PERSONALISATION IN EDUCATIONAL GAMES – A CASE STUDY

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Abstract

Nowadays, with the massive penetration of fast Internet connections, e-learning has become a usual approach. Further, it is still an active research field with many innovations one of which is gamification of learning. Game-based learning can support and even substitute traditional one and sometimes it is a preferred method. Most often students of the digital generation are interacting and acquire knowledge in virtual worlds. The ubiquitous use of computers, mobile devices and gamification have considerably raised students' expectations to a personalised experience that includes recognition of their skills and preference matching. Traditional educational games offer uniform learning resources for everyone and typically use "one-fits-all" approach. With the recent popularity of personalisation, it has become clear that it can enhance the effectiveness of teaching and increase learning outcomes for all students, as different people learn in different ways.

Improving the students' performance in educational games by providing effective personalisation of game content is a big challenge for the developers. The educational games face many challenges in pedagogical (e.g., the design of lessons structure, learning content and tasks), and technical aspects (e.g. resource provision). This paper presents a concept for personalisation of educational games developed in the scope of project APOGEE. It is based on the modelling both the user (student) and the content of the game. The goal is to enhance the learning experience by customising the type of mini-games and contextualising the content of learning tasks depending on the students' profiles that appreciate their knowledge, practices, and preferences. Moreover, today's players are expecting a personalised gaming experience as personalisation appear to be ubiquitous in all domains. The current study shows how students can enjoy such learning experience anywhere, any time with educational video games that are adaptable and personalised where possible.

The paper presents a framework that aims to provide a personalised and adapted game-based learning by incorporating different gamified educational tasks that are thought to raise both learning and gaming engagement. Therefore, the model of personalisation recognises parameters such as player's skills, performance, as well as learning and playing style. Making personalisation involves taking into account the initial user's data (profile) and further, extracting information about interactions within the game. In our case, the developed user model includes both the characteristics as a learner and as a player. Such data help to update an individual player model and enable making recommendations and customisation of chosen mini-games for the player. The focus is on personalisation of the game accordingly, aiming to sustain the student's enjoyment, giving them a better experience, meeting their requirements and rewarding their efforts and knowledge.

The study also presents survey findings of the preferences of different groups of school students for games and types of gamified learning tasks (mini-games). Furthermore, the idea is to support adaptation and personalisation of educational content and further to achieve its reusability and interoperability, thus to provide the easily manageable tool for teachers to create personalised educational video games offering individual learning paths.

Keywords: personalisation, educational games, user modelling, survey, APOGEE project.

1 INTRODUCTION

Today in technology era Information and Communication Technologies (ICT) penetrate massively in all humans' activities and teaching is not left behind. Thus, various technology tools and approaches enable innovative effective educational practices. Internet connection, ubiquitous digitalization and contemporary software applications are at the base of a massive penetration of e-learning and transformation of traditional education. Further development in this line is computer video games that continuously increase their popularity and already are becoming a daily routine, not only for digital generation adolescents but for people of all ages. As taking into account the ability of computer games both to entertain and attract users' attention many hours, their attractiveness can be transferred and

repurposed to a more meaningful application – effortless learning while having fun. This is the concept behind the game-based learning (GBL) [1]. The integration of providing engaging and motivating gaming experience of into process or activity with the purpose other than fun is known as gamification. Nowadays its potential for education process is already assessed by most of the teachers.

Often, available educational games are not appropriate for all learning subjects or pedagogical approaches. Regarding the pedagogical aspects of game-based learning, in most cases, teachers use games that usually do not match the pedagogical approach, as well as the plot and learning tasks also do not fully cover the curriculum. Additionally, educational games are scarce (and often do not exist), especially closely related to a particular subject and the matter studied. Another limitation is that teachers do not usually participate in the pedagogical design of such games. Thus, they do not have the tools to provide personalised learning content or assignments to learners. Further, available games rarely have built-in functionality for gathering information and statistics concerning tracking and recording the activities during the learning process, as well as the progress and results of learners.

