VR Training Videos: Using Immersive Technologies to support Experiential Learning Methods in Maritime Education

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ABSTRACT

The use of David Kolb's experiential learning theory which involves the process of gaining an experience and then reflecting upon that experience in order to formulate ideas is interwoven throughout maritime training schemes worldwide. Unfortunately, experiential learning can be difficult to implement due to cost and resource issues.

With the recent advancements in immersive technologies, new opportunities to engage students in the experiential learning process are becoming available. The combination of instructional 360-degree videos and virtual reality, or VR Training Videos, creates a highly immersive experience which can created at a significantly lower cost when compared to simulators or real-world platforms.

This paper will discuss the pedagogy and research-based foundation behind a proposed course design using these VR Training Videos as a part of an experiential learning process. It will also discuss the steps which SUNY Maritime College has undergone to implement this technology and course design into the classroom along with some of the initial findings of this project.

1. INTRODUCTION AND THEORY

Historically, the education of mariners was based heavily upon slowly gaining experience and learning by watching another individual or by taking part in shipboard operations. Although regulations have evolved over time and Maritime Education and Training Centers and Universities (MET's) have begun to educate mariners in a more classroom like setting, the overall training scheme for mariners continues to be heavily reliant upon gaining experience as an integral part of the learning process. As experience is seen as a critical aspect of maritime education, one of the most commonly utilized learning pedagogies is the experiential learning process. David Kolb defined the experiential learning theory as being a process in which the learner progresses through the four stages of experience, reflection, abstract conceptualization, and application. Although it generally starts with experience and flows through the following stages, the learner can jump into any part of the stage so long as all four stages have been achieved [1]. An example of this process occurring in maritime education is the common use of simulation and real-world platforms throughout the curriculum of many MET's. As pointed out by Kazuo Yoshii et al. (2017), the effectiveness of learning with multiple experiences which occur throughout the learning process is much more effective than a single experience as a part of the learning process. Due to this, California Maritime Academy and other MET's follow a curriculum structure which alternates between experiences gained throughout their curriculum [2]. Today, the experience portion is provided to the mariner primarily through the use of real-world platforms (in the form of both commercial vessels and training vessels) as well as through utilizing simulators. Both platforms provide their own advantages and disadvantages. Real-world platforms have the advantage of genuine

experience which does not lack degradation due to unrealistic situations or representations. However, they also have increased risks due to real-world consequences and safety factors and are extremely expensive to operate. Simulators are wonderful at replicating specific tasks which can be repeated as many times as needed. Unfortunately, simulators are also relatively expensive and often require an instructor to operate the system, limiting the availability of the platform to the students. As the number of regulations continue to increase and the standards for mariner education continues to evolve, MET's are continually looking for new ways to create and share these essential experiences with their students which are effective and efficient.

One technology that MET's are exploring as a new platform for experiential learning is Virtual Reality (VR). Although VR is not necessarily a new technology, recent advancements have made it an accessible platform which has the potential to create and share experiences in revolutionary ways. There are many areas throughout literature where MET's are beginning to use VR for education. One example is the U.S. Navy's use of Mixed Reality (Augmented Reality combined with Virtual Reality) for medical training and ship familiarization training [3]. Another example is that of the VR mobile lifeboat simulator which was recently launched by the Norwegian company ASK Safety [4]. Additionally, MET's are exploring the use of VR Training Videos which are 360-degree videos which are displayed on VR headsets. This combination allows for a fully immersive experience which allows for a high level of immersion while combining the benefits of video-based instruction. There have been several studies such as the one conducted by G. Meadow et al. (2017) from Solent University, which have identified the beneficial nature and instructional quality of VR Training Videos but also identified a great need to identify the proper methodology to effectively implement these VR Training Videos into a curriculum [5]. At SUNY Maritime College, we propose that one way to effectively implement VR Training Videos into a curriculum is to utilize them as an introductory platform for the experiential learning process. The VR Training Video would create the first experience within the experiential learning cycle, leading to reflection and abstract conceptualization which would be conducted through standard classroom lecture and quizzes/tests, leading into application which would be completed in a simulated or real-world environment. This would begin the experiential learning cycle earlier, better preparing the student for their interaction in the simulated or real-world environment.

