Finding Essential Complexity for Learning in Virtual Worlds

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Abstract: This theoretical paper introduces one possible avenue for measuring learner performance in virtual worlds, intended to leverage these virtual worlds as learning systems that can provide individualized learning experiences at an appropriate level of complexity for any given learner. First, we extensively define essential complexity. Then, we describe an assessment framework for finding this essential complexity in a virtual world, using a variety of embedded measurement techniques.

Introduction

As we face an increasingly complex world of nested, interacting systems (e.g., biological, ecological, physical, social, economic, etc.), a need for approaches to learning that better prepare us to engage with these systems is becoming increasingly apparent. The purpose of this article is to formalize one possible approach to the creation of an improved learning system that can prepare humans to understand and interact with an ever-changing world and its inhabitants using dynamic learning scenarios (or quests) embedded in meso-immersive (Moreno & Mayer, 2002) virtual inquiry environments. These dynamic learning scenarios would be delivered in these virtual inquiry environments at a level of complexity that is determined to be essential for a given individual learner at that time – *essential complexity*.

We provide a detailed definition of essential complexity, as manifest in three experiential forms for the individual learner: *content, process,* and *context*. We then describe an evidence-centered assessment framework for finding essential complexity for any given learner completing tasks during a learning quest based in a virtual world, using unobtrusive, or stealth (embedded) instruments designed to measure an individual learner's perceived cognitive load (in the form of mental effort).

Briefly, meso-immersive virtual worlds are immersive, game-like 3D environments housed within a computer application, presented to the learner on a 2D computer display monitor. The learner is capable of performing any number of interactive tasks by controlling the physical movement of an avatar within this immersive 3D environment.

Defining Essential Complexity

For the purposes of this paper, essential complexity is an appropriate level of complexity – of content, process, and context – for a given person in a given virtual learning environment at a given point in time.

Content Complexity

Essential content complexity is the appropriate level of content difficulty for a given learner at a given point in time during an interactive learning experience within a virtual world. Specifically, content difficulty is the range of learner difficulty in understanding the curricular content being delivered via an interactive scenario in a virtual world. From this curricular perspective, this concept of content difficulty is essentially nothing new in the field of educational research, as countless theories and studies have been created regarding appropriate content difficulty for learners with different levels of expertise or prior knowledge within a given subject domain.

Process Complexity

Essential process complexity is the appropriate level of task difficulty for a given learner – based on Vygotsky's (1978) zone of proximal development theory – at a given point in time during an interactive learning experience within a virtual world. Specifically, task difficulty is the range of learner difficulty in completing the multitude of tasks inherent in accomplishing the goals set forth within an interactive scenario/quest in a virtual world. A simplistic example of the sorts of tasks that are inherent in these quests can be found within a courier quest, which typically consists of three phases: obtain a package, transport that package, and deposit that package with its intended recipient. A package transportation task with higher levels of task difficulty might require the learner to traverse a more harrowing path with higher numbers of obstacles of increased process complexity.

Context Complexity

Essential context complexity is the appropriate level of situated complexity (of the immersive environment) for a given learner at a given point in time during an interactive learning experience within a virtual world. Specifically, situated complexity is the level of complexity inherent in the details of the environmental

affordances (e.g., Gibson, 1986) provided to the learner in the virtual world as he or she completes a quest. A simple example of high situated complexity during a quest in a virtual world is increased (potential) distractions for the learner through the addition of interactive and non-interactive in-world objects which possess increased levels of realism – ripe for task-extraneous exploration by the learner.

Finding Essential Complexity

Before we can maintain essential complexity in a virtual world for any given learner, we must find an appropriate level of complexity to deliver to that learner. To find this essential complexity, instrumentation must be developed to gather evidence through measurement, allowing for assessment of any learner's current ability levels (or expertise) concerning content, context, and process complexity.

To find essential content complexity, a learner's expertise in the subject domain(s) of the given content must be assessed. To find essential process complexity, a learner's expertise in the completion of any and all tasks inherent in the learning quest must be assessed. To find essential context complexity, a learner's expertise in contextual awareness of his or her in-world surroundings while completing the quest – as those surroundings pertain to an understanding of both the pertinent learning content, as well as the tasks necessary for completing the objectives of the quest. The activities and work products associated with content, process, and context complexity can serve as a framework for measuring appropriate levels of each for a given learner.

Table 1. Dyadic and triadic learning quest activities

Dyadic	Triadic
Approach Object	Communication About Object Movement
Depart Object	Communication About Human Movement
Projectile	Communication About NPC Movement
Automaton	Communication While Moving Object(s)
Carry Object	Complex Demonstration(s)
Push/Roll/Drag Object	Complex Sign/Signal Creation
Simple Demonstration	
Communication About Player Movement	
Simple Sign/Signal Creation	
Communication About Object(s)	

Conclusion

Once we are capable of unobtrusively collecting evidence of learner performance *in the moment*, we can then design back-end computational logic systems that can make just-in-time assessment decisions about a given learner's measured performance. Designing such assessment systems will allow us to build interactive learning scenarios in meso-immersive 3D virtual environments that are capable of *maintaining* essential complexity for the individual learner. In essence, one could build virtual environments that are truly *smart worlds* – changing themselves dynamically to reflect instantaneous assessment decisions made by the intelligent systems driving every aspect of the learner's virtual experience, including content, process, and context complexity.

References

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