These problems motivate the project APOGEE that aims to provide a framework for the development of educational video maze games [2]. Such games not only can have embedded different didactic tasks but are a source of information and knowledge. Thus, they can be e-learning resources for personalised and adapted game-based learning that is thought to raise both learning engagement and effectiveness. The educational video game-maze is designed to provide built-in functionalities with the idea to overcome most of the above-listed limitations. The concept is based on the development of three models - of the maze game, didactic tasks (represented as mini-games) and user (student). In this way, it will be possible to personalise and adapt the learning process, taking into account the characteristics and preferences of the learners.

The paper presents the model of personalisation of educational video maze games developed in the scope of the APOGEE project. The applied approach recognises the user (student's) profile data, e.g. age, gender, background, skills, performance, learning and playing style. The process of personalisation involves taking into account the initial user's data, as well as extracting and updating performance parameters concerning in-game interactions. Thus, the developed user model has to consider both the characteristics as a learner and as a player. Such complete information allows amendment of student's model and enables customisation of chosen built-in learning mini-games. The goal is accordingly to adapt or personalise the game focusing not only teaching but on the student's enjoyment, giving them a motivating experience, and rewarding their efforts and knowledge.

2 RELATED WORKS

Different educational institutions define personalised learning in different ways, depending on the context, pedagogy, applied technology, and other factors [3]. Numerous researches, as well as a shared teaching practice, point out some approaches that have proven their effectiveness in personalised learning [4, 5]. Most of these approaches can be implemented through ICT tools, so can be built-in the educational maze game, thus to support the personalised game-based learning.

- Learning by doing, i.e. didactic tasks requiring learners' actions.
- Active tasks and learning scenarios in which students have to make decisions.
- Providing immediate feedback that gives specific information in case of difficulty or problem.
- Stimulating learners' progress by focusing on their knowledge and skills.
- Providing dynamic adaptation to the learner's current performance.

The US Department of Education consider the terms "personalised" and "individualised" learning, as well as a "personalised learning environment" to refer to efforts to adapt education to meet the different needs of students [6]. In personalised learning, the tempo and the learning approach are optimized for the needs of each learner. The learning objectives, the teaching approaches, as well as the content and consistency of the curriculum, may vary according to the needs of the learners. Additionally, learning activities should be meaningful and relevant to learners, tailored to their interests. Contemporary ICT enable personalised training to be more engaging. Technological tools, such as computer video maze games provide inspiring experience and support an individual approach of learning, which often is more appropriate than traditional [7].

In this paper, the term personalisation regards a change in learning content of a game to adjust it to the needs of a particular learner. In the context of learning games, personalised gameplay modifies

according to the student's profile –characteristics, needs and individual preferences, i.e. offers a personalised learning experience [8]. The research shows that the personalised content in games provokes significantly higher engagement and extensive development of the learner's cognitive abilities and skills [9].

3 METHODOLOGY

Three types of specific knowledge are needed to make effective adaptive teaching: knowledge of the subject, knowledge of the teaching strategy and methods, as well as knowledge of learners' profiles [10]. From a didactic point of view when considering learning through educational video games, the basic principles of pedagogy – scientific accurateness, accessibility, visual illustration, activity, sequence, individual approach also should be applied [11].

Similarly, to provide adaptive learning through computer games, it is useful to be available the knowledge for the interactions in the learning process - types of instructions and demonstrations (text, audio and video), feedback types, indicating the correctness the student's response, and the types of assistance offered. Therefore, when working out the concept of an educational computer video game, three models are developed that fully represent the basic types of knowledge [10] - for the subject matter, the strategy and methods of teaching, and the learner. The described above specific knowledge for game-based learning will complement these models.

