality, meaning, and grammar) together create a systematic structure of communication and expression, otherwise known as a lexicon or vocabulary (Cohn, 2020). Combinatorial refers to allowing for infinite possibilities. A sound or phoneme can be combined to create multiple words, and words can be combined to create various sentences. Aside from verbal and written languages, the underlying structure of visual language asks what mental

representations viewers construct to understand a sequence of images and the fluency of reading visual grammar (Cohn, 2020).

Visual Language Theory, Digital Storytelling, and Episodic Memory

The principles of visual language theory do not just convey information, but they often communicate complex stories and other mechanisms that support higher-order learning. Stories are the "means [by] which human beings give meaning to their experience of temporality and personal actions" (Polkinghorne, 1988, p. 11). From a learning perspective, stories help with decision-making, and within the contextualized Simulation Educator Training, stories become a helpful tool for causal reasoning. Stories also require less cognitive effort than exposition because of the narrative framing of an experience (Jonassen & Hernandez-Serrano, 2002; Tawfik & Kolodner, 2016). Moreover, stories are the essence of shared experiences, encouraging inspiration, reflection, and motivation.

In terms of the design of learning environments, digital storytelling offers unique and creative approaches to transforming these stories into instructional material. Digital storytelling is an alternative approach to conveying instruction and includes learning outcomes, given its relationship with episodic memory. Schank and Abelson (1975, 1977) proposed that knowledge structures contain episodic information. Whether positive or negative, these experiences are stored in our memories as everyday situations where the expectations concerning the Simulation Educator Training, goals, props, and behaviors of the other people involved are evaluated. Scripts are inherently episodic in origin that arise from experiences and are applied to understand new events. As learners gain expertise, A person remembers previous situations, or scripts, like how a nurse previously treated a patient. Scripts are generally experiences but can be shorter within a larger context (Schank & Abelson, 1975). Remembered situations may be used to solve

new problems, suggest adopting a solution, alert of possible failures, and interpret a situation (Kolodner, 1992).

Over time, scripts of these experiences allow individuals to automatize episodic experiences as they engage in new problems (Schank & Abelson, 1975). Scripts, a learner's experiences, provide a window into how they can leverage the schematic narratives of visual language in designing new instruction. By understanding a learner's prior experiences, an instructional designer can craft a similar scenario with cultural and representative visuals and interactive activities to explore possible solutions (Mayer, 2002). When designing an interactive digital story in the comic medium, the presentation layer employs the visual narrative that relates to the learner's environment and experiences.

Digital Storytelling and Medical Education

Although design principles are emerging, empirical studies suggest that DST and its VLT and episodic memory application is an effective strategy within the medical education domain. For example, Zarei et al. (2021) studied nursing students applying digital storytelling medical oncology curricula to assess critical thinking skills. Thirty-two nursing students in two groups (n = 16 per group) participated in control groups (systematic instruction) and intervention (developing digital storytelling from medical cases). Two measurement instruments were used to assess digital storytelling: The Health Sciences Reasoning Test (HSRT) and a multiple-choice test. Zarei et al. (2021) found no significant difference between the groups in knowledge scores from the HSRT test ($P > 0.05$). However, there was a substantial difference between the groups from the multiple-choice test post-test analysis ($t = -2.58$, $P = 0.01$). These findings show that students in the intervention group who developed digital storytelling significantly increased retention of key medical concepts. The researchers concluded that a narrative story is a powerful

influencer and plays a significant role in better analyzing the information, thus improving analysis skills, which is part of the reason for the findings of critical thinking.

DST has been applied in other approaches within medical education, such as how nursing students describe personal experiences in palliative care (Price et al., 2015). In this study, nursing students (N= 68) provided scaffolding guidance that specified the elements of digital storytelling, including point of view, dramatic question, emotional content, gift of voice, power of soundtrack, economy, and pacing. Additionally, scaffolding guidance on delivering a professional presentation, specific assignment direction, and an explanation for the level of effort required for designing and developing digital storytelling. In terms s procedure, nursing students were instructed to create a 5-minute digital story that broke down the concepts from the formal instructional content of palliative care, including students' prior knowledge and experiences. Before the formal palliative care content instruction, all students completed an online presurvey that collected students' perceptions about palliative care. Students were then divided into small groups to share their digital stories online with their peers, and each student was required to provide feedback for everyone in the group to review.

In contrast to previous studies that focused on the cognitive benefits of analytical reasoning and critical thinking skills, this study explored the socio-emotional compassion of palliative caregivers while focusing on instructional curriculum. Students also expressed that "real" stories from their peers held their attention instead of hypothetical case studies. The researchers thus concluded, "The use of digital technology appears to be an effective collaborative pedagogy, which engages students, fosters creativity, and promotes several professional skills, including presentation, peer feedback, communication, and deportment. This

study found that digital storytelling fostered creativity and may have promoted effective learning" (Price et al., 2015, p. 70).

While the studies explored how DST may support students' cognitive and socio-emotional learning outcomes, other research has focused on how DST can reach diverse populations. For example, Limaye et al. (2018) studied the effects of digital storytelling on improving maternal and child health in the Peruvian Amazon. The researchers took a different approach conducting digital storytelling workshops with community healthcare workers and mothers (n = 28) from 13 rural communities in the Amazonian Parinari district. Participants were instructed to create storyboards that captured personal stories from experiences. From these themes, the researchers assisted in creating a Digital Story Curriculum known as Nuestras Historias (Our Stories). Lastly, an accessibility survey was administered to men (M = 47) and women (F = 60) on the digital storytelling artifacts for novelty, readability, education, and sharable. Seven digital stories created were chosen for clarity, relevance, and narrative quality. The final seven digital stories were distributed to the men and women participating in the accessibility survey for novelty (M = 89.4%, F = 83.3%), relatability (M = 89.4%, F = 93.2%), educational (M = 91.5%, F = 93.3%), and sharable (M = 100%, F = 100%). Overall, the digital stories were rated "Excellent" or "Good" by over 90% of the survey respondents who found digital storytelling useful and relevant. This study concluded health-promotion effects and argued that it empowers the community to share personal stories and experiences. However, limited technical resources, lack of digital literacy, and language barriers shed light on suggesting additional participatory research in digital storytelling approaches in low-resource and low-literacy populations. Beyond traditional learning outcomes, digital storytelling may address community-specific problems through narrative persuasion with high accessibility.

During the research profiles of specific articles and their effects, others have attempted to provide a broad literature overview. Research by West et al. (2022) retrieved over 5,000 studies, with 46 studies analyzed across seven countries between 2011-2019 through inclusion criteria that used digital storytelling in innovative ways. Methods used in the studies were qualitative (n = 44), with one mixed method and one quantitative analysis. West et al. (2022) aimed to answer three questions; 1) What is known about the purpose, definition, processes, and contexts of digital storytelling as part of the research process in health research? 2) How does digital storytelling impact the participants, research process, knowledge development, and healthcare practice? Moreover, (3) What are the key ethical considerations when using digital storytelling within qualitative, quantitative, and mixed-methods research studies? Although the review argued its learning outcomes, it noted that additional clarity is needed, arguing that "philosophical positioning is essential for advancing digital storytelling as a rigorous method with a solid theoretical grounding" (West et al., 2022, p. 18) and the need for future research.

The selected studies related to digital storytelling highlight important nuances and their impact on learning outcomes within healthcare Simulation Educator Training. Based on the research cited, various approaches to health-related digital storytelling serve as a powerful method for retention of medical oncology concepts (Zarei et al., 2021), sharing personal experiences in palliative care (Price et al., 2015), and improving maternal and child health in Peruvian Amazon (Limaye et al., 2018). In group Simulation Educator Training, the researchers discovered that digital storytelling fostered creativity, collaborative learning, and shared experiences. In healthcare education, digital storytelling in facilitated workshops is an empowering and effective method compared to more didactic approaches to learning.

Digital Storytelling, Medical Education, and Comics

Beyond traditional forms of multimedia (video, audio), alternative ways exist to apply elements of visual language theory and digital storytelling for medical education. In his book, *Comics, and Sequential Art*: *Principles and Practices*, Eisner (1990) explains how "comics employ repetitive images and recognizable symbols. When used repeatedly to convey similar ideas, they become a language – a literary form. Moreover, this disciplined application creates the 'grammar' of sequential art" (Eisner, 1990, p. 8). However, this does not distinguish if repetitive images and recognizable symbols are universally or culturally exclusive (Eisner, 1990). Comics often include characters that readers can relate to, as comics theorist Scott McCloud suggests readers identify with comic characters more than photos or photo-realistic characters (McCloud, 1994).

Comics allow complex science topics to be presented as graphic narratives that are easier to digest and comprehend. With this understanding, visual language and sequential visual narratives impact relaying concepts and differing perspectives using comics in health education contexts (King, 2017). Additionally, comics as reflection replaces the formal writing assessment in the reflection process for undergraduate and postgraduate medical students promoting natural reflective processes (Whiting, 2020). In a recent paper published in the Journal of Medical Humanities, a critical synthesis of comics presents an option for health education and the efficacy of the comic medium in educating the public about communicable diseases (Rakower & Hallyburton, 2022). Another article argued that using comics assists radiology nurses in educating patients (Saltzman, 2023). Comics as a tool provide stress mitigation for both patients and radiology nurses. Saltzman found that comics can help identify patient fears and pre-conceptions toward medical procedures in radiology (Saltzman, 2023). Graphic narratives can

also aid providers in empathizing and communicating with patients by helping patients understand that others may feel similar anxieties related to radiological procedures. In other cases, comics have been used to educate the public and patients about health conditions for years, teaching topics including immunization (Muzumdar, 2016), HIV and STD prevention (Willis et al., 2018), childhood developmental milestones (Rosas-Blum et al., 2018), infertility (Murali & Venkatesan, 2021), IUDs (Sridhar et al., 2017), follow-up care in the emergency room (Hanson et al., 2017), and patients recovering from a stroke (Furuno & Sasajima, 2015). Regarding learning outcomes, the unique format of comics, which juxtaposes text and images, has been shown to increase the retention of information (Hanson et al., 2017; Kim et al., 2017) and allow for deeper comprehension (Rapp, 2011). These examples demonstrate the vast interest in using comics as a medical education tool that can impact patients, caregivers, healthcare professionals, medical educators, and medical education students.

Beyond using comics within medicine to support patient care, others are more situated within medical education. For example, a study was conducted to determine the feasibility of an education module in the comic format for Emergency Department Simulation Educator Training (Hanson et al., 2017). Injured children who are treated and discharged require at-home care, and often, little instruction is provided to parents for handling children experiencing pain. Using a comic narrative instead of standard discharge instructions, the study evaluated attitudinal constructs on the perceived importance of using a comic and its ease of understanding, time dedicated to reading it, and recall of knowledge from it. Moreover, it evaluated the feasibility compared to standard discharge instructions. The study enrollment included a convenience sample of 50 children between the ages of 4 and 18 treated at a regional children's hospital for various pain-related complaints.

After triage, children and their caregivers were identified and approached about participating in the experiment, and a comic about pain management was provided. A previous study informed the development of the comic for children's at-home pain experience (Hanson et al., 2017). The main objectives for the comic were 1) to talk to caregivers about pain, 2) that pain relief is helped with medicine, and 3) that pain is normal. The instructional creativity of the comic narrative included a teach-back element at the end of the comic with empty speech bubbles where children were asked to fill in what they should say to help the character. Additionally, a seek-and-find activity was designed to encourage engagement and a way to measure whether children finished the story. Overall, the pain management intervention comic was well-received as likable, easy to read, and informative by both children and caregivers. However, the findings of this study revealed that the comic also informed caregivers how their child might be feeling, resulting in better attentive care. The researchers also discovered that the comic encouraged better communication between a child and their parents in the health context of pain management.

In addition to the retention of information increase, another significant aspect of comics used in medical studies is teaching abstract concepts, perspectives, and attitudes. Researchers Tsao and Yu (2016) invited students from a Canadian medical school to provide written reflections on two different comics about diabetes and then participate in a focus group (Tsao & Yu, 2016). The researchers adhered to Kolb's experiential learning theory (ELT) 's four phases: initial experience, reflection, conceptualization, and active experimentation (Kolb, 1984). The study aimed to inform how comics can affect the learning of empathy and to explore the experiences of medical students and physicians with empathy and emotional labor in patient care. The researchers found that empathy declined in the third year of medical school and chose

to conduct a qualitative study using focus group methodology and a quantitative assessment to measure changes in empathy scores.

Two animated comics were created and delivered online. The first comic shows a patient asked to start insulin and chronicles their fear of insulin initiation. The second comic shows a patient trying to follow daily lifestyle recommendations and self-management burnout (Yu & Man, 2016). Students reviewed each comic a week apart, allowing time for reflection, and then met in focus groups to discuss their impact on empathy. They found that most participants knew empathy declines through medical training, particularly starting in the third year, and that it was an expected part of the culture. Almost all the participants expressed an increase in their knowledge of the patient's perspective. One participant stated that the comic caused a dramatic shift in their knowledge, while another student said it helped them differentiate between perceived and actual views. The results also impacted the participant's attitudes toward empathy and how the comic affected how they would approach future patients. A major outcome from the data showed how the comic's repetitive sequences and color changes affected the students' moods. This resulted in keen observational skills conveying the daily routine and burnout associated with diabetes. Tsao and Yu (2016) did recognize that their study was a limited sample size in one medical college. The authors concluded comics to be an effective medium and its impact as a reminder of empathy's importance. The animated comics developed by Tsao and Yu (2016) align with other empirical studies about how DST using the comic medium is an effective strategy within the medical education domain. Comics can be effective by helping students reflect, gain knowledge, change attitudes about perspective, and improve observational skills. Comics, thus, present an interesting medium for digital storytelling in interactive ways specific to healthcare topics in medical education.

The previous study builds on the graphic medicine trend by adding animated comics to professional healthcare education. Masel et al. (2020) conducted a similar study to augment 5th-year students in medical humanities through illustrations and medical comics. One of three medical comics was randomly assigned to 506 medical students and distributed through an online learning platform. Depending on the assigned comic, the student was asked to reflect and answer questions within one week related to one of three learning objectives: 1) comprehend demands on a young doctor during a night shift, 2) reflect on a patient examination situation, or 3) recognize physical and emotional needs in patients. Of the total 506 students who engaged with the comics, the average time spent reviewing the comics was 12.75 minutes, and students wrote an average of 110.8 words per reflection. 84% of all answers were rated sufficient or exceptional. Additional qualitative data found that students perceived medical comics as having significant potential for addressing challenging topics and were well-received. The high word count on questions and time spent reflecting on the medical comics showed the benefit of understanding the difficult issue of medical humanities through comics as a teaching tool, specifically with the ability to see the perspective through the patient's eye. While the study found that medical comics significantly impacted students' attitudes about patient perspective, no control group existed. Additionally, the comics used in this study were single-panel scenes. However, no analysis of the correlation between time spent reflecting on the comic scene and subsequent word count answering the question compares to a multi-panel comic.

In a more recent study, Garcia De Avila et al. (2022) analyzed the effectiveness of nurses versus verbal guidance combined with a comic book on preoperative anxiety in children and their parents. A randomized parallel, two-group controlled clinical trial was conducted in the pediatric ward, and a blinded anxiety assessment by two nurses in the operating room. Children

aged 6 to 14 years were analyzed in an intervention group (n=30) and a control group (n=30), along with their parents. The contents of the comic book were maintained as follows: presentation of the surgical team, preoperative care and routine in the operating room, surgical environment, separation of the child from the guardian(s) at the door of the operating room, procedures performed in the operating room (e.g., monitoring, venipuncture, anesthesia, surgery, post-anesthesia care), and postoperative care in the hospital room. This study showed the impact of preoperative guidance by nurses, which included communicating verbally along with a combined comic book on anxiety in children admitted to the operating room, regarding non-pharmacological strategies for reducing preoperative anxiety (Garcia De Avila et al., 2022). Beyond cognitive benefits, this study adds to an emerging pattern that shows that using the comics format in healthcare to educate patients, parents, and caregivers increases knowledge, retains information, and reduces anxiety.

In this section, diabetic patients are depicted in comic narratives to teach medical students' perspectives on empathy, using comics to teach medical humanities, and comics used for nursing guidance for preoperative anxiety in children and parents. Comics can bring awareness by presenting perspectives from different angles to change attitudes, promote observation skills, enhance reflection skills, rethink beliefs on soft skills, and lessen the barriers to complex discussions.

Conclusion

Educational comics specifically offer a low barrier to entry, are low fidelity, can reach larger low-literacy audiences, and can be used in various medical education Simulation Educator Training to teach soft skills, increase self-reflection, and improve communication and observation skills. The value of using comics as a tool goes beyond medical education by

removing literacy skills while also reaching children or people with language disabilities. The research shows that various topics and different forms of using comics apply to various age groups, interests, and professions. Combined with animation and interactivity, comics are an emerging digital storytelling medium.

Health educators are increasingly seeking ways to support critical thinking and socio-emotional outcomes. Unlike the didactic approach to learning, DST argues the power of situational storytelling and revising a proposed result by presenting scenarios in the comic medium. There is a potential for higher retention if learners believe they can relate to the stories. Indeed, theorists suggest that "stories are the most natural and powerful formalism for storing and describing experiential knowledge that is essential to problem-solving." (Jonassen & Hernandez-Serrano, 2002, p. 76).

Instructional designers have applied the elements of DST in various ways, including comics. Research has shown that the comic medium used as a modality to communicate graphic narratives about serious and complex topics significantly impacts education (Kearns & Kearns, 2020). Grounded in Visual Language Theory, graphic sequential narratives weave images where the reader or viewer engages and relates to the story. Digital storytelling adds components of multimedia technologies for a compelling interactive experience. With visual language theory as the underlying theoretical framework for comics, instructional designers can add new knowledge and skills to understand better how to design DST and sequential narratives that relate to the learner audience through storytelling and presented in the comics medium. The trend of a comic as a medium has been shown in the training of healthcare workers and physical and mental health (McNicol, 2017). Despite the benefits of comics in medical education, there are potential gaps in the literature. For example, all the articles and papers in this section and all but one study

implemented comics in a physical analog format. There needs to be more examination of digital

storytelling with interactive components that allow for critical thinking choices, branching

scenarios, and even potential gamification designs.

CHAPTER THREE: INITIAL DESIGN

Before my involvement, the background leading to the Final Design began by designing and developing a simulation-based training program. In low-resource environments where access to technology is a known minor factor, simulation-based training has proven to be an accepted method of clinical training. However, video recordings of simulated scenarios are becoming common in low-resource settings where access to technology is limited (Dyer et al., 2018). Clinical simulations provide opportunities to practice skills in real-life scenarios, improving healthcare providers' technical and non-technical skills (Bragard et al., 2016; Walker et al., 2016). With innovative approaches to training design and the exponential development of technology, reaching low-resource audiences increases training opportunities for improving the quality of care (Walker et al., 2016). Instructors commonly use recorded videos of simulation scenarios during debriefing sessions to help facilitate guided conversations and reflection. Recall bias is prevented during video simulation scenario playback providing factual evidence and allowing participants to witness their performance rather than how they thought or felt about it (Sawyer et al., 2016). Beyond using the videos during debriefing sessions, researchers can also analyze the simulation videos to quantify and compare technical and nontechnical skills over long periods (Dyer et al., 2018).

In 2014, CARE India, in collaboration with the government of Bihar, India partnered with the University of California, San Francisco, PRONTO International, and the University of Utah College of Nursing to implement realistic simulation (technical) and team training activities (non-technical) into an existing program to improve the skills of auxiliary and general nurse midwives (Table 1). Nurse Mentors video-recorded simulations of participants practicing technical competencies for various neonatal and obstetric emergency care and non-technical

competencies in teamwork and communication. Although the results were promising, in 2018, the funding grant by the Bill and Melinda Gates Foundation (grant number: OPP 1112431, 2015) inquired about future training and increased results.

Table 1

Stakeholders Involved from the Initial Design Through the Final Design

Stakeholder	Description
CARE India	A not-for-profit Non-Government Organization (NGO) builds capacity of communities to ensure empowerment for marginalized women with a focus on sustainable and holistic interventions in women's health education.
PRONTO International	Headquartered at the University of California, San Francisco, their goal is to optimize care during birth by developing and implementing innovative training strategies.
University of Utah (UoU)	The research arm of the College of Nursing at the UoU lead programs in many disciplines in health care, primarily women's health and simulation in nursing education.

This chapter describes the origins of simulation training, my involvement beginning with the Initial Design conducted in 2018 that deployed video-based training, and the results and analysis that led to the Redesign in 2019 and the Final Design between 2020-2022 as an asynchronous interactive solution (Table 2).

Table 2

Timeline of Simulation Training Design Implementations

Design	Origins and Background				This Design Case			
	2015	2016	2017	2018	2019	2020	2021	2022
Initial Design	▓	▓	▓	▓				
Redesign					▓			
Final Design						▓	▓	▓

Background Origins of the Initial Design

In 2015, CARE India, in collaboration with the government of Bihar, launched a program to improve maternal and neonatal health outcomes in public health facilities through interventions aimed at improving skills and behavior and quality of clinical care through adult learning techniques. To address this gap, the government of Bihar and its main collaborators, CARE India and the Bill and Melinda Gates Foundation, launched a pilot program called the Mobile Nurse Mentoring Team (MNMT) in 8 districts of Bihar. The Mobile Nurse Mentoring Team was scaled up into a state-wide AMANAT program. As part of the Mobile Nurse Mentoring Team (2012 – 2015) and the AMANAT (2015 – 2017) programs, formally trained Nurse Mentors provided onsite mentoring to the nurses and the Auxiliary Nurse Midwives (ANM) posted in the labor rooms and maternity wards public facilities across the state of Bihar. The Nurse Mentors incorporated diverse teaching strategies, including on-the-job demonstrations of evidence-based practices on actual patients, bedside mentoring, didactics, low-technology, high-fidelity simulation, and team training designed by PRONTO International. The AMANAT program effectively improved maternal and newborn health indicators but was unsustainable (Creanga et al., 2020). To improve health gains obtained with the AMANAT program and make it more affordable, scalable, and sustainable, the government of Bihar, India, and its collaborators launched the AMANAT-Jyoti program (Program), which led to the Initial design and Final designs of this design case.

During this program iteration, over 700 Program-trained government nurses and Auxiliary Nurse Midwives working at public facilities were selected to become Nurse Mentors in their facilities. However, the simulation training was part of the broader Program. The new Nurse Mentors acted as the Nurse Mentor Supervisors during the Program phase. They were

responsible for training the facility nurses and Auxiliary Nurse Midwives on all training modules, including PRONTO simulation. The Nurse Mentors' new role involved conducting orientation sessions on different training modules, including the simulation techniques, which, in turn, trained the rest of the nurses and Auxiliary Nurse Midwives working in the facility (Figure 2). The focus was to assess the simulation and debriefing knowledge, self-efficacy, and skills of Nurse Mentors, the third level of simulation educators, and to describe the characteristics and physical conditions in which simulation and debriefs occur in Bihar. When replicated at scale by a third level of educators in Bihar, India, the Program identified the strengths and limitations of simulation and team training.

