Serious Games in 2025: Towards Intelligent Learning in Virtual Worlds

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Abstract. This paper outlines the current state of learning, the problems arising and research needed by developers and educators using Virtual Worlds as an intelligent learning environment. Artificially intelligent avatars are required for virtual on-line problem and case based learning. However, the use of AI requires extra supportive frameworks, models and both staff and student goals. Natural simulations and avatar interactions are all part of the learning environment but realism, student paced learning, adaptive goals, natural language interaction, feedback and assessment are active goals for the next decade of virtual education research.

Keywords: Serious Games, AI, Game Based Learning, Virtual Worlds

1 Introduction

Technology has enabled online learning to reach new heights of student numbers and courses offered by Universities around the world. Once considered the poor relation of tertiary education, online learning, Virtual Learning Environments (VLEs) and online supporting tools have come of age and are increasingly used as knowledge repositories and discussional tools. Online learning is now neither a solitary exercise nor a flat knowledge base, it requires engagement from both the tutor (lecturer, teacher, educator) and the student. Research in online learning and virtual environments is a global enterprise; Australia, China, Canada, the USA and Europe are leading the work through papers on VLEs, VWs, games based learning, goal driven education and avatar interaction. Further, back in 2013, Gartner predicted that mobile virtual worlds will be increasingly used by young users, teens and tweens [1] and the current growth of educational virtual worlds and technologies demonstrates that need.

This position paper considers the field of learning in Virtual Worlds (VWs) and the necessary research and goals to enable learning environments to be student self-paced, semi-directed and goal driven using intelligent avatars as both information repositories as well as goal supportive processes.

The paper starts with the problems and lessons learnt over the last decade of using VLEs and VWs to enable non tutor led learning. The various elements that

must be considered are outlined in section 2. The goals for the next decade are presented in section 3 and necessitate the cooperation of both AI and Natural Language specialists, Education experts and virtual environment researchers.

2 Online Learning

Many students have applied to do online courses through edX [2] or through universities worldwide such as the Open University in the UK [3] or through Harvard [4]. These courses have proliferated over the last decade and vary enormously in the levels of student support, interaction and assessment.

Many online VLEs are linear reading and assessment submission whereas some scientific environments use online laboratories or simulations such as Crystal Island [5] or Virtual Singapura [6]. Historical re-enactments or visualisations [7] are common in Virtual Worlds and there are more Arts based online environments, for language learning [8] , history or archaeology but there are has been an increase in medical and biological learning environments in recent years [9]. The choices for online education are varied, but research focus and development is also disparate.

2.1 Information Overload and Memory

One major lesson that all tutors are aware of, is that of Information Overload [10]. We are in an information rich age and many commentators suggest that the amount of information a modern student has to wade through online is exponentially increasing, most of it unnecessary or irrelevant noise. However, [10] stated that many students either drop a course, participate less or late and when they get overwhelmed with work or goals, become stressed, confused, anxious or depressed. Therefore as educators, we must be wary of Information Overload (IO) when designing course content and assessment but also be aware that students do need to encompass a reasonable amount of information to be able to assess, collate and compare facts or data. This fine balance is one that tutors must constantly assess but student cohorts are notoriously different from year to year and, indeed, from student to student so the fine-tuning of information requirements is a tutor heavy task each time a module is taught. Little is known about IO in online learning but learner readiness, the quality and quantity of information and the visual interface are considered to be relevant factors.

Capacity of memory is an area of psychological as well as educative research that covers many topics such as number of facets a person can remember at any one time, the movement of information from short term memory to long term memory and shallow and deep processing. All learning requires practice and experience and the Confucion adage or I hear and I forget. I see and I remember. I do and I understand has vital relevance here. To move from short term to long term memory, or from shallow surface to deep learning, requires repetition, and loose experiential goals. In our current Internet age it is easy to consider that all information is a click away, but we need to have some deep

learning to be able to progress from basic arithmetic to studying the movement of stars, deciding on a dose of insulin or encoding an online avatar.

Nash and Shaffer [11] discussed mapping relationships through Epsitemic Network Analysis and indicated that less facts but more skills will aid in a students preparedness for online learning. Essentially, they suggested that learning should be considered as a Reflective Practitioner partnership where a mentor guides a novice through their learning, taking into account skills and knowledge at each stage.

2.2 Types of Learning

Tutors use different models of learning from primary through tertiary education and students themselves have individual preferences for learning. Some students are good at understanding diagrams or images and others at reading information. Research indicates that students learn well from animations or videos [6] and current academic training in the UK encourages the use of more images than text in ones teaching because of the human ability to remember images better. However, this may be useful for some sciences but is not useful for subjects that are text based such as learning languages or theoretical sciences.

