vIIS: A Vocational Interactive Immersive Storytelling Framework for Skill Training and Performance Assessment

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ABSTRACT

Training and assessment of a new worker is the most vital part of any vocational industry. The landscape of jobs and work is changing rapidly, thanks to the emerging new technology and the advancement of knowledge in the scientific fields. This technological and scientific revolution presents an opportunity in the creation of new industries and occupations, enhanced productivity and quality of work life, and the potential for more people to participate in the workforce. But these come at risk and disadvantage of an increased cost of training as well as lack of proper training in a few industries. In this paper, we propose to build a vIIS framework - A Vocational Interactive Immersive Storytelling system that uses storytelling in an Interactive virtual environment to train and assess a worker a new skill. The major advantage of this vIIS system is that it provides constant feedback in an engaging immersive virtual reality environment and has better memory retention and recall of the trained task. For assessment, we intend to collect data such as task completion time, accuracy, error rate, qualitative feedback and also measure transfer learning.

CCS CONCEPTS

• **Human-centered computing** → *User interface management systems.*

KEYWORDS

virtual reality, interaction, training, framework

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1 INTRODUCTION

When a new worker joins the workforce, training is given in either of the two ways - active or passive. Active training is when a mentor is assigned to the new worker and the new skill or job is taught. The advantage of this training method is that the mentor provides instant feedback and offers their experience that enhances the learning experience. The other method is passive where an expensive training tool is used to train a new skill to the worker. It saves a lot of time of other workers who could have been assigned as mentors but this method doesn't provide feedback constantly. The passive method is not engaging as well.

In this paper, we present a framework that uses Interactive Immersive Storytelling to train a new skill and assess the worker's performance. The major advantage of this vIIS system is that it provides constant feedback in an engaging immersive virtual reality environment and has better memory retention and recall of the trained task.

2 MOTIVATION AND RELATED WORKS

To solve the problem of training workers for future jobs and new emerging technology, it is important to address the issue of providing more engaging and better learning opportunities. We need to facilitate crucial research that combines perspectives, methods, and knowledge of computer science, engineering, learning sciences, research on education and workforce training, and social, behavioral, and economic sciences. We also need to design intelligent technologies that can have a positive impact on individual workers, the work at hand, the way people learn and adapt to technological change, creative and supportive workplaces (including remote locations, homes, classrooms, or virtual spaces). Assessment is as important as training. Testbeds needs to address all the factors that can provide all-around feedback after the training. Lastly, as these new technologies enter future work environments, we need to understand, anticipate, and explore ways of mitigating potential risks. This paper aims to provide a framework that will advance the knowledge base related to worker education and training and formal and informal learning to enable all potential workers to adapt to changing work environments.

2.1 Storytelling for education and learning

Storytelling is the most primal way of communication. It predates writing and was used to share ideas, learn and communicate with others. Till date, storytelling is proven as the best way to teach and is widely and successfully used in education sectors. Extensive research is also done on how storytelling is useful in fields such as Language learning [2], Teaching [6], Means of Communication [9], Marketing and customer experience [17], PR strategy [7], retail sales [8], Children [10], and also used by socially assistive robots for storytelling, Gamification in storytelling, Journalism, Social movements, Online campaigns, Dementia, Collaborative Storytelling, Video games, Visualization, Stress, other emotional and psychiatric uses.

Training and assessment exercises inside the college condition are still oftentimes limited by classroom dividers and absence of authenticity.

[16] addresses these issues by immersing the students in a virtual environment and gets them acquainted with a storyline. Gamification components are utilized to expand the commitment with nature and spotlight consideration on the assignments at hand, including students' interest and feeling of experience to expand self-coordinated learning.

2.1.1 Digital Storytelling. Digital storytelling is a term used when digital tools and technologies are used to tell a story. They are much more engaging and informative. Digital ST has been evolved dramatically since technology advancement and easy access to digital content from cable networks and the internet. [13] tells the use of Digital Storytelling in the classroom and education. With the rise of emerging technology, immersive mediums such virtual reality (VR) and Augmented Reality (AR) are being started to use for more engaging storytelling.

