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A MODEL FOR THE CREATION OF SCRIPTED SEQUENCES FOR SERIOUS GAME APPLICATIONS

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Abstract. This article presents a method for presenting information in an interactive application, using a method that video games use to create narrative – scripted sequences – while following the principles of instructional design. A model for creating such sequences is also presented, inspired by a similar model for adventure video games. Five adventure video games were analysed to create this model. The created application has several advantages over real-life presentations: 1) the user does not physically have to appear at the location of the presentation, 2) the user can stop and start the presentation at a convenient time, and 3) the application may be more engaging than a recording of a real-life presentation.

Keywords: information technology, instructional design, game design, animation, scripted sequences.

Introduction

Video games allow players to see and experience things they may be unable to in real life, or would have difficulty with, in case of sickness or disability. This aspect of video games can be used for things that are not merely entertainment but have other positive benefits. The field of serious games uses video games for such purposes as healthcare, education and promoting healthy lifestyle choices. In this article we focus on the use of video games for education. We present a method of presenting information by using scripted sequences, typically used to create narrative in video games, while following the principles of instructional design. Many video games use scripted sequences – pre-determined events in the game world during which the player is able to move around and interact with the world in a limited way – to create narrative. However, there is little information about how to create such sequences in the academic literature. Therefore, we propose a model for creating such sequences, inspired by a similar model for the elements of adventure video games. The method and model are tested by creating a virtual presentation of the Vilnius Tech university Animation Digital Technology study programme. Such a presentation may be a substitute for a real-life presentation if the viewer cannot or does not want to physically go to the location of such a presentation. It may also save fuel costs or help avoid getting sick during epidemics like the recent COVID-19 pandemic.

1. Background research

1.1. Instructional design and serious games

Instructional design is the process of creating effective learning materials to achieve specific teaching goals. Because people learn many skills throughout their lives, it is important to categorize these skills so they may be taught more effectively, as each skill requires different methods of learning. For this reason, Gagné (1985) identified five areas of learning: *Motor Skills* (skills learned through repetitive action), *Verbal Information* (learning factual knowledge), *Intellectual Skills* (learning rules and using them for problem solving, *Cognitive Strategies* (methods of learning used by learners, either learned through self-reflection or from being taught such strategies and *Attitudes* (how the learner feels about their abilities and what they are learning). It is well known that people learn better from words and graphics than words alone (Mayer, 2017). It means that learners in multiple-representation conditions outperformed those who studied material based on a single signal (Glaser & Schwan, 2015). Thus, for the design of game-based instructional materials, addressing more than one learning objective might enhance cognitive processing and learning outcomes.

Merrill (2009) proposed the First Principles of Instruction (FPI) which are widely used nowadays for the creation of instruction-based materials. Those principles are:

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1. Problem-centred (Learners solve problems that are like problems they may experience in the real world).
2. Activation (existing knowledge is used as a basis for new knowledge).
3. Demonstration (new knowledge is demonstrated to the learner).
4. Application (learner applies knowledge to solve problems.
5. Integration (learner transfers the new knowledge to his real life).

Lo and Hew (2017) combined the multimedia learning principles (Mayer, 2017) and FPI (Merrill, 2009) to design instructional videos for mathematics learning and recommended to present a brief review of key concepts in videos. They also suggested to limit video duration to 6 minutes. Gardner et al. (2020) also applied FPI for the design of digital materials. They recommended to include realistic examples from various contexts and to create creating multiple practice opportunities. However, Tu and Snyder (2017) and Lo et al. (2018) noted that using the FPI for the educational materials does not guarantee learning outcomes if students lack motivation. Therefore, additional motivational strategies should be considered in the design process (Kuba et al., 2021).

Serious games are video games whose purpose is not only entertainment but other purposes such as education (Hersh & Leporini, 2018), healthcare (Graafland & Schijven, 2018), and fitness (Comeras-Chueca et al., 2021). Many studies approved the positive effect of computer games to enhance student learning effectiveness and motivation (Cheung & Ng, 2021). Effectiveness of the serious games depend both on their design and desired teaching results. Attitudes also help the player get through difficult sections of games. One way that serious games can teach players is by contextualizing their actions their actions through narrative, increasing the immersion, engagement, motivation and learning results of students (Naul & Liu, 2020).

