Activity in Context

Planning to Keep Learners 'in the Zone' for Scenario-based Mixed-Initiative Training in Virtual Worlds

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ABSTRACT

Traditional education has often been seen as teacher led, with a predefined body of knowledge in some domain to be conveyed via instruction. But some educators advocate a student driven approach involving knowledge construction through experience of the world initiated by exploration. A mixed-initiative approach potentially can retain the best of both forms of education. It means that the various agents can take the lead or initiative in an interaction at appropriate times, in contrast to purely tutor-guided learning or student discovery-based learning.

This paper explores how scenario-based training and learning may be staged in a 3D virtual world, and what is an effective way to support learners in such a context. It seeks to establish a number of “elements” or “influences” involved in supporting mixed-initiative scenario-based training and relate these to principles of game-based learning and experience gained in that field.

A number of threads have been brought together in this work:

- to study the cognitive psychological foundations for socially situated learning;
- to identify effective learning methods relevant to mixed-initiative interaction between agents;
- to describe the relationship between cognitive psychological activity models and an AI research-informed conceptual model of activity;
- to provide a methodology for how the concepts identified could be utilised in a training-orientated “I-Zone” supported by intelligent systems technology – a virtual space for intelligent scenario-based learning; and
- to create, document and demonstrate a resource base for experimentation and potential re-use on projects in this area.

This approach takes the form of providing a conceptualisation, describing a methodology and providing a realisation of a virtual space to support scenario-based training in a community context. The work has made available a coherent set of resources and related readings which could form the basis for future collaborative research and student projects. It provides useful inputs to continuing intelligent systems and collaboration focused research on I-Rooms – Virtual Spaces for Intelligent Interaction – with an emphasis on mixed-initiative support to scenario-based training for emergency responders.

INTRODUCTION

I approach this study as a researcher supporting communities who engage in training and experimentation in fields such as emergency response. The people involved make use of role play in simulations with detailed scenarios. Such training can have a narrower objective as compared to broader educational aims, as it may be centred on the learning and generalisation of operational techniques and situation specific knowledge required by the target community. Reality provides the context and the constraints under which a trainee can learn processes and make sense of the choices available. Trainees need to have enough knowledge to make sense of the current situation, understand what can happen, and mentally project forward what the results might be of decisions they make or activities they perform. This kind of mental projection exercises the knowledge they already have, and forces them to address situations they may not have encountered before. It introduces options unfamiliar to the trainee which have to be confronted, and pros and cons have to be argued in a shared social setting. That is often what a well-designed training scenario seeks to introduce to a trainee. My aim is to understand ways in which an effective and engaging community-orientated scenario-based training exercise can be designed and guided to be most effective for the learners involved.

The work draws on educational cognitive psychology work relevant to situated learning for members of communities engaged in knowledge-based activities. This is linked to work from artificial intelligence on intelligent tutoring systems. I then show that the information relevant to a training situation can be *represented* via a simple conceptual model of activity and agent interactions that has been developed in AI research on flexible planning in dynamic environments. This opens up the potential use of automated AI planning technologies to generate and adapt learning sequences and tutorial episodes. I describe a method to *relate* overall learning objectives to specific activities via a road map which can help when selecting or generating suitable options for activity in a mixed-initiative training situation. The core area of this study, shown as an ellipse in the flow diagram (see figure 1), is a focus on the *choices* of the appropriate and timely scenario state to set up and the scenario events to inject in order to solicit learner activities to achieve the intended learning objectives, and do that in an engaging way by keeping learners in an effective learning "zone".

The methodology can be summarised as:

- **constrain** the world situation and the activities which are possible;
- **select or generate** relevant tasks and events;
- **inject** into the situation to keep learners 'in the zone' for effective learning; and
- **induce** appropriate learner 'activity in context'.

This study has explored a virtual world realisation of the learning situation in the form of an "I-Zone" with in-world tutors or teaching assistants which can provide an immersive virtual environment to *present* the learning context to those being trained and to set appropriate and challenging objectives. This is grounded in the design of real world operations centres or training facilities used by emergency responders and the expert trainers involved in those. This flow of concepts is summarised in figure 1.