2.1.2 Interactive Storytelling. Interactive Storytelling (otherwise called Interactive dramatization) is a type of advanced excitement in which the storyline isn't foreordained. The writer makes the setting, characters, and circumstance which the account must address, however, the client (likewise peruser or player) encounter a novel story dependent on their associations with the story world. All intelligent narrating frameworks must make utilization of manmade reasoning (AI) somewhat. The engineering of an intuitive narrating program incorporates a dramatization supervisor, client model, and operator model to control, individually, parts of story generation, player uniqueness, and character learning and conduct. Together, these frameworks produce characters that demonstration "human," change the world continuously responses to the player, and guarantee that new story occasions unfurl conceivably.

Interactive Storytelling in a blended reality condition combines advanced digital and physical data. It, as a rule, utilizes an increase of this present reality and physically-based connection to make an immersive experience that relates to the emotional storyline of the intelligent account impacted by the activities of the client. Immersion is a pivotal part of such an establishment and can be impacted by various factors, for example, video, sounds, communication and, at last, the density of every single joined improvement in the environment. [12]

2.2 Impacts of Immersiveness on training

Bailenson, Jeremy et al. [1] describes the utility of using virtual reality environments to transform social interaction via behavior and context, with the goal of improving learning in digital environments. They conducted 4 experiments and demonstrated that teachers with augmented social perception were able to spread their attention more equally among students than teachers without augmented perception. Conventional ways to deal with learning have regularly centered upon information exchange techniques that have focused on textuallyâĂŘbased commitment with students, and dialogic strategies for collaboration with mentors. The utilization of virtual universes, with textâĂŘbased, voiceâĂŘbased and sentiment of 'nearness' normally is considering increasingly complex social associations and planned to learn encounters and pretends, just as empowering student strengthening through expanded intelligence. [3]

Immersion in a digital experience created by the virtual environment which involves the suspension of disbelief, and the design of immersive learning experiences that that creates fake sensory, actionable, and symbolic factors. Sensory immersion replicates digitally the experience of location inside a three-dimensional space; total sensory interfaces utilize either head-mounted displays or immersive virtual reality rooms, stereoscopic sound, and through haptic technologies that apply forces, vibrations, and motions to the userâĂŤthe ability to touch virtual objects. Interactive media now enable various degrees of sensory immersion. [4]

Virtual Reality offers the required crucial characteristics of Immersion, Interaction, and User involvement with the environment and storytelling offers very great potential in education by making learning more motivating and engaging.

2.3 Use of Interactivity in training

Correspondence can happen between individuals, individuals, and machines, individuals and programming, or even machines and machines. With reference to human-computer situations, intelligence can have numerous implications, contingent upon regardless of whether the setting is operational, mechanical, or down to earth (in which case its investigation includes the HCI and interface configuration fields), instructive, social/communicational, masterful, or recreational. Intuitiveness has been characterized as the capacity of information required by the client while reacting to the PC and the idea of the framework's reaction to the information activity. [15] sees intelligence as the degree to which clients of a medium can impact the structure or substance of the interceded condition. Be that as it may, this definition does not involve any type of reaction; an exceptional and significant impact on a domain can be to turn it off, which includes no complementary activity from the earth, and is commonly not thought about an intuitive capacity.

Learning through activity: Current reasoning about how learning happens underscores the constructivist approach, which contends that students should effectively "develop" learning by coaxing it out of encounters that have significance and significance to them. Members in a movement develop their own insight by testing thoughts and ideas dependent on earlier learning and experience, applying them to another circumstance, and incorporating the new learning with previous scholarly builds; a procedure natural to us from real world circumstances. The individual consistently builds speculations, and subsequently endeavors to create information that must, at last, be sorted out. These perspectives have affected the improvement of intelligent and virtual learning conditions, which appear to tie in well with the "learning by doing" and "hands-on" practices of present-day exhibition halls. Also, since computer-generated reality advances give a wide scope of potential outcomes for this sort of intuitiveness and backing for dynamic interest in the development of the substance, they turn out to be appropriate, incredible media for use by schools, galleries and edutainment focuses.

