

Students Attitude to Serious Games for Cultural Heritage

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Abstract: Serious games are video games designed for purposes other than entertainment and applied mainly for education or training. In the context of cultural heritage, serious games leverage technology to engage users in educational and immersive experiences related to historical sites, artifacts, and cultural traditions. The paper explores how K12 and university students assess serious games for cultural heritage concerning game experience and learnability. The research focuses on appreciating students learning tangible and intangible heritage by playing two serious video maze games – “The Heritage of Valchan Voivoda” concerning intangible heritage and the “Let Us Save Venice” game about heritage resilience and sustainability. The paper describes the game design process based on an automatic generation of the maze using a formal description, the maze topology, and the methodology for evaluating game learnability and game experience. The analysis compares results obtained by an experimental validation of the two games. The findings prove that serious maze video games, as a part of digital culture, are an appropriate tool for learning the cultural heritage of students of different ages.

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Keywords: serious games, cultural heritage, history, education, digital culture.

1. INTRODUCTION

Since their rise in the 60s of the last century, video games have become an inalienable part of digital culture on a global scale, thanks to their specific qualities of representing visual content in a highly interactive way. Later, apart from video games for fun, serious games (SG) started to intrigue people because of their opportunities for new ways of learning and training (Alvarez & Djaouti, 2012). Designing such serious (so-called applied) games pursues goals other than entertainment (Abt, 1987).

Unlike entertainment video games, which are only focused on consumer entertainment (Cheung & Ng, 2021), SG can produce fun but at the same time have didactic, practical, or methodical content (Pourabdollahian et al., 2012). Hence, SG is not only intended for entertainment but also aims to teach users specific knowledge in a particular domain or skills. This can be done by playing a specific serious game; the user can perceive and learn the knowledge. By embedding didactic content and practical knowledge in the gameplay and its key components – plot, graphics, and audio, such games represent a new paradigm for game-based learning, offering better

motivation to learn and engaging gaming experience (Abdul Jabbar & Felicia, 2015).

Most serious games are specially created for educational purposes and are called educational video games. Educational games are used in various didactic domains, such as history, crafts, art, mathematics, computer science, etc. (Udeozor et al., 2023). Educational video games provide opportunities to integrate various new technological approaches to engage users in the particular game, entertain them, and allow users to perceive didactic content. Among the main goals of educational video games are achieving the satisfaction of the users, their engagement and immersion in the game, higher rates of positive user experience, and effective and efficient perception of didactic content by the user (Rahimi et al., 2022). The ability of such games to allow learners to perceive didactic content easily is perceived as learnability (Bontchev et al., 2022). One challenge facing the creation of educational video games is integrating didactic content, which can be personalized according to specific characteristics of the learner (respectively, the player) and, thus, can achieve a satisfactorily high degree of the learnability factor and an enhanced gaming experience.

The paper is focused on the students' attitudes toward serious games for cultural heritage. It presents the design and validation of a new serious maze game for learning history dedicated to the heritage left by one legendary Bulgarian rebellion from the 18th and 19th centuries – Valchan Voivoda (Dimitrova, 2022). By comparing the experimental results to the ones received from a previous study of the authors using the “Let Us Save Venice” game for heritage sustainability and resilience and to climate changes (Bontchev et al., 2022), the authors seek here answers to two research questions:

- 1) How do K12 and university students assess the developed maze games concerning game experience and learnability?
- 2) How do young people appreciate learning about cultural and historical heritage by playing SG?

After the present introduction to the study, the paper continues with a background section summarizing related works about SG and digital culture, video games for cultural and historical heritage, and enhanced maze video games for learning. The following section is focused on the research methodology concerning game design and evaluation. Next, the paper presents the profile of the participants in the experimental validation and some results about game experience and learnability. Finally, the conclusion summarizes the findings from this study and outlines the planned future works.

2. BACKGROUND AND RELATED WORKS

2.1 Serious games and digital culture

The modern digital society of the 21st century has benefited from technological progress, and this contributes to the development of various approaches to teaching and the presentation of knowledge that a variety of users must perceive. Serious games are an area of constant growth and research by practitioners and educators (Pourabdollahian et al., 2012), mainly because they provide opportunities for game-based learning. Serious video games and game-based learning have proven their exceptional benefits in many research and experiments (Cheung & Ng, 2021). Using serious games in modern education is an interactive and successful educational practice that meets society's modern digital and learners' growing requirements.

