But Did You Die? Developing Critical Thinking in Paramedics Using Interactive Branching Scenarios

Judy Kakazu
Learning Design and Technology
College of Education
University of Hawaii at Manoa
jkakazu@hawaii.edu
https://laulima.hawaii.edu/x/HIdD

Abstract: The purpose of this project was to design and evaluate scenario-based instruction aimed at improving paramedics' medical assessment skills. Aimed at emergency medical technicians, the project used Keller's ARCS Model, Gagne's Nine Events of Instruction, and the basics of effective game design, to design instruction that presented various medical scenarios within an online platform. The goal of the instruction was to improve the technicians' critical thinking and decision-making skills. To evaluate the instruction, 12 (n = 12) emergency medical technicians participated in an evaluation of the instruction. As participants interacted with the online instruction, data related to the timing and accuracy of their performances were recorded. In addition, open-ended surveys were used to collect qualitative data with regards to the instruction. Results found participants exhibited increased speed and prioritization of questioning per scenario as a result of the instruction. Participants also exhibited increased accuracy in pre-hospital diagnoses and stronger justification of those diagnoses. While participants reported finding the instruction engaging, they indicated that the interactivity of the instruction played a more critical role. This report examines the study's findings in detail and explores possible explanations for training emergency medical technicians. Further study is needed to better understand how problem-based learning using interactive branching scenarios may be beneficial in medical education.

Keywords: problem-based learning, critical thinking, branching scenarios, medical education

Introduction

Problem Statement

Emergency medical technicians are required to elicit information in the form of a medical assessment before making critical life saving decisions. This assessment consists of two parts and serves as the foundation upon which paramedics apply their decision-making processes to formulate clinical impressions and thus an appropriate treatment plan for patients (Carter & Thompson, 2015). The first part requires interviewing the patient to obtain subjective historical medical information pertinent to the acute medical situation. The second part consists of conducting a physical examination to obtain information from a patient's objective physical

presentation. Subjective information is commonly referred to as symptoms, while objective information is referred to as signs. All information, or signs and symptoms, obtained from these two components of assessment is vital for emergency medical technicians (commonly known as paramedics) to process dynamically. Paramedics elicit and observe assessment information constantly while on calls. All information, whether it be with regard to a patient's medical emergency or whether about overall scene safety and mechanisms of injury, is used in all the paramedic's decision-making processes on how to best manage situations that change dynamically and thus requires a foundation of critical thinking.

In recent years there has been a three hundred hour decrease in the local paramedic educational training. The decrease in hours has resulted in a restructuring of curricular content. This program is the primary source of certified paramedics in the State of Hawaii. Thus, today's paramedic students do not have many opportunities during their training to rehearse didactic instructional content using a problem-based learning format.

Scenario-based learning that utilizes branching scenarios in a game-like fashion may afford paramedics of all levels the mechanism to rehearse foundational assessment skills prior to actual patient care situations (Onstott, 2019). Assessment skills that are comprised of history taking and physical examination are the foundational knowledge upon which clinical decision-making skills depend (Meyer & Singh, 2017). Learning by simulation is an important method of instruction for paramedics as it provides an experience in which improvements can be made both in theoretical knowledge and practical skills application, and for the development of medical assessment and decision making skills (Abelsson, 2017). Thus, scenario-based learning would provide paramedics with opportunities to rehearse foundational assessment skills within a simulation for the development of assessment and decision-making skills, towards a foundation for the development of critical thinking.

Purpose Statement

Therefore, the purpose of this project was to design scenario-based instruction for the acquisition of foundational medical assessment skills and to evaluate this instruction's impact on the ability of emergency medical technicians to construct efficient decision-making strategies, towards the synthesis of critical thinking.

Literature Review

The nature of the emergency medical technician's work environment is dynamically unpredictable. This differs dramatically from all other health care providers and is the setting in which emergency medical technicians routinely execute the skills of their profession (Carter & Thompson, 2015). Within the practices of today's para-medicine, paramedics are now tasked to be clinicians, rather than merely skills technicians of the past. A technician prioritizes technical skills and does not use a high level of critical reasoning. Whereas a clinician uses assessment and differential diagnoses to prioritize treatment (Radu Venter, 2020).

Foundational Knowledge for Emergency Medical Technicians

A paramedic is required to gather information actively. "Information gathering is a foundational step of the diagnostic process. It is not possible to synthesize clinical information to make a correct diagnosis without adequate data collection related to a patient's history and physical examination" (Meyer & Singh, 2017, p. 463).

History taking and physical examination information that is gathered is then synthesized into a clinical impression. Unlike physicians, who are aided by tests and other resources at their disposal while making and confirming a medical diagnoses, paramedics making provisional diagnoses are often referred to as clinical impressions. A paramedic's subsequent decision-making and patient treatment plans are dependent upon accurate assessment information. Obtaining a patient's subjective medical history is one of the core components of patient assessment. Gathering subjective history data can then provide clues to guide the emergency medical technician in the objective physical examination. Failure to gather this basic foundational medical assessment information in an effective and timely manner may lead to dire diagnostic and treatment consequences (Meyer & Singh, 2017).

Problem Based Learning as Gamified Branching Scenarios

There is growing evidence that simulation, as compared to traditional didactic, or no simulation training, improves safety, competence, and skills for learners within the health sciences (Cowling & Birt, 2018 pg. 69).

Medical problems are often ill-defined, and paramedics, now tasked with being clinicians, need rapid and dynamic problem-solving skills that require equally rapid and dynamic reflective thinking. Problem-based learning in the form of situational scenarios have been shown to have a positive impact for emergency medical technician students on the development of these skills (Walshe et al., 2019). Best practices in medical simulation design have a mechanism for repetitive practice, vary in degree of difficulty, provide individualized and active learning, provide tangible and measurable outcomes, and provide feedback within the experience and approximate clinical practices (Onstott, 2019). Although scenario-based learning has been shown to have a positive impact on the clinical decision-making skills of paramedic students, there are still barriers to this type of instruction, some of which include cost, validity, and choice of modalities (Oak, 2014). Therefore, situational scenarios that can overcome some of these barriers and provide most of these best practice features may be beneficial for the emergency medical technician learner.

Critical Thinking and Decision Making

Hazardous and unpredictable conditions such as weather, lack of lighting, traffic hazards, violence towards the paramedic, and all forms of countless and unpredictable situational variations are constant in a paramedic's working normal. Thus, Carter (2015) stated that, "a paramedic's approach to the environment and all the potential hazards and challenges it presents, mandate that before the delivery of any patient care provisions, careful consideration and preparation are completed" (p. 25).

Facione (1990, as cited in Onstott, 2019) stated, "There are several variations of the definition of critical thinking; however, a collective effort by Facione, (1990) and the American Philosophical Association defined it as a purposeful, self-regulatory, non-linear, and recursive cognitive process that a person uses to make a decision about what to do in a given context" (p. 3).

Therefore, the paramedic must have the opportunity to develop decision-making skills and thereby critical thinking. In order to develop this reflective practice, the paramedic must be able to self-identify mistakes and be allowed to learn from their errors (Thompson et al., 2017). A well-designed scenario may offer this to the paramedic learner within the safety of simulated scenarios.

Paramedics are required to elicit and observe information regarding patient medical history by asking patient interview questions and conducting an objective head-to-toe physical examination. This information is vital as the paramedic then uses it to formulate a clinical impression that allows him or her to decide on a course of treatment. The decision-formulating skills learned during problem-based branching scenarios provide the foundation upon which both emergency medical technicians at the basic life support and the advanced life support levels construct their knowledge upon. This learned method of decision-making is of further importance as it becomes the foundation of their critical thinking.

As paramedics are now tasked with being clinicians that utilize critical thinking and decision-making skills, a failure to learn basic foundational skills and be able to practice and apply these skills with reflection, is directly related to patient outcomes. A modality that allows for this process within a simulated scenario environment may be beneficial for the paramedic learner and the public.

Methodology

This project's instruction was designed as interactive branching scenarios using a web-based platform called Twine. Twine can be used to create interactive novel-type experiences. Therefore, interactive branching scenarios were created to present paramedics with intentionally designed medical assessment and decision-making experiences. Participants were given a pre-assessment scenario, a recall and review instruction, one linearly structured scenario, and three patient presentation ill-structured scenarios. A final post-assessment scenario was also presented. This final post-assessment scenario contained two medical issues within one scenario to facilitate a more real-world experience. As the participants interacted with the branching scenarios, quantitative data was collected in the background within the coding of the Twine. This was used to collect data to evaluate the impact of the instruction on the participants' speed of assessment, prioritization of history questioning, and accuracy of diagnosis. A pre-survey (see Appendix A)for demographic data and a post-survey (see Appendix B) to collect participant satisfaction comments was also administered within the Twine. This data was collected to determine the impact of the interactive branching scenarios on the participants' development of purposeful cognitive processes and satisfaction with the instruction.

Content Analysis

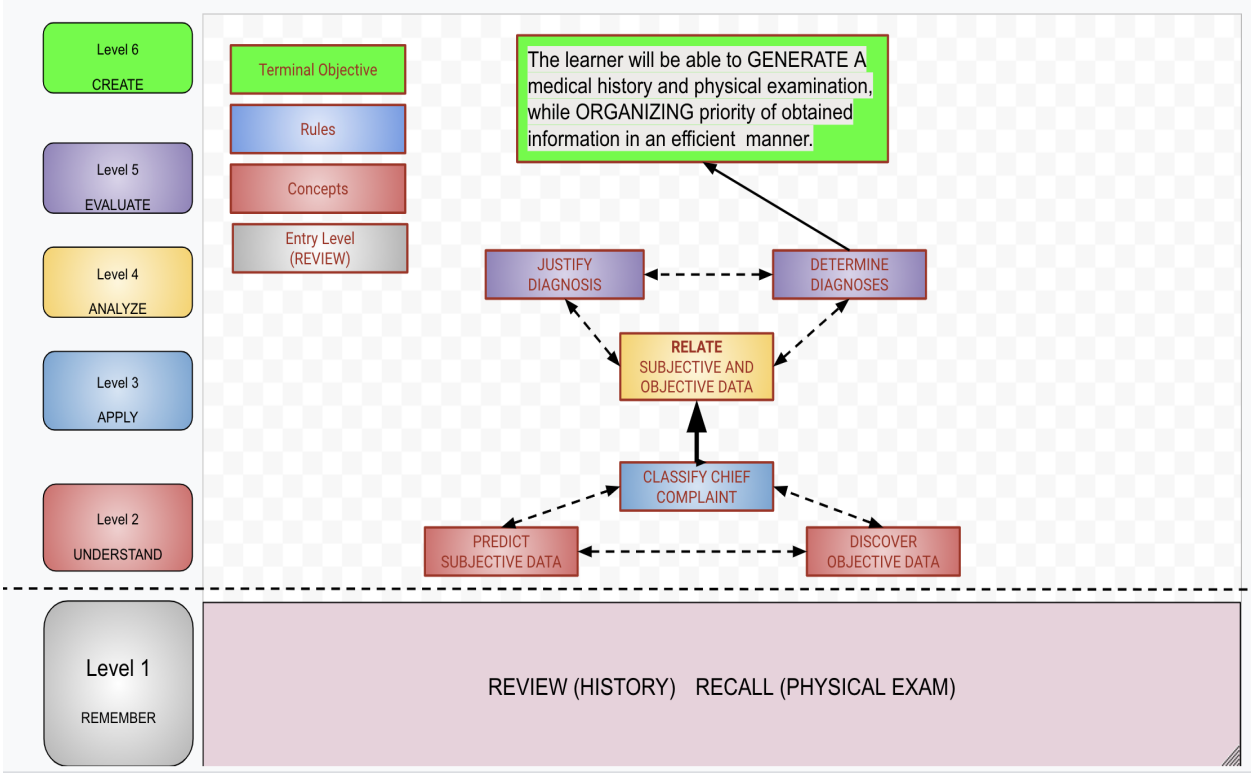
This instruction addressed the cognitive domain and was designed to impact the foundational knowledge of medical assessment skills upon which subsequent skills were constructed. The rationale being, foundational skills were needing to be solidified before the participants could perform them in an accurate and timely manner.