Learning through Play: The quick development and notoriety of amusements have activated expanding enthusiasm among analysts, and various examinations have been completed accordingly. A few hypotheses tie the learning conceivable outcomes given by diversions to inspiration and commitment. Maybe the best known is crafted by Malone [11], which considers diversions as suppliers of characteristic inspirations for learning. The initial four sorts of inborn inspirations (challenge, interest, control, and dream) might be present in any learning circumstance, even those that include just a single individual. The other components of characteristic inspiration (rivalry, participation, and acknowledgment) are arranged as relational inspirations since they depend on the presence of other players. There is a solid association that ties intelligence, commitment, and learning.[14] Together, they can frame the establishment for the advancement of a fruitful augmented simulation condition: an intuitive VR "play space," which permits kids to take part in an imaginative and productive play and accomplish the perfect mix of instructive and recreational esteem.[5]

3 VIIS - VOCATIONAL INTERACTIVE IMMERSIVE STORYTELLING: A THEORETICAL FRAMEWORK

vIIS Framework can be used to develop a system to impart training and assess the various performance metrics from measuring cognitive load to measuring recall rate. The main component *VR Environment* encapsulates three other components of this framework. They are the human component *User*, the cyber component *Story* and the *Feedback* Component.

3.1 VR Environment

The VR Environment is the main component of the vIIS framework which encapsulates all the other components. Virtual Reality is an immersive medium and because of this, the whole training and learning experience can be done in this immersive VR environment. The user is immersed in the VR environment completely and experiences the story like a real-life scenario. This aids better engagement.

3.2 User

The user is the human component in this framework. Our assumption is that the user will have little to no knowledge of the skill being taught using this framework. We also assume that the user will neither have any disability nor visual impairment as this framework requires the user to use a virtual reality head-mounted displays and joystick as an interactive tool with the VR environment.

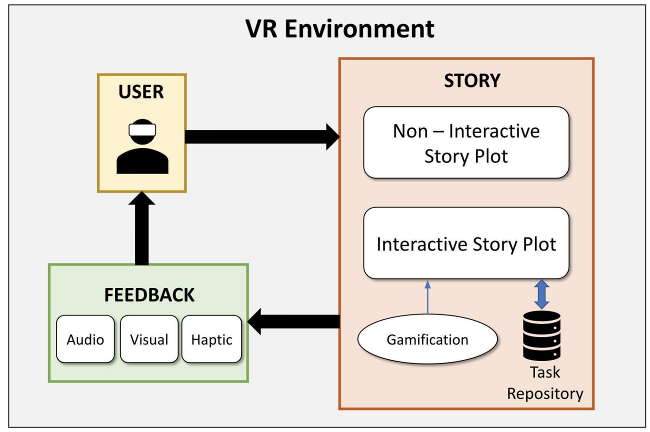

Figure 1: vIIS Framework

3.3 Story

The story component is the heart of the system. This is an immersive interactive story which is comprised of sub-components such as a non-interactive story plot and one or multiple interactive story plots. The story is a 360 degree animated video depicting a real-life scenario of any particular chosen vocation, which has an engaging narrative and consists of multiple story plots. The story narrative is developed in a way which provides a real-world perspective into the actual training in the field. For example, to teach a worker on how to use a tool, for e.g. a vernier caliper, the narrative could be of a crisis-like situation on the field where a worker is shown teaching the use of vernier caliper to his partner. When viewing the narrative in an immersive environment, the user gets a first-hand experience into the actual training, where the 360-degree environment and the immersion both play a key role in the training.

3.3.1 *Non-Interactive Story Plot.*

The non-interactive story plot is a narrative which depicts a scenario which requires learning of a new skill. The is like a training phase which is a view-only training mode (non-interactive). It resembles the traditional method of training. The training to be provided is embedded in the form of a storytelling narrative, which can be modified through a simple graphical user interface. The reason this story plot is non-interactive is that we want the user to be totally immersed in the experience without any distraction. Virtual reality is a new training medium and it takes some time for the user to get accustomed to it. The non-interactive story plot will familiarize the user with the task without adding any cognitive load of doing any activity at this point of time in the learning process.