As a part of digital culture, many serious games represent cultural heritage using different forms of content delivery – from Web-based and mobile applications to more complex computer games and virtual reality applications that employ modern game-related technologies to provide interactive experiences (Anderson et al., 2010). The usual purpose of these SGs is to provide information and build knowledge about the importance of preserving and protecting cultural heritage in all forms – tangible (monuments, historical sites, and artifacts) and intangible (like historical heroes and myths, traditions, customs, legends, and folklore practices). These games often aim to raise awareness and promote conservation efforts for endangered sites, artifacts, and traditions. Thus, they have a social impact (Mortara, 2014). Such games typically engage players in activities and challenges that involve them being aware of and learning about specific

aspects of cultural heritage while promoting and appreciating significant facts and traditions (McCall, 2022).

2.2 Educational games for cultural and historical heritage

Many SGs for education are dedicated to cultural and historical heritage. Bellotti et al. (2013) proposed a conceptual model of SandBox Serious Game aimed at cultural heritage entertainment applications. Creating serious games to raise awareness of cultural heritage often requires collaboration with domain experts, archaeologists, and historians to ensure the authenticity of the content presentation. Some essential specifics of such games include (Malegiannaki & Daradoumis, 2017):

- Historical accuracy – an accurate representation of historical events, landmarks, heroes, etc.;
- Educational content – providing players with historical facts and interactive learning resources, such as quizzes, trivia, and puzzles, to allow them to understand entirely the presented cultural heritage;
- Interactive exploration – allow players to explore virtual depictions of cultural heritage phenomena, enabling them to learn more about their significance;
- Engaging gameplay – engaging gameplay, including challenges and decision-making tasks, to motivate players to learn more about cultural heritage;
- User-friendly design – straightforward rules and easy navigation, thus enabling players to engage with the game content regardless of age and skill level.

Serious games in a cultural heritage context have different forms – from Web-based and mobile applications to more complex computer games and virtual reality applications that employ modern game-related technologies to provide interactive experiences. Some examples of serious games used to raise awareness of cultural heritage are as follows:

- *Assassin's Creed Origins: Discovery Tour* – the game that allows players to explore Ancient Egypt through guided tours and educational content and this way to learn essentials about its history, culture, and monuments (Poiron, 2021).
- *Never Alone* is a new video game genre based on the richness of unique cultures, creating complex and fascinating game worlds for a global audience. The game follows the story of a young Inupiat girl and an arctic fox during their journey through the Alaskan wilderness while teaching players about Native Alaskan folklore and traditions (Massanari, 2015).
- *Terracotta Warriors* is a serious VR game that combines 3D modeling, virtual reality, and intelligent question-answering technology to provide the audience with an immersive experience—a journey through time and space to find intriguing knowledge and details about the Qinshihuang's Mausoleum (Zhang et al., 2018).
- *Heritage Detective* – a role-playing game where detectives solve mysteries related to cultural heritage theft and preservation; it teaches them the importance of protecting and safeguarding cultural artifacts (<https://europa.eu/kids-corner/eych/>).

Fig. 1 depicts a mind map of some categories of SG for cultural heritage identified in the scope of an online survey for video games created after 2014 and using the English language for content and user interface. The figure provides the number of games found for each category.

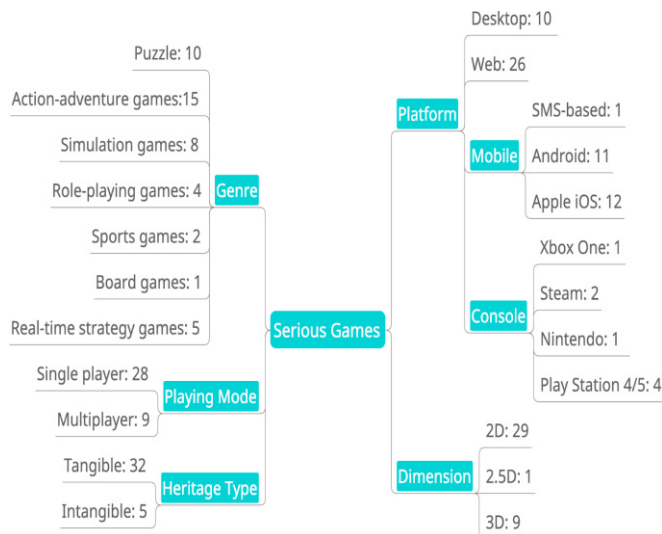


Figure 1. Types and characteristics of SG for cultural heritage.

2.3 Enhanced maze video games for learning

Enhanced maze video games for learning offer an engaging and immersive way for players to acquire knowledge and skills. By harnessing maze environments as educational platforms, these games seamlessly integrate interactive elements and challenges to foster efficient learning experiences. The key features and benefits of enhanced maze video games for learning include an interactive learning environment, engaging gameplay, problem-solving challenges, educational content integration, customizable learning paths, and progress tracking.