Initial Design Intervention of the Nurse Mentoring Program

The Program led by CARE India deployed in 353 facilities comprised of 331 public health facilities across Bihar, India, focused on improving the quality of obstetric and newborn care through onsite mentoring by facility-based nurses and Nurse Mentors. The Program curriculum includes multiple modules on evidence-based ante-, intra-, and post-partum care and neonatal-care practices. In addition, a locally tailored library of simulation scenarios on the most common obstetric and neonatal emergencies, such as post-partum hemorrhage, eclampsia, neonatal resuscitation, and teamwork and communication activities to strengthen effective communication, leadership, teamwork, and kind and respectful care. PRONTO International, the University of California San Francisco, and the University of Utah College of Nursing partnered for the simulation and team-training component of the Program intervention. To support a sustainable scale, the Program involved three levels of simulation educators (Figure 2).

Figure 2

Levels of Program Educators, Supervisors, Mentors, and Nurses

6	**60**	**700**		
PRONTO Simulation Specialists	Nurse Mentor Supervisors	Nurse Mentors	Staff Nurses	Mothers & Babies Recieving Care

5 local nurses
1 US midwife educator

Employed by the Bihar Technical Support Program (BTSP)

AMANAT-trained government nurses and Auxillary Nurse Midwives
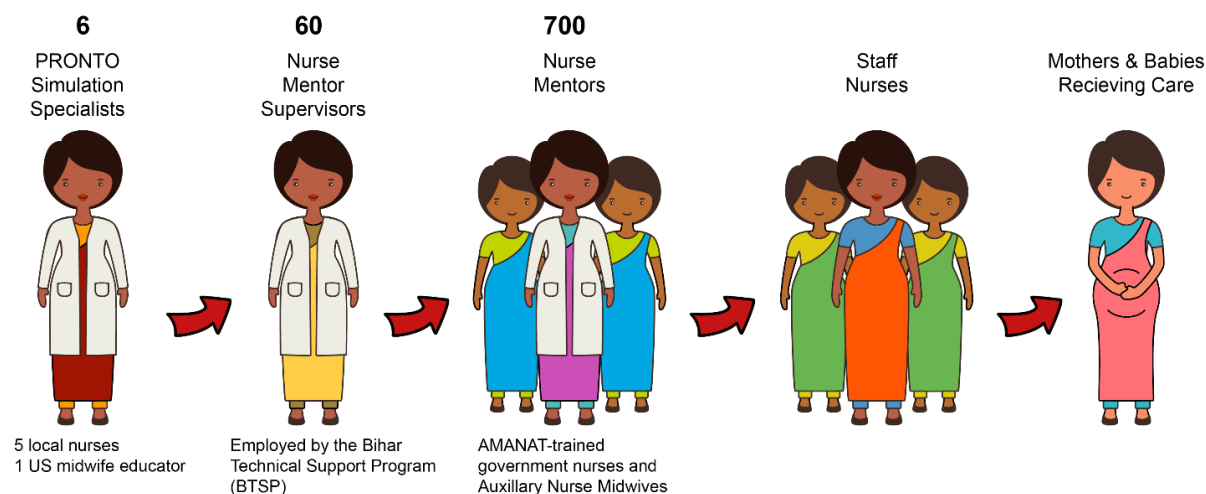
The first level of educators was six PRONTO Simulation Specialists—five local nurses with graduate degrees and one midwife educator from the United States. The second level of educators included sixty Nurse Mentors participating in Simulation Educator Training. Based on the learning objects, they were taught how to facilitate seven simulation scenarios and seven teamwork and communication activities. The third level of educators was the 700 Program Nurse Mentors, equivalent to 1-2 years of nursing training providing care in public health facilities.

Program Nurse Mentors were participant-trainees of the previous iteration of the AMANAT mentoring program and were selected using a standardized test of clinical knowledge and Objective Structured Clinical Examination (OSCE). The selected Program Nurse Mentors attended a four-day Simulation Facilitator Training (SFT) from March to April 2018. The PRONTO Simulation Specialists led Simulation Educator Training (SET) held in Patna, the state capital of Bihar, and conducted in early 2018 (Figure 3).

Figure 3

Site of the Simulation Educator Training in Patna, Bihar
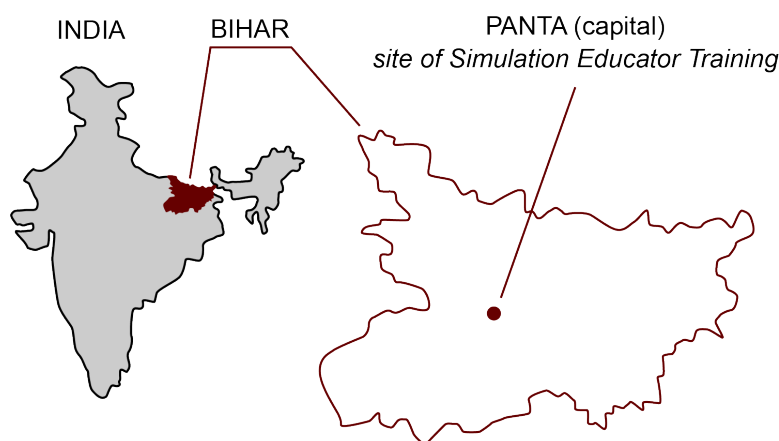
Sixty Simulation Facilitator training classes were conducted across Bihar, with approximately thirty Program Nurse Mentors participating in each training event. The Simulation Facilitator Training was led by Nurse Mentors previously trained by PRONTO Simulation Specialists. The curriculum of Simulation Facilitator Training included components of a pre-brief, how to set up a simulation, facilitate and debrief seven obstetric and neonatal emergency simulation scenarios, and seven teamwork and communication activities. The simulation setup curriculum included making simulated blood, preparing the simulated patient for the scenario, and using the birth simulator (PartoPants™) worn by the simulation patient. The facilitation curriculum described using hand signals to communicate with the simulated patient during the scenario and using a whiteboard to indicate vital signs. The Diamond Structure debriefing model taught the description, analysis, and application phases (Jaye et al., 2015). In addition, Program Mentors learned how to debrief technical, cognitive, and behavioral elements during the analysis phase of the debrief. After the Simulation Facilitator Training, Program Nurse Mentors were assigned to work in pairs in their facilities, supported by Nurse Mentors, to conduct simulation activities and develop teamwork and communication skills.

Initial Design Evaluation and Measurement for Nurse Mentoring Program

The study evaluated the strengths and limitations of the simulation-based training component of the Program. The data came from knowledge and self-efficacy tests administered to all Program Nurse Mentors before. After the Simulation Educator Training, the Program Nurse Mentors conducted videos of simulations and associated debrief sessions. The videos included in the analysis accounted for 16 of 38 districts (42%) in Bihar. Video recordings of one simulation and its corresponding debrief were coded from each facility. The videos from the program's first module focused on managing the most common obstetric and neonatal emergencies, post-partum hemorrhage, eclampsia, neonatal resuscitation, and Respectful Maternity Care (RMC).

Participants completed a knowledge and self-efficacy test with the same questions before and after the training using paper-based forms in Hindi. The objective was to measure changes in knowledge about simulation and facilitation debriefing and self-efficacy from attending the Simulation Educator Training. The knowledge test included seventeen questions on facilitating a simulation and teamwork and communication concepts. The self-efficacy test was a four-point Likert scale based on Bandura's self-efficacy theory containing ten statements about the respondent's belief in their ability to conduct a simulation. Additionally, simulation and debrief videos assessed Program facilitation skills. The simulation scenario analyzed was a postpartum hemorrhage case due to uterine atony. Simulation and debrief videos from simulations were recorded in clinics from May to July 2018. Simulation experts from the University of California, San Francisco, PRONTO International, and the University of Utah College of Nursing developed two code windows; one for the simulation and one for the simulation debrief. The simulation code window included 35 indicators of best practices to measure scenario Simulation Educator

Training-up, presence, and use of simulation materials, instructions delivery, communication and progression of scenario, educator behavior, participants, simulated patient, and overall scenario rating (Figure 4). The Simulation Debrief code window (Figure 5) included eighteen indicators measuring the time an educator spoke versus participants, the number of participants that spoke, the order of the debrief, the type of objectives covered, and the seating formation of participants. Both simulation and simulation debrief code windows reflected the scenario's objectives and simulation educator standards of best practices adapted to novice simulation educators (Boese et al., 2013; Thomas & Kellgren, 2017).

Figure 4

Code Window for Simulation Video Analysis

Figure 5

Code Window for Debrief Video Analysis

Initial Design Data Analysis of the Nurse Mentoring Program

For the knowledge and self-efficacy data collected after the training, 693 (99%) participants completed both forms. The paper-based forms were entered into an online portal using Qualtrics by study team members in Patna. A bivariate analysis was conducted using STATA 16, comparing the data from pre- to post-training. Thirty-nine simulation videos and 40 debrief videos were coded. A team of two Hindi-speaking experienced video analysts based in Patna coded the videos from September to October 2018. Two simulation educators trained as video analysts conducted the video review, and video analysts coded all pairs of videos. Finally, a video database manager exported the data to MS Excel for analysis.

Initial Design Results of the Nurse Mentoring Program

All Nurse Mentors trained (n=60) were female with an average age of 25 years (SD=2, range: 21 - 34 years). 92% (n=55) had a bachelor's degree in nursing, and 8% (n=5) had a master's degree. 60% (n=36) had no prior experience working in a maternity ward, 42% (n=25) reported they had no prior training in patient-provider interaction, and 78% (n=47) had no prior training in simulation. Most (92%, n=55) said they were either satisfied or very satisfied with their job. All 693 Program Nurse Mentors trained were female, averaging 42 years (N=631, SD=9, range: 23 - 68 years).

Knowledge results for Nurse Mentors (Table 3) show a significant increase in mean knowledge between the pre-and post-tests after completing the 4-day simulation facilitation training. The average knowledge score showed a 16% difference (p < .001) from 49% at baseline to 65%. Knowledge scores increased on all questions related to simulation facilitation and teamwork and communication except for one question where there was a slight decrease on the question related to the 'role of educator as someone who guides participants to learn.'

Self-efficacy also increased after Simulator Educator Training (Table 4). The average self-efficacy score for overall simulation facilitation increased from 2.83 before the training to 3.43 after the training (p <.001). Results were measured on a four-point scale. On average, self-efficacy related to statements about mentoring increased from 3.03 before the training to 3.30 after the training (p <.001).

Initial Design Video Analysis of the Nurse Mentoring Program

The average length of the 39 simulation videos was 10:21 mins (2:37 - 23:46 minutes). The average number of participants was 5 (min = 3; max = 9) participants per simulation. The nurses who participated in the scenario played different roles as the nurse, patient, and family members. The average length of the forty debrief videos was 12:50 minutes (range, 5:39 – 28 minutes), with an average of 8 nurse participants (min = 3; max = 13) per debrief.

Table 3

Simulation Knowledge Scores for Nurse Mentors

Question content	Pre (n=684)	Post (n=693)	Difference
Characteristics of a simulation educator	67%	62%	-5%
Information provided to participants during the pre-brief	69%	82%	13%
Participants who should hear the information about the patient scenario	52%	57%	5%
Use of whiteboard during simulation	62%	93%	31%
Use of baby cry during a neonatal resuscitation scenario	45%	49%	4%
Arrangement of participants during a simulation	46%	68%	22%
The first question to be asked during a simulation debrief	48%	75%	27%
Example of an open-ended question used in a debrief	26%	34%	8%
Benefits of using open-ended questions	55%	58%	3%
Who should talk more during a debrief	51%	60%	9%
Benefits of debriefing a simulation scenario	51%	59%	8%
Thinking-out-loud concept	41%	74%	33%

Question content	Pre (n=684)	Post (n=693)	Difference
Check-back concept	48%	81%	33%
Concept of the Two-challenge rule	57%	83%	26%
Appropriate use of SBAR	27%	46%	19%
Elements of good leadership	54%	60%	6%
The first step before running a teamwork and communication activity	26%	55%	29%
Average:	49%	64%	15%

Note. (N = 693). March through April 2018.

Table 4

Simulation Facilitation Self-Efficacy 4-point Likert Scale Scores

Category	Indicator	v	Post (n=693)	Difference
			Mean (SD)	
Simulation Facilitation	I am able to Simulation Educator Training up a simulation.	2.8 (0.8)	3.5 (0.5)	0.6
	I am able to facilitate simulation.	2.7 (0.8)	3.4 (0.5)	0.7
	I am able to debrief a simulation.	2.6 (0.8)	3.4 (0.6)	0.8
	I am able to run a teamwork activity.	2.7 (0.8)	3.3(0.6)	0.6
	I am able to teach communication techniques.	2.6 (0.9)	3.2 (0.6)	0.6
	Simulation training is important for the nurses and doctors in my clinic.	3.3 (0.8)	3.5 (0.5)	0.1
	I am confident that I am able to teach emergency management using simulation.	3.19 (0.7)	3.53 (0.5)	0.3
	A mentor cannot change the way a nurse provides care.	2.52 (0.9)	2.60 (1.0)	-0.08
Mentoring	If I try really hard, I can give other nurses information that will improve their practice.	3.4 (0.7)	3.61 (0.5)	0.2
	I know how to provide support and encouragement to students when I am leading a simulation.	3.0 (0.8)	3.46 (0.6)	0.4

Note. Pre- and Post-Training for Program Nurse Mentors in Bihar, India, in March and April 2018. The self-efficacy

scale ranged from strongly disagree to strongly agree.

Initial Design Environment for the Nurse Mentoring Program

Most of the simulations were conducted in classrooms (n=26, 65%), some were conducted in other locations (n=8, 20%), a few were conducted in operating clinics (n=5, 13%), and one was conducted in the labor room. Most of the simulations were done in a quiet location (n=28, 70%), some were done where there was some noise (n=7, 18%), and a few were done in noisy locations (n=5, 13%). Most simulations were conducted in locations with good light (n=39, 98%), although one was poorly lit. 89% of the simulations were done with adequate space, while 13% were done in crowded areas). Simulation supplies were also usually placed in convenient locations (n=36, 92%). In all cases, simulation training and debrief huddles were conducted in the same location.

Initial Design Results for Simulation Facilitation Skills

All the simulations selected for analysis contained the expected postpartum hemorrhage uterine atony scenario. Positive and negative indicators reveal the proportion of videos observed for simulation facilitation (Table 5). For example, positive indicators indicated negative, such as using hand signals or a whiteboard to communicate vital signs or when a participant laughed during the simulation. Facility nurses acted as simulated patients because they could uncover patient-centered issues in non-threatening ways to discuss during the debrief.

Table 5

Simulation Facilitation Skills Video Analysis of Program Nurse Mentors

Simulation Facilitation Skills		
Indicator	**N**	**% of Videos**
Educator role		
Simulation started at an appropriate time	39	100
Used hand signals to communicate with the patient actress at least once	2	6
Adjusted blood flow during simulation to enhance realism	0	0
Communicated vital signs via whiteboard with participants	15	38
Did not communicate verbally with the participant	39	100
Did not give vitals before the provider took them	38	97
Did not communicate verbally with patient	38	97
Physically helped participants during the scenario	2	5
Verbally coached participants during the scenario	0	0
Participant able to see vital signs on the whiteboard	38	95
Active Simulation Participants		
Asked the educator what to do during the scenario	1	3
Talked to the camera/audience during the scenario	3	8
Did not laugh	38	97
Patient Actress/Companion Role		
Wore PartoPants™ (birth simulator)	39	98
Wore injection pads	16	40
Wore IV armbands	27	68
Could see the educator	39	98
Did not laugh	39	100
Did not tell participant how to manage the scenario	37	93
PRONTO's Post-partum hemorrhage due to atony scenario-specific		
Patient actress got dizzy	28	70
Baby doll was present	17	43
Patient actress asked for the baby	13	33
Blood stains present	29	73
Blood replacement present	2	5
Observers		
Verbally coached active simulation participants	3	8
Physically helped active simulation participants	0	0

Note. (N = 39). Postpartum Hemorrhage Due to Uterine Atony Scenario conducted in Bihar, India, from May through August 2018.

Initial Design Results for Debrief Facilitation Skills

All debrief videos contained the Diamond Structure of the three phases debrief: description, analysis, and application (Jaye et al., 2015). The average number of times AMANAT-Jyoti Nurse Mentor educators spoke was 50 (range: 22 – 100), whereas the participants spoke on average 43 times (range: 17-91) during a debrief. This gave an average of 1.2:1 (range of 0.6:1 – 1.7:1) for the ratio of times the AMANAT-Jyoti Nurse Mentor educator spoke to the times that participants spoke. This ratio suggests that the debriefs are a shared back-and-forth conversation between debriefers and participants. Educators discussed behavioral objectives in 35 videos (90%), ranging from one to three times. They discussed cognitive or technical objectives in all debriefs, and the number of times ranged from one to five mentions. Table 6 displays the proportion of videos with observed indicators for debrief facilitation, such as the phases of the debrief, the types of learning objectives discussed, and the formation of the debrief (Table 6).

Table 6

Debrief Facilitation Skills Video Analysis of Program Nurse Mentors

Debrief Facilitation Skills		
Indicators	**N**	**Percentage**
Educator was sitting	39	100
Participants were sitting	39	100
Debriefing formation		
Circle	11	28
Semi-circle	21	54
Other	7	18
Debrief contributors		
Scenario participants	1	3
Both scenario participants & observers	34	87
Unknown	1	3
Simulated patient spoke	24	62
Number of participants who spoke individually		
2 participants	11	28
3 participants	13	33
4 participants or more	16	23
Number of participants who missed the debrief		
2 participants	2	5
3 participants	2	5
4 participants or more	1	3
Educator questions formulation		
Always reading the guide	4	10
Mostly reading guide	7	18
Split evenly	20	51
Mostly asking questions	6	15
Always asking questions	16	22

Note. (N = 40). Post-partum Hemorrhage Due to Atony Simulation Scenario conducted in Bihar, India, from May to August 2018.

Initial Design Discussion and Results of the Nurse Mentoring Program

Reducing global maternal mortality requires continuous improvements in maternal and newborn health. Investing in impactful and sustaining continuing education methodologies for local facilities and nurses was critical to sustain health gains in Bihar, India. The collaborative efforts of CARE India, the University of California, San Francisco, and the University of Utah College of Nursing recognized that the study was the first to measure knowledge, self-efficacy, simulation facilitation, and simulation debriefing skills. The researchers further understand that designing a video training program for third-level nurse mentor educators in India was one of few global studies. Analyzing the before and after data for simulation educator training, it was found that training conducted by Nurse Supervisors (second-level educators training by PRONTO Simulation Specialists) showed increased facilitation knowledge and self-efficacy in the Program Nurse Mentors in Bihar. Further analysis of simulation videos revealed that training conducted at primary health clinics had the correct infrastructure to support approximately 700 Program Nurse Mentors to develop the basic skills that transferred to confidence to facilitate simulation and debriefing sessions at their clinics.

Further video analysis showed that using a whiteboard to communicate and supplies during simulated scenarios was accepted. Leading simulation debriefs by having the participants sit in semi-circles created a welcoming environment to deliver the debriefing Diamond Structure (description, analysis, and application) approach. Overall, recording videos of simulations and debriefing sessions revealed promising observations for sustained training. These findings are consistent with Benner's novice-to-expert framework that simulation and debrief facilitation skills require two to three years of practice and feedback from more experienced simulation educators until competency is acquired (Thomas & Kellgren, 2017).

Despite the infrastructure challenges in health facilities in Bihar, India, all the primary health clinics that participated in this study had an appropriate area to conduct simulations. Most simulations were conducted in classrooms instead of labor and delivery rooms, which would be in situ for obstetric and newborn emergency simulation training. There was no information other than to suspect that labor and delivery rooms were occupied during simulation training. The video analysis showed mixed results in key aspects of the Simulation Educator Training up and fidelity for the postpartum hemorrhage scenario. For example, the simulation guide instructed the use of simulated blood. However, 28% did not use any simulated blood during the scenario, and the reasons for not using it are still being determined. Possible reasons are the need for more knowledge on making simulated blood, insufficient supplies, or misunderstanding about the importance of realism of simulated blood in the scenario. A nurse from the facility typically performs as the patient actress. The video analysis found no scenarios in which the patient actress laughed during the scenario, suggesting the educators communicated the importance of role-play to recreate the emergency and control the seriousness of the scenario.

Interestingly, the speaking ratio between educators and participants showed that less experienced debriefers exhibit more intentional characteristics and spend more time speaking than participants (Evans et al., 2013). Third-level nurse training was not assessed on maternal and neonatal health outcomes at the time of this study. However, PRONTO International simulation and teamwork training in India has been shown to increase evidence-based practices in identifying and managing maternal and newborn complications. The impact of third-generation nurse training on maternal and neonatal outcomes has yet to be studied. However, PRONTO simulation and teamwork training in India and other countries have been shown to

increase the use of evidence-based practices and the identification and management of maternal and newborn complications (Walker et al., 2016).

Conclusion, Strengths, and Limitations

Bihar's vast population and infrastructure introduced several limitations, including the small number of simulation videos accounting for only 11% of the facilities as part of the AMANAT-Jyoti program, recognizing that this sample may only represent some healthcare facilities in Bihar. However, the conscious effort to include diverse facilities revealed the skills of different third-level simulation educators that complemented the knowledge and self-efficacy data. The results in Tables 2 and 3 are not paired due to difficulties matching individual data. However, the unpaired results show a data-driven story given the large educator sample size (N=693).

Despite limitations, this study assessed the feasibility of scalable simulation training using third-level nurses as simulation trainers in low-resource Simulation Educator Training. The evidence provided in this study shows that simulation-based training and facilitation concepts are accepted in Bihar by Nurse Mentors (NURSE MENTORs) and that a train-the-trainer model from the first, second, to third levels is achievable and sustainable. Additionally, the study showed that the AMANAT-Jyoti program enabled public facilities in low-resource Simulation Educator Training to allocate the time and space to conduct simulations. The overall assessment of this study gave the authors an understanding of the strengths and weaknesses of AMANAT-jyoti Nurse Mentors' simulation and debriefing skills. Final thoughts from the authors recommend that future work focuses on how to anchor simulation facilitation and debriefing skills, maintain educator engagement, and move facilitators towards expert practice in a sustainable manner. The complex objectives laid the foundation for the needs assessment for the

redesign into asynchronous training. Additional limitations not revealed in this study were the technical challenges with the transfer and deliverability of video media. This study proved the sustainment of simulation training through a cascade of train-the-trainer levels. However, challenges with scaling simulation training to more health facilities in this low-resource region of India became a significant factor in the redesign discussed in Chapter 4.

