Designing Scenarios for Personalized Learning: Enabling Teachers to Apply Educational Video Games in Class

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Abstract: - Increasingly, teachers have to organize and deliver personalized, motivating and student-focused educational practices. Furthermore, they have to design learners-centered instructions, focused on learners' needs, individual learning styles and personal preferences. In the same time, implementation and use of educational video games in classroom settings remain low. The current paper aims to explore six general scenarios for designing and implementing educational video games in class. These scenarios cover all features that a teacher has to conceive in order to develop smart adaptive video games using the APOGEE game platform. By providing simplified tools and methods for building educational games, APOGEE facilitates teachers to develop and adapt its own-generated educational games. The paper identifies the main challenges faced by teachers in the process of implementation of educational video games in class. Then, the learning scenarios elements and methodology for building educational video games in the context of learning experiences are explored. We present six educational video game scenarios and their implementation framework. Finally, the focus is put on some practical issues and considerations for implementing educational video games in the classroom.

Key-Words: - Scenarios, Personalized Learning Scenarios, Video Games

1 Introduction

Within the realms of student-focused instruction, teachers have to provide personalized, motivating and meaningful educational activities, customized to their learning styles and individual preferences. In the same time, many students perceive traditional schooling as ineffective and boring [1]. Therefore, teachers need appropriate tools and methods to design learning scenarios, conform to the educational standards and requirements and at the same time, adjustable to students' preferences and learning styles.

The benefits of game-based learning (GBL) are widely explored in literature but still, educational video games are rarely incorporated within classroom settings. Teachers can be restricted to use video games in class due to a number of reasons, such as the traditional structure of school classes, the lack of appropriate infrastructure and hardware, the rigid school policy and organizational difficulties, the specifics of game data protection and privacy concerns [2]. Usually, creating an instructional game is difficult, time-consuming and costly and often ineffective in terms of learning objectives and engagement [3, 4]. For that reason, to improve learning effectiveness in video games, teachers should be better involved in educational video game design, integrating GBL within specific learning plans, learning objectives and assessment strategies [5]. Furthermore, teachers should have game-relevant knowledge in order to be able to create appropriate learning activities related to the game, recognizing the game learning elements and applying strategies for linking learning inside and outside the game and engaging students personally [3].

The current research aims to explore how a maze video game used as a container of educational puzzles (mini-games) can facilitate teachers to develop personalizable learning scenarios. It will explore six scenarios, corresponding to the main didactic strategies and phases of the formal learning process. Based on these scenarios we will develop a simplified approach for enabling teachers first to apply educational video games in class and second, to improve their capacity to provide personalized and adaptable learning experiences. The six general scenarios for designing and implementing educational video games in class cover all features that a teacher has to conceive in order to develop smart adaptive video games using the APOGEE[1] (smArt adaPtive videO GamEs for Education) game platform. By applying a simplified model for building educational games, the teacher will be able to develop and adapt its own-generated educational games. The first part of the paper identifies the main issues of designing learning scenarios. Then, personalization approaches in educational settings are explored. The third part presents six educational video game scenarios and their implementation framework. Finally, we conclude with a focus put on the practical issues and personal efforts for implementing these video-game scenarios in a real-life setting.

2 Designing Learning Scenarios

In order to develop personalized learning scenarios, within the first part of our research we will identify the main concepts behind learning scenarios design and learning personalization strategies.

2.1 Issues of Designing Learning Scenarios

Learning scenarios represent a pedagogical method for developing a set of activities and their sequence (learning paths), enabling students to acquire skills and knowledge. More specifically, learning scenarios define the main activities, roles, learning structure and environment context - location, resources, tools, and services [6]. Learning scenarios define both the role of the students and what they have to accomplish as a set of learning activities in order to attain the expected learning outcomes. On their turn, learning outcomes usually are defined in terms of skills, knowledge, and competencies that learners will develop as a result of performing specific learning activity.