Maze games usually offer customizable learning paths that adapt to individual player preferences and skill levels. Players may have the flexibility to choose different routes, difficulty levels, and learning objectives based on their interests and needs (Paunova-Hubenova, 2019).

Maze video games are a distinct category of digital games, demanding specialized problem-solving abilities like image recall, logical reasoning, word exploration, pattern identification, and more. The concept of rich educational mazes is derived from a fusion of two primary game genres: video mazes and puzzle games. Combining elements from video mazes and puzzle games enriches educational 3D maze games, offering interactive learning experiences that promote problem-solving skills and engagement. Overall, enhanced maze video games designed for education and self-learning provide an engaging and immersive learning adventure that combines the excitement of gaming with the benefits of interactive learning. By incorporating educational content into maze environments, these games have the potential to engage, educate, and inspire players of all ages.

3. RESEARCH METHODOLOGY

3.1 Game design methodology

“The Heritage of Valchan Voivoda” is a serious maze game explaining the life and the feats of Valchan Voivoda – a legendary Bulgarian rebel against the Ottoman Empire who lived in the 18th and 19th centuries. The game was generated by the APOGEE software platform following the process presented in Fig. 2. The game description was created by the APOGEE editor and generated as an XML file containing details of the circular maze topology (Fig. 3), didactic content, and the mini-games situated in maze halls. It was imported into the APOGEE maze generator with all the multimedia resources (in Bulgarian) to generate the maze automatically in the Unity 3D editor. After some additional enhancements, a WebGL version of the game was created through the build interface of the Unity platform and installed on a web server (<https://apogee.online/games.html>).

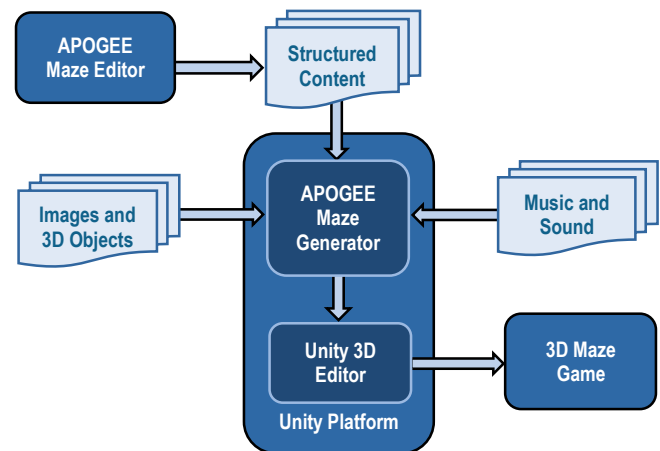


Figure 2. Maze game design process.

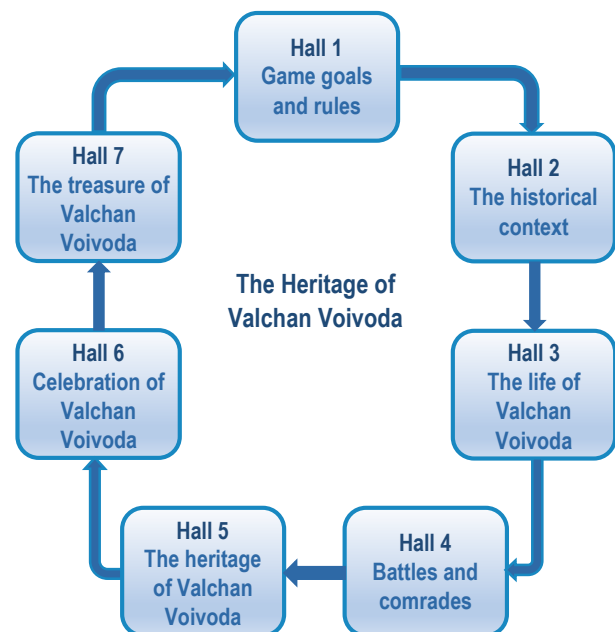


Figure 3. The maze topology.