Low fidelity simulations were deliberately used to present the content of the five scenarios. Instruction on mechanics was deliberately made transparent to the participant and immediately addressed by asking the participants to click on the hyperlink to access the instruction. These mechanics were kept simple and were the only skill the participants needed to access and complete the instruction. As the participants clicked on initial hyperlinks, they were shown an opening movie-like sequence that was used to allow participants to quickly relate with its familiarity and quickly immerse the participants immediately into the instruction.

Participants freely chose the order of history questions and physical examination components in the pre-assessment scenario. This scenario provided data with regards to initial baseline participant performance. Next, a passage presented a recall and review of the basic medical history and physical examination acronyms with which entry-level participants would have already been familiar. The following scenario then required participants to ask all history questions and do a complete head-to-toe physical examination assessment by following the strict order of the acronyms that were reviewed. These acronyms were presented in the usual manner that paramedic learners are taught how to recall history questions and conduct a complete physical examination. Here, the participants could not progress within the game-like instruction unless the passage had been completed as instructed. The three ill-structured branching scenarios then allowed participants to freely choose history questions and physical examination observations, as they would typically conduct patient assessments in real emergencies. A final scenario served as a post-assessment. This post-assessment was unique in that it presented two emergent medical emergencies that simultaneously presented within a single patient. This was meant to be similar to what paramedics encounter in real-world emergency medical situations. It also served to illustrate any impact that this instruction might have had on the participants' ability to construct non-linear thought processes within a more real-world context. Hence, this instruction's impact on critical thinking. An instructional hierarchy was developed to organize and prioritize instructional content and objectives.

Figure 1

Instructional Hierarchy



The terminal objective of this instruction was for emergency medical technicians within the City and County of Honolulu's Emergency Medical Services. Emergency Medical Technicians at both the basic life support and the advanced life support levels needed to acquire and rehearse the basic concepts and understanding of the conceptual rules before achieving the level of proficiency required by the terminal objective.

Performance objectives were created (see Appendix C). These objectives were then properly sequenced and clustered. (see Appendix D), and content presented (see Appendix E)

Although this instruction acknowledged the need for the foundational assessment skills, the entry-level for the participants was set to require that all participants be already certified emergency medical technicians and thus have already completed the basic instruction on medical assessment. This entry-level was chosen deliberately because of the time constraints for this learning assessment project. The line on the instructional hierarchy chart separated entry-level skills from the higher-order skills of concepts, rules, and terminal objective. The prerequisite at entry-level was to be a certified emergency medical technician in the State of Hawaii. This certification needed to be completed prior to learners participating in the simulation modules.

Instructional Strategy

Paramedics as a population present from various socioeconomic backgrounds, life experiences, ethnicities, age ranges, and educational levels. Many emergency medical technicians are

balancing family life with full-time employment. Paramedics commonly enjoy challenges and perform well in environments that are engaging, fast-paced, and stressful. In addition to their long work shifts and additional overtime hours, they typically do not have extensive amounts of free time.

With skills and objectives identified, content presentation and learner participation were then decided upon, targeting learner characteristics.The characteristics of the target learner population were analyzed through the four domains of learning. (see Appendix F) These characteristics, as they affected learning, were taken into consideration within the design of the instruction. For example, all scenarios included multimedia components such as video, images, audio, and animated character interactions for information presentation, as appropriate for its objective. This content contained elements that might be disturbing to some, but they are standard for emergency para-medicine and therefore not excessive for the selected population. Participants interacted with these scenario components using various input methods that were available within the functionality of Twine, such as text input boxes, interactive media involving mouse-over images, and branching passage choices displayed as clickable links.

Basic foundational assessment knowledge was presented for review and recall at the instructional entry-level. Learners progressed in their ability to predict subjective information and actively sought objective findings. Choices aided this progression that a participant made regarding history questioning and physical examination findings that were non-examples. The responses that participants received required them to actively reflect upon what information they then decided to pursue next. Negative feedback was also periodically presented as the scenarios progressed. This provided the participant feedback for a question choice with lesser efficacy. The participant was thus required to recursively cycle through their cognitive processes, compare with previous knowledge, then construct new knowledge as they then decided on their patient's diagnoses. The learner then related the subjective information and objective findings to their prior knowledge and related their information and findings. The participant then determined a primary diagnosis. This then led the learner into a continuously cyclical loop in which the learner would compare subjective and objective findings to justify their diagnosis. This is called re-evaluation. In this manner, the participant was to obtain the terminal objective in which he or she was able to generate a medical history and physical examination while organizing and efficiently prioritizing the obtained information.

The Keller's ARCS Model of Motivation (Arcs Model of Motivation, n.d.) and Gagne's Nine Events of Learning (Kruse, K. 2009). were combined with elements of effective game design (Rouse, 2005) to create ill-structured branching scenarios that offered problem-based learning to the participants of this learning assessment. As described by Shelton and Scoresby (2011), activity-goal alignment suggests that a game is more beneficial for learning if the intended pedagogy is properly embedded in the design.

Keller's ARCS Model of Motivation

Keller's ARCS Model of Motivation was used within the framework for the instructional strategies. (see Appendix G)

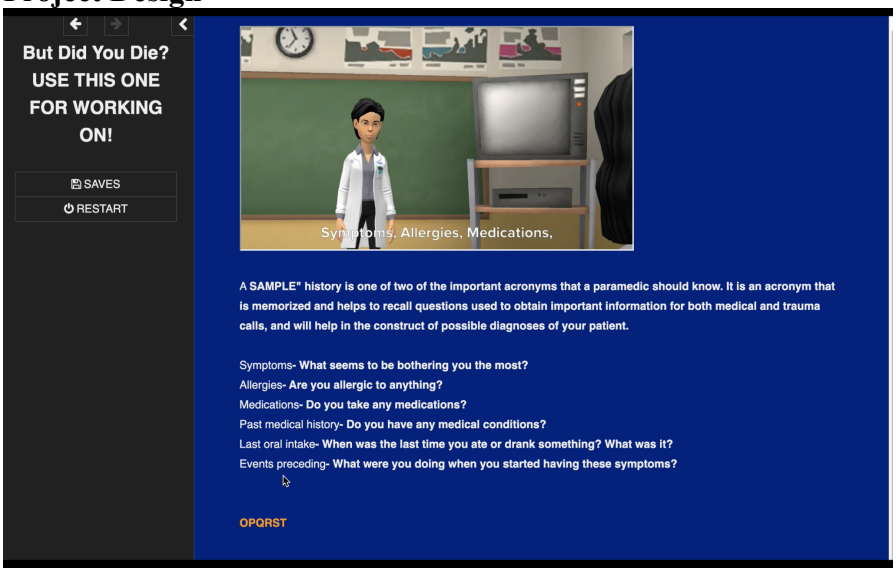
Gagne's Nine Events of Instruction

Gagne's Nine Events of Instruction was also within the framework for instructional strategies. (see Appendix H)

Elements of Effective Game Design

Elements of effective game design were also incorporated within the instruction as Twine is primarily used to create experiences, much like a role-playing game. (see Appendix I)

Project Design



Upon securing IRB approval (see Appendix J) and with current CITI certifications (see Appendix K), **i**nstructional content was made engaging by attention and regards to learner characteristics. The information presentation was short and concise. The content was designed to be challenging for the learner as one scenario did not allow progress within the game-like instruction unless participants followed the order of history taking and physical examination as required. The branching scenarios are also challenging in that the information that the patient presented was extremely vague, and specific findings were purposefully chosen to create a patient presentation that was medically challenging with regards to recalling didactic knowledge. The instruction was also made relevant by its similarity to real-life medical situations that the learners encountered. The scenarios were immersive and proceeded in real-time for immediate feedback. The instruction was accessible from any browser on any device to accommodate the learner's time and logistic constraints. The instructional platform offered a saving function so that the learner can save their progress should they need to resume the instruction at some other time. Learners may attempt the scenarios an unlimited number of times if they choose, giving the learner control over their learning.

The central portions of this module's instruction were delivered using Twine. Twine is a versatile tool for creating non-linear interactive stories that allows the incorporation of multimedia. Branching non-linear stories were created via customizable passages with code such as JavaScript, HTML, and CSS. Story passages within Twine were coded to be interactive, with many options that are similar to all the options available on a webpage. Video content for the simulated scenarios was created using Plotagon. Plotagon is an application that allows for the creation of animation with simple text. Laulima was used to host files that the Twine needed to utilize.. Google Sheets was used for the collection of learner survey responses and quantitative data from the code within the Twine. The color scheme for the Twine was chosen to be repetitive of the colors used on familiar ambulance units. (see Appendix L) Therefore, multiple integrated tools were used to create a branching scenario game-like instruction.

This instruction was intentionally designed to investigate foundational questions regarding the beginnings of the development of critical thinking. Thus research questions were targeted and specified.

Research Questions

1. How does the use of simulated branching decision scenarios impact the decision-making processes with regards to speed of medical assessment by emergency medical technicians?
2. How does the use of simulated branching decision scenarios impact the decision-making processes with regards to the organization of foundational medical assessment questions by emergency medical technicians?
3. How does the use of simulated branching decision scenarios impact the decision-making processes with regards to accuracy of pre-hospital medical diagnosis by emergency medical technicians?

Evaluation Strategy

All data was collected and then evaluated for the variables of time in a scenario, sequence of questions asked, and accuracy of diagnoses. Time in the passage and therefore overall scenario was calculated from the variable sent by the coding of the Twine. The Unix time was converted to minutes and seconds, and a total per scenario was then obtained for each participant.

Data regarding passage order from the Twine provided the sequence of questions that the participant had decided upon in each simulated scenario. The passage order was analogous to the order of questions asked to obtain a medical history. A survey collected demographics such as anonymous username and link to other demographics such as age, years of experience in emergency medical services, hours of scenario-based instruction during training, confidence with

regards to diagnostic abilities, hours spent playing video games per week, and comfort with technology information. Demographic data was then linked to participant performance data. This data was collected and utilized to determine if any trends within the data could be determined. The rating for confidence with assessment skills compares with a post-assessment survey of the same questions to gauge participants' satisfaction and, therefore motivation.

