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Developing a Meta-Model for Serious Games in Higher Education

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Developing a Meta-Model for Serious Games in Higher Education

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Abstract: This short paper presents a preliminary meta-model for educational games. A meta-model facilitates the development of high-quality, engaging, educational games because it explicitly ties knowledge requirements, transferable skills and course outcomes to game production. Our meta-model is designed to be transferable across curricula, as it modularizes domain specific bodies of knowledge (BOK), a learning taxonomy (e.g., Bloom's), and skill based challenges. The model situates learning opportunities in a plotline wherein the student-player advances by succeeding against non-player adversaries. Knowledge-based challenges framed by a learning taxonomy develop the transferable skills required by international accreditation standards and provide feedback to both the player and the faculty member. Situating assessment challenges in an immersive game environment makes them more engaging and imaginative than typical on-line tests or assignments. Here, we present our meta-model tailored for educational game development in software engineering education.

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SECTION I.

Introduction

Although many serious educational games have been developed, there is little work available on re-usable meta-models or ontologies. In software development, a meta-model is a semantic construct that rigorously defines a collection of elemental building blocks and the rules that tie their interplay together. An ontology is a more abstract semantic construct that defines a vocabulary of terms and a grammar; the grammar constrains well-formed formulae.[1] And while a hierarchical game ontology is available,[2] it is not specific to serious, educational games. As a first step, we define a meta-model because it is less abstract than an ontology.[3,4] This makes it more amenable to verification via prototyping. In the future we propose to explore an ontology for serious educational games.

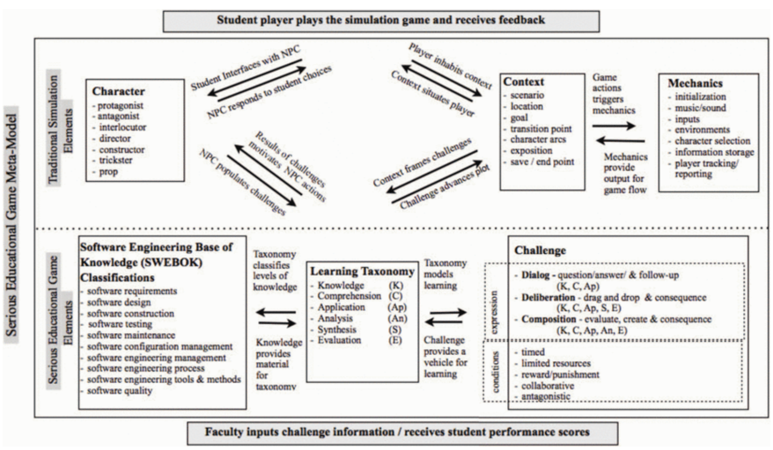

Figure 1. Meta-model for serious game using software engineering knowledge base and Bloom's taxonomy

Our proposed meta-model serves several purposes. First, it provides a structure upon which similar categories of game-play components may be designed across a greater variety of games, providing an infinite combination of playing experiences while maintaining consistent pedagogical standards. Second, it facilitates the creation of games for faculty and game designers, as they would only need to toggle particular elements of game components that best suit the desired progress towards course learning objectives. Third, the meta-model creates a consistent discourse for serious games in higher education that may be applied across accreditation jurisdictions.

SECTION II.

Meta-model

Our proposed meta-model takes a holistic approach to gaming and learning. In addition to being engaging and entertaining for student players, serious educational games must be immersive learning environments that embed specific, faculty-driven, learning objectives into a set of challenges informed by a disciplinary knowledge base and articulated via a learning taxonomy (Fig. 1).

A. External Entities

The meta-model considers two external entities. First, the game engages student players through a variety of means, providing them feedback on their gaming abilities. Second, game content is informed and crafted by instructors, who subsequently receive feedback on student player(s') progress and abilities.

B. Educational Game Elements

1) SE Body of Knowledge and Learning Taxonomy

In software engineering, international standards determine competency. The S2004 guide organizes Software Engineering Education Knowledge (SEEK)[5] into ten generally recognized sub-discipline areas with each area divided into smaller units and topics. Each topic then has a Bloom's taxonomy ability indicating required proficiency: knowledge (remembering content), comprehension (understanding the meaning of course content), application (ability to use learned material in new situations), synthesis and analysis (seeing interconnections and components of larger systems), and evaluation (assess the value of varied and variable information within specific contexts and requirements).[6]

2) Challenges

The Challenge class holds the formative educational opportunities in the game and has two modalities: expression and conditions. Expression is the form of the game's challenges. For example, the dialog challenge involves an interlocutor non-player character (NPC) asking the student player a line of interrelated questions in an interactive quiz. This challenge appeals to lower levels of Bloom's taxonomy (i.e. knowledge, understanding, application of content).

2012 IEEE 12th International Conference on Advanced Learning Technologies (ICALT), (2012): pg. 684-685. DOI.

The deliberation and composition challenges require the player to pull apart or synthesize cluster of information provided in a game setting. In our SE game, a deliberation challenger occurs after a briefing on a new secret project. After reading the brief, the player is given a set of resources that she or he must drag onto a simulated GANTT to establish a plan for completing a project under budget and on time (extending learning into higher forms of learning such as synthesis, analysis and evaluation).

Conditions are set upon challenges to motivate: players may be required to compete against time, or a NPC character; with strategically limited resources, or a combination of conditions. For example, in a dialog challenge, the player might compete against an NPC antagonist with a time limit for answering each question. Otherwise, that same challenge might be free of any conditions and the player is only taking a self-test to self-check their comprehension or recall ability.

C. Traditional Game Components

To facilitate game development, we separate rapidly changing content components from the game's reusable base forms and functional components that need only be toggled as required by instructor designers.

1) Character

The Character class includes the Protagonist (student-player) as well as a variety of non-player characters (NPC) who populate the game to engage the student player. For example, the antagonist NPC visually embodies adversity in a more interactive manner. Each NPC has a function and adjustable profile; they can have variable skill levels, attributes, and a range of visual representations from which designers may choose.

2) Context

The Context class situates the player/protagonist in an immersive world with a narrative providing the framework for game challenges. The context contains the elements for interplay between the player/protagonist and the non-player characters, setting up opportunities for learning, while reinforcing the effects of good and bad decision-making.

3) Mechanics

The Mechanics class provides the fundamental, low-level game resources such as character repository, music, and graphics. It also supports maintaining the state of the

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game including the players' progress (where they are in the game) and their assessment (how well they are doing in the game, e.g. points). This class supports the Plot class and the Challenge class.

SECTION III.

Conclusion and Further Work

We intend to complete our SE game to verify this meta-model and implement it in another game for a different engineering field. Our meta-model indicates the potential for creating a future ontology that allows for a reusable set of classes and relationships to develop effective, responsive and interactive educational game across disciplines in higher education.

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