2.0 IMPLEMENTATION AND RESEARCH

The use of VR Training Videos as an experiential platform alongside standard classroom lecture first began to be implemented and studied at SUNY Maritime College in the Summer of 2018, progressing through three distinct phases, and ended in Summer of 2019. Phase I consisted of a pilot study which was conducted to explore the general design of the VR Training Videos and the User Experience associated with them. It also allowed for the testing of the intended research design for the following phases. After reviewing the findings from Phase I, a new VR Training Video was developed for a lesson within the established curriculum. The researcher then requested that instructors use the materials alongside their normal instruction in the Bridge Resource Management Course (Phase II) and during the Summer Sea Term Course (Phase III). The lesson materials and lesson design was intended to follow an experiential model which involved creating an experience using the VR Training Videos, engaging in reflection and formulating abstract conceptualization through the use of lecture/discussion and quizzes/tests, and then applying this knowledge and creating a new experience through the use of simulation or real-world application.

2.1 Methodology

The research design which was intended for all three phases was that of a Mixed-Method, which combined the quantitative evaluation through the comparison of student achievement on tests and

student responses to a survey along with an explanatory research design which used student responses to open ended response questions on a survey and instructor observations.

2.2 Subjects

The subjects were students who attended SUNY Maritime College and were currently within a Maritime Transportation Degree program ranging from their first year of study to their final year of study. The student body at SUNY Maritime in a Marine Transportation Degree includes individuals who are 19-25 years old, predominantly male (88%), and predominantly Caucasian (76%). These students were contacted to volunteer for the study as they should be familiar with the terms but are still progressing through the levels of instruction within the program.

2.3 Implications of Research on Subjects

The risk to the students involved with the study was very low. The only potential risk was due to the risk of VR sickness. Filming techniques were used to minimize motion and increase a sense of stability within the VR Training Videos to reduce this risk. The students were also notified of this risk and were instructed to immediately remove the VR headset if they began to feel any indications of motion sickness. None of the students mentioned feeling a sensation of motion sickness throughout this study. An IRB for Phase I and a second IRB for Phase II and Phase III was submitted for and accepted through the SUNY Empire State review board. All research was conducted in line with the ethical procedures outlined in both IRBs.

2.4 PHASE I: Pilot Study

Phase I was the pilot stage and was intended to obtain information to help guide the full study (Phase II and Phase III) which would be conducted the following academic year. A full discussion on both the procedure and the results of Phase I are covered in depth in the Final Project Thesis paper which was submitted by Tamera Gilmartin in August of 2018 to SUNY Empire State College and can be referenced on the cadet360.org website [6]. This is a short overview of the study so that it can be compared to the following phases.

First, the lesson design was developed and the materials to support the lesson were created including lecture notes, a quiz, and the VR Training Video. The VR Training Video was created using 360-degree cameras which were placed in several locations on a vessel which conducted the operation of having a small vessel coming alongside. This recorded film was then edited using a video editing program which had 360-degree video editing capabilities. These videos were then uploaded into the VR headsets. The participants were broken up into two groups; one group received lecture first and then watched the VR Training Videos while the other group watched the VR Training Videos first and then received the lecture. After completing the lesson, the students were asked to take a short quiz covering the material and were asked to fill out a short survey.

The quantitative results from the tests indicated that although instruction in general made a major impact on student achievement of learning outcomes, that a combination of lecture and VR Training Videos was best. Qualitative results from the observations collected from student interaction and student comments also indicated that the use of VR Training Videos should be done first and then be followed by a discussion. Both quantitative and qualitative results related to the user experience indicated that the overall user experience for the VR Training Video was high, but that some improvements upon the camera location and presentation of information on the screen could be improved through slight refinements. Issues such as camera angle being crooked or unfamiliarity with the platform were indicated as being significant distractors which took away from the experience but did not impact the overall enthusiasm or satisfaction with the use of VR Training Videos as a learning platform.