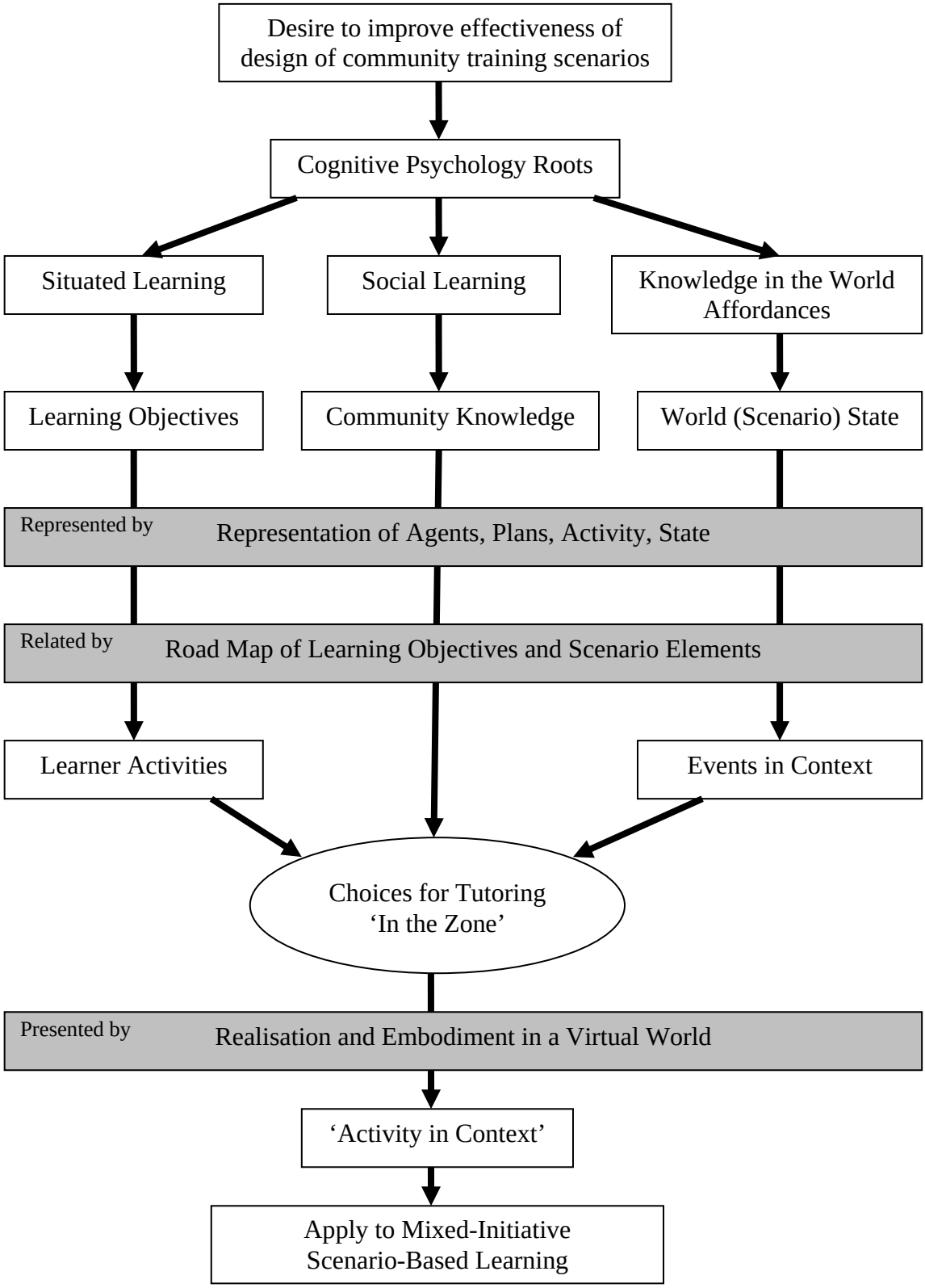

Figure 1: Flow Diagram of Concepts Explored

NOTIONS OF ACTIVITY

The approach draws on work on representation and reasoning about plans and activity (Tate, 2000) and especially on recent work on I-Rooms (Tate et al., 2010; Tate, 2011) to support collaboration in virtual worlds. One key contribution is to provide a simple, abstract and extendable representation of collaborative activity in order that some level of automated plan and agent activity analysis, planning and activity execution support can be provided.

Activity in Context

Context-specific activity is a core concept of the study. The context defines a strong set of constraints on what actions from a potentially vast set are possible and hence need to be considered. This context sensitivity can radically reduce uncertainty and search. There are lessons to be learned from this approach which could usefully be applied more generally in education, especially in a situated learning context.

Constrained Activity – Affordances

Scenarios leverage our knowledge of the real world. They can powerfully draw on the natural "knowledge in the world" (Norman, 2002), that is, the natural understanding of the constraints under which activity can take place in a real setting. Objects in the world constrain how an agent perceives it can interact with them.