1.2. Video game narrative presentation through cutscenes and scripted sequences

Video games use a variety of methods to create narrative. Two such methods are cutscenes and scripted sequences. These were chosen for analysis because of the immersion – the feeling that the player is part of the game world – that they can create for the player. Cutscenes are parts of a game in which the player does not control the player character but instead watches a narrative sequence similar to a movie. Scripted sequences (also known as *scripted events*) are similar to cutscenes, but do not remove control from the player allowing him to move around the space, but not leave or interfere with the narrative until the sequence completes. Such sequences were popularized by the first-person shooter game *Half-Life* (1998), which primarily used such sequences to present the story of the game (Domsch, 2013).

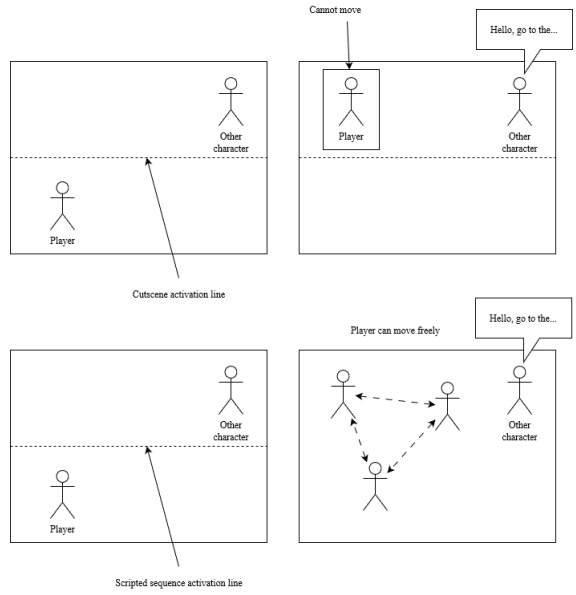

Figure 1. Differences of cutscenes (top) and scripted sequences (bottom)

In Figure 1 a schematic of the differences between a typical cutscene and scripted sequence is shown. In the top example, when the player crosses the cutscene activation line, the cutscene starts and the player cannot move until it is completed. During the cutscene, another character could be talking to the player, or some other events may be happening. In the bottom example, when the player crosses the scripted sequence activation line, the scripted sequence starts. However, unlike in the cutscene example, the player can move around the entire space, even going back behind the activation line, while the other character talks or other things are happening.

2. Methodology

2.1. Analysis of adventure video games that use scripted sequences

A model for video game analysis has been proposed by Aarseth (2003). Aarseth looks at video games as composed of three parts:

- *Gameplay*: the strategies and actions players use in the game.
- *Game structure*: the rules and systems of the video game.
- *Game world*: the narrative and created (or representation of the real) world of the game and how it is presented, e.g., cutscenes, level design, textures, etc.

Aarseth also wrote about some methods of analysing games:

- Analysing the game's rules by reading about how the game was made or talking to the developers directly.
- Watching videos of gameplay posted by fans online, reading reviews and comments.
- Playing the game yourself.

Five adventure video games have been analysed using the Aarseth model for the way they use scripted sequences to create narrative:

1. *Subnautica* (2018), Unknown Worlds Entertainment.
2. *Firewatch* (2016), Campo Santo.
3. *The Stanley Parable* (2013), Galactic Cafe.
4. *What Remains of Edith Finch* (2017), Giant Sparrow.
5. *Uncharted 4* (2016), Naughty Dog.

Games 1, 2 and 4 were played and videos of gameplay found on YouTube were analysed. Game 3 was analysed by watching gameplay videos. Game 5 was analysed from information about the game's creation given by its developers.

1. In *Subnautica* scripted sequences are used multiple times. Both times use sound to inform the player. The player can skip one of the sequences if they are playing again. The scripted sequences are used to portray narrative and open new areas for the player to explore.
2. *Firewatch* uses sound to inform the player and level design to guide the player to the sequence. The player is free to explore, but only one path leads to the sequence. Other paths are blocked off until they player is returning to their starting location.
3. *The Stanley Parable* also uses sound, through a narrator saying what action the player should take, and level design, providing only a few choices, to guide the player. Although this game does not use scripted sequences in the usual sense, the player is free to move around the space at all times, except when doors close behind him.
4. *What Remains of Edith Finch* uses level design to guide the player. The player is required to do some action during a sequence. The story is told through the character's speech and text that appears in the game world, guiding the player in the level. Usually, the player cannot change what happens in the sequence, but there is one when the player can choose from one of two options and the end of the sequence will be slightly different depending on the player's choices.
5. *Uncharted 4* uses what the developers call "interactive cinematics" which are like cutscenes, but the player can perform some game actions during them. The player is also required to do some actions to successfully complete the sequence. Because the developers did not want the players to have to restart the sequence many times, they made the gameplay simpler during such parts of the game.