The ISiS model (Intentions, Strategies, interactional Situations) [7, 8] is a conceptual framework, elaborated to structure the design of learning scenarios by teachers-designers and encouraging its sharing and reusing within learning practices. This model aims to facilitate teachers to structure and design learning scenarios, based on four complementary principles:

1. extracting context, in particular by distinguishing the context of the discipline (knowledge) from the context of the learning unit;
2. identifying intentions on strategic, tactical and operational dimensions;
3. the possibility to provide flexible design processes allowing different combinations of design steps, as well as extending the design during the implementation phase (on-the-fly adaptation);
4. reusing existing scenarios and their components, and adoption of templates to allow the teacher to design his / her scenarios more effectively.

The learning scenarios should reflect the specific learning context, defining where and how learning activities will be integrated in general learning settings.

- At the beginning of the learning course, learning scenarios should motivate learners and demonstrate specific outcomes or learning objectives.
- In the middle of the learning course, learning scenarios should evaluate the learning process, focusing students' attention on specific elements, providing in-depth knowledge, practical insights and examples for integrating theory and practice.
- At the end of the learning course, learning scenarios should provide an integrative view on the knowledge, evaluates what is learned and can serve as a reflection tool.

The learning scenario should define the frequency, or how often students will be able to use it (once or more than once). It should assign the students' role, working alone or working in teams, determining as well what kind of support and feedback students can receive. Learning scenario should describe the models of assessment, the interpretation of the results, and the reflection and evaluation strategy.

Designing specific video-game learning scenarios aims to enable teachers to structure several learning paths within the video games that will correspond to specific learning objectives. This way, teachers can build the maze according to some didactic strategies and create restricted freedom for the learners in it. By exploring the learning scenario, players will be free to select their path within several possibilities within the educational maze, and on another side, the game will be able to track any step of the player, i.e. there will be information about all the paths taken by the learners.

2.2 Strategies for Personalization of Learning Scenarios

[1] http://apogee.online/index-en.html

Personalization, individualization, customization, and focus on end-user need to designate specific approaches to consider user-oriented service design. In these terms, personalization on one side reflects knowledge and understanding of the end-user needs and on the other side investigates different ways of gathering this knowledge [9].

However, Bray and McClaskey [10] make a difference between individualization, differentiation, and personalization in learning, underlining the impact, the context and the role of the teacher and students in all of these learning strategies.

2.2.1 Individualization

Individualized learning addresses learners with special cognitive or physical needs. Learning goals are the same for all students, but students can progress through the material at different speeds according to their specific learning needs. For example, students might take longer to progress through a given topic, skip topics that cover information they already know, or repeat topics they need more help. The teacher has the leading role while adopting specific learning paths, taking in consideration strategies and approaches for adapting materials and instruction for an individual learner based on his/ her specific challenges or disabilities.

2.2.2 Differentiation

In a differentiated learning environment, learners are identified based upon their challenges in a specific content area and skill levels. The instruction is tailored to the learning preferences of different learners. Learning goals are the same for all students, but the method or approach of instruction varies according to the preferences of each student. The teacher uses an existing differentiated curriculum or adapts instruction to meet the needs of different groups of learners. Differentiation is responsive teaching where teachers proactively plan varied approaches to what different groups of learners need to learn, how they will learn it, and/or how they will show what they have learned. Teachers differentiate their instructions based on the learning needs of different groups of learners in their classroom.

2.2.3 Personalization

In personalized learning, learning starts with the learner. The learner understands how they learn best so they can become an active participant in designing their learning goals along with the teacher. The instruction is focused on learning needs, tailored to learning preferences conformed to the specific interests of different learners. For learners to understand how they learn, the learner version of the profile tool could be used to help them share with their teachers how they would like to acquire information, express what they know and what ways they like to engage with the content. When a learner personalizes their learning, learners actively participate and drive their learning. They have a voice in what they are learning based on how they learn best. Learners own and co-design their learning. Learners have a choice in how they demonstrate evidence of their learning. The teacher is their guide on their personal journey.