2.5 PHASE II: Bridge Resource Management

Phase II was intended to be the first stage of full implementation of integrating VR Training Videos into a structured lesson using the proposed experiential learning format which involves creating the first experience (VR Training Video), conducting reflection and formulating abstract concepts (lecture/discussion), and then applying the concept through the creation of a new experience (Simulator) and was conducted in the Bridge Resource Management (BRM) course which is at the end of the student's curriculum and uses simulation heavily as an experiential learning platform. The original research design was intended to follow the same format as Phase I, using a Mixed-Method approach with quizzes, surveys, and observations. Due to issues related to constraints of the BRM course, the quizzes were not implemented during this phase and there was no opportunity to alternate the placement of the VR Training Videos in relation to the lecture.

First, the materials were created by using a 360-degree camera to record the evolution of anchoring the vessel onboard the school's training vessel, which was then edited using a video editing program, and was finally uploaded to the VR Headsets for use. This was done utilizing the information gained on proper angles and camera placement from Phase I. Lesson materials including lecture notes and quizzes were also created. The instructors who taught the intended BRM course were contacted and the process of the how the study would be conducted was agreed upon. However, throughout the course, the instructors found it difficult to add the VR Training Video evolution into the classroom portion due to course requirements and time constraints. This caused the VR Training Videos to be offered as a voluntary evolution outside of designated class time. The students all received a lecture on the operation of anchoring in class first, watched the VR Training Videos outside of class, and then participated in the simulation exercise as a part of the original course. Although the simulation exercise was designed to be an anchoring exercise, many of the students did not have the opportunity to demonstrate an impact on their ability to anchor due to delays in the BRM simulation due to vessel traffic. This prevented any analysis on the observations of any impact the VR Training Videos had on the application of a subject.

2.6 PHASE III: Summer Sea Term

Following Phase II, the Anchoring VR Training Video was used again during the Summer Sea Term course. The Summer Sea Term course is an essential part of the Maritime Transportation curriculum at SUNY Maritime College, where the students gain their sea time requirements and learn through real-world application onboard the training vessel through standing bridge watches, conducting deck maintenance, and taking lecture-based classes. The researcher asked one of the instructors who was teaching the Ship Operation lecture portion of the Summer Sea Term course, to go over anchoring with the students using the VR Training Videos and then allow the students to watch the anchoring operation be conducted on the vessel first-hand. The Ship Operation lecture portion is taken by students who have completed their first year of instruction and are still at the beginning of their curriculum. This was intended to fully engage the experiential processes by creating the first experience (VR Training Video), conduct reflection and formulate abstract concepts (lecture/discussion), and then apply the concept by creating a new experience (watching/participating in the real-world evolution). The original research design was intended to follow the same format as Phase I, using a Mixed-Method approach with quizzes, surveys, and observations. Due to issues related to constraints of the Ship Operations portion of the Summer Sea Term course, the quizzes were not implemented during this phase and there was no opportunity to alternate the placement of the VR Training Videos in relation to the lecture.

The videos had already been created for Phase II, so Phase III began by implementing the VR Training Videos directly into the course. The instructor was provided with some quick instruction on how to operate the headsets and was then asked to use them in class, instruct the students, allow the students to watch the real-world anchoring operation on the training vessel, and then collect the surveys

at the end. As this was conducted the same way for all the groups of students within the Ship Operations lecture portion, preventing the opportunity for a control, a comparison between tests was not completed.

3.0 Phase II and III: Qualitative Results

Although there were many barriers to conducting Phase II of this study within the intended course, significant findings and indications were identified throughout the study. One of the most significant findings was that the use of VR Training Videos within a structured lesson must be a conscious decision on the part of the instructor conducting the class. Courses which already have a high number of learning objectives and may also have a difficult time integrating VR Training Videos into established lesson plans. Providing this material as an outside of class resource however, such as through the internet, may allow the students the opportunity to use these materials while not impacting the established structure of the course. An interesting observation was that although it is often commented that VR can be an isolating experience, the students were talking to each other throughout the experience, asking questions and making comments about the VR Training Videos. Additionally, it was observed that students who participated in the original filming of the videos commented on how it was strange to watch themselves and that they were able to see and understand more of what was happening when watching the VR Training Video when compared to participating in the original event. Finally, most of the participants during Phase II stated that the VR Training Video would have been better placed earlier in the curriculum as it would have been good as an introduction. When the video was used earlier in the curriculum as a part of Phase III, the students indicated that it seemed to be placed in the correct location for the curriculum and their current knowledge level.