Needs Assessment

I joined the project after the Initial Design, which began with a new needs assessment following the results of the Initial Design study. It prompted the questions of the scalability of Nurse Mentor facilitator simulation training across more districts in Bihar, India. I was contacted by the University of Utah College of Nursing in December 2018 requesting assistance in instructional design and developing a comic-based asynchronous learning experience. My first challenge was understanding any changes in the context, which ultimately motivated a redesign. Howard states, "Reader's understanding of the rationale behind design decisions and the trustworthiness of the entire design case may hinge on a clear presentation of the design context" (Howard, 2011, p. 42). This section will disseminate those design decisions. The content supported digital storytelling with narrative scenarios, and the comic medium fit the style and output to represent the learner's audience culturally. However, two critical areas needed additional analysis – understanding the current state of the project and a daunting amount of material to study to understand the Initial design and the subject of neonatal care.

Action Mapping the Redesign

The Visual Language Theory discussed in Chapter 2 would guide the Redesign to create the flow of digital storytelling and overall narrative scenarios. After further review, the front-end analysis revealed missing components that defined the instructional goals and objectives. Cathy

Moore's Action Mapping (Moore, 2008) was introduced to revisit the needs assessment to guide the learner and context analysis.

Action mapping (Figure 6) is a streamlined process to design and an efficient way to involve stakeholders effectively, especially when the project has already begun. The three main goals of Action Mapping are to 1) measurably commit to improving performance, 2) identify the best solution to a performance problem, and 3) create realistic activities. Starting with Action Mapping allowed the design team to refocus efforts and reassess the overall project goals.

Action Mapping (Moore, 2008) aided in realigning all stakeholders to identify that the problem was not a single problem with existing instruction, but the simulation training exposed knowledge gaps. Action Mapping enabled the design team to revisit a needs assessment; however, data collection can be expensive and time-consuming, which may yield information that could be more useful. An assumption that enough knowledge about the learners was evident to forgo collecting additional information based on previous assessments. This design case will break down how the grouping of behavioral objectives aligned with Action Mapping into four main criteria, 1) motivation, 2) skills, 3) knowledge, and 4) environment (Moore, 2008). Identifying these criteria were guideposts for defining the task and behavioral objectives and how to develop the episodic comic modules for nurse facilitators.

Data collection methods for this design case, discussed in the next section, are spread across several sources, including previous research, stakeholder discussions, and learner interviews and surveys. In the following learner and context analysis sections, it is important to note that these were conducted in parallel. The learner analysis will show working with the CARE India team in in-depth conversations with learners about their preferences for supporting and improving training. In the context analysis section, a thorough investigation of the learner's

environment explored areas to ensure cultural representation, how they will access the training, and where they will practice new knowledge. Design implications close out this chapter with resulting goals.

Figure 6

Action mapping: A visual approach to training design - Training design.

Note. Retrieved from https://blog.cathy-moore.com/action-mapping-a-visual-approach-to-training-design/
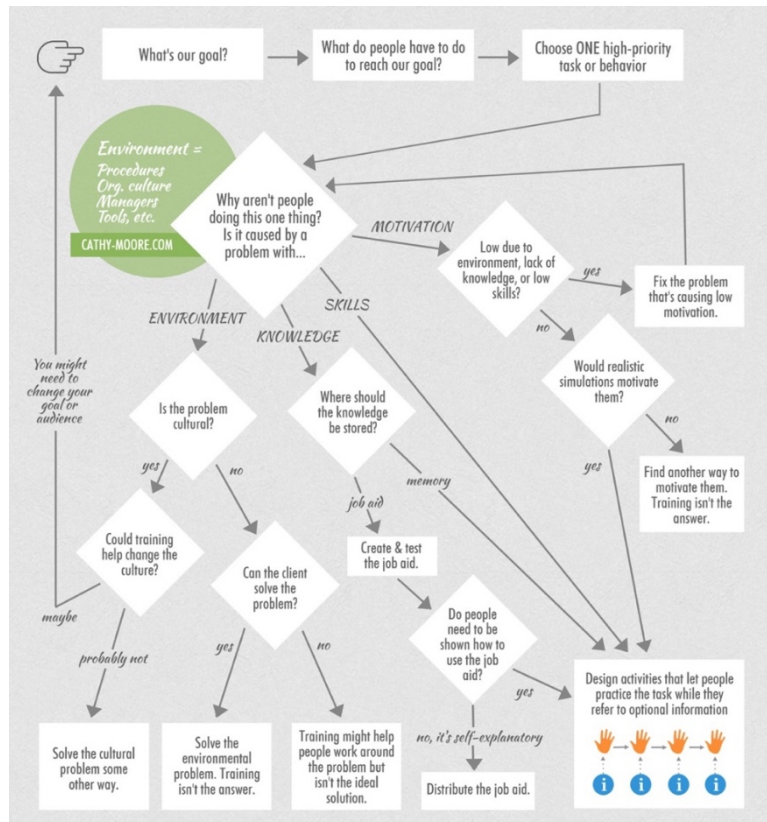
Front-End Analysis

Data Collection

Data collection was a combination of assessing data from the existing program with additional observations and stakeholder interviews to provide a deeper understanding and insights (Table 7). The current program was effective in improving maternal and newborn health indicators. Given that the employment of nurse mentors is by Bihar s India Technical Support Program (TSP) and not part of the state's public health system, the current program could have been more financially and realistically sustainable. The TSP is a partnership between CARE.org, the Bill and Melinda Gates Foundation, and the government of Bihar, India, focusing on infant mortality and overall reproductive health services across the state. CARE is a non-profit with limited funding and reach, whereas if the state's public health system employed nurse mentors, the program could be further scaled and sustained. The data collection focused on assessing the current simulation training and debriefing knowledge, self-efficacy, and skills of nurse mentors.

Table 7

Number of Stakeholders from the Initial Design Through the Final Design

Stakeholder	Core Team	Advisors on External Team
CARE India	2	8
PRONTO International	1	2
University of Utah (UoU)	3	0

In 2018, the PRONTO team developed a series of video modules to maintain and strengthen clinical and simulation skills for previously trained supervising nurse facilitators. These virtual, interactive modules allow Nurse Supervisors to learn and review topics at an individual level, at their speed, facilitating skills maintenance. PRONTO initially piloted the first

video module in May 2018 with in-country (India) staff, who subsequently held focus group discussions for immediate reactions and feedback and then extended to Nurse supervisors. PRONTO International at the University of California San Francisco (UCSF) created a survey via Qualtrics in June 2018. It revised the survey to incorporate feedback from content experts from the Leading Innovation in Quality-of-Care Education Development (LINQED) team with sixteen questions to elicit responses on three main topic areas: accessibility (feasibility/usability), acceptability, and effectiveness (see Appendix A). The survey used simple wording and concise answer choices to ensure that time spent on the survey was open to respondents with limited time. The 60 Nurse Supervisors included in the survey participated in at least one simulation training. Many supervisors facilitated and debriefed simulations before watching the interactive video module.

The core team at PRONTO, including myself, compiled data for the needs assessment, learner analysis, and context analysis from stakeholder observation notes, interviews, and learner focus groups who participated in the interactive video module pilot. Entering the nursing healthcare field, I needed to gain experience conducting a front-end analysis. It gave me a rich understanding of the learner's current experiences with simulation training, their needs, and identified knowledge gaps.

Participants and Procedures

To develop effective, scalable, and sustainable asynchronous training in a low-literacy and low-resource setting, I led several discussions and interviews with stakeholders about these criteria to establish a cohesive design team (Creswell & Poth, 2016). Stakeholders were a collective of subject matter experts (SMEs)s and researchers from three groups. The Institute of Global Health Sciences at the University of San Francisco, PRONTO International at the

University of San Francisco and Bihar, India, practicing nurse supervisors and mentors from CARE India, and nurse facilitators and nursing simulation training learners. The central main point of contact was the School of Nursing, Department of OB/GYN at the University of Utah, a PRONTO International research arm. The following sections describe each organization and critical stakeholders and the types of data collected from each.

Redesign and Final Design Stakeholder Responsibilities

      PRONTO International. PRONTO International is a nonprofit organization that designs, develops, and implements innovative training strategies that catalyze healthcare providers to make individual, team, and systems changes.

      CARE India. CARE India is a nonprofit organization that builds sustainable and holistic interventions in health, livelihood, education, and disaster relief & resilience, providing innovative solutions to deep-rooted development problems to deliver outcomes at scale.

      Project Coordinator. The project coordinator is a co-founder of PRONTO International and a key liaison between the US and India teams. She is one of the principal architects of the grant funding for this project and one of the early designers of the Initial Design simulation training. Her knowledge and history of the current program were vital, and having an interview early in the process anchored further discussions and interviews.

      Project Lead, US. Based out of the University of Utah, the project lead for the US also served as the gatekeeper (Savin-Baden & Major, 2023) for the core project team. Like the Project Coordinator, the Project Lead is also a co-founder of PRONTO International, a practicing midwife, researcher, educator, trainer, and the principal designer of the Initial Design simulation training. With her wealth of knowledge and experience, a Project Lead was a key driver in many design decisions (Howard, 2011).

Project Lead, India. The project lead for India is a member of PRONTO International with connections to CARE India. She is a practicing nurse mentor, supervisor, facilitator, and co-designer of the Initial Design simulation training. Her perspective of the nurse mentors and nurse learners assisted in identifying critical areas of attention and guided cultural and environmental design decisions.

Subject Matter Experts (SMEs). SMEs range from various individuals, including research assistants, practicing nurse supervisors, nurse mentors, nursing facilitators, and educators. Throughout this three-year project, group members changed but always came from the same positions of authority and experience.

In January 2019, I visited the University of Utah College of Nursing, interviewed the participants, analyzed current training doctrine and methods, and had virtual discussions with participants and project stakeholders in India. I interviewed US-based SMEs and coordinated with the Project Lead in India, who conducted local interviews garnering detailed information and descriptions that helped shape the strategy of a new intervention and Redesign. From February to March 2019, I conducted a rigorous investigation of current material, weekly team discussions, and educating myself on the branch of healthcare medicine of obstetrics.

Redesign Needs Assessment

The front-end analysis was an extensive process to analyze all aspects of the current state of training that drove the identifiable themes for the needs assessment, learner analysis, and context analysis. Interviews were semi-structured (Savin-Baden & Major, 2023). However, the technology in 2019 for recording virtual calls was not accessible to all stakeholders in India. Additionally, limited data plans in the region to conduct phone conference calls were not feasible. In these cases, the core team established alternate means of communicating. Email

became the main communication channel for progress and project updates, and Short Messaging Service (SMS) using the WeChat app supported short conversations or questions requiring a quick response. All US-based virtual calls utilized an electronic whiteboard and collaborative documentation using Google Docs. All digital media was coded with an organizational taxonomy and hosted on a shared cloud-based storage server for easy access, continuing collaboration, and security of files.

After several discussions with stakeholders and SMEs and analyzing the front-end data, several themes emerged around the nurses' skills, knowledge gaps, and behavioral attitudes in simulation training. Action Mapping (Moore, 2008) suggests choosing one high-priority task or behavior from the choices, environment, skills, knowledge, or motivation. Given that the overall goal of this project was to increase knowledge retention, Moore's 'knowledge' appeared as the priority. However, considering other factors that had equal importance, five overall themes were identified, including technology as a theme to organize subthemes (Table 8).

Table 8

Five Needs Assessment Themes and Subthemes

Theme	Subthemes
Environment	Cultural awareness Representation
Skills	Communication and Collaboration Facilitation
Knowledge	Simulation Pre-Brief Simulation Debrief (description, analysis, application phases)
Motivation	Behavioral attitudes Teamwork
Technology	Mobile design (smartphone, tablet) Logistics of remote access to training materials

Environment: During stakeholder and SME discussions about the environment, it became evident that cultural awareness and learner representation were critical for a self-paced

asynchronous design. I relied on photo references and descriptions to understand the learner's environment because I could not travel to India to embed myself into the learner's environment. Svihla and Boling (2020) explain that the distance between me, the designer, and the learner audience can potentially lead to problems during the design process. The focus group feedback listed cultural awareness and representation as essential factors. Nurse learners' experiences with asynchronous learning expressed environments displayed were not synonymous with their environment, and photo references often did not represent the learner audience.

Skills: Nurses who attend simulation train to become nurse supervisors/facilitators. Front-end analysis feedback from SMEs discussed a disparity in communication and facilitation skills. Nurse learners understood the content being taught but needed to gain the skills to communicate effectively and deliver training as a facilitator.

> *Some of our nurses choose to lecture on the material and refrain from involving other participants in discussing some topics. Moreover, instead of helping nurses overcome mistakes, they criticize them.*

SME feedback during the front-end analysis indicated that the simulation manuals included communication techniques but needed more basic facilitation skills.

Knowledge: Simulation pre-brief and simulation debrief essential components of the program. There are specific steps to prepare and care for birthing mothers and the arrival of a newborn. These critical steps directly impact the Gates Foundation's goal to reduce the region's infant mortality rates. Simulation pre-brief steps prevent problems for the birthing mother and the delivery of her newborn. Simulation debriefs, known as the "Debrief Huddle," are an opportunity for an open dialogue between simulation participants on what worked and what went

wrong. Knowledge of these two critical components of simulation training aligns with facilitation skills to manage the discussions.

Motivation: Behavioral attitudes such as arrogance, self-doubt, and defensiveness, among other perspectives, were identified by stakeholders and subject matter experts as potentially problematic.

> *Sometimes, nurses attend who are formally trained have egos that they know more than the nurse supervisor. Others who have had bad experiences of being yelled at for making mistakes are quiet and don't ask questions, so they don't participate for fear of being called out for making mistakes.*

Stakeholders and SMEs noted teamwork as a driver that exponentially affects all areas of simulation training. For example, potentially life-threatening issues may arise for nurses caring for the birthing mother but not working together.

> *Facilitated discussion, including the pre-brief and debrief. In between birthing simulation scenarios is where nurse participants need teamwork. The nurse supervisor impresses the importance of teamwork, but we need them to teach it or have more resources.*

Technology: During the interactive video pilot study, the infrastructure of the Bihar region limited the ability to distribute the video modules. The pilot study for using digital technology before and after simulation training proved reliable if only viewed offline. Facilitators displayed videos on a computer monitor for all participants to view. The communal delivery approach found that visibility (seeing the monitor from the nurse participant's vantage point) and sound (low-quality speakers) were distractors in achieving complete immersion.

> *It was difficult sometimes when the simulation had thirty or more participants. We had a big room, but some nurses couldn't see the monitor from where they were sitting. Our*

computer speakers were old, and we had them turned up as loud as possible, but it was

difficult and hard to hear.

Bihar is a low-resource region, and access to a reliable internet connection was not feasible to distribute the interactive video pilot on tablets. Through discussions with stakeholders and SMEs, there is a strong desire to develop the next iteration of the digital program to run on independent mobile device tablets.

Redesign Learner Analysis

Learner analysis is rooted in a scale-up of the next iteration of a digital training program with three levels of simulation educators described in detail in Chapter 3. The first level is the Nurse Mentor Supervisors who have a bachelor's degree in nursing, and many of them were residents of states other than Bihar. The second level of simulation educators were Nurse Mentors, who have an equivalent of 1-2 years of nursing training providing care in public health facilities in obstetric care. The third level of simulation educators were staff nurses at various facility clinics.

I had a few initial conversations with Nurse Mentor Supervisors and Nurse Mentors. However, our schedules rarely lined up for follow-up discussions. The Project Lead, India, is a Nurse Mentor Supervisor and is part of the core stakeholder team and a practicing simulation facilitator. Direct access to India on weekly virtual calls and timely email exchanges was paramount to understanding the learners' needs.

As the lead designer, I constructed a new digital experience from an existing program that allowed insights into learners' thinking and expectations. The difficult challenge was managing those expectations about a design they had never experienced – an interactive instructional comic. During ongoing conversations with the core stakeholder team, I introduced

concepts like spatial repetition that would enable the overall goal of increasing retention. Two

significant themes surfaced: self-paced training and confidence and seven subthemes (Table 9).

Table 9

Learner Analysis Themes and Subtheme

Theme	Subthemes
Self-Paced Training	Interactive activities Microlearning Spaced repetition
Confidence	Coaching (i.e., someone to reach out to, mentor) Constructive feedback during simulation training

Self-Paced Training: Asynchronous training allows learners to access training at their

own pace and on their schedule within a time set by the program's coordinators. I was not able to

interview any learners (NMSs or NMs). However, as stated earlier, I had access to two

experienced nurse facilitators on the core design team. Stakeholders conveyed that in designing

an experience to replicate simulation training and teach the concepts of facilitation skills, there

must be interactive activities to keep learners engaged. When I asked about presenting

microlearning as ongoing performance support, it was a general idea for delivering training.

However, understanding the learner, their environment, and technology limitations, I suggested

microlearning as an option. Spaced repetition involves multiple, short reviews of material that

allow learners to take their time to process new information.

Confidence: Coaching is an existing practice in simulation training, and Nurse Mentor

Supervisors are mentors in practice. Learners expressed that the participant-to-mentor ratio was

high and being able to connect was often tricky. They felt that having someone who could be a

confidant during training and beyond would be beneficial. Further discussion led to designing a

section on coaching and mentoring that would offer suggestions, such as a previous clinical supervisor, a college co-student, or an existing co-participant in simulation training.

In summary, the learner analysis revealed an anticipatory interest in more and improved asynchronous training and a strong interest in confidence. These two themes align with the overall objective as a solid interactive experience engages learning, and building confidence is a driving factor in increasing retention.

Context Analysis

Lastly, the context analysis revealed capabilities and limitations in designing an interactive, self-paced learning experience. Working with geographically dispersed stakeholders in different countries and multiple time zones on the same project was sometimes challenging. However, without physically visiting Bihar, India, understanding the learner context, cultural awareness, and technical constraints had to be a virtual exploration. The team discovered three cultural, modality, and resource themes (Table 10).

Table 10

Three Context Analysis Themes and Subthemes

Theme	Subthemes
Culture	Culturally representative visuals Relatable scenarios and dialogue
Modality	Offline viewing on mobile tablets Short viewing time (10-15 min)
Resources	Simulation Manuals (SimPack) Infographics

Culture: Bihar is traditionally Hindu, and any Western influence in the language, visuals, customs, etc., must be carefully considered. During this analysis phase, I asked for as many on-the-ground photo references as stakeholders in India could provide. I would also need to study

English-speaking audio localized dialects for narration, audition Hindi-speaking voice actors, and Indian-inspired music for a cohesive experience represented respectfully.

Modality: The Needs Assessment revealed technology to be a potential barrier. Bihar is a low-resource, low-income region, and delivering online instruction via the Internet was a concern. Several modes provide digitally developed instruction for offline viewing, and the Indian stakeholders encouraged me to consider offline as a priority. The Needs Assessment also revealed that, on average, the previous interactive video modules were 10:21 minutes long (min: 2:37 min, max: 23:46 min). Learners preferred 10-15 minutes of viewing time optimally, slightly longer than the recommended digital storytelling length for educational purposes at 3-9 minutes (Robin, 2016).

Resources: The current simulation training consisted of a small library of simulation manuals referred to as "impact," and nurse learners found them to be helpful in everything from how to set up a simulation, how to prepare the space for new learners, steps of the pre-brief, facilitation tips, and more. However, through stakeholder conversations, a desire to convert the manuals to interactive digital e-books to be accessible anytime. Additionally, facilitators would use posters during simulation to display checklists, reminders, steps, etc., handwritten on chart paper and taped to walls. I suggested recreating all the available simulation posters into infographics and distributing them like e-books for on-demand accessibility.

Redesign Implications

The needs assessment, learner analysis, and context analysis led to design implications that offered several options. The design was supplementary material to help Nurse Supervisors maintain their simulation facilitator skills. In designing an interactive educational program,

stakeholders wanted to preserve the interactive benefits of in-person training. In addition to safeguarding interactive benefits, it was essential to respectfully represent the learner's culture.

Debriefing is a critical component in simulation training. However, there were identifiable knowledge gaps regarding the best way to train facilitators in debriefing strategies. In a study published in the Journal of BMC Medical Education, the conclusion found that debriefing was critical to the success of simulation training (Raney et al., 2020). However, identifying knowledge gaps allowed to maximize learning, the fear of making mistakes, creating a safe learning environment, contextually appropriate debriefing strategies, and team building. Teamwork, adaptability, and a safe learning environment enhanced the quality of simulation-based training, which could help improve maternal and neonatal health outcomes in Bihar.

The Redesign included two digital story instructional comic modules in two languages (English and Hindi), all supporting material revealed in the context analysis, plus additional material in the form of printed sequential narratives (comic books). During the kick-off Redesign meeting in January 2019, nine objectives surfaced for the first two modules (Table 11).

Table 11

The Nine Objectives That Align with the Front-End Analysis

Module	Objective
The Origin Story	Safe Learning Space
	Facilitator Energy
	Pre-brief Steps
	Debrief Introduction
Super Divya Defends the Debrief	Debrief Huddle
	Phases of the Debrief
	Debriefing Difficult Participants
	Teamwork and Communication
	Situation Background Assessment Recommendation (SBAR)

Proposing a Digital Storytelling Comic

Digital storytelling is different from writing narrative scripts, and to capture the learner's attention, intrigue, and emotions, I presented the idea of a superhero/villain story arc. The idea was well-received, but we needed a theme, protagonist, antagonist, helpers, and other details I describe in Chapter 4. Establishing the characters and environment is a major consideration in writing instructional narratives for the comic medium. The first module would serve as the "Origin Story" and cover objectives 1-4. The second module would continue the story and cover objectives 5-9. The design of characters also needed to establish backstories and their purpose. The protagonist in the story is Super Divya, and the antagonist is Professor Agni. Their backstories, costume design, personalities, and more are described in detail in Chapter 4.

Module 1: The Origin Story explained how Divya became the super facilitator, Super Divya, and the origins of her rivalry with her college roommate, Amrutha, who is now Professor Agni. After the origin story in the same module, there is an introduction to simulation pre-brief steps, and Super Divya's first tool, facilitator spray, is invented. Module 2: Super Divya Defends the Debrief presented the steps of a successful debrief huddle and a general review of the phases of a debrief, closing out with teamwork and communication. These designs introduced challenges defining abstract concepts like "safe learning space" that may not be culturally familiar to the learner audience. Relying on input from the PRONTO India team acting as localized consultants to ensure the more abstract parts of the design were relevant and culturally competent. In Chapter 4, the results from a survey after the launch of this Redesign go into detail, revealing that 87.3% of participants could complete the two modules in under 30 minutes. This metric was considered carefully for the subsequent design of the Final Design to shorten the learning experience.

Unlike a ten-module curriculum where each module may stand independently, the ten instructional comic episodes in the Final Design carried a cohesive story thread. They were imperative for stakeholder engagement throughout the design process. Understanding the importance of the analytical nature of a front-end analysis was a slow process initially. I had several long conversations meeting with stakeholders, learning from, and educating myself about the learner population, what motivates them to attend simulation training, and what would improve their attitudes and performance behaviors. The team discussed existing skills and knowledge and how a digital story may close identifiable gaps. Early learner environment discussions enabled the project to move forward, but ultimately those discussions evolved throughout the project to ensure accurate cultural representation.