Time in the scenario was calculated by averaging and was evaluated on a linear scale to illustrate trends. The number of history questions was also averaged per scenario and evaluated on a linear scale to illustrate trends. Diagnoses and justification accuracy was evaluated and rated by a simple Likert scale. The efficiency of history questioning was calculated by the formula:

Efficiency = Output/Input

With Output being the diagnoses accuracy value and the Input being the number of questions asked. Multiplied by 100, gave an efficiency rating, much like how Work is calculated in Physics.

Thematic analysis was utilized for the qualitative data obtained from the survey. This was used to gather information regarding how the instruction effectively utilizes the ARCS Model of Instruction as well as how the instruction might be improved.

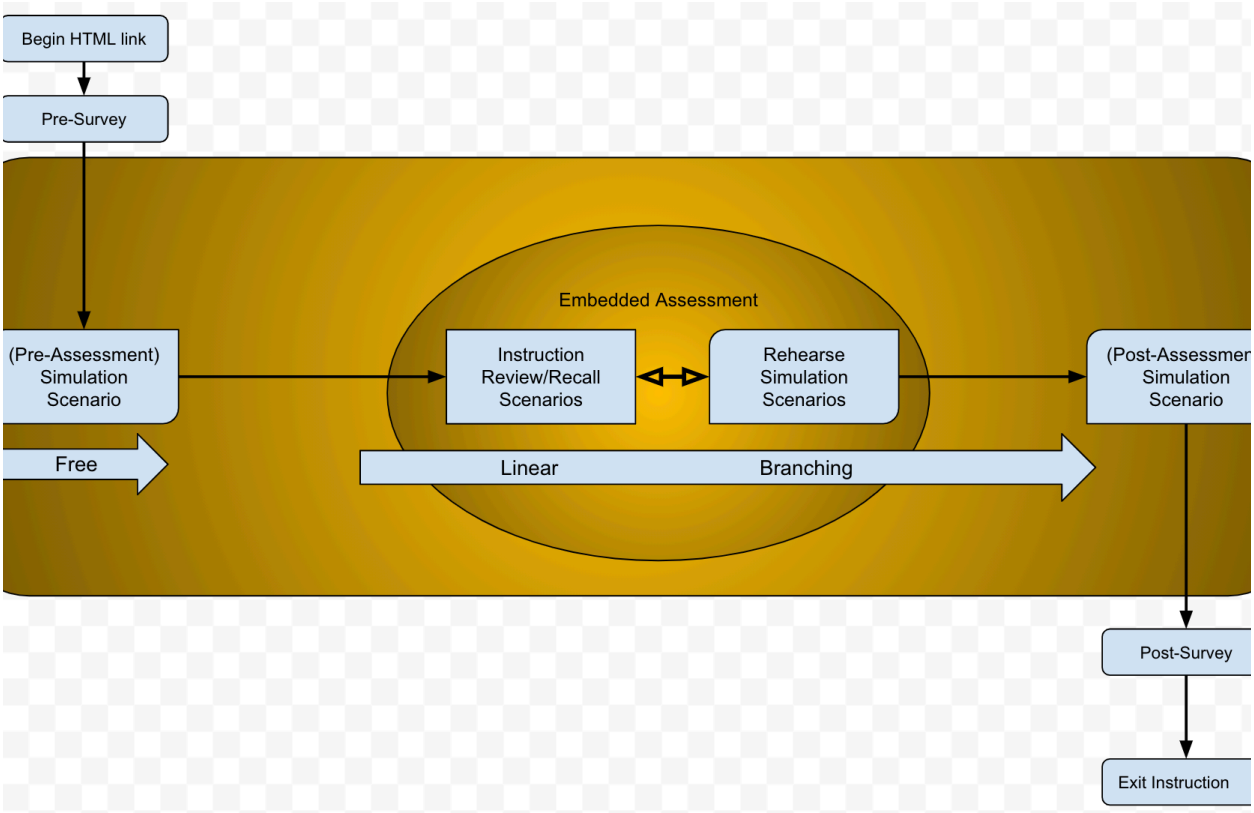
Participants

The target audience for this learning assessment was certified emergency medical technicians. Twelve participants completed the instruction, and their demographic data was collected. All participants were paramedics who are certified emergency medical technicians at the advanced life support level. There were no emergency medical technicians that were certified primarily at the basic life support certification level. Participants were all voluntarily recruited primarily by the mention of the project and participants deciding on participation. All participants were known to the project designer as current or past co-workers within the emergency medical services system. These participants have the same learner characteristics as the target audience and were, therefore, representative of that audience as learners. Participants reported the following demographic data from the pre-survey. (see Appendix M)

Procedures

Figure 2

Procedure Flowchart



Participants were provided access to the instruction via a hyperlink sent within an email. (see Appendix N) This hyperlink immediately opened the instructional module within the browser on the device of the participant's choice. Images of the Informed Consent Form (see Appendix O) were presented again, and a statement acknowledging consent needed to be clicked to proceed to the following passage within the Twine. Demographic survey data was collected within the Twine. Participants then viewed the opening movie of the instruction.

Participants were then guided by the Twine interactive scenarios throughout the rest of the instruction. The participants could choose to stop and resume the instruction at their convenience and choose to replay the instruction. The participant had complete control over these aspects and could have terminated the instruction at any time if they chose to do so.

The branching passage choices required the participant to make decisions. The participant's decisions determined what passage the scenario would proceed to next and what that passage's content would contain. Passage content also provided feedback to the participant. During all scenarios, the participants were provided with the option to input their final patient diagnoses when they felt that they were ready to do so. The input of diagnoses and justification effectively ended that scenario, and participants were then offered the option to attempt the next progression of scenarios. Upon completion of the post-assessment scenario, the participant was guided to the post-survey. Upon completing this post survey, the participant was thanked, offered contact

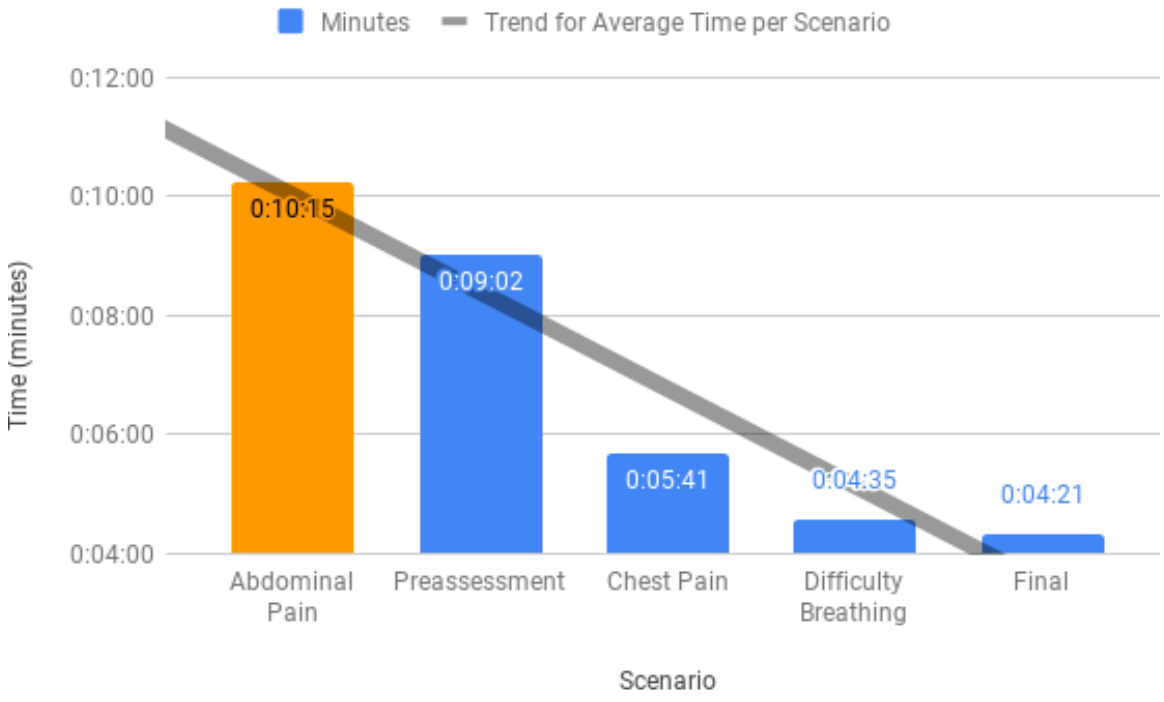
information, presented with a link to references, invited to revisit the instruction if desired, and then exited from the instruction. The subject was then instructed to clear their browser cache and history as they have completed the instruction.

Analysis and Results

This learning assessment was designed to evaluate the impact of the training on the time paramedics spend obtaining a medical history by questioning a patient, the efficiency of those questions, and any subsequent effect on the accuracy of patient diagnoses. It was hoped that improvements in speed and efficiency of history questioning would lead to increased accuracy of diagnoses.

Figure 3

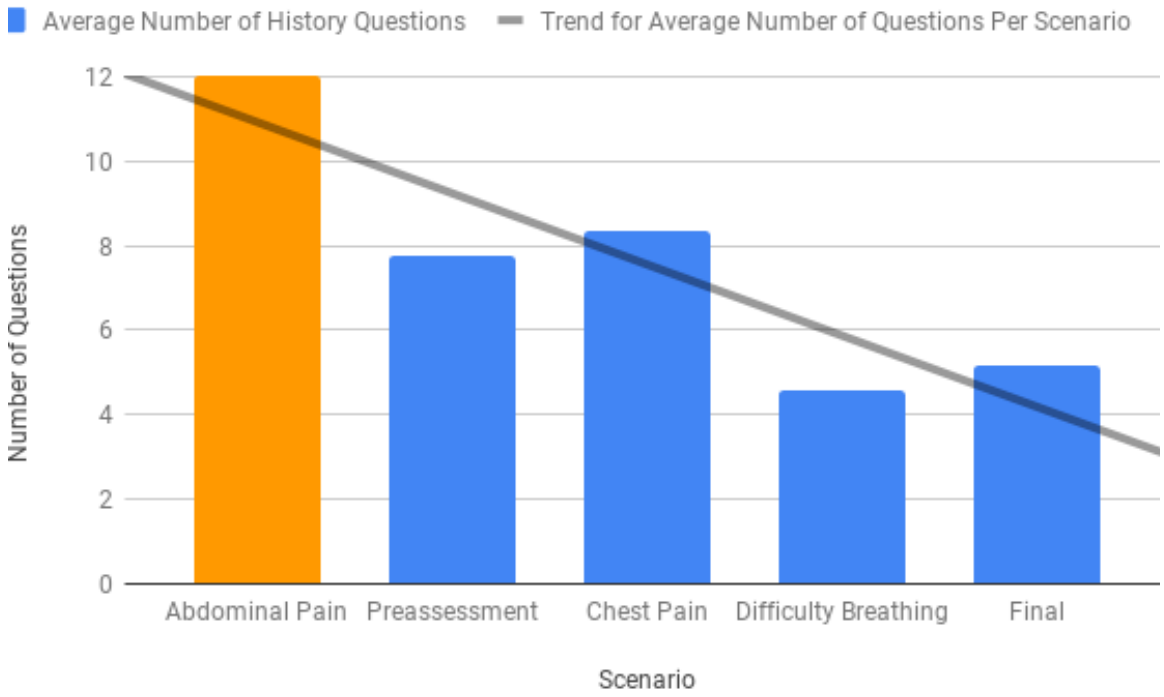
Average Time per Scenario (n=12)



Participants exhibited a linear decrease in the average total time spent per scenario across the five scenarios. This total time spent in scenario equates to how long it takes a paramedic to assess one patient. It also illustrates on-scene time that the paramedic spends assessing a patient before making a diagnosis and beginning treatment. The abdominal pain scenario illustrates the maximum amount of time a participant could spend in a scenario by asking all 12 assessment questions in a linear manner. Participants exhibited a pre-assessment scenario time of 9 minutes. By the final assessment scenario, participants decreased their in scenario time by over half.