In summary, the important aspects of scripted sequences learned from the conducted analysis are Game Narrative and Level Design, Sound, Player Control, Animation and Physics.

2.2. Model for creating scripted sequences

Following the analysis of scripted sequences and inspired by the existing adventure video game model (Ju & Wagner, 1997), we have created a model for the design of scripted sequences in video games, regardless of the genre. This model consists of four parts: *Game Narrative and Level Design*, *Player Control*, *Sound*, *Animation and Physics*. Each of those parts include specific practical recommendations.

Game Narrative and Level Design is the story of the game, how it is presented, how the levels and world are designed and how they work with the narrative. Level design should lead the player towards the scripted sequence, but in a way that allows them to choose a path for themselves.

- *Narrative*: The game story, characters, and game world.
- *Level/World Design*: The design of the game world.
- *Game Mechanics*: The game's mechanics and rules.

Player Control is how the player controls the game and how much freedom they have during scripted sequences.

- *Player Agency*: How does the game world react to the player's choices.
- *User Interface*: The player sees the usual game interface during scripted sequences, but some of the player's options should be restricted.
- *Game Control*: The restrictions imposed on the player during the scripted sequence, but the player should still be allowed to move around.
- *Camera Control*: How the camera is controlled during the scripted sequence. It should not let the player know that the sequence has started but appear to be a seamless transition between the regular gameplay and the scripted sequence.

Sound is what the player hears during the scripted sequences, how it is used to guide the player. Sound can be used to inform the player of important events and lead the player. However, the player should not be able to avoid the scripted sequence if it is important to the narrative.

- *Speech Animation*: The speech animation of characters.
- *Sound*: What the player hears and how the sound changes during the scripted sequence.

Animation and Physics is what animations are needed and how the physics simulation is handled.

- *Overall Animation*: Animation that does not fall into any of the other categories. Something unique to the scripted sequence.
- *Movement/Walking Animations*: How characters move in the world. Do they walk, roll, etc.?
- *IK*: Inverse Kinematics. Helps characters place their feet realistically on uneven surfaces.
- *Physics Simulation*: Realistic physics simulation in the game.

Which elements are used depend on the game. The game narrative elements are all necessary for the creation of a scripted sequence. Game interfaces and control schemes vary depending on whether the game is played on PC, console, mobile or VR platforms. Also, some games do not require highly realistic physics simulation or animation.

3. Creating the application

3.1. Design of the application

The first part of designing the application was deciding on the location that would be recreated in the application, what the user will be doing and how it will be presented. The location chosen was an area of the Vilnius Tech university central building outside of the Aula Magna hall. It was chosen to be familiar to the potential users of the application. It was decided early on that the application should simulate a study programme fair like the ones that happen regularly at Vilnius Tech. However, it was decided to focus only on the three Information Technology master study programme specializations and keep the main presentation about the Animation Digital Technology specialization. The user is meant to collect the pamphlets of the three study programmes. However, the Animation Digital Technology pamphlet is missing, and the player is required to listen to the presentation and participate at certain moments during the presentation before they receive the last pamphlet. The presentation features a few of the subjects that students will study in the study programme. The user is asked to participate in the presentation by doing certain tasks or selecting something from a list of options. The presentation itself resembles a real-life presentation with a presenter coming onto the stage and speaking. However, during the presentation it is possible to create situations and events that are impossible in real life, which are expected to make the presentation more interesting and memorable to the viewer.

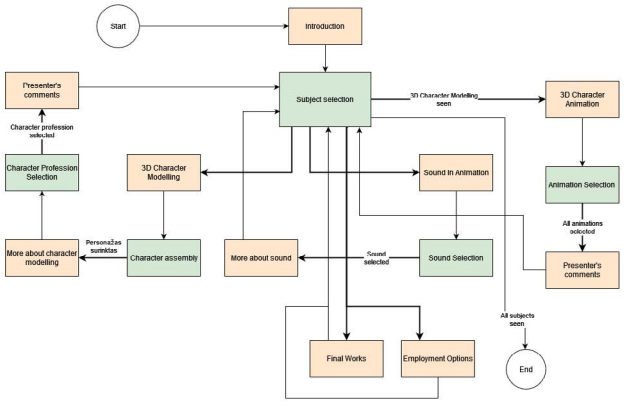

Figure 2. Scripted sequence state tree in the application

Figure 2 shows the state tree of the scripted sequence in the application. Thick arrows show transitions dependent on the actions or selections of the player. Normal arrows show automatic transitions that happen when the timeline finishes. Green states are states in which the player can make a choice or is required to do something. Orange states are states during which the player cannot influence the sequence. Figure 3 shows a graph of actions the player can perform. Collecting the pamphlets can be done in any order.