CHAPTER 4 – DEVELOPING A DIGITAL STORYTELLING COMIC

The research shows that digital storytelling is a collaborative exercise where an instructor or teacher facilitates a group of individuals, guiding them through creating a digital story (Limaye et al., 2018; West et al., 2022). In some cases, the comic medium was implemented in test and control groups to analyze the benefits of using the medium (Masel et al., 2020; Tsao & Yu, 2016). However, the literature only studied a single topic at a time, with generic characters and either printed analog or non-interactive passive viewing experiences (Price et al., 2015; Zarei et al., 2021). This leaves a gap in opportunities to explore VLT by interacting with visual narratives where learners control the narrative. This Design Case highlights three important principles for instructional designers interested in developing an interactive digital story in the comic medium.

1. Designing culturally relatable characters in a digital storytelling comic.

2. Representing environmental culture in a digital storytelling comic

3. Considerations for interactive activities in a digital storytelling comic

Table 12

Design Reflections for Relatable Characters in a Digital Storytelling Comic

Section	Topics
Designing Relatable Characters in a Digital Storytelling Comic	Character Design Process for the Two Main Characters
	Character Design Process for Color Testing, Skin Tone, and Representative Clothing
	Designing Culturally Related Tertiary Characters

The digital story Redesign (2019) began with an inquiry of the learner population about what type of theme and style of comics they were most attracted to. Unanimously, the Bollywood style was chosen for its cultural references, and a good versus bad superhero story was an established storytelling archetype. To establish the main characters, the core team started

with an Origin Story to introduce the protagonist, the antagonist, and their backstory to learn

about their personalities. I considered several factors as I approached the character's visual

design based on their backstories. First, the protagonist, Super Divya, and the antagonist,

Professor Agni, were friends as Divya, Amrutha, and college roommates before becoming arch-

rivals. The Redesign digital story consisted of two asynchronous modules. At the end of Module

1, The Origin Story, Divya became Super Divya, and Amrutha became Professor Agni,

launching their rivalry. This first module was essential in establishing the main character's

backstories and setting the premise for the overall digital story. Therefore, each character needed

to have a before and after appearance.

Secondly, to relate the characters to the learner audience, they require traditional Hindu

dress to represent the learners' environment. To help with the character development and,

ultimately, the overall look and feel of the artwork, I hired an experienced visual storyteller and

comic artist. Developing one-off or background characters is relatively easy, but the main

characters, Super Divya and Professor Agni, had to portray their attitudes and personalities

visually. The goal was for learners to connect with the characters personally, cheer them on, or

love to hate them. Developing personas often helps when creating characters. However, I became

familiar with the learner audience through studying the Initial Design (2018) and having multiple

conversations with stakeholders that allowed us to focus on designing the characters. As I detail

below, objects and spaces also had to be considered characters that require the same attention to

detail discussed later in this chapter.

Character Design Process for the Two Main Characters

After several iterations of ideas, I scheduled a character development meeting with

stakeholders to survey them on the characters' possible appearance. How tall should they be?

What skin tone color should they have? What are they wearing? Do they have any accessories? To aid in character design, the comic artist and I developed a character development matrix (Table 13). In the first column, each character was listed by name. Various nurses were portrayed as simulation participants across the Redesign's first two modules, deciding to list them as general Nurse characters and then change their appearance as needed—the remainder of the matrix listed high-level character attributes. From here, we could begin developing each character one at a time for the digital story. While drafting a digital story about a protagonist and antagonist was the main storyline, the characters must also be represented culturally. For learners to connect and relate to the characters, various characteristics, such as clothing and environment, must be adhered to. Table 13 lists the Final Design (2020-2021) character names; however, Super Divya was first named "Agent Sim," and Professor Agni was initially "The Professor" (Figure 7). Further discussion led me to suggest renaming the two main characters with proper names for added relatability. Thus, Agent Sim became "Super Divya," and The Professor became "Professor Agni" early in the Redesign development.

Table 13

Adventures of Super Divya character development matrix

Character	Height	Skin Tone	Hair	Clothing	Accessories
Divya	5'4"	Olive	Dark brown with a braided ponytail over the right shoulder	Salwar Kameez, sandals	None
Amrutha	5'6"	Dark Olive	Black with ponytail	Salwar Kameez, blk flat shoes	None
Super Divya	5'4"	Olive	Dark brown with a braided ponytail over the right shoulder	Salwar Kameez, cape, white lab coat, flat shoes	PRONTO Pouch w/ Sim tools
Professor Agni	5'6"	Dark Olive	Blk w/ braided ponytail	Salwar Kameez, full button-down knee-length white coat, sandals	Red Pen
Seema	5'5"	Saddle Brown	Blk shoulder length	Salwar Kameez, white lab coat, flat blue shoes	Notebook
Nurses	5'3" to 5'7"	Olive Saddle Brown	Various styles and lengths	Various Salwar Kameez or Saree, various shoes, or sandals	Bangles, Bindi

Figure 7

Proof of Concept Cover Art for Module 1 Redesign, The Origin Story.
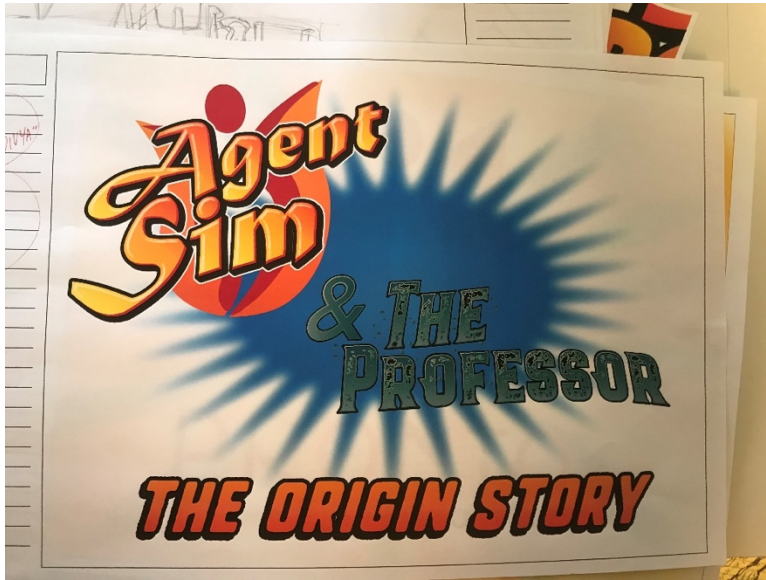
Beyond just the character descriptions, the dress is significant in the Indian culture to distinguish hierarchy position, stature, or profession. Nurse Mentor Supervisors and Nurse Mentors wear a lab coat over a Salwar Kameez, a traditional combination dress. The Salwar is loose pajama-like pants. The kameez is a long shirt or tunic. Nurses and Nurse Midwives typically wear a white Saree, an un-stitched stretch of woven fabric arranged over the body as a robe. The challenge with designing an interactive digital story was creating two main characters with two different before and after clothing appearances. The comic artist and I spent significant time researching Indian cultural clothing, fabrics, colors, shoes, hairstyles, and various characteristics to aid in developing the two main characters (Figure 8).

Figure 8

Character Development Research for Divya and Agent Sim.

It should be noted that when developing characters for a comic story, there will be an enormous amount of time drawing the same characters in various poses and expressions. We had to balance the design of the characters with the development of the narrative within the DST. Therefore, consideration for interactivity and animation was strategized to foreshadow the digital story's design. The initial sketches are rough, with minimal detail and careful attention to joints to separate arms, legs, and heads from the torso for future animation when developing the Final design interactive digital story. The line work needs to be simple, and each pose be recognizable as the same character. After several iteration sketches, a model sheet of the character designs was presented to stakeholders for review and approval to begin developing the Redesign. Divya/Super Divya model sheet is shown in Figure 9, and Amrutha/Professor Agni model sheet is shown in Figure 10.

Figure 9

First Design Sketch of the Divya/Super Divya Character Model Sheet.

Figure 10

First Design Sketch of the Amrutha/Professor Agni Character Model Sheet.
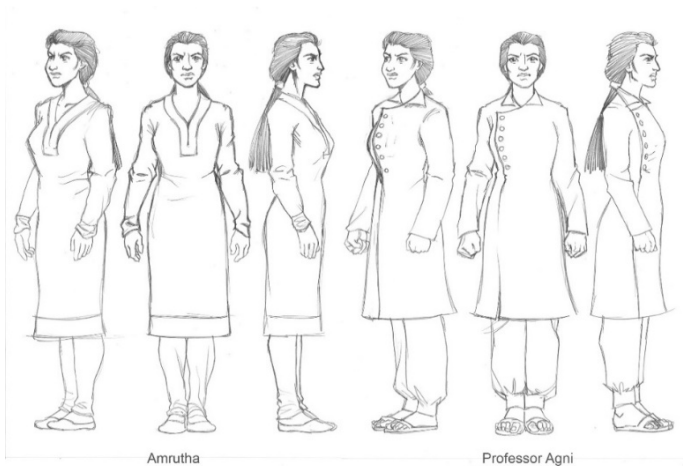
Character Design Process of Color Testing for Skin Tone and Clothing

Representation was at the forefront of every decision during the Redesign (2019) character development process. Before proceeding to ink and full color, the color of the main character's skin tones must be considered. After the model sheet sketches were approved, a character model sheet was designed with six pairs of the Super Divya and Professor Agni

characters with proposed clothing colors and skin tone variants (Figure 11). The stakeholders

chose #3 for Super Divya and #4 for Professor Agni.

Figure 11

Super Divya and Professor Agni's Color and Skin Tone Variant Model Sheet.

The final step in the process was an action pose model sheet of both main characters'

personalities. Figure 12 shows the early Divya and Agent Sim (Super Divya) comparison, and

Figure 12

Redesign of Ink and Color for Agent Sim, Later Named Super Divya.

Figure 13 compares early Amrutha and The Professor (Professor Agni).

Figure 13

Redesign of Ink and Color for The Professor, Later Named Professor Agni.

Through color testing, two things emerged. First, the colors for Divya and Amrutha differed from those chosen for them as Super Divya and Professor Agni. As archrivals, Super Divya and Professor Agni had to balance an overall color scheme for the future design of additional characters and environmental scenes. The Divya and Amrutha characters would only appear in Module 1, The Origin Story, in both the Redesign (2019) and Final design (2020-2021) and, therefore, would not be a leading factor. Secondly, through several conversations with stakeholders in India, an interest in using bright, bold colors synonymous with the Bollywood style and acceptable in Indian culture. Studying Bollywood graphic design led to the final color palette with a skin tone, two primary and one complementary color (Figure 14).

Figure 14

Final Color Palettes for Divya/Super Divya and Amrutha/Professor Agni.

Divya's final color palette

#DA9F60	#B9E0D0	#83B3A3	#FECF2D
Skin	Salwar Kameez		Accent

Super Divya's final color palette

#F7974F	#F05735	#0FBDCC
Salwar Kameez		Cape

Amrutha's final color palette

#E5A96B	#18658A	#7C6888	#FAAC32
Skin	Salwar Kameez		Accent

Professor Agni's final color palette

#F2F2F2	#9AADCB	#BF4F53
Coat	Salwar	Accent
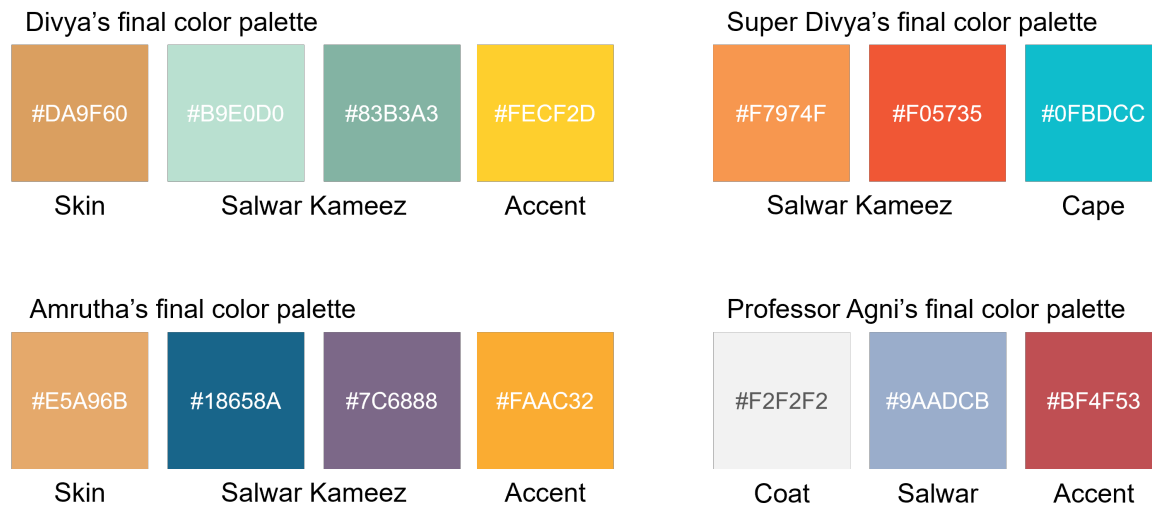
There was a concern about recreating the filigree design on Divya's Kameez (Figure 12). However, since she was only present in Module 1 wearing this dress, it was determined to keep the design. Secondly, there was a concern about Amrutha's Salwar Kameez being red. Red in India symbolizes love, commitment, strength, and bravery, characteristics not aligned with Amrutha's transformation into Professor Agni. Because Amrutha's lab coat was full-length, and to keep the color palette at three colors, her Salwar was light blue, and an accent complimentary rust red color was chosen for her sandals and hair tie. After the name Agent Sim changed to Super Divya, the Redesign (2019) final ink and color were proposed showing her colors changing to orange and an orange-red Salwar Kameez. The Final Design (2020-2021) fine-tuned Super Divya with multiple facilitator poses, a PRONTO International logo on her left shoulder, and a blue cape (Figure 15). Assembling a multiple-pose model sheet assisted in developing the interactive digital story for modeling poses and gestures, and the arms and head were separate elements for future animation.

Figure 15

Final Super Divya Ink and Color Model Sheet with Proposed Facilitator Poses.
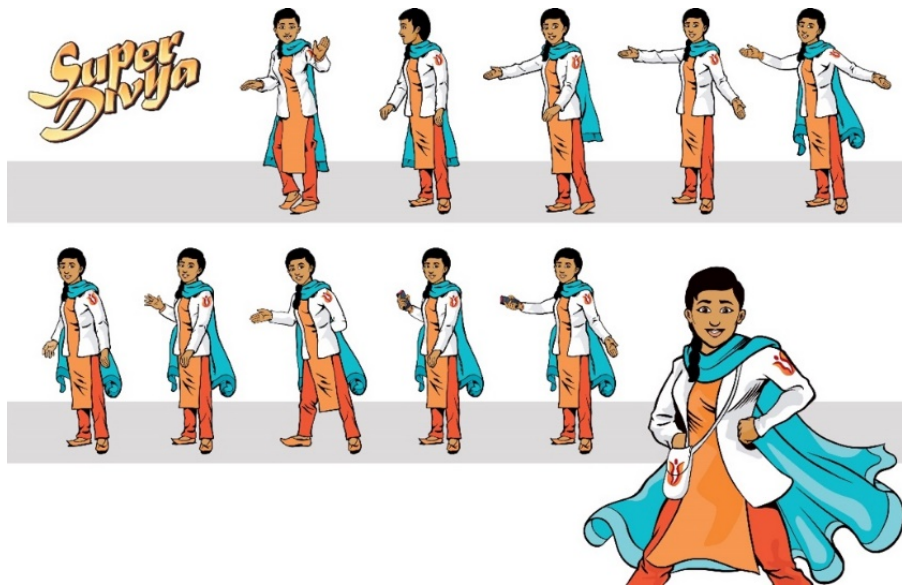
Designing a Cast of Inanimate and Anamorphic Supporting Characters

Developing characters can be arduous, depending on the story's context. Creatively, characters can be anything. In this story, the protagonist and antagonist are human arch-rivals, yet each has a supporting cast of characters to help them. Super Divya, the protagonist, carries a "PRONTO Pouch," metaphorically used to carry various tools to help simulation facilitators become Super Facilitators. Throughout the digital story, Super Divya develops various tools supporting the instructional design and alignment with learning objectives. Throughout the digital story, each episode focuses on one learning objective where Super Divya develops a tool in her lab to assist facilitators. The Notebook was the first tool Super Divya introduced to encourage learners to journal their thoughts and note what they learned during simulation training (Figure 16).

Figure 16

Practicing Genuine Self Notes when Accessing the Notebook from the Tools Menu.
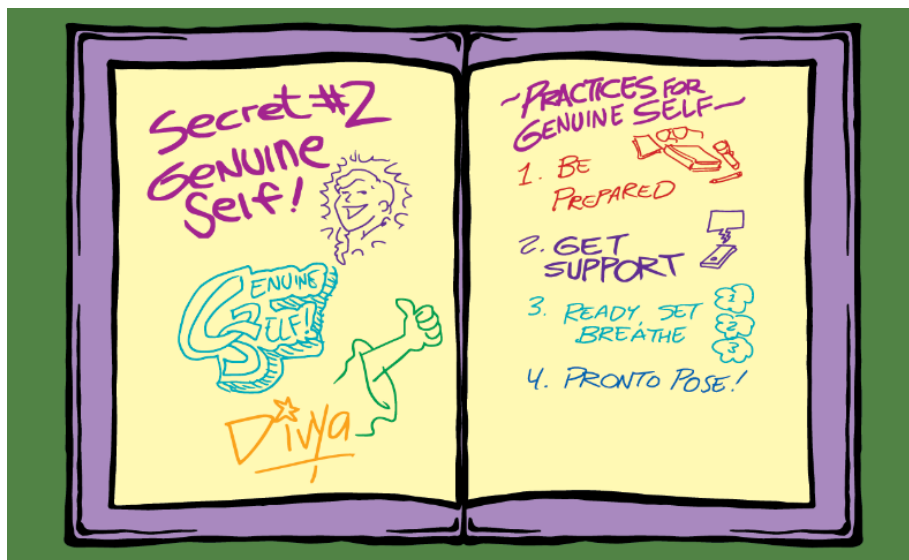
In addition to the Notebook tool, Super Divya developed five additional tools, each with a purpose and powers. With each episode, a PRONTO Pouch tool focuses on one learning objective where Super Divya assists facilitators in defending Professor Agni's bugs (Figure 17).

Figure 17

Interactive Visual Glossary of Super Divya's PRONTO Pouch Tools.
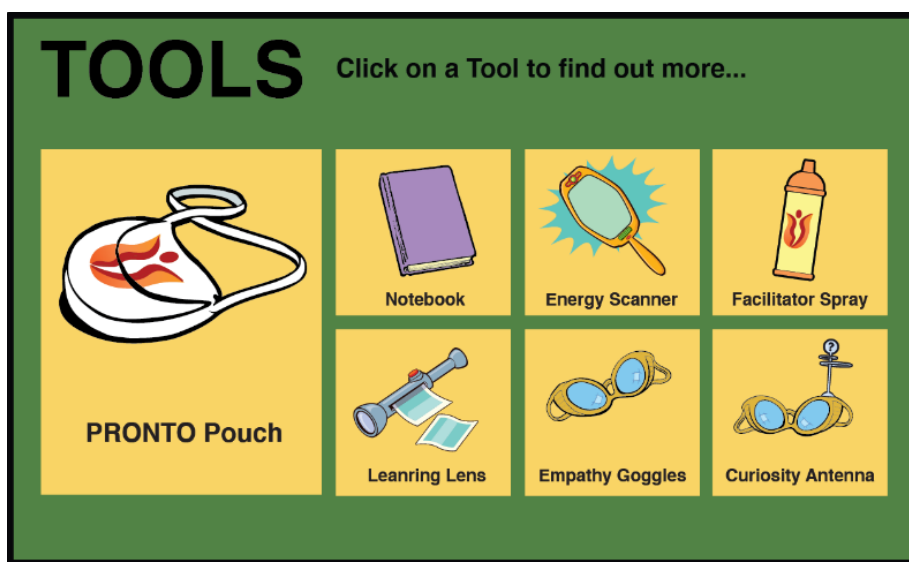
Table 14 displays Super Divya's PRONTO Pouch tools matrix beginning with the Notebook to Facilitator Spray, Energy Scanner, Learning Lens, Empathy Goggles, and the Curiosity Antenna (Table 14).

Table 14

Design Matrix for Super Divya's PRONTO Pouch Metaphorical Tools

Tool	Purpose	Powers
Notebook	To remember Super Diya's tricks and hints.	Knowledge of these hints can help fight Professor Agni's bugs.
Facilitator Spray	Identify feelings. Naming feelings will help make the facilitator less vulnerable to Professor Agni's bugs.	Once a facilitator uses the spray to identify her feelings, she can use Genuine Self-practice to re-center and strengthen herself against Professor Agni's attacks.
Energy Scanner	Connect with your body, calm your mind, and focus on the present moment.	It helps the facilitator be fully present and bring their genuine self to the training.
Learning Lens	Focus attention and capture important moments from the simulation to be discussed in the debrief.	It helps take mental snapshots during the simulation. Also, facilitators can focus on and avoid being distracted by emotions and circumstances to see what is happening in the simulation.
Empathy Goggles	To help facilitators recognize clues in body language and facial expressions. These clues help facilitators understand what participants might be feeling.	When a facilitator has empathy for providers, she overcomes the effect of Professor Agni's bugs, helping facilitators at all stages of training, and is especially helpful during the debrief.
Curiosity Antenna	To help facilitators become curious and ask questions of participants during the debrief.	When a facilitator is curious about what happened during the simulation, they can engage participants and overcome the effects of Professor Agni's bugs.

The Final design of the digital story allows learners to interact with the globally accessible Tools menu, which learners can access more information about each tool and its purpose. In contrast, the antagonist, Professor Agni, works out of a lab where she develops metaphorical bugs named to represent a Nurse mentees' emotions and sends swarms of bugs to disrupt simulation training (Table 15).

Table 15

Design Matrix for Professor Agni's Metaphorical Bugs

Bug	Purpose	Signs and Symptoms	Vulnerabilities
Fear	To infect nurses with fear, making them too nervous about participating in a simulation feeding on hierarchy.	Fear in nurses can show up as nervous laughter or hesitancy to participate in the simulation or debrief.	Fear bugs cannot enter a safe learning space. The fear bug loses power when nurses feel comfortable and safe in a simulation.
Trickster	To cause chaos and destroy the physical learning space.	Messes up the simulation space before the facilitator arrives or creates a challenge for set up (i.e., no water, no cooling).	A facilitator chooses a Genuine Self practice to focus the mind and find the energy and creativity to put the room together.
Skip	To cause facilitators to skip steps of the SimPack, affecting every person differently – tired, bored, anxious, pressed for time, or forgetful.	The facilitator may experience an unsettling feeling inside that makes them want to skip parts of the pre-brief.	Facilitator Spray helps the facilitator recognize and name what feeling the bug has caused and then choose a Genuine Self-practice to re-center.
Fluster	Usually attack in swarms. These bugs distract the facilitator and make it difficult to focus on important moments in the simulation.	The facilitator may feel distracted by her emotions or outside events and need help focusing on the simulation's action.	The swarm of Fluster bugs is dispersed when a facilitator pays particular attention to the moments in the simulation that match the learning objectives.
Frustration	To frustrate facilitators with the participants and their performance during the debrief.	Facilitators may feel impatient or annoyed when something goes wrong, or a clinical management or communication step needs to be included.	A debrief huddle weakens the frustration bug, helping the facilitator name her feelings, re-center herself, show empathy, and make goals for the debrief.
Ego	To cause the facilitator to feel that their thoughts on the simulation are more important than the participants, preventing the facilitator from being curious about the providers.	The facilitator may talk too much during the debrief, interrupt participants, and only ask closed-ended questions. This will make the participants want to refrain from participating or learning.	When facilitators are interested in participants, the Ego Bug becomes less powerful. The Curiosity Antenna helps facilitators ask a more open-ended questions, speak less and listen more.
Defensiveness	The Defensiveness bug's bite causes participants to become closed off to learning.	Participants need help admitting they could have done things differently during the simulation. They will be defensive of their behavior and not be open to learning during the debrief.	A facilitator providing correct clinical information and engaging the entire group in the debrief helps the participant feel open to learning.