Figure 4

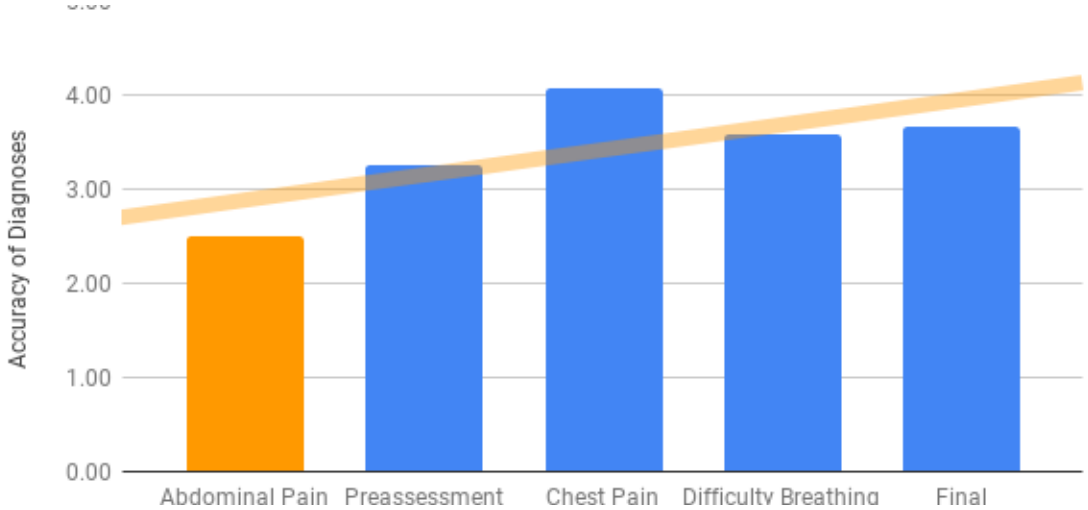
Average Number of History Questions Asked Per Scenario (n=12)



As shown in Figure 4, participants on average showed a trend of a linear decrease in the number of questions they asked their simulated patients during each scenario. This is equivalent to fewer questions being asked and to be answered by the patient. This correlates with the decrease in time spent in the scenario and an increase in the efficiency of the participants' questioning.

Figure 5

Accuracy of Diagnoses per Scenario (n=12)

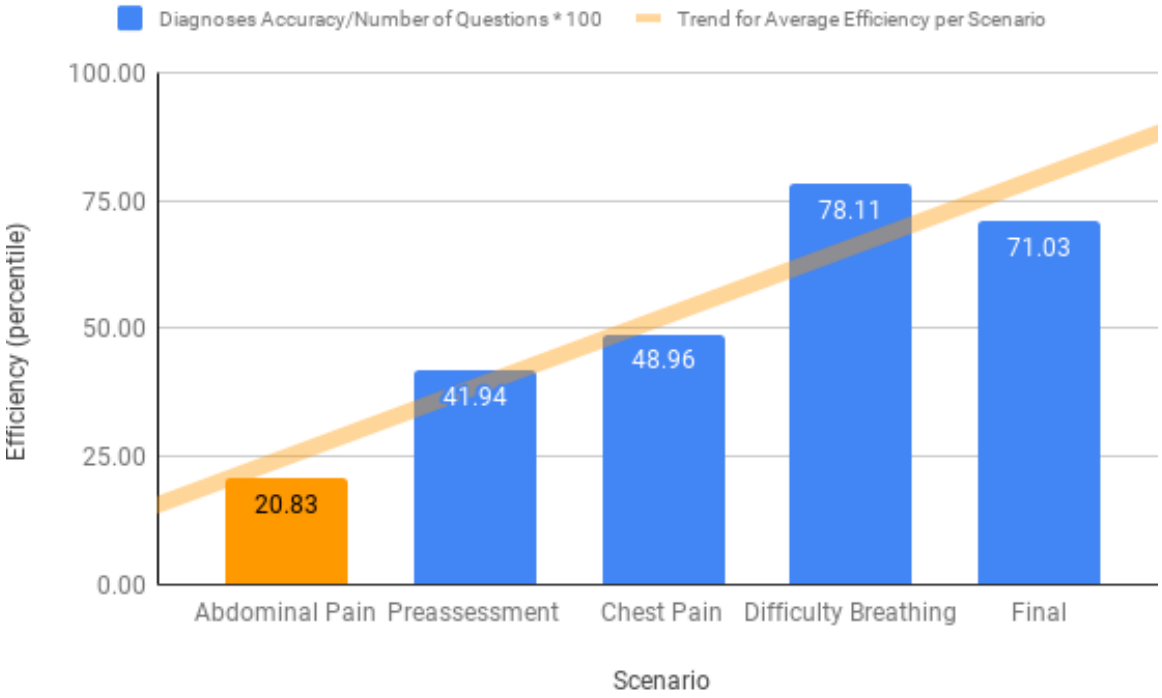


Note. n=12

Figure 5 illustrates participants' accuracy rating with regards to their diagnoses per scenario. This is plotted per participant average, and the data sets illustrates and increase in diagnostic accuracy as the scenarios progressed.

Figure 6

Percent Efficiency of Questioning Per Scenario (n=12)



While not part of the original research questions, the analysis of data in Figure 6, using a simple Physics formula for Efficiency, illustrated that as the participants progressed through the

instructional scenarios, they were constructing more accurate diagnoses while asking fewer medical history questions. Analogous to an engine's performance, 100 percent efficiency is theoretically unobtainable. In Figure 6, the abdominal pain scenario is shown as less than 21 percent efficient, as this scenario required participants to ask all 12 history questions before determining their diagnoses. Participants' pre-assessment is also shown as being at just under 42 percent efficiency. By the final two scenarios, participants exhibited closer to 71 and over 78 percent efficiency with regards to the information they elicited through a lesser amount of questioning.

Figure 7

Accuracy of Diagnoses and Justification Averages per Participant (n=12)

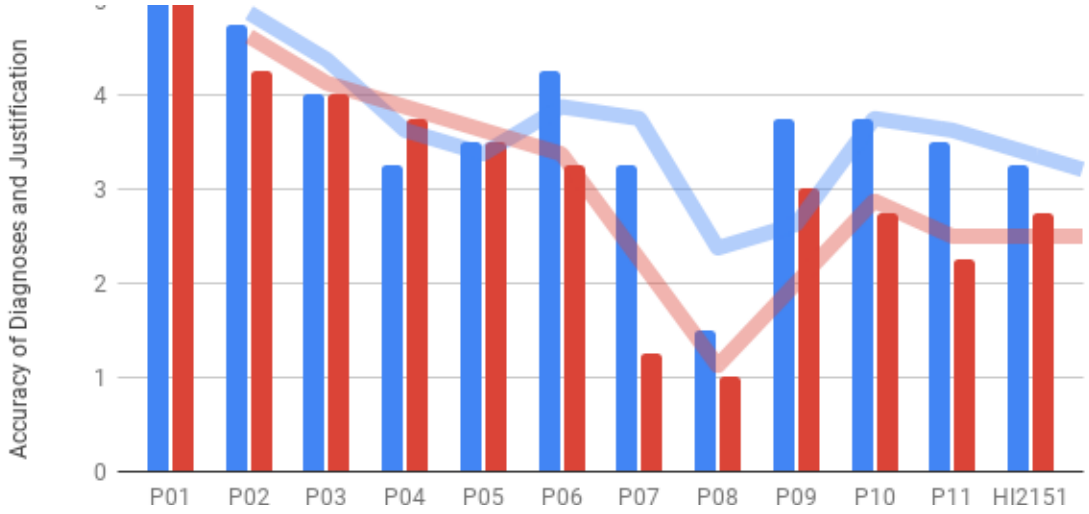
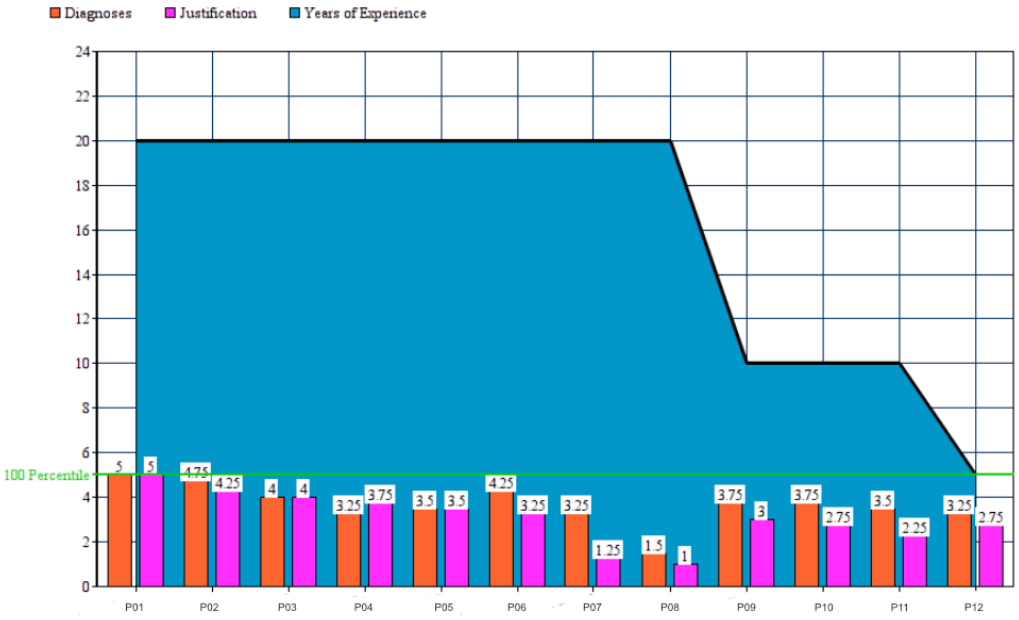


Figure 7 shows the correlation in terms of when participants are plotted out individually with regards to the accuracy of their diagnoses and their justifications for those diagnoses.

Figure 8

Accuracy of Diagnoses and Justification vs Years of Experience (n=12)



Note that the sample size in Table 4 (n = 6), which shows participants post-survey data, there was a coding error for one question related to satisfaction. Therefore, although six participants agreed, three data points are unaccounted for and are large enough to skew this category of satisfaction in another direction. Therefore, this figure should be viewed in light of the qualitative data analysis.