A mix of learning styles is recommended by many educationalists, from reading texts to performing practical laboratory or classroom exercises, coupled with videos or discussion classes.

With regards to educational theory, collaborative learning or construction, problem based learning, game based learning, role playing, questing and virtual fieldworks are all being used [12]. Recent work, [13] , has considered situatedness and meaningful contexts and the way groups work together. Olympiou et al. [14] have considered the students mental model and whether visible or invisible objects can help abstract concepts for understanding.

Other concerns authored by recent researchers include coding schemes for collaborative decision making and the motivation of students [6], student attention and assistance needed and the believability of the environment [15].

Jacobson et al [16] suggested designing for a Virtual Pedagogy, aligned with university or school syllabi. They suggested that levels of technical assistance could be guided by a Student Lab book, essentially as a road map through a course. The notion of Productive Failure is encouraged as a way of learning better, that is, the student learns more by repeating experiments to attain a goal with expected failures of design, data or results as an in-built design objective by the tutor. Thus, states and transitions are required for both the Student Lab book and the virtual experimental framework.

2.3 Types of environment and tools

Currently tutors use Virtual Learning Environments such as Moodle [17] and Blackboard [18] or Virtual Worlds such as Secondlife [19] or open source variants such as OpenSim [20]. Game based simulations can be written in either of the

latter environments but some tutors prefer to use game engines from Minecraft [21] or similar. However, many tutors use smartboards, videos or audio for supporting and enhancing learning from textbooks or whiteboard. Essentially a mix of learning environments from story telling or reading a book to writing an essay, through discussions and video lessons to physical or virtual practical sessions are all part of the rich choices a tutor has.

Jacobson et al. [16] added the necessity of designing for aesthetics in a virtual environment. The more aesthetically pleasing, or fun, a working environment is, the more a student will engage. For example, designing an algorithm to move a robot around a screen can be fun, but designing an algorithm for moving Dr Whos Tardis through space in a simulated 3D environment can be exciting as well as competitive.

To develop a useful VLE or VW a large cohort of experts are needed, from the tutors who know the content to the developer, computer scientist, skilled at programming the environment and the artist who creates the avatars or objects. Any processing framework such as for avatar discussion, intelligence or direction requires a corresponding framework for goals and transitions. By going further into the learning process, such as the aforementioned memory and cognitive issues requires the assistance of educational psychologists. Making the whole environment creative, adaptive and interesting would also require game based learning researchers. Immersion in an online environment is possible through 3d projection CAVEs or through headsets and body sensors. The development of headsets such as Google Cardboard or Oculus Rift and newer eye tracking devices all enrich the user experience. Cheaper drone technologies may allow real time feedback from external environments such as archaeological digs or flood planes. A future in which distributed robots feed tactile information from an external site, coupled with overviews from drones is no longer science fiction. This decade will see online educational environments undergoing seismic changes.

Consequently there are many researchers needed to develop a virtual educational environment and each will use either games engines, frameworks, screen captures, activity recognition, natural language processing, interaction models, databases etc. alongside the general issues of network load, efficiency and robustness.

2.4 Levels of interaction

Students should have access either to a laboratory based Virtual World (or VLE) where their learning or experiments are embedded. A CD may be applicable if the students are geographically distributed but there are obvious technical requirements associated with either approach.

Once a student has done some learning on their own, they can be linked to other students through discussion fora or through the virtual environment. Chat rooms, discussion areas etc are all applicable here. Tutors can monitor and lead topics but it is important to constrain discussion to relevant issues and not allow interference from external topics. The goal of this level is to prepare the student for self-directed or goal-directed learning in the virtual environment.

Once these basic levels have been passed to the tutors required level, the students can then be given entry to the self paced virtual world or simulation. By this stage, therefore, some prior knowledge through the previous levels has been gathered (and perhaps tested for). The virtual environment will allow a mix of learning strategies that tutors may switch between, depending on the required tasks. The use of headsets, tactile input and 3D projections as well as soundscapes will enable the student to have a more enriched, and therefore memorable, experience.

2.5 Roles and Guidance

Current research has shown that before going into online or virtual learning, a student must have attained a core knowledge or skill set [14] [22] before beginning more group based or self paced working. Thus, the tutor is extremely important and necessary to lead the student towards the appropriate level. A tutor must be an active presence in teaching even when learning is mainly online.