Bug	Purpose	Signs and Symptoms	Vulnerabilities
Self-Doubt	To make participants doubt their clinical skills and knowledge.	Participants will feel insecure about their clinical performance during the simulation and may feel uncomfortable participating in the debrief.	When a facilitator focuses on the team's successes and engages the whole group, including the observers, instead of asking targeted questions to just the participants in the simulation, the Self-Doubt bug can be weakened.
Disinterest	To make participants lose interest in the simulation.	Participants will not allow themselves to act as though the simulation is real and need help to engage and pay attention during the debrief.	When a facilitator can connect the simulation experience to real-life experiences, the Disinterest bug becomes less powerful.

Due to their Hindu translation, a few names given to the bug characters in the Redesign (2019) had to be changed in the Final Design (2020-2021). Naming bug characters to align with the learning objectives was often too abstract, or there needed to be an equivalent name in the Hindi language for the concept. For example, in the Redesign (2019), a bug was called "Hurry," referring to moving hurriedly and carelessly. While that was accurate in English, the translation meant to be "quick," which was more of an absolute definition in Hindi than a conceptual understanding. In this Redesign (2019) module, Super Divya led a lesson aligning with the learning objective about skipping steps in the simulation setup called the SimPack™. In this example, missing a step in the SimPack™ was attributed to the facilitator running late and skipping necessary steps to ensure the simulation began on time. However, it was discovered that skipping steps is also related to laziness or lack of commitment. Therefore, the design of the bug character did not need to be changed. However, the "Hurry" bug name was changed to the "Skip" bug in the Final Design (2020-2021). In context for that episode's lesson, Professor Agni's perpetual goal is to disrupt and ruin the simulation by sending a swarm of "Skip" bugs to infect participants, causing them to skip important steps and ultimately destroy the simulation (Figure 18).

Figure 18

Interactive Visual Glossary of Professor Agni's Bugs
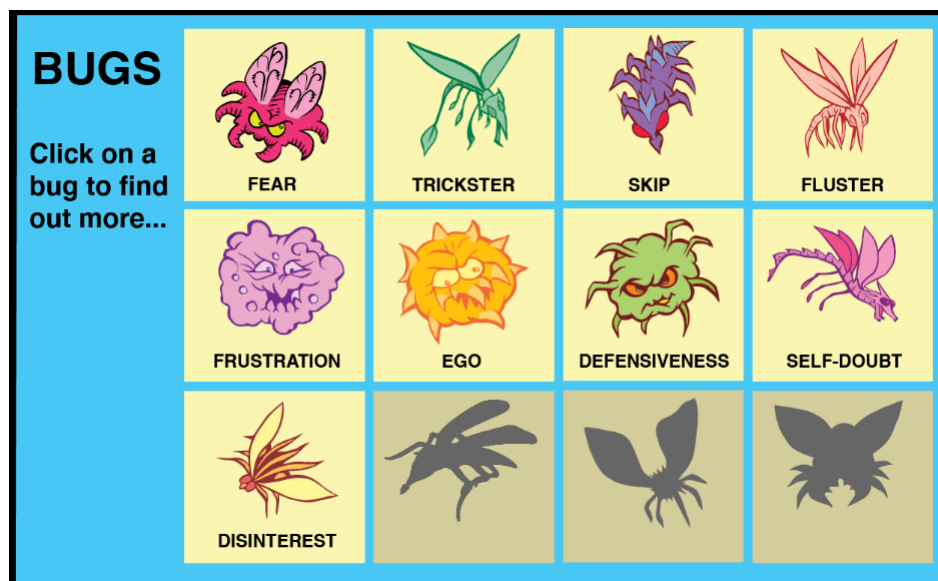
Note. The last three silhouettes of bugs are reserved for future bugs developed by Professor Agni and the League of Villains, leveraging an end-scene cliffhanger.

Whereas the Final Design (2020-2021) consisted of ten modules, later defined as episodes, the Redesign (2019) consisted of only two modules. In the first module, titled The Origin Story, Amrutha is transformed into Professor Agni, and she commits her life to developing custom bugs to destroy simulation efforts. The institutional design introduced these bugs as metaphorical emotions that Nurse facilitators and mentees experience. The Fear bug was the first bug introduced in Module 2 of the Redesign (2019). The Fear bug aimed to infect the nurses with fear, making them too nervous to participate in the simulation causing symptoms of nervous laughter or hesitancy to participate (Figure 19).

Figure 19

Detailed Description of the Fear Bug Accessed From Interactive Visual Glossary
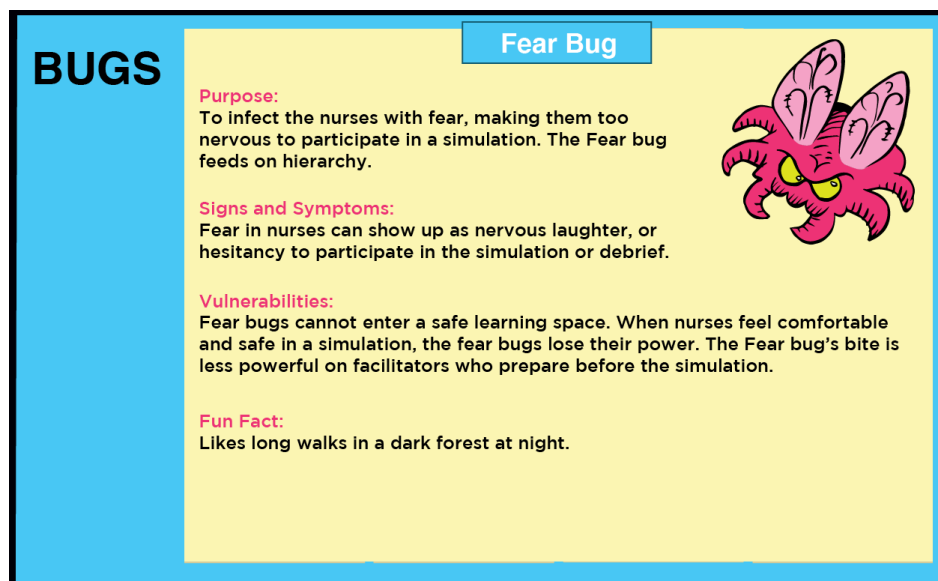
The Final Design (2020-2021) was an opportunity to reevaluate the modules into episodes and give Professor Agni's bugs a prominent character presence. While a few bugs affected the nurse providers' emotions, others affected the physical space of the simulation training environment.

Designing Culturally Relatable Tertiary Characters

The Nurse participants were designing the last set of characters wearing white Sarees. The initial model sheet sketch for the Redesign (2019) incorrectly portrayed the proper wearing of the Saree in all the models (Figure 20). From left to right, the fourth character in Figure 20 is the closest to the correct wearing of the Saree, except that it stops at the knees and should go down to the ankles. A Saree is an un-stitched stretch of woven fabric arranged over the body as a robe. However, proper wear proved challenging due to the combination of styles shown in Figure 20, where the Saree draping needs to be culturally respectful, relatable, and consistent.

Figure 20

Model Sheet of Nurse Participants Incorrectly Portraying a Traditional Saree

With stakeholder guidance, I asked for a real-time photo to use as a reference (Figure 21). The picture helped establish which shoulder the Saree draped over. Shirts worn under the Saree were various colors, and some women preferred to wrap the Saree that exposed the midriff of their body (Figure 21).

Figure 21

Traditional Saree Worn by Nurse Mentees During Simulation Training

Noticing a Bindi on some of the women in reference photos, I asked stakeholders about their significance and whether we should account for them in character designs. I learned that Hindu mothers would historically place a black dot known as a Bindi on the forehead of their children to ward off evil spirits. Religiously, men and women would wear a red Bindi daily as a reminder to keep God at the center of thought. Traditionally, Hindu women would also wear a Bindi to signify marriage. However, a Bindi can be worn in modern India for cultural, religious, or fashion reasons. The decision was to add a Bindi to all nurse participant characters to respect the culture and design relatable characters (McCloud, 1994). Lastly, Indian women traditionally wear bangles on their wedding day and after marriage to symbolize good health and fortune.

The Redesign (2019) character development process involved several iterations over a few months. The instructional design of the Redesign (2019) modules was in similar production, and later in the Final Design (2020-2021) episodes, the refinement of all characters was finalized. The creative challenge of designing and developing culturally representative Indian characters in their environment was a satisfying exercise in character development. Instructionally, the content design for Super Divya, leading the journey to becoming a "Super Facilitator" like herself, surprisingly became the backstory. Super Divya's PRONTO Pouch Tool characters took center stage aiding in increasing knowledge. Professor Agni's bugs also became the love-to-hate characters because learners could recognize and relate to the emotions characterized by the bugs, which led to their knowledge retention.

Representing Culture in a Digital Storytelling Comic

Table 16

Design Reflections for Culture Representation in a Digital Storytelling Comic

Section	Topics
Representing Culture in a Digital Storytelling Comic	The Simulation Training space Culturally Representative Design for Super Divya's Lab Culturally Representative Design for Professor Agni's Lab Culturally Representative Environmental Design

It is easy to take for granted a way of life we become accustomed to, how we see things, and cultural behaviors. When we see or experience something we are comfortable with may appear natural, and nothing seems out of place. However, when we experience things or events where we feel unrepresented in gender, ethnicity, or culture, we feel out of place and uncomfortable. Designing a digital story using comics correctly representing the culture and environment of the learner audience depicted in the scenes is equally important as the characters. Cultural representation relies heavily on the smallest visual details, from the style of the shoe a character wears to the style of the rug on the floor. The biggest lessons were learned during the Redesign and Final Design (2020-2021) of creating the comic art for the interactive Super Divya comic. Indeed, comics can convey nuanced concepts to communicate complex ideas about health, exploring emotional and social issues while allowing readers to see themselves in learning representations and develop a level of empathy beyond that which can be achieved through textbook readings alone (Anand et al., 2018; Green & Myers, 2010; McNicol, 2017; Tsao & Yu, 2016). Super Divya's PRONTO Pouch communicated nuanced concepts like the Empathy Goggles, allowing facilitators to "see" the feeling of others, and Professor Agni's swarms of bugs explored emotional issues like disinterest and self-doubt. Those concepts aligned

with instructional digital storytelling. However, visually communicating non-instructional concepts that connect the viewer to the digital story is equally important.

Three physical spaces dominated this digital storytelling interactive comic from the (a) Simulation Room, (b) Super Divya's, and (c) Professor Agni's labs. The challenge with creating these three spaces was attention to detail and respecting cultural representation. The difference for the Simulation Room was that it needed to represent the actual physical space, while Super Divya's and Professor Agni's labs were fictitious. Both are discussed below.

The Simulation Training space

The Simulation Room is a physical space seen at various times throughout the interactive episodes. For the Redesign (2019), I needed to recreate the space as accurately as possible while simultaneously time foreshadowing all instructional scenarios that will take place in the room. After studying several reference photographs shared by the Indian stakeholders, simulation facilitator training is a low-resource portable setup with folding tables for manuals and supplies, paper posters taped to walls, and cots or portable beds for the simulation patient (Figure 22).

Figure 22

Photographic Reference of an Active Simulation Training Room in Bihar, India.

Paying attention to details of the physical space supports digital storytelling interactive instruction and respecting the representation of the learner's culture. The physical space and the details of the supplies and tools used during simulation training are significantly important for two reasons. First, accurately drawing comic art to represent the supplies used during simulation training, and second, to understand the low-tech, low-fidelity physical space (Figure 23).

Figure 23

Photo Reference of a Simulation Training Room in Bihar, India

The design of the final comic art for the Simulation Training room for the Redesign and Final Design (2020-2021) renderings exaggerates the physical space, allowing for various angles and points of view. It was decided not to include the patient bed or other furniture for the main room art allowing the ability to layer additional artwork as needed (Figure 24). The rationale for not including artwork for the patient bed in the Simulation Training Room background design supports a flex space for simulation scenarios and classroom-style instruction, such as a debriefing huddle.

Figure 24

Simulation Training Room in Final Design Comic Art Style
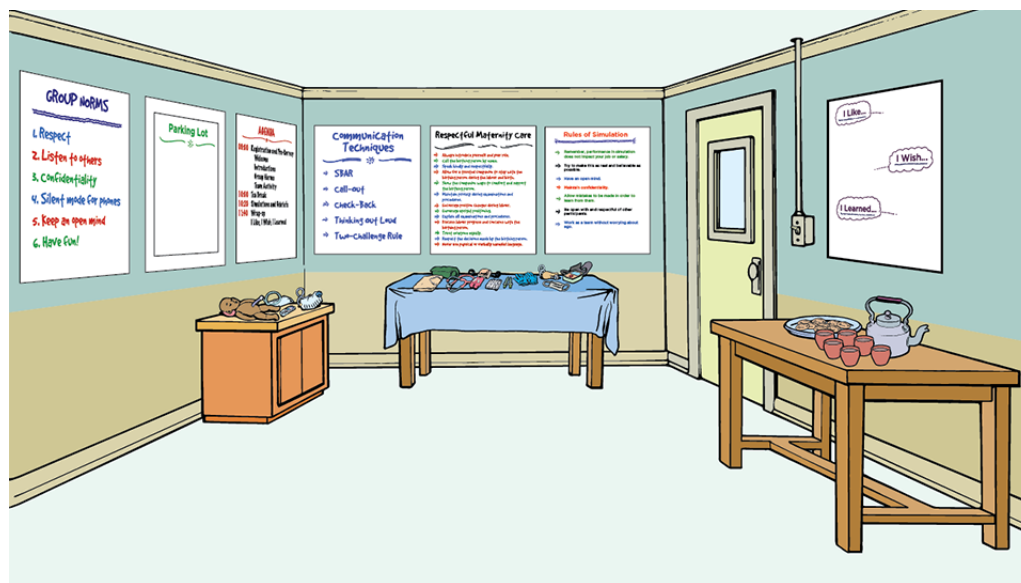
Depiction of the physical space is not just the layout, but the details convey important cultural

considerations. One notable detail during stakeholder conversations was having drinks and

snacks during the debriefing portion of simulation training. Early sketches of the simulation

snack table visualized a common food and beverage served in Western cultures, such as coffee,

water bottles, pastries, and other snacks. It was important to correct early sketches accurately

representing the culture. The snack table was updated with a traditional pot of hot tea, culturally

accurate teacups, and a platter of cookies (Figure 24). This was important for the current and

future design of the DST. Indeed, foreshadowing is a literary technique to clue readers about

future events. Visual foreshadowing is a narrative tactic widely used in the film industry to set

viewers' expectations (Li et al., 2020). Presenting the full simulation room early in the digital

story provides a small sample of visual foreshadowing of the neonatal birthing station and

simulation supply table in the back of the room. Various props, from the neonatal birthing station

and the simulation supply table, are used in later episodes. Full-screen stand-alone art created of

the simulation supply table provides opportunities to use the props for instructional visual narratives (Figure 25).

Figure 25

Supplies and Equipment Table in Comic Art Style

Additionally, participants would sit in chairs in a semi-circle for instruction about Simulation Debriefing while the Nurse Mentor Facilitator led the debriefing. They were creating an inverse view of the simulation room needed to establish that the space was visually the same room. The table with tea and cookies anchors the view from Figure 25 to the simulation debriefing side of the room while also being conscious of representing the size of the space (Figure 26). The two views in Figure 25 and Figure 26 establish the setting in every episode in the Final Design (2020-2021). Once the room art was finalized, elements such as chairs could be moved or a patient bed added, characters could be added to the scenes as dictated by the digital story, and various elements could be animated or included in an interactive activity.

Figure 26

Snack Table and Chairs Representing the Opposite View of the Simulation Room
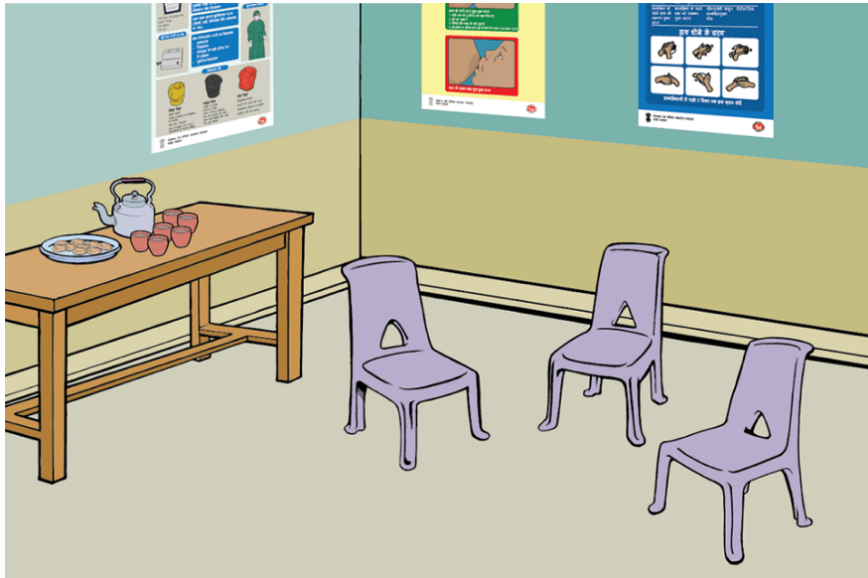
Culturally Representative Design for Super Divya's Lab

While the Simulation Training Room was created for designing scenario-based nurse participant and facilitator instruction, an alternate space was needed for Super Divya. This space had to accommodate Super Divya, allowing her to introduce learning objectives, explore learning strategies, administer interactive activities, explain concepts, lead discussion, conduct classes, demonstrate tools from her PRONTO Pouch, and a desk to work on her laptop or hold virtual calls. This space was a challenge thinking through all the possible scenarios and scenes that still needed to be written or designed. With no reference photos to guide the design, I asked as many questions as possible to understand what an office environment might look like while being culturally representative, equivalent to a space in Bihar, India. Table 17 shows a development matrix list of details for Super Divya's Lab.

Table 17

Design Matrix for Super Divya's Lab and Office Environment

Item	Description
Space dimensions	Square in size with one door and one window. Large enough to conduct experiments and hold classes with a corner for a desk and computer, and a bench counter work area for interactive instruction.
Colors	Play homage to Super Divya's Salwar Kameez from when she was a student – light green, aqua, with golden yellow accents
Furniture	Minimal. Small wooden desk, office chair, and a small table for tea.
Room Details	Corner bench counter workstation with poster of Professor Agni's bugs. Corner desk area with bulletin board with various notes, photo of Divya and Amrutha from nursing school graduation. A wall-mounted white board, a wall-mounted medicine cabinet, and a poster of current real-life Super Facilitators
Technology	Big screen TV over bench counter workstation, microscope, laptop on desk, and bug alarm apparatus.
Other	Ceiling fan, plant, hook on wall to hang PRONTO Pouch, and a clock over the door.

From the Super Divya Lab matrix, I created a 3D model in Google Sketch for the

Redesign modules depicting as many details from the matrix as possible. Depending on the

instructional design and the angle view needed, I would rotate the 3D model, export an image,

and share it with the comic artist to draw from as a reference (Figure 27).

Figure 27

3D Model Reference Google Sketch to Culturally Represent Super Divya's Lab

The Final Design of Super Divya's lab changed through various iterations. In one example, the initial design had the whiteboard above Super Divya's desk for planning and keeping notes. In later episodes, Super Divya's lab served as a classroom, and the whiteboard was moved to a different wall, with a bulletin board replacing it above her desk. The challenge was designing this space prior to predicting how the space was used in the Redesign of two modules to all the changes needed to accommodate the various scenes for ten episodes in the Final Design. The resulting panoramic design allowed for a full-width view of Super Divya's space by also allowing it to zoom on the left side of the space targeting the bench counter workstation or the right side for desktop-related activities (Figure 28).

Figure 28

Panoramic Comic Art Style of Super Divya's Lab

The full-width illustrated view of Super Divya's Lab referenced the room's details. When changing angles or views of the room, this reference was a guide to ensure the proper placement of those details. To support or carry the overall digital story forward, including small details such as a graduation photo of Divya and Amrutha from a scene in Episode 1, The Origin Story. Figure 29 shows Super Divya from various angles and views while adhering to the room layout and attention to detail. This lets viewers know where they are in the digital story without a narrative

explanation. Additionally, leveraging visual repetition continually presents PRONTO Pouch tools that align with episode objectives without drawing direct attention to them until the learning strategy of the digital story dictates (Figure 29).

Figure 29

Three Angles of Super Divya in Her Lab

In another example shown in Figure 30, Super Divya's big screen TV above the counter is used the interactive activities in the digital story. During the instructional design phase, the model of video recording facilitators during the Initial Design (2018) was revived in the Final Design (2020-2021) interactive digital story. Super Divya would show recorded videos on the TV screen in her lab as narrated instructions (Figure 30). Note the items on the bench counter workstation in Figure 28 and Figure 29 compared to the same items in Figure 30. From the 3D model in Figure 27, we could create any angle while adhering to the continuity of the visual narrative. During the Redesign (2019), representing a superhero working environment that looked like it would belong in the natural, cultural environment of the learners is a key attribute of digital storytelling and the overall appeal to support the visual narrative.

Figure 30

Super Divya Using a Remote Control to Play a Simulation Video Recording

Culturally Representative Design for Professor Agni's Lab

Professor Agni's Lab was the third space to create. Like Super Divya's Lab, it was a fictitious space. However, we had more creative liberty in creating a space for a supervillain. In the Redesign (2019), Professor Agni's Lab did not get much attention, with only an early peak into her lab at the beginning of Module 1 and again at the end of Module 2. We also discovered that Professor Agni was an afterthought in the context of the instruction with minimal dialogue. In the Final Design (2020-2021), we revisited the dialogue in the first two modules, now called episodes and intentionally wrote more about the personality of Professor Agni's motivations and fears. Thus, her lab environment needed refinement to accommodate various scenarios and lab experiments. Like the design matrix for Super Divya's Lab, we revisited the design matrix for Professor Agni's Lab (Table 18).