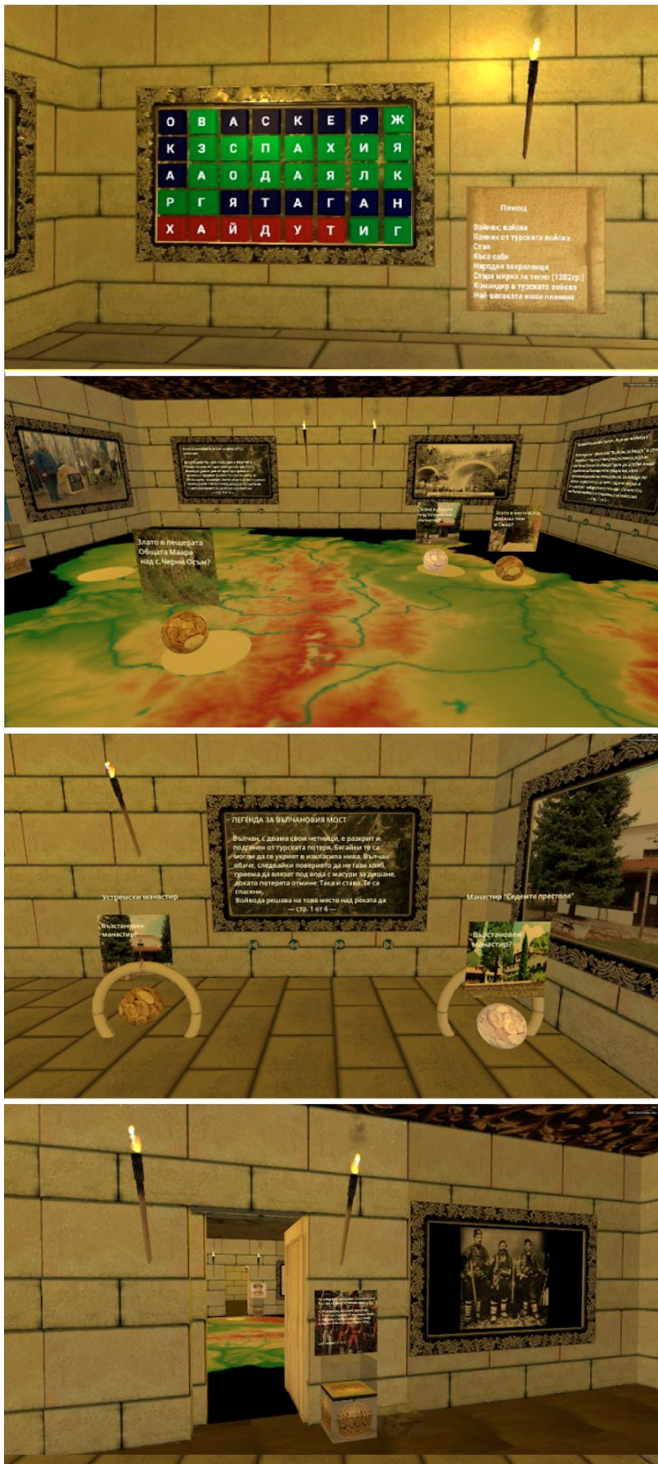


Figure 4. Game screenshots.

Fig. 4 shows screenshots of some of the mini-games allocated in the maze: word soup, rolling balls to places on a map and rings, and answering a question to unlock the door.

3.2 Evaluation methodology

The evaluation methodology applied in this study follows the one used to validate the game “Let’s Save Venice,” including a gaming session and an online survey about game experience and learnability. The survey aimed to measure learnability and game experience and create a concise questionnaire to avoid

participants being bothered with excessive questions that would demand significant time to answer. To assess the learnability of the game, the Senapathi framework for evaluating learnability (Senapathi, 2005) was used, adapting it to focus on aspects related to educational game validation. The authors replaced the four original contextual factors with others specific for educational game validation – didactic tasks in the game, game learning environment, player specifics, and the maze game as a learning tool. Participants were asked about their age, gender, gaming habits, and play outcomes. Based on previous research (Bontchev et al., 2020), metrics, such as final game score, hidden object discovery, and total playing time, were used to indicate player attitude and engagement. Additionally, the authors asked participants to rate the ease of learning and evaluate components of the game experience.

4. RESULTS

The section compares the obtained results from two surveys exploring students’ attitudes to learning by playing games for cultural heritage. The games are “The Heritage of Valchan Voivoda” concerning intangible heritage and the “Let Us Save Venice” game about sustainability and resilience of tangible heritage (Bontchev et al., 2022).