There is a clear overlap for descriptions of contextualised and constrained (by the world) activity to the use of the term "affordance" – how the objects in the world constrain and limit the choices open, often to a single natural choice. Klein (1998) recorded emergency responders as stating "But I don't plan, I just know what to do" which reflects the richness of the knowledge in the world which they respond to. "Affordances" provide knowledge in the form of easily understood limitations on behaviour. I believe this approach is relevant for use by a tutor in mixed-initiative scenario-based training and learning situations. The tutor can set up suitable environmental constraints and tasks to limit choices and guide learning. We wish to take people to the edge of their understanding and then keep modifying the environment and objects in it to limit the learners' scope for activity to maintain them in a high-value targeted learning situation.

I-ZONE AND VIRTUAL CLASSROOM ASSISTANT REALISATION

As a concrete focus for the study, I have been exploring technologies which could be used to embody an AI classroom assistant in a social space in a virtual world. The aim of the assistant would be to make use of good educational techniques which have proven effective to support training tasks in the virtual space and allow it to engage in mixed-initiative support of the learners within that space.

The availability of a realistic rendering of the environment in which training occurs can be a very important element in encouraging effective situated learning in a social context. The main training space is provided by an "I-Zone" which is a simulation of an operations or command centre within which training takes place. Information is

received, tasks are assigned, communications occur and decisions are made which can have an impact on the current world state in which the training takes place.

Within the main I-Zone 3D virtual operation centre, there is a key of embodiment represented by the learner's own avatar, and the avatars of others who they interact with (see figure 2). It is often useful to have role-playing ancillary agents and technical support agents, who are "Non-Player Characters" (NPCs) and may have limited interactivity that is understood by the main players in the scenario. This can radically reduce the costs of scenario-based training by not requiring human control of such agent functionality, yet provide realism for the interactions to be taught and used in the training situation. In some situations the active entities are best represented by realistically performing objects or equipment in the virtual world rather than human-in-appearance NPC avatars and agents.

Figure 2: Example I-Room in use for an
Emergency Response Incident Training Scenario

As part of this study a number of technologies have been explored to ensure that a suitable basis would be available to provide an embodiment for a classroom assistant in a virtual world like Second Life™ or OpenSimulator, but potentially using facilities that could be provided in any suitably open scripted virtual world in future.

This has involved the following elements, which have been examined in sufficient detail to ensure that resources are available and identified, that preliminary investigations indicate they could work in the AI classroom assistant context, and that a simple demonstration has been performed to check the facilities out.

1. Avatar Embodiment via use of Non-Player Characters without user monitoring or login – using OpenSimulator NPC (2013) technology (see figure 3).

2. Chatbot facility for answering questions and giving guidance – using the Pandorabots (2013) (ALICE) and MyCyberTwin chatbot frameworks.

3. Link to external knowledge-based systems, intelligent activity planning and task or procedure following aids, and natural language text chat generation – using the I-X Technology Helper (Tate, 2011).

4. Link-up with a Virtual Learning Environment (VLE) such as Moodle, or a collaborative community web portal such as OpenVCE.net.