Table 4

Participant Motivation Ratings on the Post-Survey

Area	Item	*n*	*M*	*SD*	Min	Max
Attention	The game-like platform made me want to complete the scenarios.	12	3.14	1.51	1	5
Relevance	When a theory, interpretation, or conclusion was presented in the scenarios I tried to decide if there was good supporting evidence.	12	4.17	0.58	1	5
	I think I will be able to apply what I have learned in these scenarios to my work.	12	3.92	0.52	1	5
	The scenarios were realistic.	12	3.67	0.89	1	5
Confidence	If I try hard enough, then I will understand the material in these cases.	12	3.83	0.58	1	5

	I tried to identify a colleague whom I could ask for help if necessary.	12	3.27	0.79	1	5
	I'm certain I can master the skills being taught in these cases.	12	3.36	1.29	1	5
Satisfaction	The most satisfying thing for me in these cases was trying to understand the content as thoroughly as possible.	9	3.78	0.83	1	5

Discussion

Paramedics are required to make timely diagnoses and treatment decisions. Treatment decisions can only be made when a paramedic has decided on a probable diagnosis with regard to his patient. In other words, a paramedic must know what is wrong with a patient *before* the paramedic can begin life-saving treatment. In order to decide on a diagnosis, paramedics must elicit assessment information efficiently. This is done in the form of a subjective medical history and an objective physical examination. Not only must paramedics elicit this information, but they must do so in a timely manner. One way to improve this skill is to develop an order of prioritization for the medical history questions and then to make this order more efficient by asking questions that would provide the most informational value first.

In this project, the researcher used interactive branching scenarios and observed how participants progressed through the instruction. As shown in Figure 3m the average time participants spent in each scenario decreased linearly.. Although this may have partly have been due to participants becoming accustomed to the mechanics of the Twine instruction, the downward slope of time in each scenario remains consistent, even in the final assessment scenario where the complexity of the medical problem of the patient was increased. If acclimatization to game mechanics was a major factor in this observed increase in speed of assessment, it might be expected to see an initial downward slope, then a leveling off as participants progressed through the rest of the scenarios. This was not the case as the increase in speed of assessment remains consistent even within the more complex final assessment scenario. This would indicate that another factor might be responsible for the increased speed seen as participants progressed through the scenario. Within the instructional hierarchy and thus also within the instruction, there was designed two intentionally cyclical processes. Thus within the design of the instruction, participants were intentionally guided by the branching scenarios to cycle and repeat through these processes, allowing for cycling between eliciting performance and the reflection required for critical thinking.

The number of medical assessment questions also decreased as participants progressed through the scenarios. While 12 questions were the maximum amount that could be asked by participants in each assessment scenario, participants started with eight questions on average. This is due to the fact that all participants were experienced paramedics who may have progressed away from a linear method of assessment due to their years of experience.

While the final assessment scenario shows that participants had decreased the number of medical assessment questions asked to an average of five questions, participants asked closer to four questions in the second to last scenario (difficulty breathing). This results is consistent because the final assessment scenario was a more complex medical presentation, with two simultaneous medical problems within one patient. On average the participants asked only one additional history question. The latter difficulty breathing scenario showed that participants decreased the number of questions they were asking by half by the end of the instruction. This shows that as the participants cycled through the instruction, they were cognizant of and therefore reflective on their choices and prioritization of their questioning.

Participants also displayed an average increase in their accuracy of medical diagnoses. This finding, when evaluated in light of Figure 4, where participants displayed a decrease in the number of questions asked, showed that participants appeared to be asking fewer questions and therefore eliciting more useful information per question. Participants appeared to be deciding on which questions were most important to ask, and in what order. The participants subsequently exhibited more accuracy in their diagnoses and when their efficiency was calculated, they exhibited a gain of over 36 percent efficacy. This may reiterate the effectiveness of the instruction with interactive branching scenarios, in which participants were allowed to decide on choices, with opportunities for both reflection and feedback thus allowing the participants' to construct a method to increase the efficiency of their medical assessment skills of their own motivation. This may lead to the critical thinking, which Facione (1990) defines as "purposeful, self-regulatory, nonlinear, and recursive cognitive process that a person uses to make a decision about what to do in a given context".

Figure 7 shows that the accuracy of the participants diagnoses seems to correlate with their ability to justify those diagnoses. Upon first appearance, it may seem to indicate that certain individuals simply have more years of experience, and are therefore more accurate with their diagnoses and their ability to justify those diagnoses. However, in Figure 8, we see that this is not the case. Accuracy of diagnoses and justification was plotted out for each individual with regards to their years of experience as a paramedic. Figure 8 does not show a correlation between accuracy of diagnoses and justification with years of experience.While on average, all paramedic participants exhibited increases in speed, prioritization, and accuracy of diagnoses, their individual levels of performance did not depend on their years of experience. This was a surprising finding and may indicate that the actual initial didactic content, or perhaps the method of training needs to be further studied. Although this study did not plot out grouping by hours of education or grouping by instructional time spent in branching scenarios, these are areas that

may be important to examine and consider as we move to create more efficient paramedics that are able to develop and utilize critical thinking skills in all aspects of patient care.

Table 4 illustrates participants responses with regards to satisfaction with this interactive branching scenario instruction. Participants were highly satisfied with most aspects of the instruction. Participants surprisingly did not particularly enjoy the gamified aspect of the instruction, nor did they find the animated videos engaging. Participants indicated that they preferred real medical images because it would allow them to better assess their patients severity. This may also have been a factor in participants justification of diagnoses ratings. The participants may have been unable to justify their patient's diagnoses because they were not provided many real medical images within the instruction. More investigation into this area would be needed.

Conclusion

In conclusion, an excellent way to design and evaluate this project has been with the use the ADDIE Model. The ADDIE Model is a systematic and logical process that stands for Analyze, Design, Develop, Implement, and Evaluate. Although this is taught as a linear process, it can also be cyclical and that is when it becomes most efficient. This is analogous to how paramedics are taught the basic skills for medical assessment.It is interesting that perhaps the contented quality of instruction of any foundational didactic material play a large role in subsequent performance. When utilizing newly acquired skills perhaps years of experience is not as crucial as the quality of foundational knowledge The ADDIE Model's allows for reorientation during the design process and can be relied upon when building solutions to real-world problems.

Interactive branching scenarios are effective in teaching paramedics assessment skills that they can then apply to real-world emergency medical practices.Continuing evaluation into the method of presentation, to possibly provide learners with increased modalities of interaction with branching scenarios as well as provide real medical images may increase learner satisfaction with the instruction and therefore increase the effectiveness of interactive branching scenario instruction for paramedics.

Much gratitude to all the professors and the ohana within the Learning Design and Technology Department at the University of Hawaii at Manoa. Also thank you to my critical friends. This process would not have been possible without your knowledge, unwavering patience and support. Thank you.

References

Abelsson, A. (2017). Learning through simulation. *Disaster and Emergency Medicine Journal*, 2(3), 125–128. https://doi.org/10.5603/demj.2017.0027

Arcs model of motivation [pdf]. (2017, July 24). Texas Tech University WorldWide eLearning. Retrieved April 30, 2021, from http://www.tamus.edu/academic/wp-content/uploads/sites/24/2017/07/ARCS-Handout-v1.0.pdf

Birt, J., Moore, E., & Cowling, M. (2017). Improving paramedic distance education through mobile mixed reality simulation. *Australasian Journal of Educational Technology*, 33(6). https://doi.org/10.14742/ajet.3596

Carter, H., & Thompson, J. (2015). Defining the paramedic process. *Australian Journal of Primary Health*, *21*(1), 22. https://doi.org/10.1071/py13059

Cowling, M., & Birt, J. (2018). Pedagogy before technology: A design-based research approach to enhancing skills development in paramedic science using mixed reality. *Information*, *9*(2), 29. https://doi.org/10.3390/info9020029

Darabi, A., & Arrington, T. (2017). Designing Instruction for Critical Thinking: A Case of a Graduate Course on Evaluation of Training. *International Journal of Teaching*, 29(3), 551–559. Retrieved from https://files.eric.ed.gov/fulltext/EJ1150794.pdf. (n.d.).

EMS World. (2015). *Getting the most from your history and physical: Chest pain patients.* https://www.emsworld.com/article/12149999/getting-the-most-from-your-history-and-physical-chest-pain-patients

Janing, J. (1997). Assessment of a Scenario-Based Approach to Facilitating Critical Thinking Among Paramedic Students. *Prehospital and Disaster Medicine*, 12(3), 42–48. https://doi.org/10.1017/s1049023x00037638. (n.d.).

Kruse, K. (2006). *Gagne's Nine Events of Instruction: An Introduction* [pdf]. E-Learning Guru. Retrieved April 30, 2021, from http://www.kvccdocs.com/teaching-online/teaching-online/nine-events.pdf

Meyer, A. D., & Singh, H. (2016). Calibrating how doctors think and seek information to minimise errors in diagnosis. *BMJ Quality & Safety*, 26(6), 436–438. https://doi.org/10.1136/bmjqs-2016-006071

Munroe, B., Buckley, T., Curtis, K., & Morris, R. (2016). Designing and implementing full immersion simulation as a research tool. *Australasian Emergency Nursing Journal*, 19(2), 90–105. https://doi.org/10.1016/j.aenj.2016.01.001

Oak S. N. (2014). Medical simulation: a virtual world at your doorstep. *Journal of postgraduate medicine*, 60(2), 171–174.

Onstott, K. L. (2019). *Perceived Impact of Virtual Scenario-Based Branching Simulations Among Radiology Program Students*. [Dissertation, Boise State University]. ScholarWorks. https://scholarworks.boisestate.edu/td/1637/.

Perona, M., Rahman, M. A., & O'Meara, P. (2019). Paramedic judgement, decision-making and cognitive processing: a review of the literature. *Australasian Journal of Paramedicine*, 16. https://doi.org/10.33151/ajp.16.586. (n.d.).

Radu, V. (2020, September). *The Current State of Critical Thinking in EMS*. JEMS. Retrieved December 5, 2020, from https://www.jems.com/commentary/the-current-state-of-critical-thinking-in-ems/

Rouse, R., III. (2004). *Computer game design: Theory and practice* (2nd ed.). Wordware Publishing, Inc.

Thompson, J., Houston, D., & Dansie, K. (2017). Teaching students to think like a paramedic: Improving professional judgement through assessment conversations. *Australasian Journal of Paramedicine, 14*(4). https://doi.org/10.33151/ajp.14.4.543

Walshe, N., & Hegarty, J. (2019, November 4–6). *O2 A systematic review to evaluate the comparative effectiveness of educational interventions on health care professionals' situation awareness: implications for training* [Conference paper]. Abstracts of the Association of Simulated Practice in Healthcare, 10th Annual Conference, Belfast, UK. https://doi.org/10.1136/bmjstel-2019-aspihconf.2

Appendices

Appendix A

Pre-Survey Questions/Demographics

Username (Please choose a username that will be anonymous and that you will use throughout the game).
What is your level of emergency medical technician certification?
How many years of experience do you have as an emergency medical technician?
What is your age?
How proficient are you with technology?
How do you perceive your proficiency with regard to medical assessment?
How do you perceive your proficiency with regard to pre-hospital medical diagnoses?
How many hours per week do you play computer games?
Approximately how many hours of scenario-based training have you had prior to your certification?