2.2.4 Personalized Learning Framework

Within their framework for adopting personalized learning, Bray and McClaskey [11] explore the six main phases of learning personalization process. During the first step, teachers should identify the learners' profiles based on their needs, strengths, challenges, aptitudes, interests, talents, and aspirations. The students' profiles enable teachers to recognize their preferences for accessing the content and its form, for effective engagement strategies and for models to express their knowledge and understanding. The students' profiles can include both learning style and gaming preferences and can be determined based on different methods and tools [12].

During the second step, the teacher should set four differentiated learning zones, based on four distinct students' profiles. This way every student can freely choose his preferred physical or virtual learning zone. The third step includes the development of universally designed lesson, or flexible blueprint for creating instructional goals, methods, materials, and assessments that work for everyone. Teachers can design adaptable learning scenarios. The fourth step involves driving and supporting questions, encouraging students to take part in instruction co-design activities. The fifth step aims to select tools, resources, and strategies for appropriate learning and teaching. The final step includes an assessment as learning, or actively engaging learners to reflect and critically assess their learning progress.

2.3 Elements for Development of Game-Based Learning Scenarios

Based on the framework of Torrente et al. [13] we defined the following model to describe the APOGEE learning scenarios. Every video game learning scenario should follow the three main stages: scenario design, learning objectives, content development, and scenario implementation. The GBL scenario should have the following elements:

1. learning objectives: subject, pedagogical goals, student characteristics, training context;
2. game elements - story, goals, characters, scenes, challenges;
3. learning activities, integrating game within the general learning process: before, during and after the game;
4. evaluation and assessment of the learning process;
5. scenario application, game development, and implementation.

Defining these elements, teachers can easily design their own educational video games using the APOGEE maze game platform.

3 Video Game Learning Scenarios

Based on the developed learning scenario framework, we defined six main video games learning scenarios. More generally, fig. 1 visualizes games addressing general or specific knowledge domain, differentiating on learning activities (exploration and learning or knowledge use and testing). The first set of learning scenarios (LS1 and LS6) approaches a general knowledge domain and includes learning and exploration activities. The second set of scenarios (LS2 and LS3) investigate specific and more narrow knowledge domains but employ active learning strategies such as experience-based learning and gaining in-depth understanding games. The third section includes testing scenario LS4, covering different strategies to assess and evaluate knowledge, by using it in specific contexts. The final section aims to make an overview and to summarize learning LS5 by adopting games that will recall and remind general knowledge.

Figure 2 defines the suggested sequence of the six video games learning scenarios, facilitating teachers to understand how to adopt and apply video games within the educational process. This way, the first scenario explores an introduction game, where learners have to experience the new learning content. In the specific context of APOGEE, the maze game in the introduction scenario can incorporate a specific number of rooms, reflecting the structure of the learning content. Furthermore, first scenario - LS1 - can adopt multiple puzzles and mini-games as for example, enabling learners to explore the maze, to open doors by solving 2D puzzles, playing word soup mini-games, memory games and discovering hidden objects. When learners get a general overview of the learning domain, they can explore in details the experiential game LS2. By applying the experience-based learning cycle of Kolb [14], teachers can design learning scenarios, including game activities such as exploring, discovering, connecting, finding, pointing out and others. The third game – LS3 involve students to gain an in-depth understanding of a specific knowledge domain by applying advanced cognitive models and strategies. Then, the testing game LS4 aims to facilitate students' learning process by designing dynamic and competitive testing experiences. Summary game scenario LS5 explore the overall knowledge domain, this time focusing on the most important contextual knowledge. Finally, interdisciplinary game LS6 aims to connect the new knowledge domain to other disciplines, allowing learners to get a better understanding and perspectives of the links and connections within the learning content.