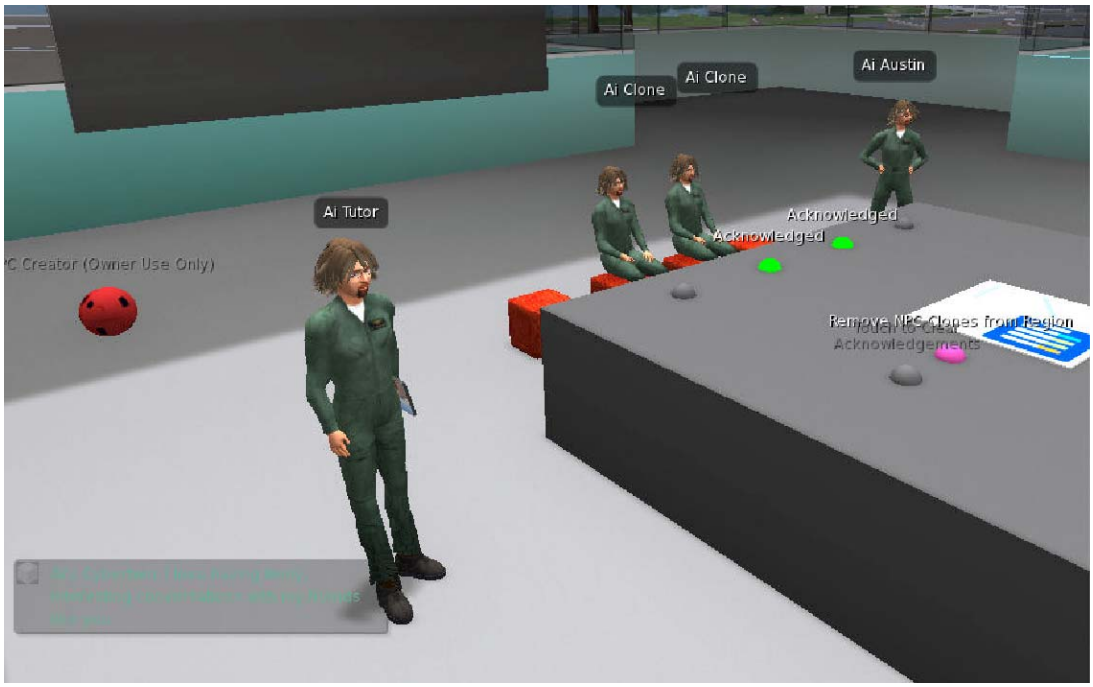

Figure 3: NPC Avatar Tutor with “tablet” attachment link to MyCyberTwin chatbot and seated NPCs

SUMMARY AND FUTURE DEVELOPMENTS

This study has focused on readings in cognitive psychology which could inform scenario-based training employing a mixed-initiative training style rather than top-down tutor guided learning or entirely bottom-up discovery-based learning by students. It is also informed by early work on artificial intelligence as applied to education and tutoring systems to understand the techniques which are employed. I have related this body of work to my own previous practically motivated work on knowledge rich plan representations and the underlying conceptualisation employed in my research. A road-mapping methodology of relating learning objectives and their desired outcomes to scenario-based learner activity in a suitable social and situated context to improve the knowledge and experience of the student has been described. An educational game-based research informed work flow and lexicon of learner activities relevant to community scenario-based learning context have been identified. A choice of scenario context to set up and events or activities to inject can be made in

this framework to present a challenging and meaningful situation to the students in an immersive and embodied realisation of an operations centre in a 3D virtual world.

During the course of the study an approach to support scenario generation and adaptation in a mixed-initiative situated training context has been made explicit. This comprises:

a) an ***embodiment*** of the target training situation in a virtual world which allows for an immersive and engaging user experience;

b) employ natural ***constraints*** "in the world" for what can and cannot be done via interaction with the environment through appropriate scenario setup and provision of situation realistic devices and communications mechanisms, and which provide natural affordances on what activity can be performed;

c) set up of appropriate, realistic, challenging and motivational ***tasks or objectives*** within the scenario guided by the learning objectives desired;

d) carefully select and inject scenario ***events*** into the training situation to maintain interest and keep learners "in the zone" for effective learning;

e) induce appropriate ***context-specific activity*** by the learners to respond to the situation they find themselves in.

The approach is grounded in a rigorous yet conceptually simple ontology representing plans, activities, processes and agents, and their interactions (Tate, 2000). This representation can handle relevant objectives being stated in a dynamically changing world state. This allows the potential for using generative AI planning technology in the creation and dynamic adaptation of training episodes. It allows for AI-driven non-player characters to be introduced which can participate effectively in the mixed-initiative evolving scenario.

The methodology can be summarised as:

- **constrain** the world situation and the affordances it presents;
- **select** or **generate** relevant tasks and events;
- **inject** into situation to keep learners 'in the zone'; and
- **induce** learner activity in context.

Within an "I-Zone" virtual scenario-based training space, the use of Non-Player Character (NPC) technology has been explored to provide an embodiment of a virtual classroom assistant. Some key methods for providing a range of interactivity and knowledge-based tutoring support have been added. These include chatbot technology for answering frequently asked questions and providing helpful guidance and links, chat logging, links to knowledge-based systems and AI planning support and links to a virtual learning environment.

I have explored the framework in the context of applications to training for crisis and emergency response, but it has potential in other domains. Those engaged in medical

training, for example, are also required to design well crafted scenario elements which stretch the knowledge, experience and skill of the trainees.

The framework, methodology and experiments described and the virtual worlds embodiment experiments performed are intended to provide a conceptual and technological resource base for potential collaborative research projects and ideas for student projects in future. More details of the approach and technical aspects of the systems used, as well as details of the educational cognitive psychology foundations for the approach are given in Tate (2012), a study for an e-Learning MSc dissertation.

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