The parts of the scripted sequence model are used as follows:

Game narrative and Level design: 4 lectures related with the Digital Animation master study program were proposed during the scripted sequences:

- *3D Character Modelling*. The user is tasked with collecting pieces of a simple mannequin character scattered around the room. When the player collects all the pieces, the character builds itself. The presenter then asks the user to pick a profession for the character: either a farmer or a knight. When the user selects the profession, the presenter concludes the subject.
- *Sound in Animation.* A ball is dropped from the ceiling onto the floor which makes no sound when hitting the floor. The presenter asks the user to pick a sound from three possible sounds for the ball to make. When the user chooses the sound, the ball is dropped again, but this time it makes the selected sound. The presenter then asks if the ball was more interesting with sound and explains that sounds are created and added to objects by the animators.
- *3D Character Animation.* The presenter begins by talking about how animators create stories with motion. He then allows the user to make the character created earlier do something by selecting from three options. Each option is different depending on the selected

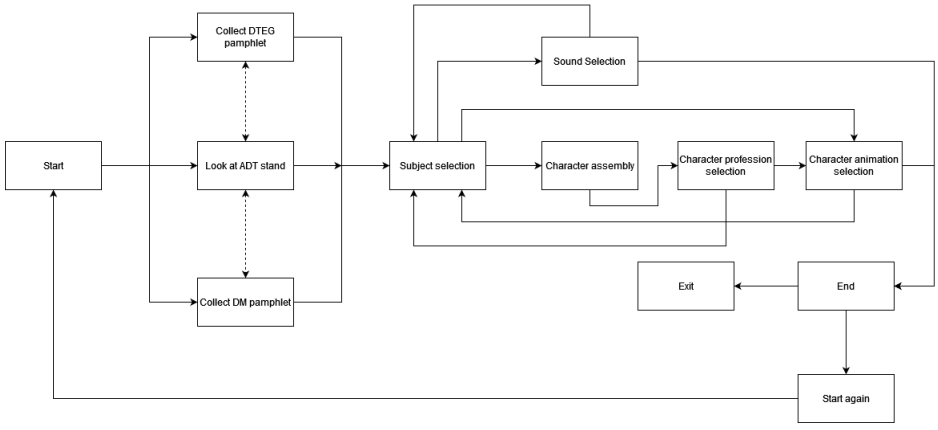

Figure 3. Graph of player actions

profession. The user has to select each option at least once to complete the task. The presenter then concludes the subject.

– *Questions*. The user may ask questions relating to the study programme by selecting either *Final works* or *Employment options*. *Final works* is about what kind of end projects are created during the programme in order to graduate. *Employment options* is about where and what work that graduates may do after graduating.

Player Control step was implemented through camera control and game control and player choices (shown in Figure 3):

– *Camera Control*. The application is like a first-person video game in which the camera is attached to the player character and feels like the player is looking through the character's eyes. The user has complete camera control at all times and the camera does not change to a different one during the scripted sequences.
– *Game Control*. During scripted sequences the player can walk around the space freely. The player cannot interfere with the sequence, but they can make slight changes to the sequence within certain restrictions.
– *Player Choice*. The presentation starts with a short introduction about animation in general, the user is prompted to select a subject or question. The subjects can be chosen in any order. However, the subject 3D Character Animation can only be selected after the subject 3D Character Modelling has been completed, because it would not make sense to animate a character that does not exist yet. After a subject is completed, the user may choose another subject or question to ask. When all subjects and questions are completed, the presenter says goodbye and walks off the stage. Then the player gets the last pamphlet and can exit the application. The application takes about five minutes to complete.