Chen et al's work on Information Overload [10] indicates that a primary role of a tutor is to recognize that each student will learn at their own speed and can cope with different amounts of information. Voogt et al's work [13] suggests that collaboration, grouping and partnerships must all be guided and practical or technical concerns such as policies, timing, belief systems or the broadband capabilities must all have a monitoring agent. Olympiou et al [14] also considered the students mental model through prior knowledge and abstraction of objects. This necessitates the tutor acting as an oracle for designing functional tasks through estimating high or low levels of prior knowledge. Bogdanovych et al. [23] previously indicated that virtual agents (if used) should have a human agent to guide and formalize the environment, the functionality and the interaction.

The above work suggests that tutors have to become experts in educational as well as dialogical frameworks, computer skills for encoding functionality into an avatar or developing a simulation as well as developing pre-tests and post-tests.

2.6 Lessons Learnt

Worldwide, there are many active researchers and educationalists building virtual worlds or environments to cater for rising student numbers and the changing needs of the 21st Century student. There are many facets to building working environments, especially developing virtual worlds wherein students can act out scenarios through avatars, or going further, immerse themselves through headsets and sensors. Learning goals and layers of syllabus aligned knowledge must be encoded to enable a useful learning experience for students rather than a repetitive or one time play experience. Thus frameworks for learning, essentially encoding learning theories into programmed environments, goal driven processes and adding variation for experiential learning is a blue sky research goal. Further, adding the experience of the tutor, with changeable levels of guidance and tutor interaction, as shown by [6] [16] [22], is necessary for student engagement and development.

A concern rarely mentioned by researchers is that of assessment. Grading is often done by production of a set of searched for objects, a quiz or a short class test on information gleaned from objects or avatars. Thus, research on better ways of assessing in-world or online work is required.

As a supportive tool in the classroom, enabling students to learn or play at their own pace, virtual worlds or learning environments have proved their place. They are invariably not tutor friendly to adapt or maintain and require a considerable skill set to develop and use on a frequent basis with differing environments or goals for students to attain.

3 Virtual Learning Goals for 2025

Section 2 outlined only a small sample of current research and issues in Virtual Learning Environments and educational Virtual World development. However, even with such a short sample it is obvious that many researchers worldwide should form partnerships to develop the next generation of online educational support tools:

- Natural Language Processing is needed to make avatars realistic and to adapt their responses depending on the students level of knowledge or skills.
- Game Engine designs should be adapted for learning theories, ensuring that there are scaffolded learning mechanisms embedded with an engine.
- Good scripts and narratives are just as important as the objects embedded in the virtual environment. All have to be naturalistic.
- Scripts, objects, information and student goals should all be adaptive to lend credibility and a sense of realism to the environment.
- Goals should be changeable depending on the level of prior knowledge of the student and their skill set.
- Skills and knowledge have to be tested for and analysed in a non game intrusive way. Similarly, student assessment must be hardened to be more than quizzes or multiple choice tests.
- The virtual worlds need a better interface for tutor (and student development) and to adapt the case studies, objects or narratives.
- Easier mechanisms for creating objects, avatars or storylines should be developed through game engines.
- There should be a mix of learning required of the students; problem solving, book learning, laboratory experiments, discussion rooms and groupwork.
- Student support from tutors should be semi-structured with the student allowed to learn at their own pace but with reasonable (and adaptive) goals to push them towards recognisable achievements.
- The use of powerful Artificial Intelligence is needed to create intelligent adaptive virtual interactions with online avatars directing or demonstrating to the student. Making the avatar as realistic with the NLP noted above will increase student engagement and will also allow tutors to anonymously take over the roles of avatars for monitoring and assessing students.

- Allowing student development of VW objects, areas or avatars will also increase their engagement with a scenario.
- Reflection of their experiences should be enabled via student file storage to form a history of their school or university development.
- Tutors need to be able to share their worlds through safe environments such as educational clouds or networks.

Technologies are advancing faster than tutors can embed them into educational scenarios or environments. However, this technological race gives educationalists a rich variety of tools to use and create experiences that students will enjoy, remember and learn from.

4 Conclusions

As student numbers grow and educational technologies reach into the outback, the desert and the mountain, educational tools will be required to have far easier interfaces for designing appropriate scenarios, games and exercises for students of all ages. An easy interface for the tutor to edit, adapt or maintain is essential. The offered environment must have a built in and large variety of exercises, scenarios and assessments as well as changeable, adaptive and entertaining avatars with randomised movement of information objects. This requires the fields of AI and Natural Language Processing to meet with game designers, educationalists and Virtual World programmers and designers. Only then can a Virtual World be perceived as a more than supportive tool in the teaching arsenal.

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