Another important aspect of modelling is the opportunity of expanding the models if necessary. Expandability is a factor in ensuring optimal modelling, though it should be noted that addition of new attributes or components during the process of modelling of a system may require significant changes in relations and interactions among them. In the particular case, additional components (e.g. learner characteristics or features) may be added to the three models developed.

3.1 Modelling the Game Content

The requirements of basic principles of pedagogy [11] imply that knowledge and facts have to be presented through adequate methods. Accessibility requires the learning material to take into account the learners' abilities, thus to motivate and stimulate their interest in learning. Hence, learning matter besides logical consistency should be gradually complicated. Furthermore, the volume of learning content should be accurately selected and combined with a visual illustration, as well as take into account the characteristics of learners.

The content structuring includes description, granulation, and personalisation. Usually, e-learning systems apply different ways of granulating learning content. Typically, each structural unit is defined in terms of its interrelations with others. For example, a training course consists of several thematic and logically distinct parts/sections, which in turn comprise some lessons, each of which may cover one or more topics. The mass distribution of eLearning systems has led to the need for standardization in this area. As a result, several interoperability standards for e-learning platforms and content management systems have been developed [12, 13]. Thus, learning resources based on these standards can be easily reused and combined in different ways to adapt or personalise to the learners. The thorough analysis of these standards reveals that their specifications cover many issues of e-learning architecture, starting from the technical parameters of the learning resources and coming to those related to their pedagogical application - e.g., the structure of the curriculum, description of the curricula objects (through a broad set of metadata), purpose.

From the review of learning content standards, it can be concluded that its structuring is mainly subordinated to the functional requirements of eLearning systems and the possibility of multiple uses [14]. Numerous studies have suggested that the reuse brings many advantages to teachers, where the first is saving time and resources for developing new learning resources. Additionally, sharing and subsequently modifying or personalising learning materials also provides another opportunity for enrichment and enhancement of their quality. There are several basic requirements for the learning resources to be easily modified and used multiple times [15]:

- Granularity – refers to the level of decomposition of the instructional content. It also concerns the design of learning objects, meaning that they have to be intentionally created to be pieces of a vaster in size resource.
- Design – regards the presentation of information (knowledge) and educational tasks (pedagogical approaches).

- Accessibility – refers to the ability of a learning resource to be found by users who wants to use it.
- Compatibility – relates to the extent to which the resource can be used in many different platforms and training systems.
- Copyright – refers to the respect of intellectual property rights and indicates the authorized ways of using (and modifying) the learning resource.

To summarize the most significant factors that enable reuse of learning resources are as follows: learning objects should be stored online in databases and correctly annotated with metadata that allows users to find, access and share them. Moreover, learning objects should be, as far as possible, independent of the learning context for which they were developed. In this way, they will be suitable for different courses, groups of learners and learning environments [15]. Therefore, learning objects must be modifiable (easy to modify, update, present differently, change some of their parameters) and independent of the platform, thus to be reusable with or without changes in other learning contexts.

3.2 Modelling the Student

Here are listed some of the most popular in literature techniques for creating a student model:

- *Stereotyped model* – multiple set groups are created then each learner is assigned to one of possible categories (e.g. beginner, advanced, expert), which determine personalisation [16].
- *Overlay model* – student's knowledge is flexibly modelled, concept by concept, and updated when the learning progress occurs. Brusilovsky introduces this approach and widely implements it in adaptive hypermedia training systems [17]. The drawback of the model is the necessity to divide the area of knowledge in advance into specific themes or concepts. The accuracy of this model depends on the degree of granulation of the knowledge area. Further, it depends on the detailed assessment of learner's knowledge considering the topics learned.
- *Combined model* – it combines pieces of the above two models. Initially, the learner is categorized by a stereotype. Further, the model gradually modifies by superimposing information obtained in the course of learning interactions.