Sound is used to inform the user that the presentation has started by playing a noise when it starts. Sound is also used to convey information to the user during the presentation. The presenter begins talking after he steps onto the stage. The sound of the presenter's speech becomes louder as the user approaches to stage, and quieter when the user gets further away. Sound is also used in the *Sound in Animation* section of the presentation when the dropped ball hits the ground. Also sounds are played when the mannequin character performs his animations to make them more interesting and to add to the idea that sound is important to animation. The sounds were taken from the Freesound library of Creative Commons licensed sounds (at https://www.freesound.org/). The presenter's speech was recorded by the author.

Animation and Physics:

– Animations were created for the mannequin and the presenter walking, getting on and off the stage, and the mannequin assembly. Other animations like the presenter turning around or the sitting animation of the audience were taken from the Mixamo animation library (at https://www.mixamo.com/).
– Physics is used only in the *Sound in Animation* section for the falling ball. Also physics is required to keep the user inside the scene through collisions with the environment.
– Speech animation was not recorded as motion capture and keyframe animation for speech is a time-consuming process. IK for characters was also not used to keep the application's scope manageable.

In Figure 4 game world and a screenshot of the running application is shown. The presenter is standing on the stage. The mannequin character with the knight profession chosen can be seen in front of the stage. In the bottom left corner, the collected pamphlets are shown. They are colour-coded to match the colours of the posters of their respective subjects. In the bottom right corner, the subject selection menu is shown. The red coloured options are *3D Character Modelling*, *3D Character Animation* and *Final Works*. As mentioned earlier, the red-coloured options have already been selected once, but the player may choose them again and pick different choices during them. To the right of the options menu a mouse icon is show. The left button slowly changes colour from blue to yellow to indicate that this button can be pressed. Also, the

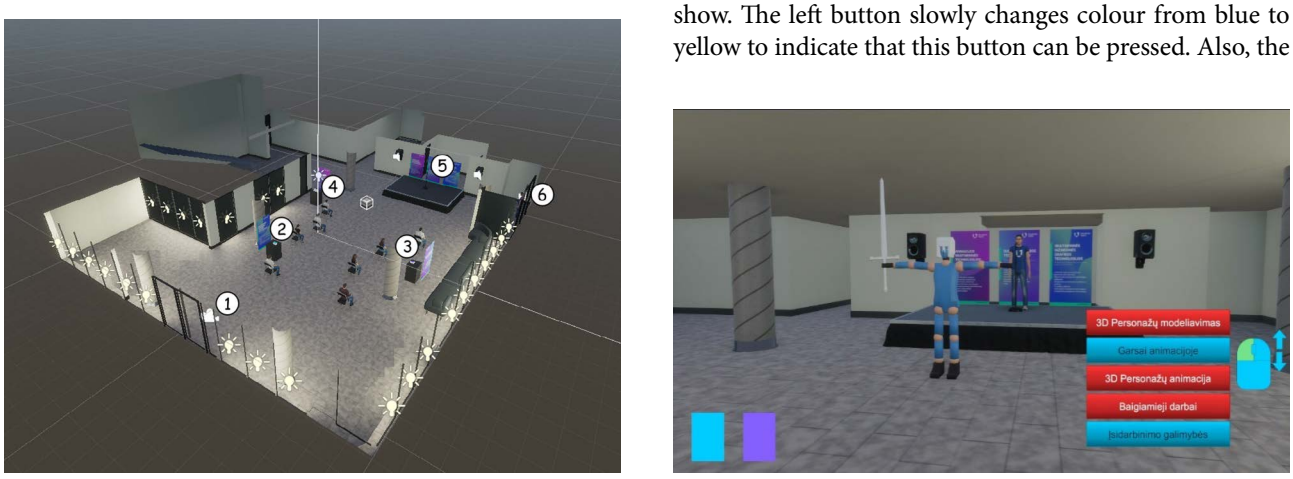

Figure 4. Game world and the presenters view during the scripted sequences

middle wheel and arrows are highlighted to indicate that the mouse wheel can be scrolled.

The presentation ends after all subjects and questions have been selected at least once. To let the user, know which subjects and questions have already been selected those options are coloured red. When the presentation ends the user is given the final pamphlet and they may leave the application. The application can also be closed at any time during the presentation.