The results from Phase III of the study indicated a high level of enthusiasm towards the use of VR Training Videos as a learning platform. The comments in the surveys indicated that the narration provided in the video, along with the text-based prompts and labels where very helpful as they guided the students towards the important learning material. Overall, the user experience levels were high, however the issue of the sound being too low was also consistently indicated. This lesson took place in a classroom aboard the training vessel which had very loud air blowers for ventilation. This made it difficult to hear the narration. The instructor moved the class into the library where the ventilation noise was much lower, fixing the issues with sound. Finally, it was noted in both Phase II and Phase III that the participants were very enthusiastic about the VR Training Videos and the potential they had as a teaching platform, often suggesting other lessons where they would be beneficial such as cargo operations or docking operations.

4.0 PHASE II AND PHASE III: Quantitative Responses

As issues arose during both Phase II and Phase III for properly implementing a comparison on the impact VR Training Videos made upon performance on a quiz/test, the quantitative results for these two phases came from the survey responses. Although Phase II was conducted with students towards the end of their studies and Phase III was towards the beginning of their studies, the responses between

both groups were very similar and carried similar percentages so the results below are combined from Phase II and Phase III.

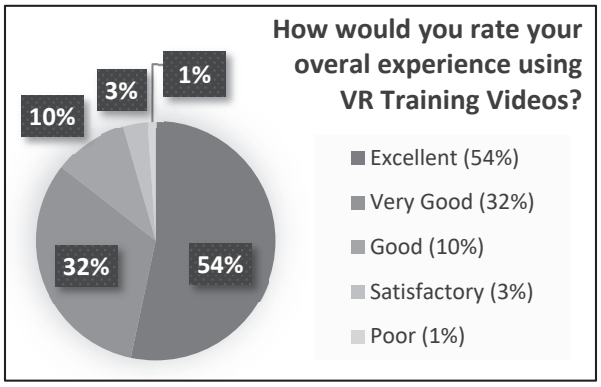

Figure 1. Overall Experience of VR Training Videos. n = 90

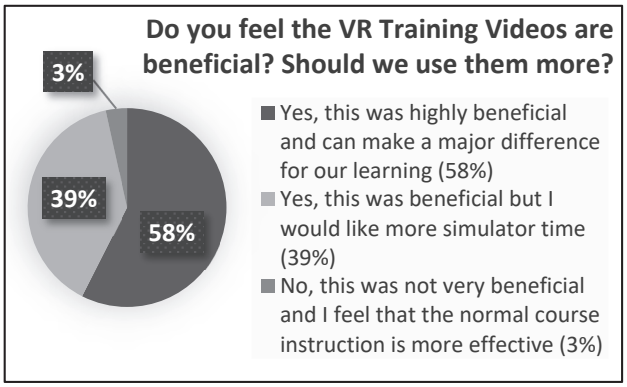

Figure 2. Student perception on how beneficial the VR Training Videos were for education. n = 90

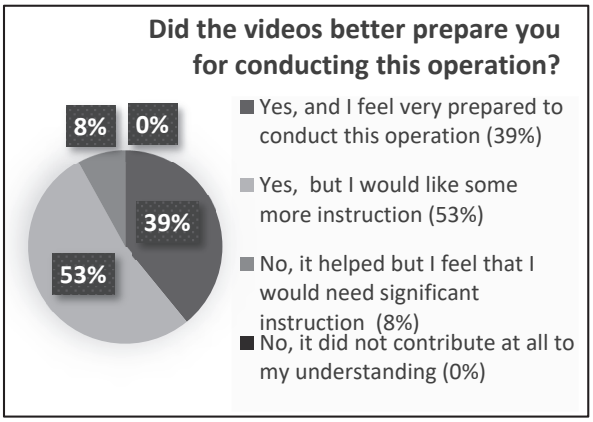

Figure 3. Effectiveness of VR Training Videos at preparing students for participation in shipboard operations. n = 90