In GBL a significant user's characteristic is playing style. Research distinguishes types of playing, defined as players' permanent features, from playing styles that treat "motivation as a more temporary state, meaning that players can accept different playing styles in various games or at different times" [18]. Therefore, the personal playing style is temporary parameter and has to be defined in the context of a particular type of game. Playing styles are extremely important for the adaptation of player-oriented digital games [19]. The psychological theories are the basis for categorizing many of the playing styles [20, 21]. According to some research, there is a parallel between playing and learning styles, as motivation is considered to be in the core correlation with learning [18].

Learning style is another user's characteristic that has impact on the effectiveness of GBL. It is characteristic of cognitive and psychosocial behaviour, which is a relatively constant indicator that reflects the way learners perceive and interact with the learning environment. Kolb defines the Learning Style Inventory where learning styles are organized in the two-dimensional space as follows: The abscissa presents the processing continuum (i.e., how one approaches the problem solving – by observation or by action) while on the ordinate is presented the continuum of perceptions (what students think or feel about a particular task, i.e. their emotional response) [22]. Based on this work, researchers using a different approach, offer a new classification of learning styles [23]. They introduce the pairs of styles reflector – pragmatist and theorist – activist as mutually consistent, while in Kolb's model learning styles are seen as combinations of the learning cycle stages.

4 RESULTS

When working out the concept of an educational computer video game, models are developed that fully represent the three basic types of knowledge – for the subject matter, the strategy and methods of teaching, and the learner [10]. Further, to achieve adaptive learning through computer games, it is useful to be available the knowledge for the interactions in the learning process - types of instructions and demonstrations (text, audio and video), feedback types, indicating the correctness the student's response, and the types of assistance offered. The described above specific knowledge for game-based learning complements these models. Hence, in the scope of project APOGEE, the following

models have been developed: Model of learning content, Model of the game (including the game methods and strategy as well as the pedagogical approach used in the Didactic Models of tasks), and Model of end user (student). These models are specifically designed for the purpose of creating a 3D video game of type enriched educational video maze. At the core of modelling is the model of the game end-user, which provides requirements to the other two models in terms of personalisation and adaptation. At the core of modelling is the model of the game end-user, which provides requirements to the other two models in terms of personalisation and adaptation. Fig. 1 presents the main interrelationships between the models determined through an analysis of the context of the game being developed.

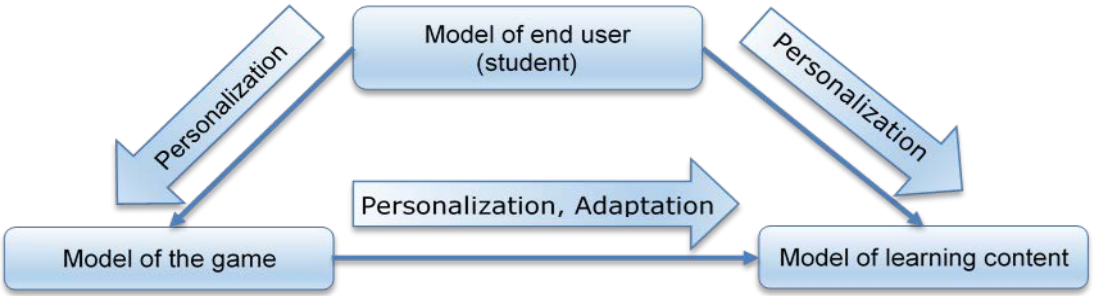

Figure 1. Main interrelationships between the models.

Model of learning content – reflects the subject area; its formulation is determined by the teacher who designs the game. Performance, complexity and volume of learning content depend on the type of built-in mini-games and the platform for which the game is intended. Personalisation depends on the user profile described in the Model of end user and on the availability of appropriate learning resources that meet the requirements of the given profile attribute.

Model of the game – does not depend on the Model of learning content. It's personalisation and adaptation depend on the user profile described in the Model of the end user.

Model of the end user – defines attributes according to which is making the personalisation of learning content and adaptation of difficulty of the process of gameplay.