Table 18

Design Matrix for Professor Agni's Lab Environment

Item	Description
Space dimensions	Square in size with one door shown in a panoramic view. Large enough to conduct experiments with a bench for lab equipment and bug enclosures.
Colors	Play off Super Divya's costume – orange and red orange
Furniture	Minimal. Counter on back and left side walls. Front counter bench for experimentation. Step ladder.
Room Details	Door in right corner of the room with air duct above the door. Counter on back wall for bug incubator machines. Large planning board on left wall. Working counter in foreground for experiments and bug creation. Wall-size chalkboard on the right wall.
Technology	Three bug incubators. Bug creation machine. Ceiling-mounted computer monitor that floats up and down.
Other	Glass dome covers for bug housing

Professor Agni's Lab was an enjoyable space to create visual thinking about what a supervillain might need to strategize, plan, and create metaphorical bugs that affect the feelings of simulation participants. The lab for Professor Agni went through several iterations before finalizing the lab for the Final Design (2020-2021). Unlike Super Divya's Lab, where we needed the ability to display multiple views and angles, Professor Agni's Lab only needed a profile view to zoom in on areas of the lab or pan from left to right (Figure 31).

Figure 31

Panoramic view of Professor Agni's lab
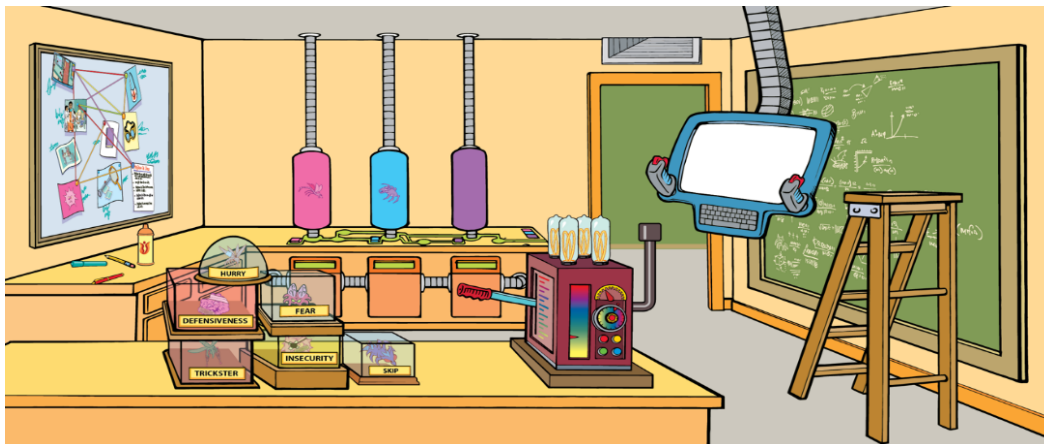
Five factors went into the design of Professor Agni's lab. First, she needed a place to strategize her attacks on simulation training. Instead of a whiteboard, we decided a floor-to-ceiling chalkboard was more fitting to emphasize the effort into her plans. Secondly, carrying the same idea from Super Divya's lab, a bulletin board occupied the opposite wall for notes and tracking progress. Third, Professor Agni needed a computer, but we wanted her lab to look busy with her bug creations with lab counters and no desk. Her computer became a floating design that retracted from the ceiling. The last two factors required space to create her bugs and space to clone them and launch the attack swarms against Super Divya and simulation training.

Because Professor Agni's Lab was not a traditional space found in the learner environment in Bihar, India, and ongoing challenges surfaced as new creative ways to use the space emerged as we developed the digital story. New ideas influenced earlier episodes of the DST. For example, after Professor Agni incubated a swarm of bugs, she would release them to disrupt simulation training by infecting the attitudes and emotions of nurse participants or destroying the physical space of the simulation room. New questions emerged in later episodes in the DST's Final Design (2020-2021). How does Professor Agni release the bugs? What can be designed visually without a narrative explanation of how bugs are released? One early idea was to have Professor Agni open a window and release the bugs like a carrier pigeon. While a good idea, it would also result in redesigning Professor Agni's Lab in a three-dimensional design, adding a window. Instead, several ideas were introduced until the simple solution of adding an air duct above the door in Professor Agni's Lab. Adding an air duct to the background art of the room was an easy update. However, to maintain consistency throughout the DST, there was a considerable effort going back to previous episodes and updating all scenes with Professor Agni's Lab. The effort was an investment in the visual narrative having the bugs leave the

incubator tubes already designed on the back wall and then fly up and out through the air duct. Because the effort to update previously published art was cost in time, deep thought and discussion concluded that even small visual changes have a major impact on the project timeline. The only way to prevent major design changes going forward was to fully write the instruction and script for every episode, even in a rough draft, to conceptualize and foreshadow potential design changes before developing any future artwork. Unlike writing a screenplay for a film, designing an interactive digital storytelling curriculum across ten episodes has unique challenges that are nearly impossible to forecast.

Because Professor Agni's Lab was fictitious, the question was how to make her lab look villainous and still adhere to cultural representations. Two things of importance emerged through discussions with stakeholders. First, early sketches of the DST had two whiteboards on either side of the room. However, whiteboards are not readily available or used in simulation training settings. Further discussion with stakeholders revealed that chalkboards and bulletin boards are often used in some simulation training settings. A chalkboard and a bulletin board contributed to the narrative of a supervillain science lab, with the added benefit of using them to convey learning strategies. The overall visual narrative of each episode in the digital story began with Professor Agni strategizing how to attach the next simulation training. At the end of each episode, after Professor Agni failed, she would reflect on why her plan did not work. I influenced the stakeholders to tie the chalkboard and bulletin board in with the narrative script and use them to reinforce the learning objectives. The resulting instructional design and visual narrative would have Professor Agni strategizing at the chalkboard at the beginning of each episode after her spy bug told her the next learning objective. Like Super Divya's Lab, who kept a running tally of Professor Agni's Bugs with a poster hanging above her lab counter (Figure 28), Professor Agni

pinned photos and notes of simulation and the PRONTO Pouch tools used to defeat her bugs. At the end of each episode, Professor Agni would reflect on the artifacts pinned to the bulletin board, lamenting how her plan failed. Collaborating with the comic artist, we designed a large floor-to-ceiling chalkboard on one side of the room and a large bulletin board for Professor Agni to record her failures on the other side (Figure 32).

Figure 32

Professor Agni's Bulletin Board and Large Strategizing Chalkboard
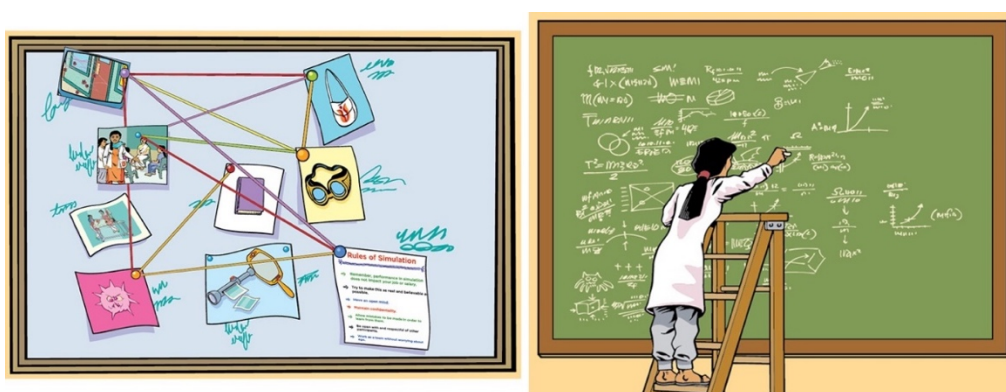
When writing the Final Design (2020-2021), the premise was to have the learner experience Professor Agni in her lab at the beginning of each episode, excited about how she would create a new bug to defeat Super Divya (Figure 33).

Figure 33

Visual Sequential Narrative of Professor Agni Creating a New Bug

The middle of the episode was the digital storytelling interactive instruction led by Super Divya. At the end of the episode, a frustrated Professor Agni was back in her lab, not understanding how her newest bug was defeated (Figure 34). While Professor Agni's monitor was villainous in its design, she had spy bugs that sent video signals back to her lab, where it was important to ensure the monitor feeds were exact visual representations of other spaces within the digital story. In doing so, this visual technique supports learning with the continuity of the narrative and maintains cultural consistency through visual storytelling.

Figure 34

A Defeated Professor Agni Viewing a Feed from a Spy Bug on the Villain Monitor

Culturally Representative Environmental Design

The characters and their spaces must tie together to represent a culturally cohesive environment. During the Final Design (2020-2021), when various characters moved in and out of scenes, it was critically important to ensure background elements maintained cultural relevancy and accuracy by keeping appearances the same throughout the DST. More importantly, how and where characters appear throughout the digital story culturally matters. Characters participating

in debrief huddles sit in chairs in a semi-circle (Figure 26), where their sarees need to be correctly represented in a seated position. Characters participating in simulation training were represented in standing positions and wearing personal protective equipment (aprons, face shields, masks, and gloves). These two scenes are part of the same narrative. For example, a character participating in a simulation scenario scene will be the same character represented in the debrief huddle. Drawing the character in one scene with PPE and seated in a chair in another scene in the same narrative is critical not to forget minor details that could have a major effect on the learner audience, such as forgetting to add the character's Bindi from one scene to the next.

From character to environment design, I knew the importance of establishing a strong representation early in the Redesign (2019). During the analysis phase of the project, a lengthy discovery occurred, gathering and collecting documents, simulation manuals, and a library of reference photos to understand the learner's environment. In an early scene in the Redesign, the story follows Divya and Amrutha as college roommates conversing in their kitchen. Drawing a kitchen may seem easy; however, drawing a culturally correct kitchen within the DST requires the request of an accurate reference. One of the nursing mentor stakeholders in India took a photo of her kitchen and sent it to us as a reference (Figure 35).

Figure 35

Indian Kitchen Photo Reference to Design Divya's and Amrutha's Kitchen
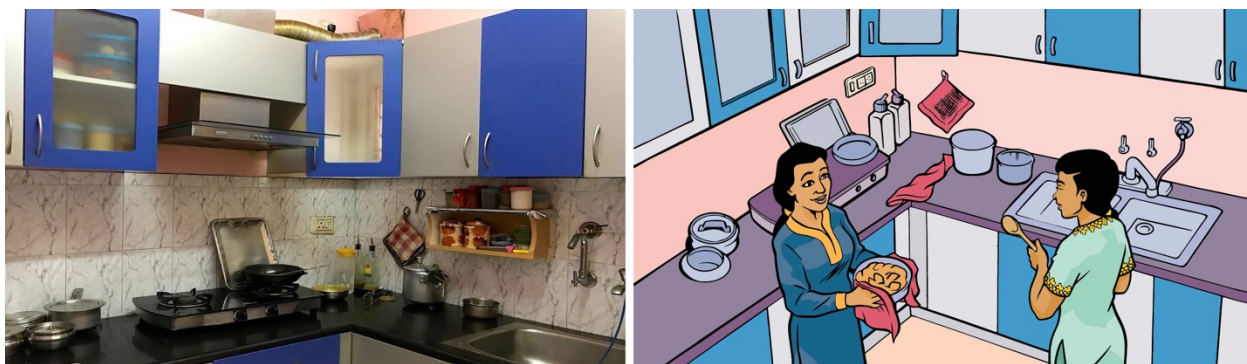
It should be noted that the additional benefit of designing a digital story in the comic format is finding opportunities to include direct relatability creating spaces or objects that learners can connect and relate to straightforwardly, such as the details in a kitchen. In this case, a stakeholder who provided the photo was thrilled that her actual kitchen was used for the kitchen of our main characters while they were roommates.

The designs also extended to other areas central to the digital story. In another example, an early design sketch of Divya during nursing school clinical rotations depicts a scene with her tending to a patient with several inset panels expressing the scene's pace. Figure 36 shows an early sketch for the Redesign (2019) on the left and the Final Design (2020-2021) art on the right. Note the arrows showing the ratio of nurses to patients. The early sketch shows an 8:6 ratio of nurses to patients. After a stakeholder review, it was learned that the ratio is reversed, and there is never a time when two or more nurses are available per patient. The layout changed for the Final Design (2020-2021) art, with the inset panels remaining unchanged, but the main scene with Divya shows her as the only nurse with four patients in the background.

Figure 36

Nurse-to-Patient Ratio Storyboard Sketch of Divya During Nursing School

The environment design also uncovered unanticipated design elements within the DST. In an early scene sketch for Module 1 of the Redesign (2019), Divya (before Super Divya) and Amrutha (before Professor Agni) are attending class together as nursing students. In the scene, Amrutha is using a red click pen. During stakeholder reviews of the artwork, it was learned that the learner audience needs access to ballpoint pens and only uses disposable pens. These small details make the biggest difference in being culturally accurate. Otherwise, the design risks need to be more trusted and taken seriously. However, the pace at which the project was moving to meet the deadline of the Redesign (2019), Module 1 was published with Amrutha still using a red pen in the scene (Figure 37).

Figure 37

Divya and Amrutha in Class with Amrutha Using an Incorrect Red Click Pen

The review cycles overlooked replacing the red pen, yet the learner feedback received after the release of both modules of the Redesign (2019) did not notice the error. The red pen became a cameo character in the Final Design (2020-2021). Figure 37 shows Amrutha using the red pen in the classroom. In a later scene, the red pen appears on the counter in Super Divya's

lab, and several red pens are in a cup on her desk in Figures 28 and 29. The red pen arrives again in Professor Agni's lab in Figure 31 with no logical understanding of how it moves from one lab to another. While the red pen was culturally inaccurate and had no real purpose or backstory, all the project stakeholders began imagining what powers it might hold and whether it was a Super Divya tool or a spy tool for Professor Agni.

Considerations for Interactive Activities in a Digital Storytelling Comic

Table 19

Design Reflections for Interactive Activities in a Digital Storytelling Comic

Section	Topics
Interactive Activities in a Digital Storytelling Comic	Global Access to Interactive References
	Designing an Interaction to Define a Safe Learning Space
	Designing an Interactive Game-Like Activity a Classroom Facilitator Might Employ
	Designing an Interactive Choice-Driven Scenario

Sequential narrative storytelling is linear by design, whereas interactive digital storytelling leverages the nuances of multimedia learning (Mayer, 2002) with interactive activities allowing non-linear experiences. The sequential visual narrative design approach of the Final Design (2020-2021) followed a subtle pattern throughout all the episodes tying all three spaces of Super Divya's lab, Professor Agni's lab, and the Simulation Training room together visually without the need for additional audio explanation or onscreen text. Each episode began with an invigorating Professor Agni, followed by Super Divya in her lab, Simulation Training room, or both, and closing with Professor Agni again showing her defeat with a cliffhanger dedicated to winning in the next episode. This visual pattern and interactive activities throughout the digital story allowed learners to focus on the instruction and less on where they were in the story.

The challenge with the Redesign (2019) was a passive presentation with minimal interactivity and no practice activities. After the launch of Modules 1 and 2 in late 2019 of the Redesign (2019), the feedback was positive as it related to content and the visual design of the digital storytelling comic. However, because the nature of the content was lecture-based facilitation language, there needed to be more opportunities for activities. Additionally, the resulting feedback revealed that important topics for facilitation training should have been included. During the Final Design (2020-2021) kick-off meeting in early 2020, we saw an opportunity to reconstruct the Redesign (2019) by disassembling the modules and repurposing the content across ten new titles along with additional learning objectives and overall shorter seat time per episode.

For the Final Design (2020-2021), Module 1, now *Episode 1 – The Origin Story*, remained mostly unchanged. The rivalry between Super Divya and Professor Angi began in module 2, now Episode 2 – Facilitation Secrets Part I. In this episode, Super Divya introduces Safe Learning Space as the first secret and Genuine Self as the second secret in *Episode 3 – Facilitation Secrets Part II*. Implementing interactivity into the digital story comic had to adhere to the flow of the story, maintain visual cohesiveness, and not distract from the learning objectives. Super Divya begins by introducing the Notebook, the first tool in the PRONTO Pouch. As learning objectives are met, Super Divya encourages learners to take notes and refer to them as needed during facilitation. A scene in the digital story may require several panel images to progress the visual narrative. The storyboard was divided into three columns, with the left displaying the final artwork. The middle column included the narrative script written in English and Hindi, and the right column was reserved for animation, development, or navigational notes (Figure 38).

Figure 38

Sequential Narrative Storyboard of Super Divya Introducing the Notebook

Scene 2	Introduction		
2.4 A, B, and C	Super Divya's Notebook (cont'd)	Script	Notes:
		<1>I use this notebook to keep track of my observations that remind me of the recipe for a successful simulation. मैं अपनी टिप्पणियों और विचारों के लिए इस नोटबुक का उपयोग करती हूँ जो मुझे एक सफल सिमुलेशन के नुस्खे की याद दिलाती है।	<1>picks up notebook from workbench <2>Close up of notebook (first appearance) <3>Wide shot of Super Divya holding notebook
		<2>I recommend that you use a notebook to write down thoughts you have during our adventures. You can use this notebook to record any ideas and questions you have about how to be a facilitator. मेरा सुझाव है कि आप हमारे इस रोमांच के दौरान अपने विचारों को लिखने के लिए एक नोटबुक का उपयोग करें। एक अच्छे फैसिलिटेटर बनने के लिए आपके पास जितने विचार और प्रश्न हों, आप इस नोटबुक में लिख सकते हैं।	
		<3>You can even bring your notebook with you as you run simulations. Just make sure Professor Agni never gets hold of it! आप सिमुलेशन चलाने के समय भी अपनी नोटबुक अपने साथ ला सकते हैं। बस यह सुनिश्चित करें कि आपकी यह नोटबुक कभी भी प्रोफेसर अग्नि के हाथ में न पड़े!	

In the storyboard example in Figure 38, Super Divya introduces the Notebook to learners. She narrates in sync with the visuals how she uses her notebook to keep track of observations that help remind her how to run a successful simulation. This scene continues with Super Divya recommending that learners use a notebook to write down thoughts, reflections, and questions to journal their experiences as facilitators. Learners can access the tools from the interactive global references to review pages in the Notebook anytime (Figure 17). Each episode adds pages to the Notebook that align with that episode's learning objectives. For example, in Episode 3, Genuine Self Practices is a learning objective introduced as handwritten notes in Super Divya's notebook. (Figure 39).

Figure 39

A Notebook Page Displaying the Genuine Self Practices
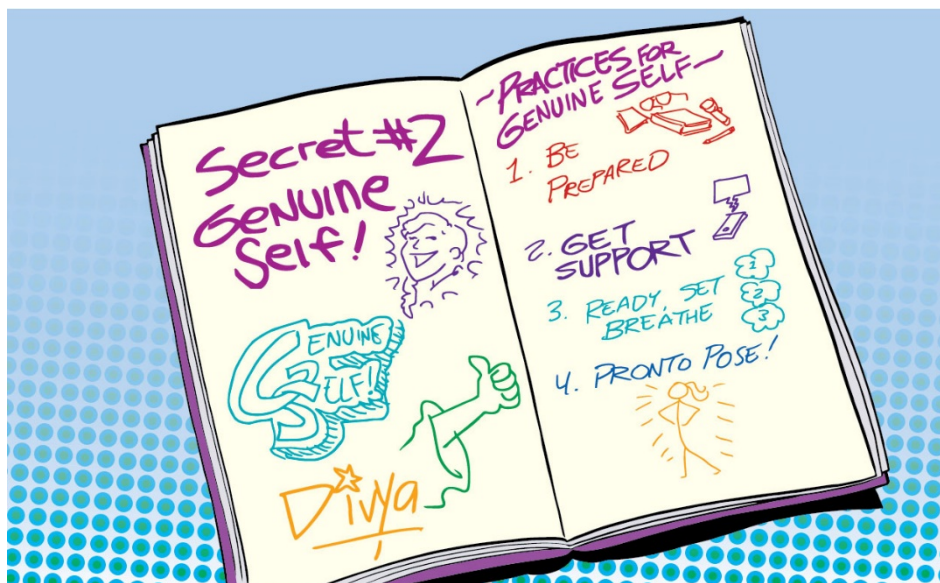
Global Access to Interactive References

While all of Super Divya's tools were not fully designed or all of Professor Agni's bugs named and assigned to learning objectives, the tools and bugs character development described earlier in this chapter provided a simple way to offer global interactivity across all the episodes as an interactive reference. As described earlier in this chapter, each tool has a purpose and power, and each bug has a purpose, signs and symptoms, and powers. As the digital story progressed and the introduction of new tools and bugs, a global interactive glossary was a solution allowing learners to review tools and bugs from previous episodes. At the beginning of each episode, learners were reminded how to access the global glossary by clicking or tapping on a tab in the upper right corner of the user interface labeled "tools" or "bugs." Even though future tools or bugs were not fully designed, I developed a template for tools and one for bugs that could easily be updated with new additions as the digital story evolved.

Designing an Interaction to Define a Safe Learning Space

We asked several learners to define what they understood Safe Learning Space meant. Universally, the response was defined as keeping the physical space safe for learning, such as keeping the work area tidy, replacing chairs along the wall or at a table, or keeping trash picked up. The concept of an emotionally safe learning space by allowing open and honest feedback, trust, and an empathetic facilitator was foreign to the learner audience. However, once explained, there was a consensus of understanding. The first big challenge for the Final Design (2020-2021) was "How do we visually teach the learning objective of an emotionally Safe Learning Space to a low-literacy audience who does not understand metaphorical storytelling?" In *Episode 2 – Facilitator Secrets Part I*, Super Divya introduces Safe Learning Space while explaining and narrating the steps in the digital story. We see Super Divya in the Simulation Room beginning with step one, where she encourages learners to arrive early and prepare the room for simulation training (Figure 40).

Figure 40

Super Divya Arriving Early to Set Up the Simulation Space
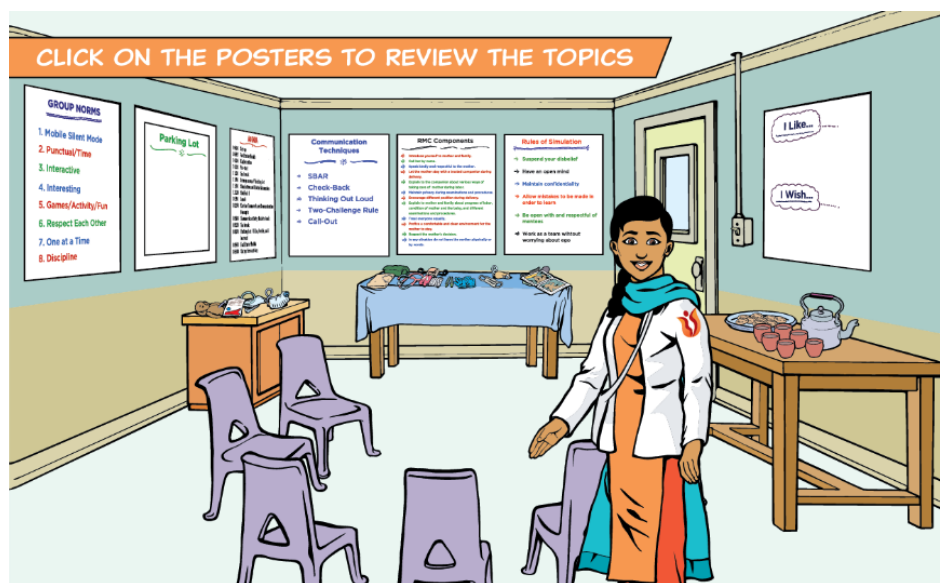
Step two is hanging relevant posters on the wall, such as agenda, simulation rules, communication concepts, group norms, and others as needed to aid as visual reminders that simulation training is a safe and active learning space. While this visual scene is in context to the actual physical space of a simulation room, more detail must be needed to read and comprehend what is written on each poster. A click-and-reveal interaction allows learners to explore and view the posters independently (Figure 41). This allows learners to control the pace of the digital story lesson by reading the posters at their pace with unrestricted navigation until they are ready to proceed. In doing so, the learner can reduce their cognitive load.