3.2. The instructional design principles used in the application

The First Principles of Instruction (FPI) were applied in the design of the application narrative and level design:

- *Problem-centred* means that the situation presented is like a situation that the learners may experience in real life. The application meets this principle by creating the situation of a study programme presentation, which may be something the users may go to as part of looking for a master's degree study programme.
- *Activation and Demonstration of new knowledge* means that new knowledge is given to the learners. In this application, the new knowledge includes the presented topics related with the digital animation. These topics are demonstrated using audio of the presenter's speech and tasks the user is asked to perform.
- *Application and Integration.* The new knowledge is framed in the context of things the users already know. In the application the existing knowledge required is use of computers, first-person video game control schemes and existing knowledge of animation the user may have. Integration – learner transfers the new knowledge to his real life and makes a decision on the master study program they want to enter.

3.3. Implementation

The *Timeline* function of *Unity* was used to create the sequences. A *Timeline* asset was created for each subject sequence. When the player is asked to do something, the timeline is paused and resumed when the required actions are completed. A simple first-person character controller was imported from the *Unity Asset Store* to be used for the player. A raycast is used to check if the player is looking at something that can be picked up. Then a hand icon and a computer mouse icon with the button that should be pressed highlighted appears. Items are picked up by pressing the left mouse button. Collected items are shown in the bottom left corner of the screen. To always allow the player to move around the space even when needing to select an option from a menu, a system like the one used in *Firewatch* was created. Using this system, the mouse wheel is used to select an option, while the left mouse button is used to confirm the selection. This ensures that the player can still move and look around. A pause menu was created so the player can exit the application at any time.

4. Discussion

The Unity game engine allowed to easily create the application. The Timeline feature was useful for creating scripted sequences and animating different objects, such as the presenter going on and off the stage and organizing animations for the mannequin character. The completed application is a fully playable study programme presentation. It allows the user to select subjects in any order.

The possible advantages of this method over a real-life presentation are as follows:

- User is not required to physically appear at the presentation's location. This is useful if they cannot appear during the time of a real-life presentation.
- User can start the application at any time and close it if they do not have time to watch the whole presentation. They may also restart the application later. In real life the presentation would have a specific start time and might not be repeatable.
- Recordings of a real-life presentation may be less engaging than the immersive environment a virtual world can create. Also, they are limited by things that can be done in real life.

The disadvantages compared to real-life presentations are as follows:

- This kind of virtual presentation may be a less social experience than a real-life presentation.
- The questions available are pre-selected and may not include what the viewer may wish to ask. Also, the responses to the questions are always the same.

A feature that is not included in this version of the application that may be added to a full version of the application is resuming the presentation from where the user left off, which would allow the user to watch the presentation fully if they do not have much time to do so in one session. However, the presentation itself takes around five minutes to complete, so this feature may be unneeded.

As of the writing of this article, the application has not been tested with users, and its effectiveness in presenting information in an interesting way is unproven. More work is required to evaluate the application with users to see if this form of presenting a study programme is interesting and useful.

Conclusions

The new model for the design of scripted sequences in serious games was presented in this paper. This model consists of four parts: Game Narrative and Level Design, Player Control, Sound, Animation and Physics. Each of those parts include specific practical recommendations. The created model was tested by creating an interactive study programme presentation. While effectiveness of the serious games (specifically, learning games) depends both on their design and desired teaching results, instructional design principles also should be applied when creating game-based application for better information transfer. Thus, in this paper First Principles of Instruction (FPI) were included the application through the game narrative and level Design phase.

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SCENARIJAUS ĮVYKIŲ SEKŲ, SKIRTŲ RIMTŲ ŽAIDIMŲ PROGRAMOMS, KŪRIMO MODELIS

L. Dapšys

Santrauka

Straipsnyje pristatomas informacijos pateikimo būdas interaktyvioje kompiuterinėje programoje, taikant metodą kompiuteriniuose žaidimuose perteikti naratyvui – scenarijaus įvykių sekoms, laikantis mokymo dizaino principų. Pristatomas tokių sekų kūrimo modelis, įkvėptas panašaus kompiuterinių žaidimų nuotykių žanro modelio. Naujam modeliui sukurti buvo išanalizuoti penki nuotykių žanro kompiuteriniai žaidimai. Sukurta programa turi keletą pranašumų, palyginti su gyvais pristatymais: 1) vartotojas fiziškai neprivalo pasirodyti pristatymo vietoje; 2) vartotojas gali sustabdyti ir pradėti pristatymą patogiu laiku; 3) programa gali būti patrauklesnė nei realaus pristatymo įrašas.

Reikšminiai žodžiai: informacinės technologijos, instrukcijų dizainas, žaidimų dizainas, animacija, scenarijaus įvykių sekos.