4.1 Model of the End User

Within the APOGEE project, the combined approach is used for modelling the user of the video maze game. The student's model comprises static and dynamic parts that are initialized during the user's registration in the game portal. The components that don't have assigned values are not involved in the personalisation or adaptation processes. Dynamic ones must be related with techniques to retrieving current in-game values to update the model of a particular user. This approach requires a well-grounded way of producing and structuring user data. Additionally, it is necessary to define the essential user data that have to be retrieved and recorded so that this significant information to support dynamic adjusting the user model. A reasonable compromise must be made to limit the amount of extracted and stored information while to reflect the ongoing learning and game interactions and results. Unregistered users will also be able to play the video games available on the portal. However, the gameplay will not be customized, as well as their achievements will not be reflected in the scoreboard of the players.

When creating the user (student) model, the features related to the process of game-based learning should be included. Hence, the educational game can be adapted to the profile of students by using their models. In this way, it is possible to customize the learning interactions of the student with embedded didactic tasks. The goal is to increase the efficiency of game-based learning through personalisation of educational games. One of the approaches to the achievement of this goal is by comprehensible presenting learning content in an engaging context (i.e. in the form of gamification).

According to the project concept, a broad-spectrum flexible (extensible) modelling approach has to be used to develop the model of the user of an educational computer video game thus the following three main aspects of this model are addressed:

- General characteristics of the user – for identification of the student;

- Characteristics as a player – related to an appropriate type of adaptation and customization of specific parameters of game and gameplay itself to the user's background and preferences;
- Characteristics as a learner – related to a particular type of adaptation and personalisation of educational content and built-in didactic tasks to learning needs and preferences of the user.

Below is given a detailed description of all features, where static part of user characteristics (relatively constant), usually support the process of customization and adaptation of the educational maze game. Dynamic characteristics (variable) represent current results that students achieve when playing.

General characteristics of the user – include two sets of attributes as follows:

1. Static characteristics – *student's name, nickname and password* (for identification and security issues such as personal privacy and protection); *e-mail address* (for providing feedback); *age* and *gender* (for personalisation issues – defines the complexity of gameplay, degree of difficulty of learning content and type of built-in mini-games).
2. Dynamic characteristics – a*chieved results* (chronological list of the results of the player in different game sessions) and *other student's data* (at the teacher's request).

Characteristics of the user as a player – include the following two groups of attributes:

1. Static characteristics – *age, gender and playing style* support the personalisation and adaptation of the game. The first two are part of general features and relates to the personalisation of learning content and to the preferred type of built-in mini-games. The playing style also determines the choice of built-in mini-games. Within the APOGEE project, the four playing styles based on Kolb's experimental theory defined in [24, 25] are accepted. These styles – rival, dreamer, logic and strategist are applied to control the adaptation of training.
2. Dynamic characteristics - represents the score of the user as a player that reflects the achieved game result and is a record of the following parameters:
    - *Points for all solved tasks* in mini-games – they reflect the number of resolved tasks and their complexity. This indicator shows the learner's performance, i.e. demonstrated skills.
    - *The efficiency of play* – indicates how the players show their skills. Increases inversely proportional of the number of attempts to solve the particular task.
    - *Speed of solving a game task* – indicates how fast the player plays effectively. It depends on playing times of each mini-game, their degree of complexity and number of solved tasks.
    - *Acquired wealth* – for each player represents collected objects in the game. It is used for positioning the player in the hall where he was at the end of the previous game session, displaying already collected wealth. The indicator shows the ranking place of the player.
    - *Aggregated result as a player* – determined of the above-described parameters.