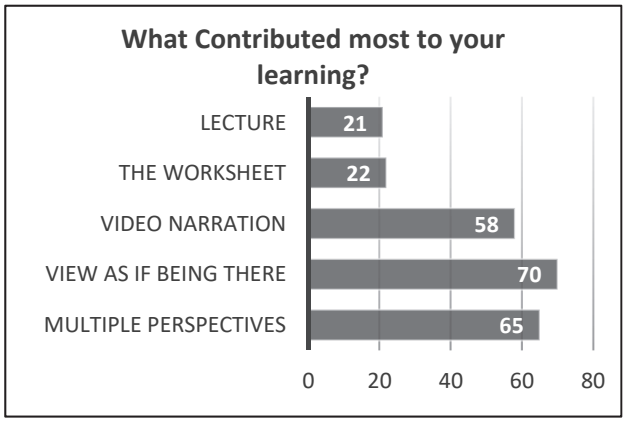

Figure 4. VR Training Video contribution to student learning. n = 90 (multiple responses allowed)

The responses concerning the overall experience of using the VR Training Videos along with the perceived benefit of the videos indicated a high level of enthusiasm and perceived benefit from the students. Although there were a small number of responses which indicated a satisfactory or poor experience, there was an overwhelming majority of responses for excellent or very good indicating that overall, the students were very pleased with the experience (see *Figure 1*). There was also an overwhelming majority which responded that the VR Training Video was beneficial, but some also noted that more time practicing with the simulator would be beneficial. Very few indicated that normal course instruction was more effective than the VR Training Videos (see *Figure 2*). As for the question on how prepared the students felt, almost all responded that the VR Training Videos had contributed to their learning with a majority indicating that more instruction would be beneficial (see *Figure 3*). The responses to the question asking what contributed the most to the student's learning, items related to the design of the VR Training Videos received the majority of the responses. These included that the videos were the immersive nature of the first person view, being able to view the event from multiple perspectives, and/or the narration of the video (see *Figure 4*).

5.0 CONCLUSIONS AND FUTURE RESEARCH

The purpose of this project was to implement and test the use of VR Training Videos as an experiential learning platform. The proposed methodology of implementing the VR Training Videos within an experiential learning framework was to first have the students interact with the VR Training Videos to gain an experience, then conduct reflection and formulate abstract conceptualization through the use of lecture and quizzes/tests, and then apply the knowledge through the use of simulated or real-

world scenarios. Both Phase II and Phase III did not follow the exact flow which was intended, but rather did lecture first, followed by VR Training Videos, more discussion, and then application. However, the students did progress through all the stages. As Kolb also states in his experiential learning theory, it is possible to jump anywhere in the process but it is critical to allow all of the stages to occur for deeper learning [3]. It was difficult to force a strict format following this methodology for VR Training Videos into a class which had already been designed. However, when the experience aspect through the use of VR Training Videos was allowed to fall naturally where it fit the best in the individual class, such as an outside assignment or within a flexible classroom setting, it could be very effective. The students also indicated that although they felt the VR Training Videos were very effective as a learning platform, the lecture/discussion portion was also important and had contributed to their learning as well. The students also placed a very high emphasis on the need to continue with further experiences such as in the simulator or in the real-world, allowing for true application of what they had learned. It was also noted that VR Training Videos were more effective at an introductory level, essentially creating the first step in the experiential learning process by allowing the student to observe the evolution safely, focusing on the lower knowledge levels such as learning the nomenclature and processes through the guided narration and text provided in the VR Training Videos, before moving into higher levels of knowledge and application.

Although the placement of the VR Training Videos within the experiential learning cycle did not seem to impact their overall effectiveness so long as all stages were addressed, more research into the use of VR Training Videos as an experiential learning platform should be conducted to establish if there truly is an impact or if there is a preferable method as was indicated in the pilot study. The comments by the students who had been present for the filming of the video on how they saw things differently when watching the event through the VR Training Video also presents interesting opportunities for research. As the students commented that they were able to see things from different perspectives and noticed things they did not during the filming of the video, VR Training Videos might present a good opportunity as a debrief tool as well, making it a potential tool for the reflection and abstract conceptualization portion of the experiential learning process, following an activity which occurred in the real-world or in the simulator. This and other new or unique uses for VR Training Videos should be explored further as VR Training Videos have the potential to create revolutionary teaching methods which were unavailable in the past.

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