Beyond Simulation: Establishing First Principles of Fidelity in the Design of Digitalised Abstract Learning Content

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Abstract

As the remote delivery of digital learning content gains prominence, specifically following the Covid-19 pandemic, the design of remotely deliverable learning materials provides for expanded areas of research. An aim of this study is to establish whether first principles of fidelity can be established for designing and developing abstract learning content – namely content that cannot be learned via direct simulation – and where these first principles may be derived from. The initial experiment consists of the creation and deployment of a game that will be used to teach an abstract scientific principle and assess the potential for the design of further such experiments, based on the experiences and results. The initial experiment has recently completed the build phase and is at the beginning of the deployment phase, with results being generated from May 2022-onwards.

Keywords: Abstraction, Design, Digital, Fidelity, Game, Gamification, Learning, Simulation.

1. INTRODUCTION

Learning simulations are utilised across a wide variety of disciplines. Battlefield planning (Cheng, W.Y et al, 2019), general production management (Riis, J.O. ed., 2016), human-machine interaction (Lee, A.T., 2017), physics systems (Sheikholeslami, et al, 2016), N-body type problems (Sellwood, J.A., 2020) and in human factors related scenarios (Dode, P, et al 2016). An emergent overriding commonality between simulations across these and other disciplines is the desire to replicate, analyse and improve performance in their mirrored real-world equivalents. The methodologies for virtual simulation design, however, are subjective, and encompass a wide range of theories, disciplines and cultural norms. Many simulations demand a real-life situation simply be replicated as faithfully as possible at a visual and/or kinetic level – aircrafts, for example (Rolfe, J. M. and Hampson,B.P. (2003). Other situations can benefit from a degree of abstraction so a participant can re-visualise the information (Mar, R.A. and Oatley, K., 2008). An aim of this study is to map the territories that inform us to what level of direct simulation and what level of abstraction are required for the design of learning content.

2. RESEARCH

2.1 Research Problem

Digital learning has benefitted from numerous technological advancements in recent years, with a powerful toolset now at the disposal of multimedia developers. Conventional desktop creative tools and software have the potential to be complimented with the use of virtual and augmented reality, and game engines such as Unreal and Unity; and the ways that traditional pedagogical models can be integrated with immersive digital environments is an active area of research (Barari, N et al (2020). Research into simulations originally gravitated towards methods of replicating the real-world equivalents via the design of the simulation itself, with devices such as aircraft simulators forming early research into training simulations (Page, R.L., 2000). However, further research is needed to establish and codify other component factors that will lend equivalent fidelity in diverse subjects. Areas for consideration include: how to create the optimum learning experience for abstract subject matter that is comparable to a directly replicated simulation; and how the use of tools such as artistic abstraction; embedding of pedagogical principles (chiefly motivation, exposition, direction and reflection) and immersion through the use of gamification and narrative can achieve this aim.

2.2 Research Questions

What are the underlying reasons for success and failure in digital learning simulations and simulations across different disciplines?

Can the level of abstraction deemed appropriate for a simulation be derived from definable sets of principles?

How can established pedagogical principles be mapped into sophisticated digital learning artefacts and what level of redesign of these may be necessary to deliver the optimum results?

3. METHODOLOGY

3.1 Research Solution

To enable greater engagement and retention of dry subject matter using reimagination and abstraction, a gamified digital interaction, developed using Unreal Engine 4 and Adobe Captivate has been developed for an engagement group. With a lower fidelity click-reveal activity for the control group.

In the initial experiment, the engagement group calculates a required escape velocity to successfully complete a launch exercise. Learning objectives are interwoven within the narrative elements and the game itself is thematically linked to the learning content. In the initial experiment, the physics principle of escape velocity will take the form of the user making the required calculation, then flying a craft from the surface of a planet into orbit.
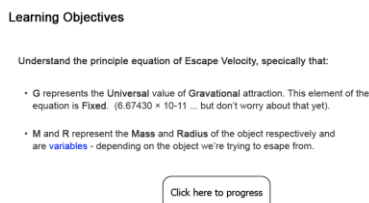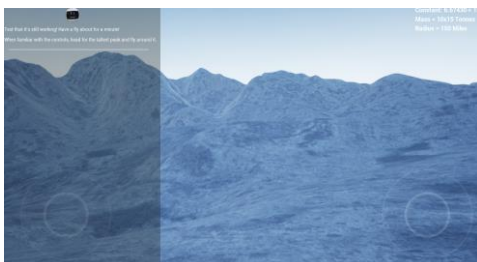
Diagram 1.1 – Learning Objectives

Diagram 1.2 – in game example

4. Summary

This study is currently at the built/pre-deployment phase and will be distributed to participants from May 2022. Feedback solicitated from participants will be utilised to inform the construction and refinement of further such artefacts for further experimentation. The study will primarily focus on the user experience with regards to the gamification of the learning objectives, the thematic resonance the gamified activity has with the learning content, and if/how it has increased motivation, retention of knowledge and subject interest.

5. References

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