Appendix B

Post-Survey Questions

Username
If I try hard enough, then I will understand the material in these cases.
When a theory, interpretation, or conclusion was presented in the scenarios I tried to decide if there was good supporting evidence.
I think I will be able to apply what I have learned in these scenarios to my work.
I tried to identify a colleague whom I could ask for help if necessary.
I'm certain I can master the skills being taught in these cases.
The game-like platform made me want to complete the scenarios.
The scenarios were realistic.
The most satisfying thing for me in these cases was trying to understand the content as thoroughly as possible.
What aspects of this instruction were most useful or valuable?
How would you improve this instruction?
Placeholder/Thank you/For more information contact/Exit point

Appendix C

Performance Objectives

#	SKILL/OBJECTIVE	PERFORMANCE OBJECTIVES
EL1	REVIEW history and physical examination components.	Emergency medical technicians at the paramedic level of certification will recognize with 100% familiarity, history taking and physical examination acronyms utilised in paramedicine, with 100 percent recognition, when viewed in a presentation. .
EL1	RECALL history and physical examination components.	Emergency medical technicians at the paramedic level of certification will recall individual components of history taking and physical examination acronyms that are utilised in paramedicine with 100 percent recall of all components of each acronym.
L2	PREDICT subjective data.	Emergency medical technicians at the paramedic level of certification will predict all history taking questions in the linear order of the acronym, by indicating a question corresponding to the letters of each acronym with 100 percent accuracy.
L2	DISCOVER objective data.	Emergency medical technicians at the paramedic level of certification will discover in a linear (head to toe) manner all objective physical examination findings, when content is presented within multimedia, by indication of the discovery with 100 percent accuracy.

L3	RELATE subjective and objective data.	Emergency medical technicians at the paramedic level of certification will relate all subjective history and objective physical examination data by reflecting on feedback from correct and incorrect decisions provided by the instruction, for as many times as needed to generate a primary clinical impression.
L4	DETERMINE diagnoses.	Emergency medical technicians at the paramedic level of certification will determine a clinical impression by indicating their conclusion, with the use of one concise medical terminology indicative of the most relevant diagnosis.
L4	JUSTIFY diagnoses.	Emergency medical technicians at the paramedic level of certification will provide justification for their diagnosis by indicating their reasoning of how they related their subjective history and objective physical examination data for all scenarios completed.
L5	TERMINAL OBJECTIVE	The learner will obtain a subjective medical history and discover physical examination elements, and be able to relate the two with justifications in an efficient manner.

Appendix D

Sequence and Clustering of Objectives

CLUSTER	OBJECTIVES	TIME
1	REVIEW history and physical examination components.	5 mins
2	RECALL history and physical examination components.	5 mins
3	PREDICT subjective data. DISCOVER objective data. RELATE subjective and objective data.	60 mins
4	DETERMINE diagnoses. JUSTIFY diagnoses.	20 mins
5	The learner will obtain a subjective medical history and discover physical examination elements, and be able to relate the two with justifications in an efficient manner. (Terminal Objective)	Total: 1.5 hours

Appendix E

Content Presentation

SKILL: REVIEW history and physical examination components.	#1
OBJECTIVE: Emergency medical technicians at the paramedic level of certification will recognize with 100% familiarity, history taking and physical examination acronyms utilised in paramedicine, with 100 percent recognition, when viewed in a presentation.	
CONTENT PRESENTATION	
Information Presentation: Review information will be provided in a video and embedded within Twine. Terminologies will be also provided via text within Twine.	
Examples: This will be a simple presentation of the information.	
Non-Examples: None	
Pretest & Embedded:	Pretest scenario, prior to instruction will serve as pretest for all content. Embedded will be the progress through this section of instructional content.
Feedback	Immediate feedback will be provided within Twine by multimedia with regards to the learners choices as they progress through this instruction. Feedback will be provided via learner self reflection facilitated by the game mechanics of Twine. This will be ongoing continuous learner self assessment as feedback.
Posttest	This will be an ongoing continuous assessment within quantitative data of Twine. This will be in the RECALL objective of the instruction. This will be in all scenarios.

SKILL: RECALL history and physical examination components.	#2

OBJECTIVE: Emergency medical technicians at the paramedic level of certification will recall individual components of history taking and physical examination acronyms that are utilized in paramedicine with 100 percent recall of all components of each acronym.	
CONTENT PRESENTATION	
Information Presentation: Multimedia instruction will be provided. Text may use a roll-over function to present a question and then answer reveal type of mechanism within Twine.	
Examples: This will be a simple recall of presented information.	
Non-Examples: None.	
Pretest & Embedded:	Pretest scenario, prior to instruction will serve as pretest for all content. Embedded will be the progress through this section of instructional content.
Feedback	This will be an ongoing continuous assessment within quantitative data of Twine. This will be ongoing continuous learner self assessment. There will be generalised feedback at the end of the scenario. This will be in a Posttest scenario.
Posttest	Learners will self assess with presented answers provided by the roll-over text function. This will be ongoing continuous learner self assessment. This will be in a Posttest scenario.

SKILL: PREDICT subjective data. DISCOVER objective data. RELATE subjective and objective data.	#3

OBJECTIVE: Emergency medical technicians at the paramedic level of certification will predict all history taking questions in the linear order of the acronym, by indicating a question corresponding to the letters of each acronym with 100 percent accuracy. Emergency medical technicians at the paramedic level of certification will discover in a linear (head to toe) manner all objective physical examination findings, when content is presented within multimedia, by indication of the discovery with 100 percent accuracy. Emergency medical technicians at the paramedic level of certification will relate all subjective history and objective physical examination data by reflecting on feedback from correct and incorrect decisions provided by the instruction, for as many times as needed to generate a primary clinical impression.	
CONTENT PRESENTATION	
Information Presentation: Twine will be used to create branching decision scenarios with various embedded multimedia content. The feedback from learner choices within Twine will be the presenting content for this skill. Plotagon will be used to create short audio/visual content. Learners will be presented with methods within Twine to indicate their decision choices.	
Examples: A higher value data object gathered, will result in positive feedback within the feedback choice video branch	
Non-Examples: Will be embedded within the feedback within Twine. A lesser value data object gathered, will result in negative feedback within the feedback choice video branch.	
Pretest & Embedded:	Pretest scenario, prior to instruction will serve as pretest for all content. Immediate feedback will be provided within Twine by multimedia with regards to the learners choices as they progress through this instruction. This will be an ongoing continuous assessment within quantitative data of Twine. This will be ongoing continuous learner self assessment. (Embedded) Quantitative data will be collected during learner progression through the instruction. This will be within the mechanics of Twine. This data will then be evaluated via rubric and graphical analysis.

Feedback	Immediate feedback will be provided within Twine by multimedia with regards to the learners choices as they progress through this instruction. This will be an ongoing continuous assessment within quantitative data of Twine. This will be ongoing continuous learner self assessment. There will be generalised feedback at the end of the scenario. This will be in a Posttest scenario.
Posttest	Learner will input a diagnosis for the particular scenario within Twine Immediate feedback will be provided within Twine by multimedia with regards to the learners choices.

SKILL: DETERMINE diagnoses. JUSTIFY diagnoses.	#4
OBJECTIVE: Emergency medical technicians at the paramedic level of certification will determine a clinical impression by indicating their conclusion, with the use of one concise medical terminology indicative of the most relevant diagnosis. Emergency medical technicians at the paramedic level of certification will provide justification for their diagnosis by indicating their reasoning of how they related their subjective history and objective physical examination data for all scenarios completed.	
CONTENT PRESENTATION	
Information Presentation:	
Examples:	

Non-Examples:	
Pretest & Embedded:	Pretest scenario, prior to instruction will serve as pretest for all content. (Embedded) Justification for the diagnosis will be within the data of prioritization of the scenario passages which will be evaluated via rubric.
Feedback	Immediate feedback will be provided within Twine via multimedia with regards to the learners choices as they progress through this instruction. This will be an ongoing continuous assessment within quantitative data of Twine. This will be ongoing continuous learner self assessment. There will be generalized feedback at the end of the scenario.
Posttest	Learners will input a diagnosis for the particular scenario within Twine. Immediate feedback will be provided within Twine by multimedia with regards to the learners choices. Learners will be provided with an input modality to state justification of their diagnosis. This will be evaluated subjectively along with all data collected.

SKILL: The learner will obtain a subjective medical history and discover physical examination elements, and be able to relate the two with justifications in an efficient manner.	#5
OBJECTIVE: TERMINAL OBJECTIVE	
CONTENT PRESENTATION	
Information Presentation:	

Examples:	
Non-Examples:	
Pretest & Embedded:	Pretest scenario, prior to instruction will serve as pretest for all content.
Feedback	Immediate feedback will be provided within Twine by multimedia with regards to the learners choices as they progress through this instruction. This will be an ongoing continuous assessment within quantitative data of Twine. This will be ongoing continuous learner self assessment. There will be generalised feedback at the end of scenario.
Posttest	Final scenario with two clinical impressions needed. Learners will be provided with an input modality to state justification of their diagnosis. This will be evaluated subjectively along with all data collected.

Appendix F

Learner Characteristics

Cognitive	*Physiological*
● Varying levels of certification ● Varying years of experience ● Educational backgrounds range from high school graduates to Master's Degrees ● May have widely varying dual areas of employment such as RN, service, technical trades. ● High incidence of ADHD diagnoses amongst the population. ● Tendency to break rules when necessary. ● Creative ● Good critical thinking skills ● Calm under pressure ● Better performance under stressors ● Chronically fatigued ● Good lateral thinkers ● Learners may feel it's a waste of time learning something they perceive they are already familiar with. ● Impatient ● Various levels of comfort with technology ● Rapid thought processing · ● Enjoy high intensity activities ● Short attention span ● Like novelty ● Enjoy challenges	● Wide age anywhere from 18 years old to 60+ years old. ● Activity ranges from physically fit to multiple chronic injuries such as back, knee, shoulder from employment. ● Consumes high levels of caffeine ● Chronically fatigued ● Poor diet ● Sleep deprived ● High incidence of sleep apnea ● Constant state of sympathetic response ○ Increased Cortisol ○ Increased Adrenaline ● Frequent exposure to higher levels of carbon monoxide from ambulance exhaust ● Frequent exposure to contagious diseases ○

Affective	*Social*
● Self confident ● Decisive ● Comfortable in leadership roles ● May be argumentative ● Enjoys stress. · ● Does not enjoy decision making when off work ● May be meticulous ● Intolerant of boredom ● Prideful. ● Impatient ● Risk takers ● Prefers high intensity work ● Prefers work in short periods of time ● Dislikes long lecture ● Resistant to authority ● Prefers immediate rewards ● Enjoys excitement ● Loyal	● Challenging of authority ● Not readily accepting of others ● Excellent reader of people· ● Can be antagonistic towards administration· ● Have many family obligations ● May have multiple jobs· ● Work a lot of overtime shifts ● Prefers to be in control of situations ● Straightforward/forthright ● Can be abrasive ● Can be argumentative ● May disregard authority ● Less able to relate to those not in emergency medical services ● Competitive ● Authoritative ● Long shifts spent at work

Appendix G

Keller's ARCS Model of Motivation

Objective	Skill	Content
Attention		Learner attention was gained and maintained by the presentation of the story like instruction and will target the learners initial, as well as ongoing attention as they progress through the instructional material. Initial attention is gained by the opening movie-like sequence that attempts to quickly immerse the learner within the virtual environment.
Relevance		Relevance to the real world was incorporated within branching scenarios as the learner was presented with simulated emergency medical situations that the learner will experience by being required to make clinical decisions. The learner also experienced immediate feedback of the consequences resulting from their decisions. This is identical to consequences in emergency medical situations with real patients.