Characteristics of the user as a learner – include the following attributes:

1. Static characteristics – age, learning style, level of knowledge, interests and objectives, and special educational needs support the customization and adaptation of the game.
    - *Age* – affects the personalisation of the learning content;
    - *Learning style* – relates to the type of didactic tasks embedded in mini-games and their personalisation. Within the APOGEE project, the learning styles of Honey and Mumford activist, theorist, reflector and pragmatist as described in [19].
    - *Level of knowledge in the subject area* – a stratified scalar index with predefined values, e.g. beginner, advanced and expert. It is determined explicitly either by the student himself at the beginning of each game session (at the first play in the portal) or by the lecturer;
    - *Interests and objectives* – chosen from predefined values (e.g. initial introduction to the topic, detailed study, knowledge testing, etc.). They depend on the applied pedagogical scenarios and concern the personalisation of the learning content in mini-games.
    - *Special educational needs* – affects the adaptation of game dynamics, the presentation of learning content (e.g. short and simple sentences in dyslexia), and the help.

2. Dynamic characteristics – represent the user's assessment as a learner; they reflect the achieved score in the game and comprise the following attributes:
    - *Points for all solved assignments* – the indicator increases by each solved learning task (e.g. questionnaire, quiz, and puzzle) with a value depending on their current complexity. Presents the learner's performance, i.e. shows what the student knows.
    - *Learning efficacy* – indicates how the players have revealed their knowledge (for example, whether they firstly have entered the correct answer/solution to the task or has hacked it after several attempts).
    - *Speed of solving a learning task* – indicates how fast the student plays effectively. The parameter depends on the reciprocal values of the playing time of each mini-game, its degree of complexity and the number of solved tasks.
    - *Acquired knowledge* – reflect the learning path in the game for each learner. This metric enables positioning the player in the room where he was at the end of the previous game session. The indicator shows to the teacher which learning units already taught and along with the performance gives an appraisal of the learner's knowledge level.
    - *Aggregated result as a learner* – summarises the above-described parameters.

It should be noted that when a registered user starts a new game, the system checks if there is an unfinished previous one (it keeps the last one) and asks if the user wants to continue it. In this case, the game is loaded with the player positioning in the corresponding hall, all the parameters of the game being in its original condition, and the results achieved beforehand are preserved, including the collected objects and points.

4.2 Model of Learning Content of the Game

The technologies behind contemporary GBL provide many tools to enable customization. Therefore, the developed model of the learning content of the game is consistent with the concept of learning through personalised gameplay. The principle behind designing the structure of learning content in the educational maze game is in line with the concept of reuse of learning resources. Hence, it is used the object-oriented approach, which is based on the creation of digital components (objects) that can be utilised repeatedly in various contexts and even for different purposes. The technology for creating learning resources by assembling interoperable and reusable components (such as Lego blocks) is based on widespread metadata specifications and standards for learning content [26].

The structure of learning content in the educational maze consists of three levels of granulation. The top level is a lesson or a complete part of it related to some learning topic. Thus, they build learning content in a particular room of the maze game. Each lesson or topic comprises a multitude of learning objects (LO) that are embedded in the educational tasks of mini-games and informational boards on the walls of maze rooms. They should be personalisable and allow repeated use in various learning contexts (in different mini-games and different levels of complexity/difficulty of learning content). For this purpose, they consist of small information units (IU), which can be used on their own. Such structure of learning content essentially conveys the idea of LEGO blocks - small components that can be used on their own but also can easily be combined with other ones to form a comprehensive learning object (LO). Hence, the essential pieces of learning content are the small unique information units of different types - text, image, 3D object, sound or video. These IUs will be stored in a database and indexed to make them easy to search and reuse in various contexts. The content designer (teacher) can use them alone or combine with other ones to form personalised learning objects that match learning goals and students' needs. Learning objects are also accurately described, indexed and structured in a database. Thus, they are easily accessible and allow reusing and customization (to change the content by replacing some information objects with other ones or adding new ones). The developed model enables the following degrees of granularity of the learning content (Fig. 2):

- *Learning object level* – it consists of one or several information objects (from one or different types). The highest level of personalisation and adaptation is allowed.
- *Task level* – a given learning task may consist of one or more learning objects. Personalisation and adaptation are at the level of learning objects.

