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4 ASSESSMENT AND PERSONALIZATION IN LEARNING GAMES

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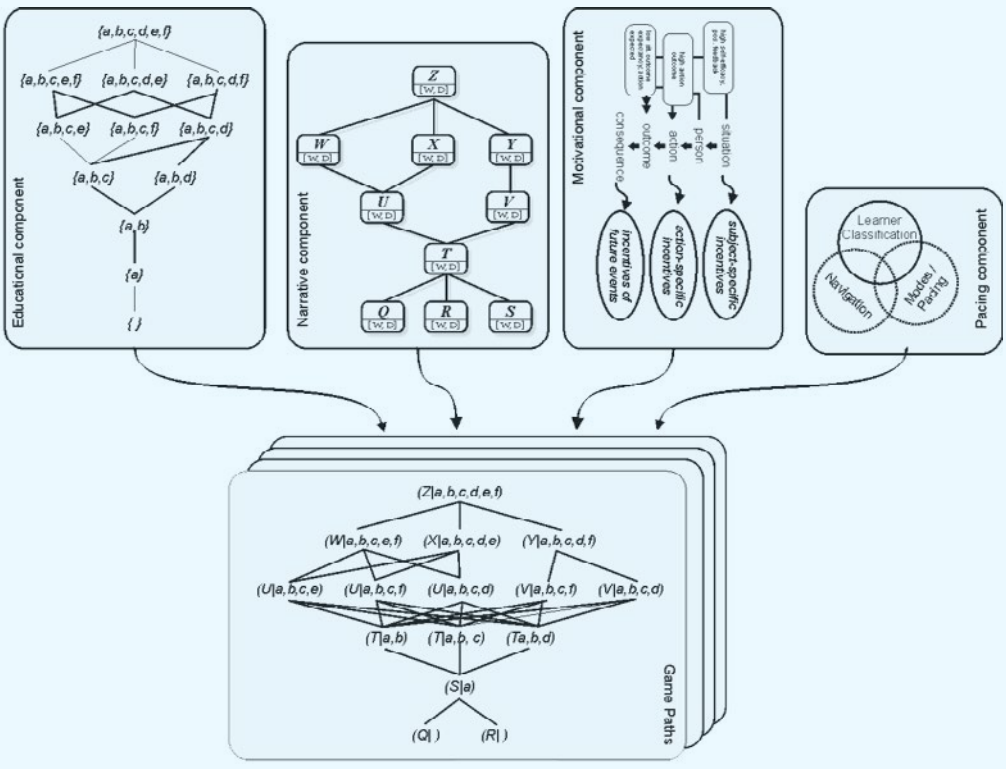
ABSTRACT

A substantial body of research highlighted that an appropriate personalization of learning experiences is a major success factor for learning games . The experience of flow and immersion is seen as a key advantage of serious games. And it can only be achieved if the game difficulty and learning-related challenges are tailored to a person's abilities. This article introduces Micro Learning Spaces as a psychometrically sound and a practically successful conceptual approach for stealth assessment and a seamless adaptation in serious games.

KEYWORDS

Psychometrics, Competence Assessment, Item Response Theory, Knowledge Space Theory.



CONTEXT

Although recent meta-reviews [1] revealed the potential of serious games to facilitate learning, a clear downside of many existing approaches to game-based learning is a lacking accordance with school curricula, context conditions (such as time constraints), and in particular a lack of smart game personalization to support individual learners at best. A key to sound, adaptive individual support is an understanding of the learners' abilities, strength, competence gaps, learning paths, and perhaps emotional/motivational states. This, in turn, means that a strong and valid in-game assessment is of crucial importance. Val Shute and colleagues [4], in their influential work, often argue that assessment and personalization is often too simplified, abstract, and decontextualized to suit the needs of successful individual learning support. To realize a successful approach to in-game learning we need methods and techniques to support the game systems in assessing learning/development progress and abilities (knowledge or skills) in a formative way and to enable the systems to provide the learners with appropriate and tailored support and guidance.