Figure 41

An Explorative Interactive Activity Showing the Group Norms Poster
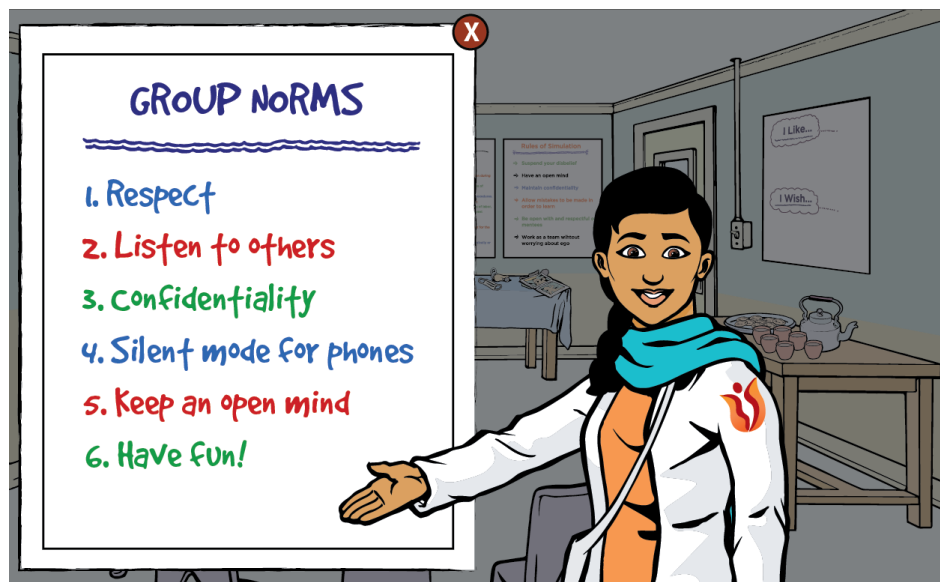
Designing an Interactive Game-Like Activity, a Classroom Facilitator Might Employ

Additional design discussions involved when and where to implement an interaction or an activity while maintaining a first-person narrative story. Throughout the design, I looked for opportunities to introduce ideas that a facilitator might employ in a classroom environment and how to recreate an interactive game-like experience through digital storytelling. The learning

objectives for Episode 9 of the Final Design were teaching the steps of leading simulation debriefs by having the participants sit in semi-circles that created a welcoming environment to deliver the debriefing Diamond Structure (Jaye et al., 2015) consisting of the description, analysis, and application phases. For the Description phase of the debrief, the idea of a game show where the facilitator asks a question, and participants quickly respond with a buzzer to be the first answer and earn points (Figure 42).

Figure 42

Super Divya Facilitating a Debrief Huddle in Her Lab Preparing for an Activity

Super Divya began the lesson by displaying three interactive buttons on her big-screen TV in her lab (Figure 43). Learners would navigate through the interactive lesson by selecting the buttons on the TV to display a question about that phase. Once the question is displayed, learners would hear a gameshow buzzer sound effect and select a Super Divya lab participant to answer the question. The interactive design included each participant having a response, but only one would answer correctly.

Figure 43

Interactive Sequential Narrative During the Description Phase of Debriefing
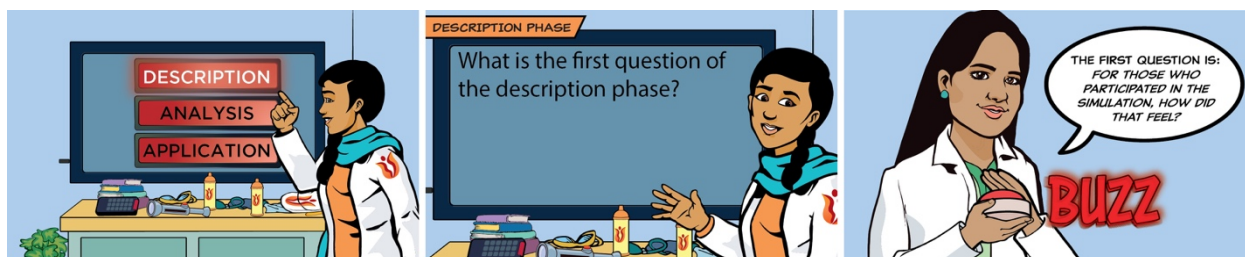
Initially, I wanted to design learning about the phases of a debrief as an interactive practice activity. However, shifting to a second-person perspective, the first part of the design is not an asynchronous practice activity. The second part is a learning interaction where the digital storytelling engages the learner to prepare for a later activity in the same episode when Super Divya teaches how to ask open-ended questions during the Analysis phase. Keeping with the game show theme for facilitator activities, Super Divya brings a spin-the-wheel game into the debrief setting (Figure 44).

Figure 44

Super Divya Preparing a Game for the Debriefing Session
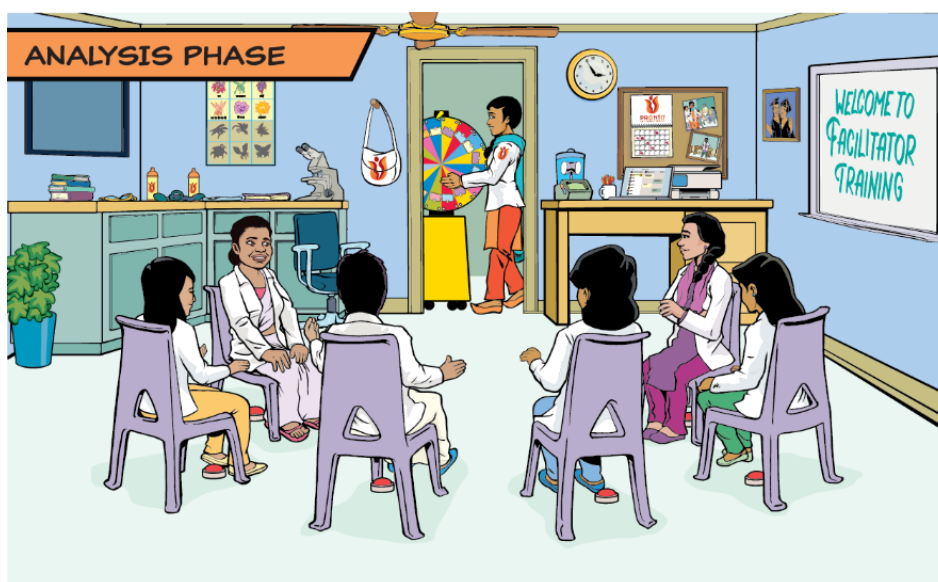
In the digital story, the learner activates the wheel to start its animated spin with complementing sound effects. When the wheel stops, a participant is shown reading the question on the randomly selected card. Learners are then presented with the question revealed on that card and asked to choose if it is an open-ended or closed-ended question (Figure 45).

Figure 45

Interactive Sequential Narrative During the Analysis Phase of Debriefing

I am not aware of any current applications in digital storytelling using visual narratives in the comic medium for interactive practice activities. However, this is a helpful visual narrative because the learning objectives align with the interaction and place the learner in the context of participating in the simulated game, engaging them to play along. On the next screen, the learner sees the question card in first-person view and chooses whether the question is open-ended or closed-ended. Appropriate feedback is shown based on the learner's choice.

Designing an Interactive Choice-Driven Scenario

The most challenging interaction to develop was the final interactive scenario that continued practicing tailoring debriefing questions based on participant feedback. While researching interaction designs for asynchronous learning, I could not find an industry standard to draw inspiration from. The original design sketch included three different audio-recorded scenarios in a composition layout of three columns (Figure 46).

Figure 46

Original Pencil Sketch Design for the Interactive Branching Scenario

The prototype design of this interactive branching scenario directed the learner to select a choice that would lead through a specific instructional path. Feedback from learners and stakeholders revealed a navigational path that needed clarification. Additionally, after making a choice, the learner needed help to try again and continue practicing. This design included a landing screen with branching navigation that directed the learner down one of three paths based on their selection and then returned them to the same landing page for a final selection. Nurse learners would choose a scenario to listen to supported by an onscreen transcript and then return to make the best selection based on the interaction's question. Learners struggled to navigate to the main landing page after the first release of Episode 10 – The Epic Battle Over the Debrief and this interactive scenario.

Additionally, the programmatic logic became complex, evaluating every navigation possibility and deciding whether to block or redirect the learner. This was the most challenging interaction to design and develop, and running up against a delivery deadline, a consensus among

stakeholders came close to removing the interaction and redesigning it as a passive narrative explanation. Every problem has a solution, and I did not want to sacrifice the success of the previous nine episodes without a capstone interaction.

Leveraging Perceived Affordance for Learner Interaction

The design of the interactive DST extended beyond just the different pathways learners might pursue. The shape and color of buttons play a significant role in communicating a direction or action. For example, the two interactive scenarios include the same style buttons. The shape of buttons, known as pill-shaped, are the only shapes in the digital storytelling comic that represent a button with a perceived action. In the linear interactive scenario, three panels display for the learner to select which scenario to listen to an audio narrative. After listening to all three scenarios, the learner selects the best choice. Three different colored buttons presented a perceived affordance that selecting them resulted in some action. The shape of the buttons communicated interactivity, and the color, label, and icons defined the expected action. For example, the audio icon communicates the perceived affordance the learner understands audio will play when the button is selected, or a button label acts as directional instruction. Redesigning the branching navigation approach resulted in a single screen preventing the learner from having to navigate away from the interaction (Figure 47).

Figure 47

Sequence Displaying a Branching Interactive Choice-Driven Scenario
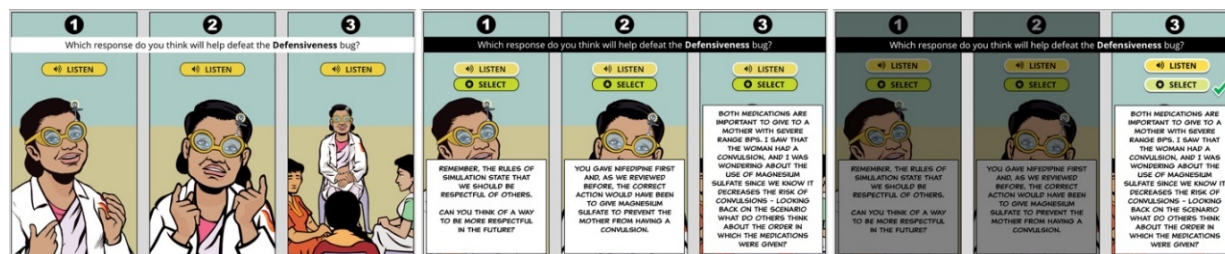
The design remained unchanged, with a single question asking the learner what response a nurse participant would choose to defeat Professor Agni's bug. Learners would listen to all three audio recordings, each having a different response and an onscreen transcript. After listening to all three recordings, three additional buttons would appear, asking the learner to select the correct one. Unlike the previous interaction, there was only one correct response for this scenario. If the learner chose the incorrect response, audio feedback explains why it was incorrect. The limitations in the authoring environment and learner environments forced an innovative approach to navigation, keeping the entire interaction, including multiple audio sources, in one scene keeping the overall navigation linear.

The chapter highlights three unique design aspects: 1) designing culturally relatable characters in a digital storytelling comic, 2) representing environmental culture in a digital storytelling comic, and 3) considerations for interactive activities in a digital storytelling comic. Within designing culturally relatable characters in a digital storytelling comic, design considerations consisted of the character design process for the main characters, Super Divya and Professor Agni, the character design process of skin tone and clothing color testing, and designing culturally related tertiary characters. In terms of representing environmental culture in a digital storytelling comic, this design case highlights the context of the simulation training space, culturally representative design for Super Divya's Lab, culturally representative design for Professor Agni's Lab, and culturally representative environmental design. Lastly, this chapter highlighted considerations for interactive activities in a digital storytelling comic, global access to interactive references, designing an interaction to define a safe learning space, designing an

interactive game-like activity a classroom facilitator might employ, and designing an interactive choice-driven scenario.

CHAPTER 5 – IMPLICATIONS AND FUTURE RESEARCH

The resulting output of an interactive asynchronous instructional digital story in the comic medium with multiple-character dialogue audio is a celebratory moment. However, designing and developing this project was a three-year effort with a complete overhaul after the first year and several design changes that sometimes caused backward momentum. Traditional projects typically have safeguards to prevent scope creep associated with design changes. Maintaining design principles while encouraging and welcoming new digital storytelling ideas across a ten-episode curriculum was challenging. This chapter summarizes the implications of combining digital storytelling design practice and sequential visual storytelling, stakeholder feedback, and several ideas for future research.

When designing an instructional digital story in the comic medium, the visual narrative and principles of VLT are paramount to connecting directly with the learner audience. This chapter highlights three implications for designing a digital storytelling interactive comic in representative character design, cultural and environmental representation in the context of the learner's environment, and considerations for interactive activities.

Table 20

Implications for Designing an Interactive Digital Storytelling Comic

Design Implications	Design Considerations in Context
Implications for culturally relatable characters in a digital storytelling comic.	Physical characteristics and culturally relevant clothing and fashion. Writing a culturally representative narrative script.
Implications for representing culture in a digital storytelling comic.	Designing for cultural behaviors, mannerisms, and gestures. Representing cultural locations and physical environments. Designing a culturally relevant sequential visual narrative.
Implications for interactive activities in a digital storytelling comic.	Designing linear interactive choice-driven scenario design Leveraging perceived affordance for learner interaction

Implications for Culturally Relatable Characters in a Digital Storytelling Comic

Physical Characteristics and Culturally Relevant Clothing and Fashion

In the early stages of the Redesign, a significant effort was committed to studying the physical characteristics of people in India, including facility nurses. Upon reflection, one consideration the artist and I learned was not inviting stakeholders earlier in the process. Our initial focus was our main characters in Divya/Super Divya and Amrutha/Professor Agni, who were the same person with two different clothing outfits. Before reaching out to stakeholders for specific details, we focused too much on fashion design in sarees and the salwar kameez than body types and skin tones. I recommend creating a character development matrix shown in Table 13 early in the process and before any character designs are left to assumption. I propose a template matrix as a helpful tool for beginning the process of defining each of the characters' physical characteristics (Table 21). This recommendation involves studying culturally relevant characters and prefiling the character development matrix before meeting stakeholders. This allows for appropriate details to be considered that maintain consistency while serving as a reference point throughout the design process.

Table 21

Template Matrix for Designing and Developing Culturally Relevant Character

Character	Height	Skin Tone	Hair	Clothing	Accessories
Protagonist					
Antagonist					
Tertiary 1					
Tertiary 2					
Tertiary 3					
Tertiary 4					

Another implication in designing tertiary characters was the proper wearing of sarees and the salwar kameez. Prior literature on DST and comics highlights design elements that might include emotive that visually show a character's feelings (Tsao & Yu, 2016) or the perceived importance of using a comic to ease the understanding of medical care (Hanson et al., 2017). In designing a DST in the comic medium, this design case highlights that clothing is an important aspect of VLT to ensure correct cultural representation for the learner audience to connect and relate to the characters. In that sense, requesting photo references from stakeholders of facility nurses in the context of simulation training provided crucial details for correct representation in the Final Design.

Writing a Culturally Relevant Narrative Script

Writing a narrative for an instructional digital story differs from writing a script for instructional narration, especially for DST. The context of writing a script for this digital story was twofold. The stakeholders were accustomed to writing instructional facilitator manuals and academic research papers, and I needed to learn the subject matter better to write the narrative. One practical design strategy is to define a character's personality and backstory before writing. There are two potential reasons for this recommendation. The first is to think about a character's

backstory, allowing a more in-depth writing experience for the initial script better to understand the character's (a) personality and (b) motivations for actions. This also becomes important later in the design process, where other designers can convey with consistency about the language and tone of the character throughout the design of the interactive DST comic. An example in a later episode of the script presented a concern when Professor Agni was attending a virtual call with other villains suggesting she was not alone in her quest and that destroying simulation was a global effort. The script for this later episode held implications that affected earlier episodes because Professor Agni's tone and personality changed, revealing she was not working alone all this time, resulting in a debate on whether to revisit earlier episodes and edit previous scripts.

An important implication is that everything must tie together from the visual representation of the character's body language, expression, tone of voice, physical space, and the importance of verbal messaging and instructional value. In my experience, designing and developing comic art for a digital story before the script is in its final version leads to redrawing art to line up with story edits, or the narrative writing enters a forced edit to fit the art. Whereas previous research around DST in the comic medium was mostly focused on the design elements such as static photos and images (Zarei et al., 2021) and video (Tsao & Yu, 2016), this design case highlights more of the design process in preparation for development. One recommendation to prevent rewriting and redrawing is planning read-throughs or "table reads" of the script as a function of the scriptwriting process. Indeed, a table read is considered one of the most important steps in the production process. Table reads often refer to filmmaking. However, the process is the same and should be considered within the instructional design field when designing DST. Table reads allow project team members to role-play the characters in the digital story and read

the script aloud. The process exposes gaps in the story and provides insights into the tone and personality of the scriptwriting for each character.

Moreover, a table read might expose conversational elements such as dead pauses. When acting out the comic characters in the digital story, you can also emphasize the emotive aspects, such as emphasis or inflection in the voice that convey more complex dialogue among the characters. This allows learners to better resonate with the narrative, especially when emotions are conveyed within the scenario.

Implications for Representing Culture in a Digital Storytelling Comic

Designing for Cultural Behaviors, Mannerisms, and Gesturing

The DST design should include the narrative and convey cultural norms, behaviors, gestures, and body language. In my experience, asking for or listing every behavior in advance was easier once it became relevant in the script and during the initial design sketches. For example, culturally inappropriate behavior is to have the left hand or elbow above the table while eating (Figure 40). Behaviors are only sometimes depicted as individual gestures, another example. Physical objects within an environment may complement or support cultural behavior. In another panel in the same scene, the two main characters are seen studying together on a couch. However, a couch is rare in India for young college roommates. The scene was redrawn to show the two characters sitting on the floor on a rug in the upper right panel, with only one hand above the table and the left under the table in the main image (Figure 48).

Figure 48

Storyboard Sketch of Divya and Amrutha Using Hands and Elbows While Eating

The challenge that instructional designers face is that they may need to be fully knowledgeable of cultural norms about the learner audience. It is important to manage expectations with stakeholders early in the design phase and acknowledge a need for cultural understanding. In that sense, one must be observant and curious about all aspects of the behaviors of the learner audience, including explicit and implicit cultural norms that are meaningful within a culture. When VLT and DST diverge from a comic representation inherent with an audience within a cultural context, it undermines your credibility as a designer and may impact learning outcomes.

Representing Cultural Locations and Physical Environments

Like character design, locations and environments can be characters requiring a design matrix. Reference photos of the actual learner environment will show specific cultural details otherwise not seen in stock resources. If the opportunity presents itself, travel to the learner's location and study the physical environment in person. In my case, I could not travel to India and therefore relied heavily on reference photos. One implication of this storytelling design is that designs should be mindful of all environments throughout the DST. As noted in Chapter 4, two of the environments were fictional, and one represented an actual simulation training room. In

this experience, designing comic representations of the physical spaces and backgrounds was more difficult than designing characters. A design implication is to separate global objects and props into two approaches. Examples of global objects are furniture, plants, pictures, posters hanging on a wall, the placement of light switches, lights, and lamps, or anything considered a permanent fixture. Examples of props are things the characters may use in one scene, not another, or physical items in the narrative's context. For instance, while Super Divya's lab was fictional in its design, the physical characteristics aligned with cultural relevance, such as having a small wooden desk (global) and an analog notebook (prop). Again, the simulation training room represented an actual training space where décor, furniture, and other global items needed accuracy. For example, the snack table in the simulation training room led to cultural assumptions in its design. We initially designed the snack table with a tablecloth, bottles of water, and pastries. While appropriate in other cultures, the typical snacks during simulation training in Bihar, India, are tea and cookies, and the table often had no coverings. I recommend getting as many reference photos as possible of every aspect of the learners' environment.

Additionally, request several pictures of the same space from different angles as details are exposed from different perspectives. Whereby having multiple angles of the same room or object enhances the authenticity of the narrative in a DST. Therefore, VLT in digital storytelling should also consider non-verbal cues and physical objects to fully ensure the authentic characteristics of the context as designers construct compelling instructional narrative comics.

Designing a Culturally Relevant Sequential Visual Narrative

To date, literature on DST and comics suggest design elements include combining the art of storytelling, combining some graphics, images, text, and optional audio narration or music to present information on a specific topic (Robin, 2016). Combining the art of storytelling that

combines graphics and images as the comic medium shows the visual benefits of comics to increase engagement and retention (Hanson et al., 2017; Kim et al., 2017). Foreshadowing is a literary device alluding to future events in a story and a visual technique to subtly present an idea, object, or concept to assist the learner without additional narrative. There are several visual techniques to assist the flow of a story, and one simple technique to implement is to establish scenes with visual cues that lead the learner through a visual sequence. Establishing the scene or "establishing shot" is a term used in comics to pull the viewer into an environment to convey basic facts about that environment, such as when and where the scene is taking place. A cultural visual representation can add details for the viewers to recognize and relate to.

Aside from Episode 1, The Origin Story, most scenes and environments for the Redesign and subsequent Final Design were held in one of three environments—Super Divya's lab, Professor Agni's lab, or the Simulation Training room. Each time a scene changes within an episode, a connection depicting moving from one environment to another must be established. VLT tells us that *connecting scenes* with sequential visual narratives prevent awkward transitions and confusion from one scene to the next (Cohn, 2020). However, this has yet to be explored for digital storytelling in the comic medium for asynchronous interactive learning. In the context of this design case, it was important to engage the learner to continue the narrative moving forward regularly. A recommendation for these transitions within a digital storytelling comic might include a recap of a learning objective, a knowledge check learning activity, changing the setting where the learning occurs, and adding compelling narrative elements such as a suspenseful cliffhanger. There are many foreshadowing techniques in a digital story to establish expectations or move through scenes, and it is a powerful visual technique to carry the viewer through the narrative (Figure 49).