Confidence		Learner confidence is constructed by the learner, as she navigates through the scenarios and builds proficiency. Immediate positive feedback, in the form of positive patient outcomes, will build learner confidence. Immediate negative feedback also addresses learner confidence in the presentation of a challenge or a non-response, for the learner to eventually overcome. The learner was allowed to rehearse and repeat scenarios as many times as the learner wanted, therefore confidence building is self-directed and controlled by the learner.

Satisfaction		The ARCS model states that there is a direct relationship between satisfaction and motivation. Therefore, the presentation of instructional content in a gamified manner, with intentional respect toward the elements of good game design was used to address learner motivation. Health care students may be more motivated if presented with actual images and videos of disease processes or catastrophic events (Onstott, 2019). Therefore, scenes, additional visuals, terminology, speech of the simulated characters, slang terminology and other designed elements within the instruction contained graphic representations of disease processes, and stress inducing interactions that the learner was exposed to,were no greater than what is encountered and expected in real world situations.

Appendix H

Gagne's Nine Events of Instruction

Step	Objective	Skill	Content

1	Gaining Attention	Reception	● The learner's attention was captured through an initial movie-like passage at the beginning of the instructional material. ● Intermittent scenes of shorter duration (cut-scenes) will be utilized for learner feedback as a result of a decision and may also be intentionally placed within the branching scenarios to introduce additional information. ● Cut scenes will also be used to promote the fluidity and engagement of the learner with the scenario storyline. ● There will also be a movie-like passage at the end of each scenario that is responsive to the learner's choice of final medical diagnosis ● This ending will be variable and will provide final feedback upon the learner's process within the branching scenario.
2	Informing Learners of the Objective	Expectancy	● Learners were informed of the learning objectives within the progressive instructional scenarios. Initial scenarios will present the initial objectives within the character interactions and the storyline. ● As the instructional objectives progress to a higher level, scenario objectives presented by the simulated characters and presented situations will mirror the learning objectives. ● This will be seamlessly integrated within each scenario, as well as present the progression of objectives within the overall instructional content collectively.

3	Stimulating Recall of Prior Learning	Retrieval	● Learners will recall prior learning that were stimulated according to the level of objectives that the learner is experiencing within the instruction. Initial recall was simple and presented the basic foundational knowledge of assessment as a review. ● Acronyms were presented and briefly reviewed for recall by the learner. ● As the learner progressed through the more complex branching scenarios, the learner would recall prior learning from previous scenarios within the instruction in which the learner's decision making resulted in a less than optimal or poor patient outcome. ● As the learner navigates through each scenario and if the learner chooses to repeat failed scenarios, these experiences will serve as a recall for the learner's next attempt at a scenario.
4	Presenting the Stimulus	Selective Perception	● Content was presented within the scenarios. ● Although the instruction progresses from simple scenarios to complex branching scenarios, each scenario effectively presents the identical content. ● This content is the foundational skills for medical assessment, which is medical history and physical examination. ● As the instruction, and therefore scenarios become more complex, the learner will be required to present the instructional content via their own recall as the mechanics of the scenario will require learner input of information. ● This content will be presented within a gamified instruction that can be accessed via different electronic devices of the learner's choice.

5	Providing Learner Guidance	Semantic Encoding	● Learner guidance was provided to support the learners in learning the content of the instruction. ● Initial guidance will utilize acronyms. Role playing by the simulated characters within the scenario will also provide guidance that is not obvious to the learner. ● This type of guidance will also be in the form of examples and nonexamples in the form of consequences in patient outcomes. ● Additional visuals, audio, background information within the scenario will also provide the learner with guidance within the more complex branching scenarios. ● Overall learner guidance will also be provided within the progression of the scenario storylines within the game like instruction.
6	Eliciting Performance	Responding	● Learner performance was elicited within each scenario, as well as within the progression of the scenarios as each scenario required the same basic skill set. ● The only thing that changes as the learner progresses is the application of critical thinking within the learner's decision-making process. ● Multiple scenarios will provide the learner with practice even if the learner only chooses to play the gamified instruction once. ● The learner will also have the opportunity to repeat the instruction as many times as the learner chooses to do so.

7	Providing Feedback	Reinforcement	● Feedback was provided to the learner that differed at different objectives. ● For the initial and simple objectives, a simple confirmation that the learner has completed the objective will be provided. ● For the more complex objectives that will be presented to the learner by the branching scenarios, the learner will receive either, feedback that acknowledges the learner's accomplishment with correct decision making and therefore arrival at correct diagnoses or remedial feedback that will suggest that the learner will require more practice and will not give learner the solutions.
8	Assessing Performance	Retrieval	● Assessment methods were embedded in the mechanics of the game like instruction. ● There was an obvious component of assessment in which the learner was presented with feedback via the simulation. ● The learner will then be expected to reflect on this feedback and reassess their strategies to progress through the remainder of the scenarios. ● Therefore, there should be a component of learner self-assessment that will enable learners to "win" the final scenario. ● There is also another component of learner assessment that will not be transparent as it is incorporated within the mechanics of the game. ● This will provide a more quantitative assessment of learner performance.

9	Enhancing Retention and Transfer	Generalization	● Virtual simulation and branching scenario instruction will enable learners to retain the knowledge that they have constructed within the simulated scenarios and hopefully transfer this knowledge for use in real world applications.

Appendix I

Elements of Effective Game Design

Objective	Design	Content
Teaching Game Mechanics	Incorporated at the start of the instruction and transparent. Intuitive Immediate Effortless	Clicking on hyperlink Using participants own device of choice
Guidance	Just in time. Does not give the answer.	Embedded within review and recall Twine passage
Non - Linearity	Players Choices	
Identify with Avatar	Initial/Early	Opening movie, similar avatars
Game Save	Able to save and return	Function of the Twine
Play Again	Able to play repeatedly and make different choices	Different choices within each scenario
Immediate Feedback	Click on hyperlink to obtain	Animated videos imbedded

Appendix J

IRB Approval Letter

UNIVERSITY of HAWAI'I® MĀNOA

Office of Research Compliance
Human Studies Program

DATE:	January 14, 2021
TO:	Hoffman, Daniel, PhD, University of Hawaii at Manoa, Department of Learning Design and Technology Kakazu, Judy, MD, University of Hawaii at Manoa, Department of Learning Design and Technology
FROM:	Rivera, Victoria, Dir, Ofc of Rsch Compliance, Social&Behav Exempt
PROTOCOL TITLE:	"But Did You Die?" Development of Critical Thinking in Paramedics Using Branching Scenario Problem Based Learning within a Novel Interactive
FUNDING SOURCE:	None
PROTOCOL NUMBER:	2020-00921
APPROVAL DATE:	January 14, 2021

NOTICE OF APPROVAL FOR HUMAN RESEARCH

This letter is your record of the Human Studies Program approval of this study as exempt.

On January 14, 2021, the University of Hawaii (UH) Human Studies Program approved this study as exempt from federal regulations pertaining to the protection of human research participants. The authority for the exemption applicable to your study is documented in the Code of Federal Regulations at 45 CFR 46.104(d) 3.

Exempt studies are subject to the ethical principles articulated in The Belmont Report, found at the OHRP Website www.hhs.gov/ohrp/humansubjects/guidance/belmont.html.

Exempt studies do not require regular continuing review by the Human Studies Program. However, if you propose to modify your study, you must receive approval from the Human Studies Program prior to implementing any changes. You can submit your proposed changes via the UH eProtocol application. The Human Studies Program may review the exempt status at that time and request an application for approval as non-exempt research.

In order to protect the confidentiality of research participants, we encourage you to destroy private information which can be linked to the identities of individuals as soon as it is reasonable to do so. Signed consent forms, as applicable to your study, should be maintained for at least the duration of your project.

This approval does not expire. However, please notify the Human Studies Program when your study is complete. Upon notification, we will close our files pertaining to your study.

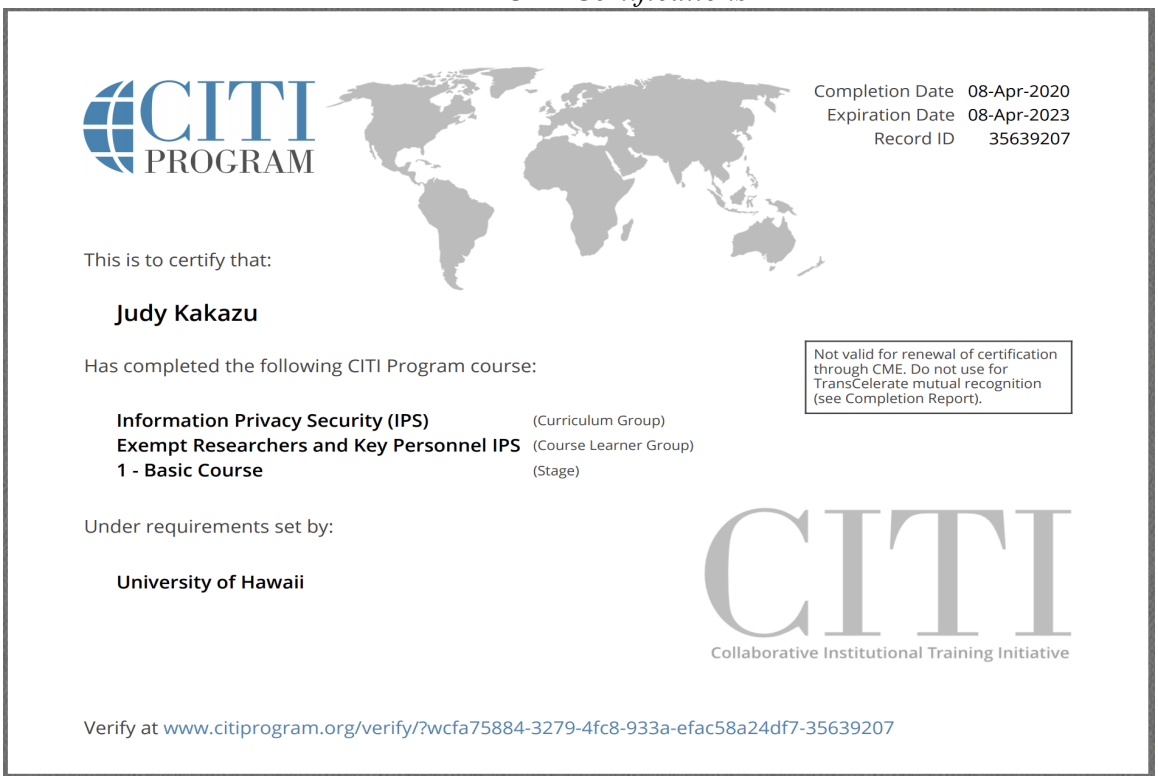
If you have any questions relating to the protection of human research participants, please contact the Human Studies Program by phone at 956-5007 or email uhirb@hawaii.edu. We wish you success in carrying out your research project.