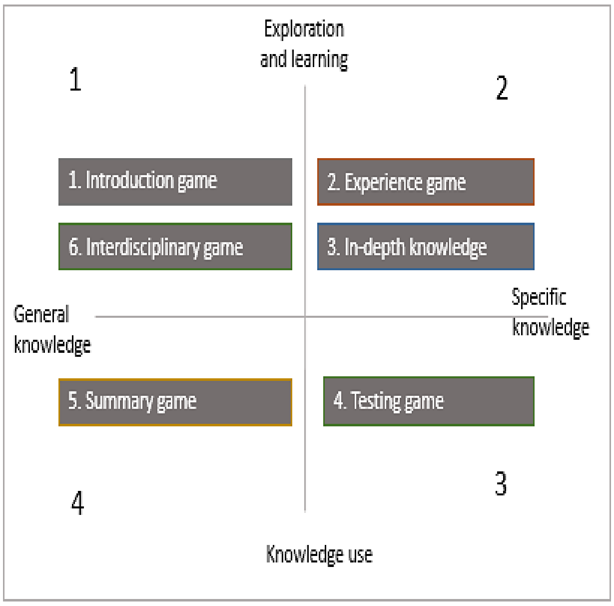

Fig. 1. The general framework of video games learning scenarios

3.1 Approaches for Game Tailoring Based on the Student Profile

The teacher-generated video games within the platform APOGEE can be easily tailored (personalized, individualized, and/or differentiated) according to various characteristics of the student profile, i.e. to characteristics of the learner and the player. From one hand, didactic content in the game can be personalized for an individual learner to his/her age, gender, learning outcomes, and specific learners' styles and preferences. According to these characteristics of the learner, the storyboard engine embedded inside the game can tailor several issues of the narrative, namely:

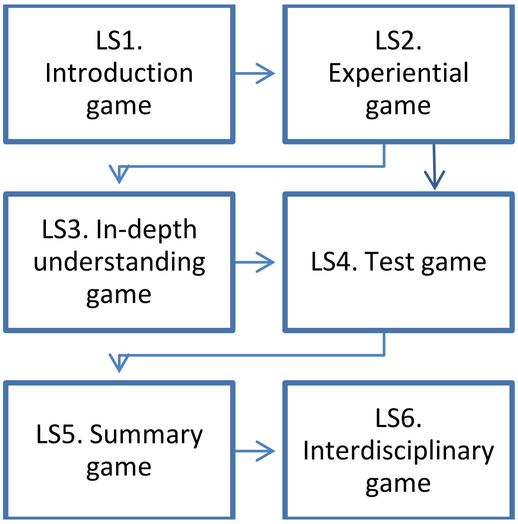

Fig. 2. The logic of video games scenarios implementation in general learning process

- The didactic content complexity – it is supposed to be different for learners of different age, having a different learning style, or demonstrating different learning outcomes;
- The didactic content structure – the content may appear in short consecutive paragraphs or as a continuous text;
- The presentation of the didactic content – by changing the font, size, color, etc.

From the other hand, puzzle mini-games embedded into maze halls may have difficulty and/or audio-visual parameters dynamically changed according to some properties of the player model such as the playing style and outcomes. For example, according to the player model, the game engine could change dynamically some features of puzzle game mechanics like:

- The mechanic difficulty of solving the puzzle – e.g., by varying the number and forms of tiles constituting a 2D image puzzle, or tailoring the velocity in a shooting mini-game embedded into a hall of the maze;
- The audio-visual features of the puzzle mini-games embedded into the maze – such as illumination, contrast, sound volume, sound tempo, etc.

The puzzle mini-games embedded into the maze can be applied for a personalized learning process.