TARGETED ISSUE

Micro Learning Spaces (MLS) is an extension of Knowledge Space Theory, which is a psychometric, combinatorial approach to technology-enhanced adaptive assessment and tutoring, developed in the 1980s. MLS is based on knowledge structures, which are based on the relationships of atomic skills (e.g., the ability to add two integers). These relationships establish Knowledge Spaces, which can be interpreted as a set of admissible learning paths from holding none of the competences in a domain to possessing all of them. In MLS, these spaces have been combined with Problem Spaces (i.e., a formal representation of problem-solving steps, which typically appear in digital games), interactive storytelling structures, and Formal Concept Analysis, a conceptual approach to data mining. On this basis, that essentially reflects the pedagogical concept of a learning game, the game as such identify the learner's available and lacking skills, possible knowledge gaps and misconceptions or whether a learning is stuck at a certain step in mastering a challenge in the game. In turn, the game can autonomously adapt difficulty levels, educational interventions, or feedback to the concrete needs of a learner. The details of the approach are described by Kickmeier-Rust and colleagues (2012) [3].

PROPOSED SOLUTION

In the context of the RAGE project (rage-project.eu), which was the flagship project on serious games, in the context of the European Horizon 2020 programme, we developed software assets for CbKST and MLS, that allow game developers easily integrate educational (stealth) assessment, learning analytics, and educational adaptivity in their games. Technically, the assets are based on C# and tailored to the Unity3D platform. On runtime, the game passes logging information to the asset, which then reasons over learning processes, potential knowledge gaps, successful and unsuccessful problem solving steps as well as motivational states, and recommends appropriate and tailored adaptations (e.g., altering the difficulty level), hints, and feedback. The game can subsequently identify appropriate game elements and adapt the concrete gaming experience accordingly.

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RELEVANT INNOVATION

The solution has been exemplified in a variety of digital educational games, one of them the Watercooler game [2]. This game was developed by Nurogames, Germany in the context of the RAGE project. The player is a person

hired by a game studio to help nurture the "team working" between employees at the studio through interpersonal relationships. Engaged as an office assistant, the explicit goal is to contribute to the studio success by improving, enabling, prompting and challenging the attitudes, values, and social skills of the virtual team the players are placed within. The attitudes and values exhibited by a set of virtual characters may be positive or negative and the game ultimately functions as a mirror, which reflects the player's own values and attitudes. The game was designed mainly for students engaged in subjects to which there is a digital skills bias, in which "soft" skills may be regarded as not important by the student, which is often the case for graduates in technical domains. The game provides recognition and space where students are able to develop meta-skills in a game environment where the failure consequences are much reduced, engendering an understanding of, for example, communication, leadership or conflict management and resolution skills. The name "watercooler game" refers to the main game scenario where the virtual employees meet at a central water dispenser in the office, where social interactions occur.

PROJECT OUTCOMES & RESULTS

The game can be linked to the CbKST-based reasoning and adaptivity assets, which enables an appropriate educational and motivational adaptation. In this particular case, the adaptation includes an evaluation of conflict management skills based on the Thomas-Kilmann-Model (1974). This scale differentiates two dimensions, assertiveness and cooperativeness, and identifies personal conflict modes along these dimensions. The interactive theory-based adaptations of gameplay and interaction formats, including feedback to the player, turned out to be a successful means of reasoning over the interactions between player and virtual characters and tailoring the game to the learner's abilities and attitudes.

CONCLUSION

Inevitably, the next generation of digital educational games will need to incorporate smart educational features to meet up high expectations to the genre anduse the full potential of digital games for serious purposes, specifically learning. Research from the field of Learning Analytics and Intelligent Tutoring Systems provides conceptual solutions. With the RAGE project, these solutions are (partly) freely available to game developers in form of software assets.

PERSPECTIVES & NEEDS

Research and technical development in this area will continue. Specifically trending technologies such as machine learning and data mining will further bolsters the educational value and the possibilities of technical educational solutions for serious games. A significant challenge is bringing these technologies into a broad market. It is on game studios to take up available conceptual and technical solutions and to develop mart educational games. Projects such as RAGE attempt to reduce the barriers by offering educational assets (for example for game analytics, avatar systems, emotion detection, and language processing) that can be easily implemented in educational games without requiring substantial scientific expertise. The assets are available through the platform www.gamecomponents.eu.

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