3.3.2 *Interactive Story Plot.*

Where there is only one non-interactive story plot, the story can have any number of interactive story plots. These plots are interactive in nature, where the user can perform a task to help the story narrative to move forward. These interactive story plots not only provide more intense training but also to assess the performance of the user. In contrast to the non-interactive story plot, where the user only views the training narrative, where the user also interacts within the immersive environment to get hands-on training on the learned task. The tasks are selected from the task repository and gamification is used to enrich the user's experience.

3.3.3 Gamification. The training narrative could be designed in a way such that the user feels motivated to interact with the environment in order to gain loyalty points. The user interaction could be focused on learning the assigned task by breaking it up into lots of smaller sub-tasks, where performing the interaction plays a key role in learning a sub-task. For example, to learn how to use the vernier caliper, the story could break the learning process into chunks of sub-tasks, where one sub-task could be to caliber the vernier caliper before starting any measurement. Here, by motivating the user to perform the sub-task, he could be given loyalty points. This way the user feels more engaged while being trained.

3.3.4 Task Repository. The task repository consists of many tasks which can be added as an interactive story plot. This story plot narrative is designed in a way which involves the user as part of the narrative, and when the story reaches a point where after having demonstrated how to perform a sub-task, the story could turn towards the user and ask her to perform the sub-task. This way the user is forced to interact in order to move the narrative forward. Multiple tasks can be added to the story as interactive story plots.

3.4 Feedback Component

The feedback component is integrated with the environment which continuously analyzes the user's performance and reports the metrics on a graphical user interface in the form of audio, visual or haptic feedback. The audio feedback could be from a virtual avatar in the story, the visual feedback could be displayed on the user interface of the head mounted display and the haptic feedback could be in the form of vibrations from the joystick used to interact with the VR environment.

To supplement the training, the user could also be required to perform an off-line evaluation of the learned task. Manual comparison of the offline evaluation can be compared against the performance of immersive evaluation, and the narrative can be adjusted accordingly.

4 EXPERIMENTAL TESTBED

For the purpose of evaluating our framework, we have developed an Immersive Story that teaches the user how to use a micrometer. A micrometer is a tool used for accurate measurement of components in mechanical engineering and industrial settings. Figure 2 shows the 3D micrometer model we used in our narrative. The story begins with a scene of the manufacturing factory. Figure 3 shows the scenes from the immersive story. There are workers who are seen working in the scene. Suddenly, there is a mishap in the factory, a pipe has burst open and the water has started spilling all over the floor. There are two main characters in the story, David, who is a factory worker and Remy, who is the plumber. Remy runs to rescue and stops the leaking pipe with a temporary cap. In order to fix the pipe, Remy wants to replace the broken cap of the pipe with a new cap. For this, he should find out the width of the cap. There is a conversation between David and Remy. Remy decides to teach David how to use a micrometer to find the correct sized cap replacement for the pipe if anything happens in the future.

Figure 2: Image of micrometer used in our story

Figure 3: Scenes from our immersive story

At this point, the non-interactive story plot begins in which Remy teaches David how to use a micrometer. Using a micrometer involves various steps. After this, a set of interactive story plots begins in which the user is given multiple tasks. To complete these tasks, the user interacts with the VR story and enacts in the character of David.

The user uses HTC Vive as the head-mounted display for being immersed in the VR environment. To assess the user's performance, we collect various data such as task completion time, accuracy, error rate, and qualitative feedback. We also examine the transfer skills by asking the user to use an actual micrometer and measure an object outside of the virtual environment.

5 CONCLUSION

Due to advancement in technology in the industrial sector, there is a risk of jobs lost to automation and demand for skills not met by current educational pathways. In this paper, we proposed a vIIS framework - A Vocational Interactive Immersive Storytelling system that uses storytelling in an Interactive virtual environment to train and assess a worker a new skill. The components of the IIS framework were explained that included a VR Environment, human component, story component, and a feedback component. The importance of storytelling, immersion, and use of interactivity was also described and how it plays a great role in a training environment. For assessment, we intend to collect data such as task completion time, accuracy, error rate, qualitative feedback and also measure transfer learning.

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