- *Lesson (topic) level* – usually comprises several learning tasks with the corresponding learning objects that match the requirements of users of some category. The least customization and adaptation options are allowed - at the level of learning tasks.

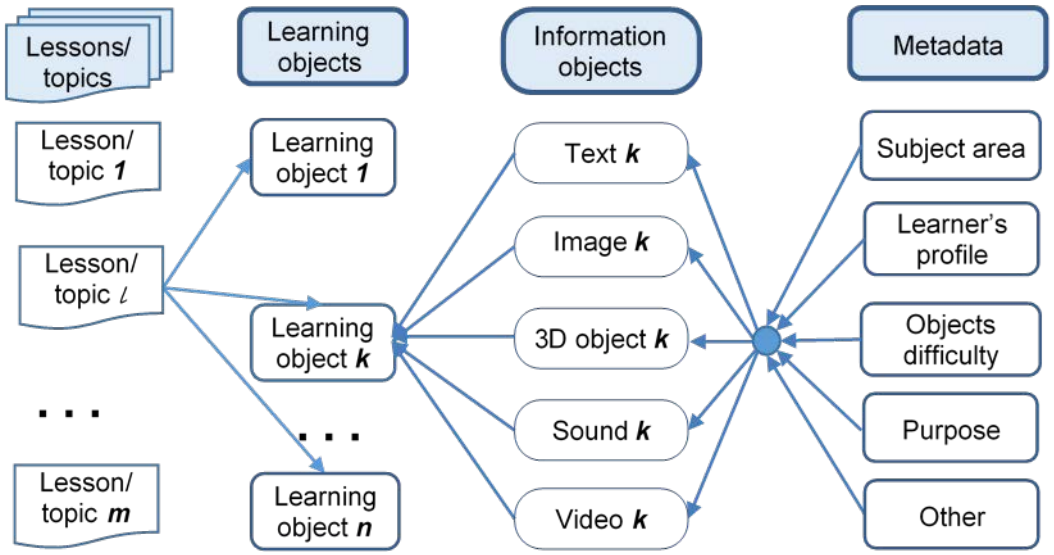

Figure 2. A metamodel of the learning content

The developed concept implies that mini-games and information boards in the room of the educational maze will present learning content corresponding to individual lesson or topic. There may be only one instance of each mini-game and up to eight information boards - two on each of the four walls. Each information board presents a narrative resource (e.g., facts, phenomena, and events), part of the lesson, which may consist of multiple pages/slides without limitation in volume. Such a narrative learning object aims at acquiring new knowledge, expanding knowledge (interrelationships), validating (reviewing) or preparing for a test. Individual mini-games are didactic or gaming tasks, with up to three levels of complexity/difficulty, as well as with optional and customizable content. The idea is that all types of learning objects are described with metadata indicating their most important parameters. In this way, they will be easier to identify and facilitate their reuse and personalisation [15]. Some learning objects may allow practical implementation in several types of mini-games.

The learning resource hierarchy is defined as follows: Each resource (lesson/topic) may contain many other resources (learning tasks and objects), i.e. every resource may have any number of building blocks and correspondingly different characteristics. Thus, the eXtensible Markup Language (XML) is appropriate to represent the hierarchy of objects. It supports a platform-independent data exchange.

4.3 Personalisation of Learning Content of the Game

The structure and size of the learning content included in learning resources are essential for enabling their personalisation or adaptation for reusing purpose. An additional factor is the availability of rich metadata. For example, information on the intended use may help course authors in selecting and reusing the appropriate learning resources. Personalisation of the educational content of rich educational video maze game is based on the model of the user (student) both as a learner and as a player. Recognition of characteristics of players is related to tracking and recording their actions for the purpose of providing them with personalised in-game experience. Customisation takes place at different levels and includes:

Personalisation of the lesson content - depends on student's age, school marks and current in-game achievements. It refers to the narrative content (presented on the information boards) and learning tasks that require answers to questions embedded in mini-games such as “Sesame, open!” and the “Quiz”. Customisation is based on the following criteria:

- Degree of complexity/ difficulty of the learning content - it determines the terminology used and the way of presentation of knowledge.
- Level of lessons content – three levels: elementary (includes only the most essential facts and ideas), fundamental (introduces more detailed matters, events and concepts) and in-depth

(involves supplementary data, theories and opinions, even knowledge related to other subjects, e.g. interdisciplinary links that are optional depending on teacher's choice).