3.2 Puzzle Mini-Games as Personalized Learning Elements

The dynamic game adaptation outlined over appears to be orthogonal to the personalization of learning content. The puzzle mini-games embedded into maze halls might be tailored to the player/learner profile according to both the approaches for dynamic game adaptation and personalization of learning content. As shown in fig. 3, each puzzle can hold to varying degrees these two approaches. The farther away is a game from the center of the chart, the better it maintains one or both the approaches for tailoring the game. We plan to support 10 different types of such personalizable puzzle mini-games [15], as follows below:

G1. Answering a question about unlocking a door to another hall in the maze;
G2. Answering several questions (a quiz) about the didactic content presented in the hall;
G3. Arranging a 2D puzzle, which is automatically generated from an image;
G4. Solving a ‘word soup’ puzzle (searching specific words in rows, columns, or diagonals) – in all directions;
G5. Rolling balls marked with both text and image to:

- certain positions on the map shown on the floor;
- certain objects (rings) located on the floor in the hall.

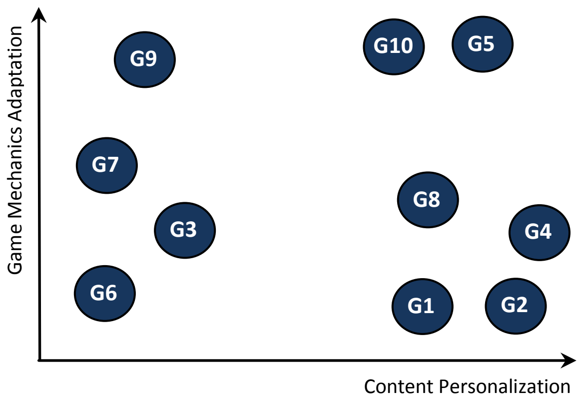

Fig. 3. Abilities of puzzle mini-games to support personalization of learning content and dynamic game adaptation

G6. Detection of visible translucent objects;
G7. Detection of invisible objects hidden in larger visible objects by moving the large objects;
G8. Ordering and classification of found objects by specific feature;

G9. Memory development game – the player has to remember and match equal colors, images or texts;

G10. Shooting on moving objects (e.g. balloons with a 3D didactic object attached to them).

Inside the first maze room, several game activities and self-report tools will differentiate implicitly and explicitly the students' profiles, in order to allow individual profile next to be applied for content personalization and/or for a game adaptation. In addition, teachers will be able to set other elements like speed, time, competition, and constraints on the learning task making the educational game more engaging based on students past achievements and preferences.

4 Conclusions

The potential of educational maze games for teaching in school is yet to be revealed and studied in depth [15, 16]. The article presented initial research exploring how a maze video game can be applied as a container of educational puzzle mini-games for facilitating teachers to develop personalizable learning scenarios. We outlined six game-based learning scenarios, which correspond to the main didactic strategies and phases of the formal learning process. After the scenarios, we defined the main approaches for tailoring an educational video game according to various characteristics of the student profile. While the personalization of didactic narrative is controlled by the storyboard engine embedded inside the game, the adaptation of the game mechanics is steered by the game engine. These two types of different approaches were applied for personalization and adaptation of various puzzle mini-games embedded into the principal maze game, as personalized learning elements.

Based on the six game-based learning scenarios, we develop simplified approaches for enabling teachers to apply educational video games in the classroom. They will be able to design and generate automatically their educational games through the APOGEE online platform. The generation of maze video games is based on a formal definition of the maze game and without any need to program the control neither over the game engine nor over the storyboard engine. The formal definition of a 3D maze can be created from the scratch using XML templates provided by the platform, however, in the near future teachers will be able to define their mazes through an online drag-and-drop visual editor with easy and intuitive graphic interface. Thus, teachers will define rich educational maze games as containers of various puzzle mini-games aimed at bringing personalized and adaptable learning experiences. Further, these learning experiences will be enhanced by the use of intelligent virtual players able both to help the learner and to answer his/her questions regarding the learning domain of the maze game.

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