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A Modular Approach for Multi-Dimensional Learning Support in Educational Games

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Abstract: In this paper we present a modular approach for learning support in game environments. In applied or educational games both aspects are important – the fun to play and a topic to learn. While traditional games or leisure games only focus on the enjoyment and entertainment of the player, educational games also aim to convey knowledge and competences. However, in order to fulfill this goal, an applied game should take care that the player actually learns. The various components of our approach specifically support the learning aspects in a game in different and balanced ways. This includes adaptation of the game for smooth competence development, maintaining motivation, support in problem solving tasks, support for meta-cognition and reflection, and adaptation to the players' personality.

Keywords: Educational games, adaptation, competences, motivation, reflection support

1. Introduction

Digital learning games represent an e-learning technology that is increasingly recognized by educational practitioners (Johnson, 2014). With their highly engaging and motivating character games constitute effective educational tools for creating authentic learning tasks and meaningful, situated learning (De Freitas, 2013).

Psychological research has targeted many aspects of leisure and educational games, such as engagement, challenge, motivation, and achievement. Starks (2014) proposes a cognitive-behavioral game design model that incorporates a wide range of psychological constructs and relates them with game design elements. In this three-tier model cognitive elements (e.g. knowledge, goals, encouragements) are connected with game design elements derived from the Social Cognitive Theory (Bandura, 2006) and the Theory of Multiple Intelligences (Gardner, 1983). According to the model of Starks, this leads to the factors that make games both enjoyable and educational, which are engagement, challenge, flow, persistence, and mastery. All of these factors have been extensively researched from a psychological perspective. For example, the flow concept (Csikszentmihalyi & LeFevre, 1989) describes a situation when people are highly engaged and lose track of time, which often happens, when competence development and game challenges are balanced (e.g. the game should not demand to much or too little from the player).

While all these concepts are important and helpful for increasing the performance in serious games, there is a distinction between performance and learning (VandeWalle et al, 1999; Fisher & Ford, 1998). For example, there is a difference, if the goal of a game is to learn about topic and acquire knowledge or just to complete tasks and challenges not related to learning topics. Supporting and assessing learning requires a clear model of learning activities and the processes involved towards the achievement of learning goals.

This paper presents a modular approach for learning support that takes into account these psychological aspects and relates them with a technical design that can be included in educational games. Hence, these components consist of an integration of pedagogical and technical concepts.

2. Learning Support in Educational Games

The suggested overall approach for learning support in educational games is developed in the context of the RAGE project and is depicted in Figure 1. Basically, the game consists of the components for game play (e.g. storage, user interface, and environment) and educational components that enrich the game with learning aspects. This separation enables the re-use of the educational components for different games and thus makes the development of new games faster and more efficient. The educational components include competence development, motivation support, reflection support, and personality-based game configuration. All of them provide adaptation features to personalise the game based on learners' actions and overt behavior. Together they provide learning support in different ways including realizing meaningful learning goals and sequences in terms of knowledge and competences, maintaining the motivational state, prompting reflection during the game, and tailoring the pre-configuration of the game to personality traits. Additionally, they also support typical game aspects, such as challenge, flow, persistence, and mastery. These components include a conceptual and technical design, which enable the software implementation of the educational concepts.

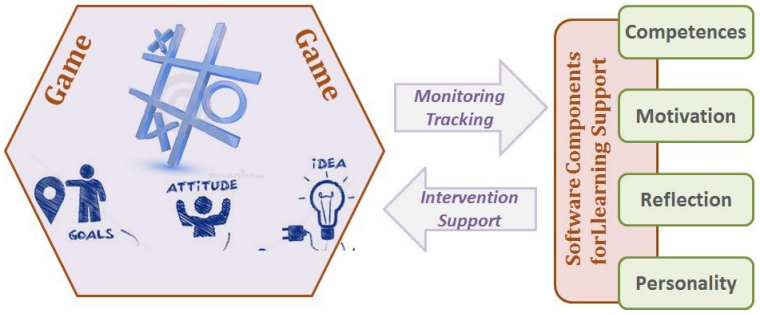

Figure 1. Overall approach for learning support in educational games.

The first component is the competence-based adaptation component that monitors the player's behavior, automatically assesses competences, and recommends game activities using the assessed competences. Task performance and problem solving behavior in game levels and game situations is monitored while a learner plays a game. Based on this information, a competence state is (re-)calculated using a pre-defined competence model created during game development. Given the identified competence state of a player recommendations can be delivered to the game about which game situation, level, or task should be presented next. An authoring tool allows modelling the competences and how they are related to game activities. This approach is based on Competence-based Knowledge Space Theory, which is a mathematical-psychological framework for knowledge and competence representation, assessment, and adaptation (Heller et al., 2006).

The inclusion of motivational aspects in applied games is crucial. Instead of only assuming that games are motivating per se, it is important to design games in a way to enhance and maintain the player's motivation. Due to the dynamic nature of motivation, game should be adapted to the needs of the player. Similar to the competence-adaptation component, the motivation-based adaptation component consists in an assessment part and an intervention part. The motivation assessment is done by tracking a player's activities and calculating the motivational state (attention, confidence, satisfaction) out of this information. Based on the motivational state messages are triggered, for instance to encourage the player to carry on or congratulating on successful performance. The adaptation model is based on the framework for motivational adaptation developed in the 80Days project (Steiner et al., 2012).

In order to provide cognitive and meta-cognitive support, the behavior of players is tracked in terms of the tasks and activities they are doing. If it is detected that a player is carries out a task in a wrong way or omits required activities, messages can be triggered and sent to the player. These messages shall prompt reflection on the learning and game experience at certain points, based on psycho-pedagogical considerations. The messages are based on a catalogue of intervention types developed in the 80Days project (Kickmeier-Rust et al., 2011). An authoring tool allows modelling the desired and undesirable behavior, the interventions and the rules for triggering them.

The last component is the player profiling component, which allows adapting the game before the player starts. Pre-game adaptation is enabled by presenting a short personality questionnaire when first entering the game. Based on the analysis of the players' responses, personality traits are identified and the game features and versions may be tailored to a player's characteristics. An authoring tool allows the creation of such questionnaires, the calculation of personality scores and their interpretation in terms of game adaptation.

3. Conclusion and Outlook

This poster paper presented an approach for providing learning support on multiple dimensions in educational games. This approach is realized by a set of software components that support different learning aspects. The modular design enables the use of these components by game developers and game designers, which makes the development process more efficient, professional, and cheaper.

The next step is the integration of these software components with an educational game, in order to test and evaluate our approach. This integration enables testing technically whether the components function correctly and pedagogically whether the components support learning as it would be expected. Moreover, a user-centric evaluation will be conducted to validate the practical usefulness and learning effect.

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