UH Human Studies Program, Office of Research Compliance
Office of the Vice President for Research and Innovation, University of Hawai'i, System
2425 Campus Road, Sinclair 10, Honolulu HI 96822
Phone: 808.956.5007 • Email: uhirb@hawaii.edu
https://www.hawaii.edu/researchcompliance/human-studies
An Equal Opportunity & Affirmative Action Institution

Association for the Accreditation of Human Research Protection Programs, Inc. Full Accreditation

Appendix K

CITI Certifications



CITI PROGRAM

Completion Date 08-Apr-2020
Expiration Date 08-Apr-2023
Record ID 35639207

This is to certify that:

Judy Kakazu

Has completed the following CITI Program course:

Not valid for renewal of certification through CME. Do not use for TransCelerate mutual recognition (see Completion Report).

Information Privacy Security (IPS) (Curriculum Group)
Exempt Researchers and Key Personnel IPS (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

University of Hawaii

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wcfa75884-3279-4fc8-933a-efac58a24df7-35639207

CITI PROGRAM

Completion Date 08-Apr-2020
Expiration Date 08-Apr-2023
Record ID 35577903

This is to certify that:

Judy Kakazu

Has completed the following CITI Program course:

Not valid for renewal of certification through CME. Do not use for TransCelerate mutual recognition (see Completion Report).

Human Subjects Research (HSR) (Curriculum Group)
Exempt Researchers and Key Personnel (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

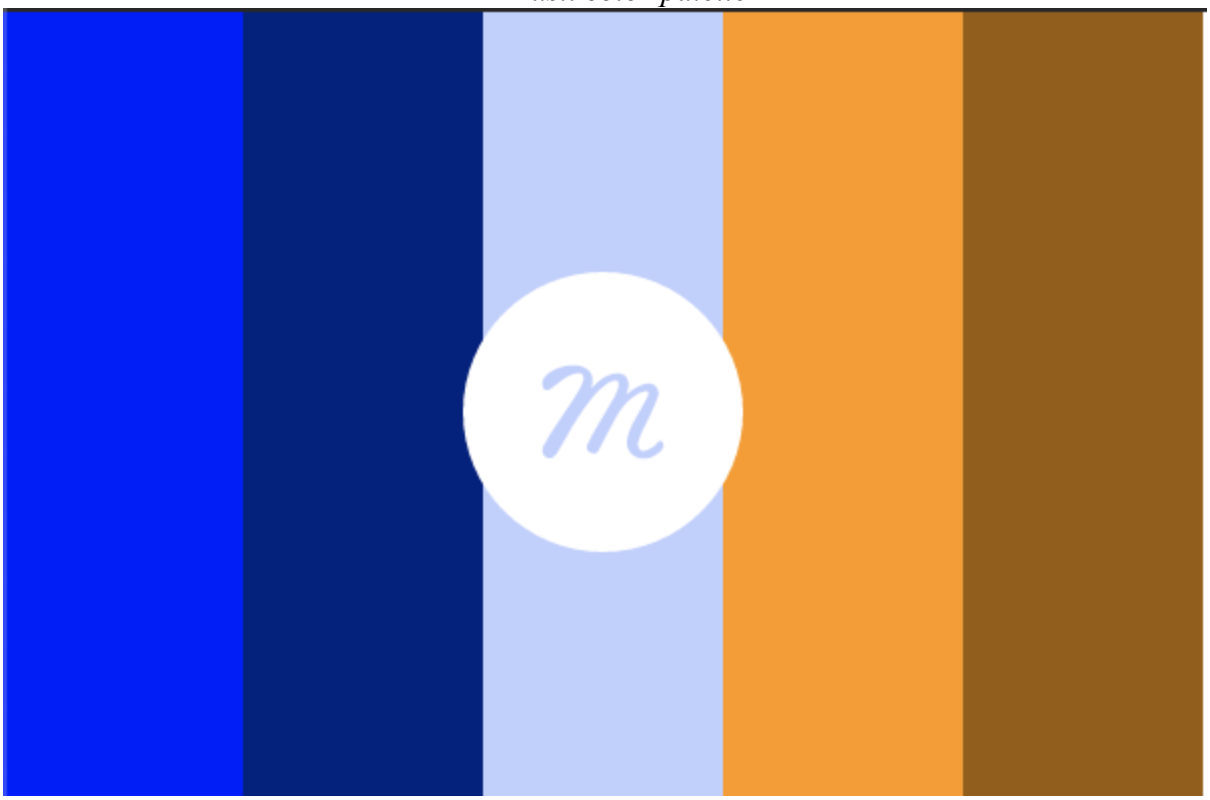
University of Hawaii

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w43382a2e-fa58-4a93-8b06-337e7fb675c6-35577903

Appendix L

Musli color palette



Appendix M

Pre-Survey Data

Table 1

Participants; Self-Reported Demographics

Characteristic	Count	Percent
EMT Paramedic	12	100%
30-39 years old	2	17%
40-49 years old	5	42%
50-59 years old	3	25%
60 years or older	2	17%
1-4 years experience	0	0%

5-10 years experience	1	8%
10-19 years experience	3	25%
20+ years experience	8	67%
1-2 hours SBT*	1	8%
2-5 hours SBT*	1	8%
5-10 hours SBT*	4	33%
10+ hours SBT*	6	50%

Note n=12 *Scenario Based Training Before Certification

Table 2

Participants; Self-Reported Proficiency With Technology

Characteristic	n	M	SD	Min	Max
Perceived proficiency with technology	12	3	0.95	2	5
Hours per week playing computer games	12	3.33	4.44	0	10

Note n=12

Table 3

Participants; Perceived Proficiency with Medical Assessment and Diagnoses

Characteristic	n	M	SD	Min	Max
Perceived proficiency with Assessment	12	3.5	0.90	3	5
Perceived proficiency with Diagnoses	12	3.42	0.90	3	5

Note n=12

Appendix N

Email Script

Aloha,

My name is Judy Kakazu, and I am a graduate student at the University of Hawai'i (UH) at Mānoa in the Department of Learning Design and Technology. I am doing a research project as part of the requirements for earning my graduate degree. You have been identified as a certified emergency medical technician and I hope that you will be interested in participating in my research project. If you choose to participate, you will be asked to experience online scenarios and answer survey questions geared toward emergency medical technicians. Your participation in this project is completely voluntary.

Please review the attached consent form for further details. If you agree to participate, please type your information into the consent form within a reply email to the address jkakazu@hawaii.edu.

Here is the link to the project. https://laulima.hawaii.edu/x/HIdD5R

There is also the same consent form built into the project, so don't worry if you are unable to type on the attached consent form. Just try your best and send it back.

If you have any questions about this study, please text, call or email me at 808-383-5696 or jkakazu@hawaii.edu.

Thank you for your time and consideration,

Judy Kakazu

Appendix O

Consent Forms

Consent to Participate in a Research Project

Daniel Hoffman PhD, Principal Investigator

Project title: "'But Did You Die?'; Development of Critical Thinking in Paramedics Using Branching Scenario Problem Based Learning within a Novel Interactive."

Aloha! My name is Judy Kakazu, and I am a graduate student at the University of Hawai'i (UH) at Mānoa in the Department of Learning Design and Technology. I am doing a research project as part of the requirements for earning my graduate degree.

What am I being asked to do?

If you participate in this project, you will be asked to experience online scenarios and answer survey questions for emergency medical technicians.

Taking part in this study is your choice.

Your participation in this project is completely voluntary. You may stop participating at any time. If you stop being in the study, there will be no penalty or loss to you.

Why is this study being done?

The purpose of my project is to evaluate the impact of scenario-based learning on emergency medical technicians. I am inviting you to participate in my project because you are a certified emergency medical technician.

What will happen if I decide to take part in this study?

You will be asked to complete surveys and experience an online browser-based instruction on your electronic device of choice, such as your cell phone, tablet or laptop. This will include scenario videos and will seem much like an online game. You will be asked for your input during this game. It should take about 1.5 hours to complete but you may stop and save your progress and continue when you have time. I will be collecting this data so that I can later evaluate my project.

What are the risks and benefits of taking part in this study?

I believe there is little risk to you by participating in this research project. You may become stressed or uncomfortable making decisions and answering any of the questions or receiving information and feedback from the instructional module. If you do become stressed or uncomfortable, you can skip the question or take a break. You can also stop participating at any time.

Consent to Participate in a Research Project

Daniel Hoffman PhD, Principal Investigator

Project title: "'But Did You Die?'; Development of Critical Thinking in Paramedics Using Branching Scenario Problem Based Learning within a Novel Interactive."

There will be no direct benefit to you for participating in this study project group. The results of this project may help to improve scenario-based learning for emergency medical technicians.

Privacy and Confidentiality: I will keep all study data secure on a password protected computer and within protected online storage modalities. Only my University of Hawai'i advisor and I will have access to the information. Other agencies that have legal permission have the right to review research records. The University of Hawai'i Human Studies Program has the right to review research records for this study.

After the study project is completed, I will erase or destroy the stored data. When I report the results of my research project, I will not use your name. I will not use any other personal identifying information that can identify you. I will use pseudonyms (not your real names) and report my findings in a way that protects your privacy and confidentiality to the extent allowed by law.

Although we ask everyone in the study group to respect everyone's privacy and confidentiality, and not to identify anyone in the group or repeat what might be said during the study, please remember that other participants in the group may accidentally disclose what was said. Avoid sharing personal information that you may not wish to be known.

Compensation:

There will be no compensation for this project.

Questions:

If you have any questions about this study, please call or email me at 808-383-5696 or jkakazu@hawaii.edu. You may also contact my advisor, Dr. Daniel Hoffman, at 646-462-0017 or hoffman2@hawaii.edu. You may contact the UH Human Studies Program at 808.956.5007 or uhirb@hawaii.edu. to discuss problems, concerns and questions; obtain information; or offer input with an informed individual who is unaffiliated with the specific research protocol. Please visit http://go.hawaii.edu/jRd for more information on your rights as a research participant.

Consent to Participate in a Research Project

Daniel Hoffman PhD, Principal Investigator

Project title: "'But Did You Die?'; Development of Critical Thinking in Paramedics Using Branching Scenario Problem Based Learning within a Novel Interactive."

If you agree to participate in this project, please sign and date the following signature page and return it to: *jkakazu@hawaii.edu*

Keep a copy of the informed consent for your records and reference.

Signature(s) for Consent:

I give my consent to join the research project entitled, "'*But Did You Die?'; Development of Critical Thinking in Paramedics Using Branching Scenario Problem Based Learning within a Novel Interactive.".*

I also acknowledge that I am giving consent electronically to all contained in this form by accessing the hyperlink to begin the project.

Name of Participant (Print): _____

Participant's Signature: _____

Signature of the Person Obtaining Consent: _____

Date: _____