Personalisation of gaming content – depends on attributes in students' profile - e.g. age, knowledge level, as well as their current in-game achievements. It refers to the learning tasks that require, besides subject knowledge and playing skills:

- Presentation of the gaming content built into mini-games in the maze, e.g. showing/ hiding target positions or adding redundant (wrong) target positions in "Rolling Balls" mini-game.
- Using different types of learning mini-games in the maze depending on the profile of students (age, gender, learning style) and preferences – see Fig. 3.
- Customisation of parameters of learning mini-games in the maze depending on age, gender and playing style of students.

Fig. 3 shows a comparison of students' preferences to learning games, expressed as averages. The assessment is made on the 5-step scale of Likert (1 - "definitely not" to 5 - "definitely yes"). The results clearly show that boys have stronger preferences and game favourites, while on the opposite – girls are more uncertain in opinions, so their preferences to all types of games can be clustered within just one point. The differences are relatively smaller even there is a coincidence for some types of games.

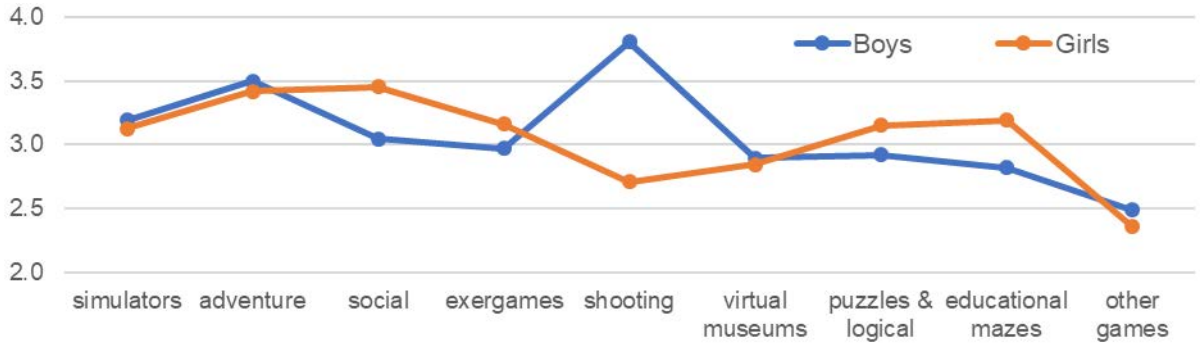

Figure 3. Preferred games for learning

5 CONCLUSIONS

This research presents the results related to the personalisation of educational video games, developed under the APOGEE project. It shows the developed declarative models designed to model educational maze games with structured learning content. The paper outlines the methodology used to create the three models, specifically designed to allow creating these games: Model of end-user of the game (student) that is dealt with in three aspects: general characteristics, end-user as a learner and as a player. Model of the game includes the game methods and strategy as well as pedagogical approaches used in didactic models of built-in tasks (mini-games). Model of learning content is directly dependent on personalization based on the model of end-user (student).

When modelling the learning content of educational video maze games with built-in didactic tasks, the fundamental pedagogical principles are implemented together with granulation. Thus, the structure of learning content enables customisation. Further, GBL involves students in conscious and meaningful active actions, unlike the traditional mechanical memorization of learning matter. Thus, educational video maze games provide the opportunity for an individual approach to learners by personalisation of learning content to their goals and interests, as well as to the learning and gameplay styles.

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