Figure 49

Establishing a Connection Between Two Locations Using Visual Narrative
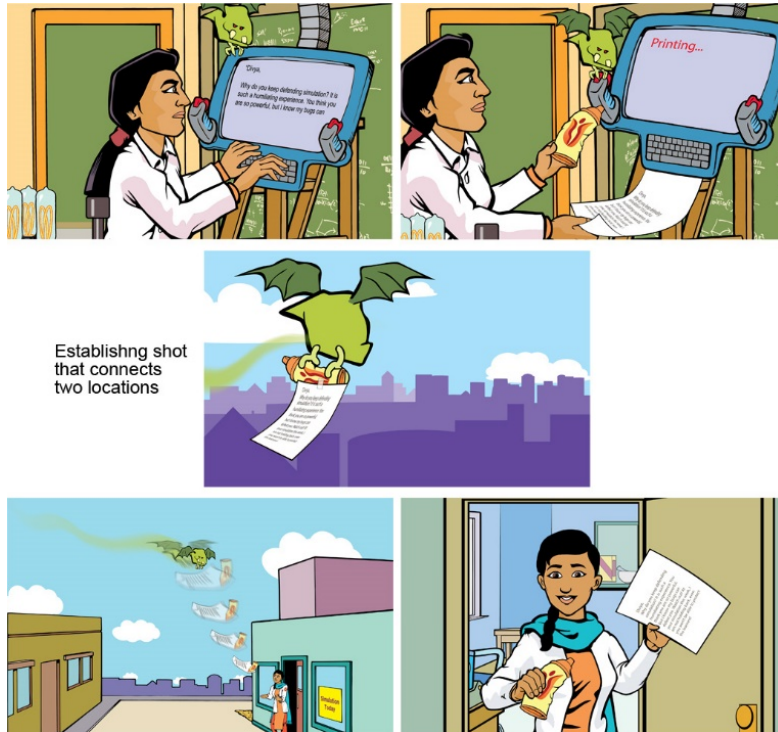
Instructional designers should note that this approach is not a "hard ending" of a scene. Rather they should care that this is a visual narrative technique to engage the learner, compelling them to continue through the learning. As previously noted, visual foreshadowing is a narrative tactic widely used in the film industry to set viewers' expectations (Li et al., 2020). However, it is a gap among instructional designers who develop DST within comics. I recommend studying the script carefully and looking for opportunities to implement sequential visual narratives with wordless images where possible.

Implications for Designing Interactive Activities in a Digital Storytelling Comic

Designing Linear Interactive Choice-Driven Scenario Design

Interactive activities are valuable in asynchronous learning allowing the designer to give the learner control regarding choice and then reveal more information or choices that drive

engagement. A design implication thus involves careful consideration of the value of the interaction, how it ties to learning objectives, and how a learner will navigate the interaction. The idea and design of an interactive activity may be well-intentioned; however, it needs to support at least one learning objective. Moreover, after making an incorrect choice, the feedback encouraged learners to listen to the scenario again, which supports iterative problem-solving. The learning objective of listening and observing is a component of the debrief session where facilitators detect how participants feel. A choice-driven interactive scenario is typically complex in its design which includes solving for every possible navigational path preventing dead ends, endless loops, and confusion.

As noted in Chapter 4, one of the earlier challenges was the need for more personnel to scale the simulation training across Bihar. Therefore, an asynchronous approach in the Final Design was a solution to overcome these challenges, especially in light of the challenge of scaling video training in low-resource settings. To overcome these challenges, I recommend designing a simple choice-driven interaction for scale and duplication when designing linear scenarios. This is helpful during the design and development phases because designing for scale and duplication suggests creating an underlying template structure for repurposing. In other research, reusable learning objects are defined as short, 10-minute learning objects, focused, self-contained digital resources covering a discrete topic (Windle et al., 2011). It was important for this design case to leverage reusable learning objects in new and creative ways to support a low-literacy audience (Kalra et al., 2022). For example, if the scenario design in a digital storytelling comic calls for a two-character dialogue with separate branching feedback, design the activity as a template for simply swapping characters, dialogue bubbles, and other content elements for duplication (Figure 50).

Figure 50

Interactive Sequential Narrative Scenario Shown as a Template for Reusability
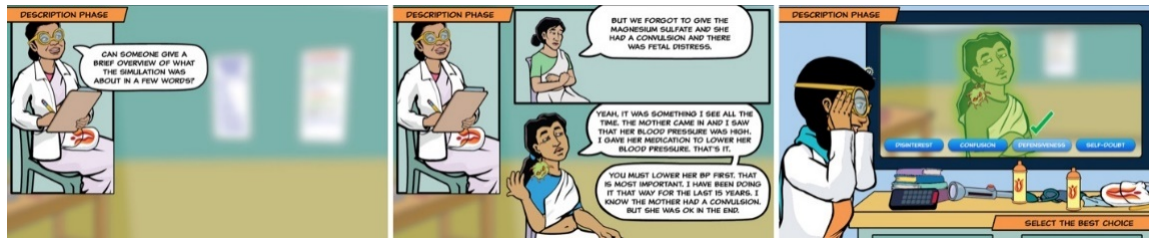
Based on this design case, I recommend designing interactive scaffolding practice with foreshadowing visuals that guide the learner in a choice-driven linear navigation path. This is especially true for ill-structured cases for decision-making and problem-solving (Tawfik et al., 2022), which are essential for digital storytelling. Choice-driven exploratory navigation may have many possible choices and decisions that are important, allowing learners to pursue multiple solution outcomes. By doing so, the interactive options help learners to understand their choices by offering constructive feedback that builds confidence. This also allows learners to revisit and practice interacting with the same scenario to compare their choices. With the ability to see multiple feedback options, the learner is more engaged and might help improve overall knowledge retention.

Leveraging Perceived Affordance for Learner Interaction

In the late 1990s, Don Norman (1999) introduced the phrase "perceived affordance" to clarify the use of affordance in user interface design. Norman describes perceived affordance as "some graphical depiction suggests to the user that a certain action is possible" (Norman, 1999, p. 40). For example, a button presents an expectation that something will happen when clicked or tapped. There is a crossover of foreshadowing with perceived affordance with visual narrative comic art that allows designers to introduce an interactive element early in the design. First,

leveraging the visual design of available icons, such as play or audio icons, prevents unnecessary instructional onscreen text. Secondly, introducing icons and interactive elements such as navigational buttons early in the design presents an opportunity to customize the elements with branded colors. Following these foreshadowing techniques sets a pattern of behaviors that help designers manage learner expectations on how to interact with and navigate the interactive digital storytelling comic. I recommend creating a style guide that identifies every potential interactive element within the digital story (Figure 51). Within that style guide, define each element, purpose, and expected action. For example, all buttons used in an interactive multiple-choice will be pill-shaped, blue in color, and a one-word label indicating choice or direction. Style guides are beneficial for several reasons. First, depicting interactive elements in a style guide acts like a blueprint that defines onscreen position coordinates, branding colors, font type usage, and the element design, such as button states. Secondly, a style guide removes the potential of duplicating redundant interactive elements for the learner. Lastly, a visual style guide assists the designer in managing expectations with stakeholders by preventing the introduction of new elements outside the visual theme's design.

Figure 51

Style Guide Showing Size and Color Parameters of Interactive Elements
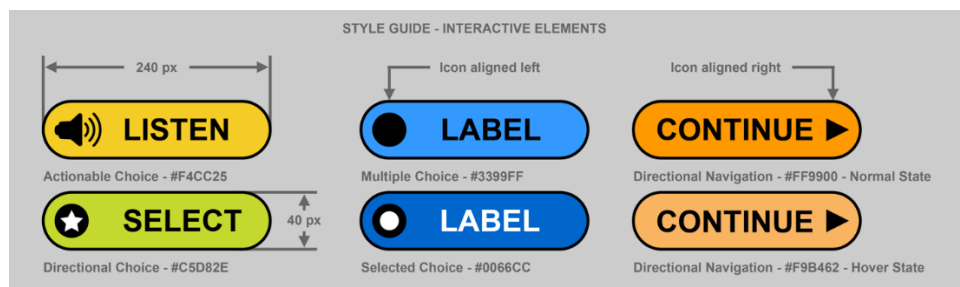
Stakeholder Feedback

In the context of this project, stakeholders included four levels of feedback. The first level included the stewards of the funding grant. The second level was the internal core design and development team from PRONTO International (1), the University of Utah (3), and CARE India (2). The top-level stakeholders and the core team meet monthly to discuss project timelines, progress, or any issues unrelated to instructional design or development. All major design and development decisions came from the core team, who met weekly for over two years to discuss, debate, decide, provide feedback, redirect, and correct details of each episode. The third stakeholder level was nurse facilitators and mentors in India who taught simulation training and administered the Super Divya curriculum in their training. This group provided feedback on test implementations providing feedback on the overall learning experience, and any technology issues. The fourth and last level of stakeholders were the end user nurse participants who shared feedback on their learning experience with the DST comic and suggestions for future content.

Unlike typical asynchronous training, this digital storytelling interactive comic had thousands of moving pieces and digital assets from content, narrative scripts, managing a comic artist and the digital art, managing voice actors, voiceover audio, interactive considerations, and technical hurdles. To encourage iterative feedback between the core team, which was consistent and frequent, there was no set number of review cycles because the length and context of each episode dictated various levels of engagement. For example, *Episode 1 – The Origin Story* was a passive presentation with no interactivity or practice activities that only required two review cycles to finalize. In another example, *Episode 3 – Facilitation Secrets Part 2* was about genuine self-care, including several interactions, a meditation activity, and a meditation video.

An iterative design and development process was established early in the Redesign (2019) and fine-tuned for the Final Design (2020-2021), where learner involvement and feedback were encouraged. Unsure how the overall concept of a digital storytelling interactive comic would be accepted, early participant feedback established confidence that the Redesign (2019) needed to be on the right track for usability. During an early focus group in May 2019, one of the pilot participants shared, "Interesting. I thought comics were for fun. This is informative" (personal communication, May 2019). A CARE India program administrator shared other feedback associated with learning outcomes, "The comic lessons were appreciated by the nurses and feasible to use" (personal communication, May 2019). Unlike initial acceptance and usability testing during the Redesign (2019), the Final Design (2020-2021) feedback was largely testing the scalability and knowledge retention of the digital story. Another pilot was launched in late 2021, deploying six of the ten episodes with a collective of positive feedback that included, "Super Divya teachings are important skills for facilitation and observation," and "I could see that nurses' retained knowledge and shared what they learned with others after attending simulation" (personal communications, August 2021). Additional feedback received forecasted future opportunities to continue innovative approaches that teach abstract concepts using digital storytelling in the comic medium. "Super Divya reminded me it is okay to make mistakes and feel better about myself" (personal communication, August 2021). Bandura hypothesized that self-efficacy expectations will determine a person's coping behavior, how much effort they are willing to exert, and how long it will be sustained in the face of obstacles and adverse experiences (Bandura, 1977). Comics suggest an advantageous communicative medium for abstract concepts like self-efficacy, exploring empathy at a deeper level, and anxiety among nursing students.

Future research

Combining the benefits of the comic medium with digital storytelling shows promising results for asynchronous interactive learning. During this project's Redesign and Final Design, I encountered opportunities to develop new processes, workflows, and models. Of these new ideas in digital storytelling, future research would add to the growing trend of interactive instructional comics. In addition, there are several opportunities to study creative ways to increase interactive engagement presented as comics.

Future Research in Comics and Accessibility

According to the Bureau of Internet Accessibility, "Federal agencies and their contractors are required to conform with WCAG 2.0, and websites of private businesses are required to be accessible" (2019). While private businesses publish asynchronous learning, or eLearning, to operate and be compatible to run on a website, the Learning and Development industry is not required to ensure eLearning is WCAG compliant. Monsido, a website optimization and web accessibility firm, predicts, "Accessibility will become a significant competitive factor for private companies with increased legal pressure for private companies to comply with accessibility" (Monsido, 2023). This digital storytelling project is accessible with the minimum requirements, i.e., alt text, tab order for screen readers, and closed captions. A debate ensued about including closed captions because there were onscreen speech balloons for characters. However, only scenes with multiple characters included speech balloons. There are no speech balloons in scenes where Super Divya or Professor Agni speak solo. Discussion of whether to include closed captions in a low-resource, low-tech environment was not a concern due to the low-literacy audience. However, the final decision included closed captions, and scenes with speech balloons would have exact onscreen words. This raises a question for digital storytelling

with comics on whether speech balloons should be present regardless of the number of characters in the scene. Alternatively, character dialogue speech balloons could act as closed captions. Currently, most authoring platforms allow the ability to add closed captions in video, or eLearning design is limited to the style or placement of the closed caption fields. Future research could study if a screen-readable hand-written comic font could be positioned in a speech balloon to replace the default closed captions, thereby exploring accessible instructional comics. This research would help understand how learners process visual narratives using alternative forms of interactive dialogue. In other related research, Maier (2019) continues to research the semantics of speech balloons on how viewers interpret wordless pictures. Future research could explore these ideas that introduce new ideas for accessible wordless instructional comics (Maier, 2019).

Allowing Learners to Control Character Dialogue and Narrative Pacing

Digital comics are not a new format. Many companies, such as Amazon's ComiXology, allow readers to subscribe and read comics on digital devices. Some of these comics are interactive with sound effects, animation, and interactivity. Additionally, readers can view in panel mode, where a single panel of a comic is shown on the screen, and by swiping left or right, readers can control the pace and navigation of their reading experience. The Super Divya, a digital storytelling comic, is a linear experience by design with forward and backward navigation. Also, by design, interactions within the digital story have controlled navigation whereby learners would always know their location in the menu structure. It should be noted that popular eLearning development software is no-code platforms with limited gesture controls for swiping in multiple directions. However, most eLearning development software includes at least left and right swiping gestures for navigation at the page or screen level only.

Future research could ask whether learners hold control of bi-directional navigation instead of automatic linear progression. There may be additional benefits to learning where the learner would interact with onscreen elements to control the narrative instead of the standard next and back buttons or auto-advancement. For example, when two or more characters in an analog comic are present, both characters' speech balloons are shown simultaneously. Alternatively, in an interactive digital storytelling comic, the learner could control the pace of the dialogue by interacting directly with the speech balloons instead of standard navigation buttons. This approach could be applied to branching scenarios allowing learners to control the pace of the character dialogue, encouraging thoughtful reflection and reduction in cognitive load in choice-driven scenarios.

Principles of Digital Storytelling for Asynchronous Learning in the Comic Medium

Digital storytelling was coined by Joe Lambert in 1998 that generated a movement to give less fortunate individuals a voice to tell their stories (Lambert & Hessler, 2018). At that time, the seven principles of digital storytelling were pre-mobile devices and focused on a mixed-media design with a video output (Table 22).

Table 22

Original Principles of Digital Storytelling Developed by Joe Lambert in 1998

Principle	Description
1	Begin with a point of view
2	Finding a moment within a dramatic question
3	Visual emotional content
4	Gift of narrative voice
5	Power of soundtrack
6	Economy
7	Pacing

Continuing to build on Lambert's digital storytelling principles, Robin (2016) added a 12-step process (Table 23).

Table 23

Steps of Digital Storytelling, Expanded by Bernard Robin in the Early 2000s

Principle	Description
1	Choose a topic
2	Conduct research
3	Write first draft of script
4	Receive feedback on the script
5	Revise the script
6	Sourcing or creating images
7	Respect copyrights
8	Create a storyboard
9	Record audio narration
10	Add background music (optional)
11	Assemble the digital story
12	Publishing

The twelve steps published in the early 2000s were aimed at teachers preparing students for skills in the 21st century by conducting digital storytelling exercises in the classroom, promoting student's understanding of digital literacy, technology literacy, global literacy, and visual literacy (Robin, 2016).

I do not disagree with Robin's twelve steps of digital storytelling in the context of when they were first introduced. However, step seven in respecting copyrights should be included in step six, sourcing and creating images. Also, Robin's step ten for adding background music is optional, reducing the twelve steps to ten. For classroom instruction, I would suggest combining steps six and seven into one step and renaming and combining steps nine and ten as adding audio and music. What remains is a new set of digital storytelling principles I propose through the comic medium for asynchronous learning across universal designs (Table 24).

Table 24

Proposed Principles for Narrative Digital Storytelling in the Comic Medium

Principle	Principle Name
1	Know your audience
2	Narrative storytelling
3	Sequential visual narrative and wordless pictures
4	Character design with respect to cultural
5	Environmental design with respect to cultural
6	Leverage perceived affordance for interaction design
7	Leverage perceived affordance for interface design
8	Technical capabilities and limitations

A study of industry professionals practicing instructional design presents opportunities for future research to learn if a new set of digital storytelling principles could become an instructional design model or as part of a needs assessment of the analysis phase. Coaching instructional designers on using digital storytelling principles during a learner context analysis for onboarding students or employees in an urban setting could highlight socio-economic concerns. Another example of future research might be where instructional designers would facilitate a digital storytelling exercise studying the effects of social isolation and anxiety among geographically dispersed students or work teams. Implementing digital storytelling principles for diversity, equity, and inclusion in corporate settings might be a creative way to explore multicultural organizations where different religions and cultural practices exist. In academic settings, a future research example might be introducing digital storytelling principles as a curriculum that studies the imposter syndrome of first-generation students. Another academic study might be about international students and their experiences studying abroad which research shows digital storytelling reduces anxiety (Garcia De Avila et al., 2022). Combined with existing instructional design models, the proposed digital storytelling principles in the comic medium

(Table 21) could support future research for instructional designers to experiment with various abstract concepts and emotional contexts as a viable option. Depending on the artifact, and as shown in this design case, digital storytelling is only limited by the creativity of the instructional designer and those participating.

Designing for Abstract Concepts in Self-care, Mental Health, and Empathy

The overall goal of the Super Divya episodes is to recognize self-care. In the digital story, she develops tools that include, for example, learning to name emotions and identify one's genuine self. The benefits of using the comic medium in this digital story are bringing to life these abstract concepts. In this comic episode series, we designed a set of tools for Super Divya to aid in the visual storytelling of abstract concepts. For example, Genuine-Self practices help the facilitators and participants to connect with their bodies, calm their minds, and focus on the present moment. This practice also leads to other practices taught by Super Divya, such as breathing techniques, asking for help from colleagues and friends, and preparing for how to manage emotions in difficult situations. Another tool in Super Divya's PRONTO Pouch is the Empathy Goggles, a tool we designed for Super Divya to help nurse mentors recognize clues from the provider's body language and facial expressions. These clues help nurse mentors understand providers' feelings and meet those feelings with appropriate teaching techniques. One of the last tools in the digital story is a device that attaches to the Empathy Goggles called the Curiosity Antenna. Learning happens when the mind is open to asking questions, and the Curiosity Antenna helps nurse mentors and providers approach complex situations with an open and flexible mind and ask questions to participants and patients more often.

We successfully taught these abstract and nuance concepts with the help of Professor Agni's bugs. With the ability of the comic medium to transcend the abstract, many possibilities

need continued explanation and reinforcement with future research. One idea for future research could look at a study whereby participants are given an abstract concept and asked to design a digital story in the comic medium told from a flipped perspective (King, 2017). An example of flipped perspective might be the topic of cyber security teaching the cause of a virus attack, leveraging the comic medium to craft an instructional story from the perspective of the viruses as characters. Current research in digital storytelling mostly looks at telling stories from a first-person perspective (West et al., 2022). In another example, participants could explore the emotional anxiety of patients entering an MRI exam where the comic medium would exaggerate the emotions in vivid characterization. By highlighting these emotional aspects in digital storytelling principles, learners can empathize with socio-emotional elements of real-world experiences resulting in better attentive care, observational skills, and attitudes toward future patient care (Hanson et al., 2017; Tsao & Yu, 2016).

Conclusion

Using video for training was an innovative learning approach for the Initial Design in the low-resource region of Bihar, India. The Initial Design training goals focused on teaching technical and non-technical skills to providers and their mentors by recording themselves conducting simulation training and debriefing by watching the videos together. PRONTO International focuses on innovative training programs for clinical educators who are facility-based clinicians helping other providers to learn, grow, and manage their patient's care. PRONTO found that most clinician training for health providers focuses on technical skills, but few focus on the provider's and their mentors' health and well-being (Kalra et al., 2022).

PRONTO International is leading a movement in India for innovative midwifery education. In early 2022, PRONTO launched the Super Divya curriculum of episodes during

midwifery educator training. Midwifery educator participants were from the state of Telangana and the Fernandez Foundation, one of the leading midwifery education institutions in India. The Super Divya curriculum offers the opportunity to connect with cadres of clinical educators at scale–which is critical for India. From a mental health perspective, Super Divya normalizes the idea that clinical providers and educators should take time for self-care, resulting in lower burnout rates and higher-quality patient care.

This interactive digital storytelling comic was chosen to combine storytelling and the comic medium to communicate complex ideas about health, convey nuanced concepts, explore emotional and social issues, and allow learners to develop empathy beyond what is achievable in other formats. The Final Design was piloted on 205 nurses in India, and the results of this initial study were published on February 25, 2022, in the International Journal of Environmental Research and Public Health (Kalra et al., 2022). The study found that the digital storytelling episodes were appreciated by nurses, feasible to use, and improved knowledge retention of important teaching skills. The study also showed opportunities to continue innovations on abstract concepts affecting provider mental health. There are many opportunities to scale the Super Divya digital story into other low-resource and low-literacy regions in India and worldwide to improve the quality of life for nursing providers while helping to reduce the global infant mortality rate. This design case has shown that employing a carefully designed asynchronous interactive digital storytelling comic increases knowledge retention on topics such as critical thinking skills in clinical settings, empathy in patient care, and self-care affecting the mental health of nursing providers.

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Appendix A

Section 1 – Respondent Info

1. Which PRONTO simulation facilitation trainings did you attend (select all that apply):
   a. January 2018
   b. December 2018
   c. None
   d. Other
2. How many simulations have you facilitated (i.e., set up and run a simulation)?
3. How many debriefs have you led?
4. How many times did you watch the video module?

Section 2 – Usability

5. What device did you use to access the video module?
   a. Smartphone. Specify type (i.e., Samsung, Redmi, etc.)
   b. Tablet
   c. Computer
   d. Other (specify)
6. Were you able to open the video module link?
   a. Yes
   b. No
7. How much time did you spend watching the video module?
   a. Less than 15 minutes
   b. 15-30 minutes
   c. Greater than 30 minutes
8. Did you have trouble using any of the following functions during the video module? Please click any features that did NOT work for you.
   a. Start
   b. Pause
   c. Move forward
   d. Move backward
   e. Hear audio
   f. All functions worked

Section 3 – Acceptability

	Strongly disagree	Disagree	Agree	Strongly agree
9. The content of the video module applies to my job as a Nurse Supervisor.				
10. The content of the video module would be helpful to Nurse Mentors if in Hindi.				
11. Watching the video module was a good use of my time.				
12. The video module will help me improve as a simulation facilitator				
13. I would like to see more video modules like this one.				

If 'Strongly disagree' or 'disagree' is indicated for questions 9 – 13, ask why.

14. Please share any ideas for topics you have for future video modules. _____

We appreciate your taking the time to watch this video module and give us feedback. As you consider the questions below, please don't rewatch the module. We are trying to see how well the material is remembered after the module, and your answers are anonymous.

15. What did Super Divya learn about what makes a good simulation facilitator?
_____

16. After watching Super Divya, what will you do differently next time you facilitate a simulation?
_____