4.1 Players’ profile

The experimental validation of “The Heritage of Valchan Voivoda” video game occurred in Bulgaria during the “Researchers’ Night” events in 2021 and 2022. In total, 24 children (13 boys and 11 girls) aged from 8 up to 16 years participated in the game online sessions and, next, filled out the Web-based quiz about learnability and game experience. Their mean age was $M=11.29$, with a standard deviation of $SD=2.26$, which is lower than the mean age of the university students in the “Let Us Save Venice” survey ($N=24$, $M=25.20$, $SD=6.48$). Figure 5 shows the reported weekly amount (in percentages) of playing video games for fun and for learning for both the games – “The Heritage of Valchan Voivoda” and “Let Us Save Venice.” For both game surveys, most students reported not playing video games for fun or learning. About 40% of the respondents disclosed playing games for fun for more than one hour per week, while only one-sixth declared playing games for learning between one and five hours weekly. No students appeared to play video games for learning more than 5 hours per week.

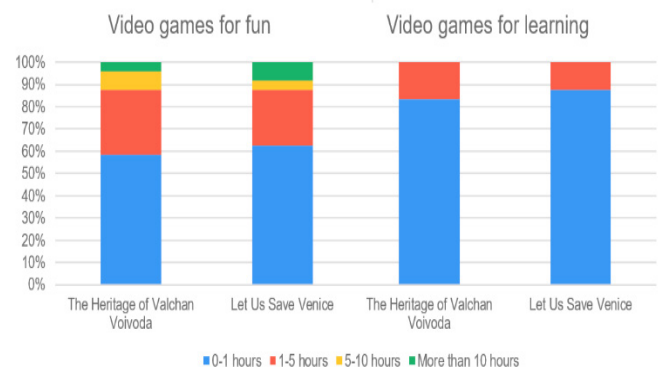


Figure 5. Reported weekly amount of playing video games.

4.2 Game validation

The participants in the survey played the game “The Heritage of Valchan Voivoda” between 12 and 40 minutes, having a mean playing time of $M=27.38$ minutes. The fastest players played only the mandatory mini-games, whereas the more interested ones played the optional mini-games. The average score (measured in points and number of hidden objects found) was about 65% of the maximum. Through the detailed explanation of the game rules and the online support provided for playing the game, only seven participants finished the game successfully by obtaining the maximum score and finding all the hidden objects.

After the game sessions, all the participants filled in the online quiz. Figure 6 provides a comparison of the average values of each game learnability attribute (reported on a five-level Likert scale from 1 – Strongly disagree, up to 5 – Strongly agree) for both the games – “The Heritage of Valchan Voivoda” and “Let Us Save Venice.” The results are very similar, excluding the higher assessment of the informative feedback for “The Heritage of Valchan Voivoda” (significant at $p<0.01$). For both the games, the favorable evaluations prevail – the respondents have chosen predominantly Agree and Strongly agree for each attribute of learnability. The correlations between learnability attributes for “The Heritage of Valchan Voivoda” are in Table 1 (statistical significant values are in bold). They are stronger than the ones found for the “Let Us Save Venice” game and have similar significance levels.

Table 1. Correlations between learnability attributes

	Ease of Learning	Familiarity	Consistency	Predictability	Informative Feedback	Error Handling
Ease of Learning	1					
Familiarity	***0.63604	1				
Consistency	*0.50322	***0.61028	1			
Predictability	0.38960	0.38760	***0.75399	1		
Informative Feedback	**0.55765	***0.65031	***0.62011	***0.76406	1	
Error Handling	***0.61461	0.37775	0.31554	0.24022	**0.53354	1

* $p<0.05$, ** $p<0.01$, *** $p<0.001$, **** $p<0.0001$

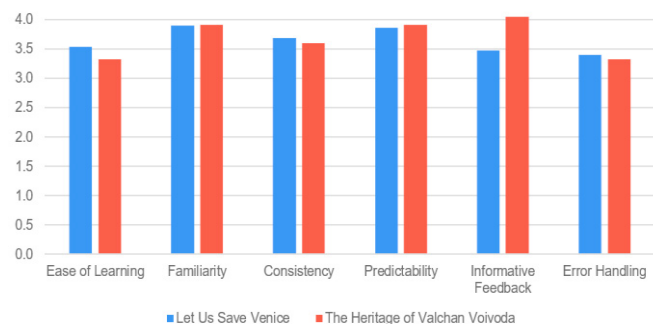


Figure 6. Attributes of game learnability.

Next, Fig. 7 compares the means of the seven factors of game experience for both games using the same five-level Likert scale. The mean values representing the average for the assessments of all the mini-games get comparable scores. The highest results are observed for flow, competence, positive affect, and immersion. Significant differences are found only

for the three factors assessed with lower values – challenge, negative effect, and tension. These factors received lower values for “The Heritage of Valchan Voivoda.” T-tests proved the significance level of $p<0.01$ having a small effect size (Cohen’s $d\approx0.2$).

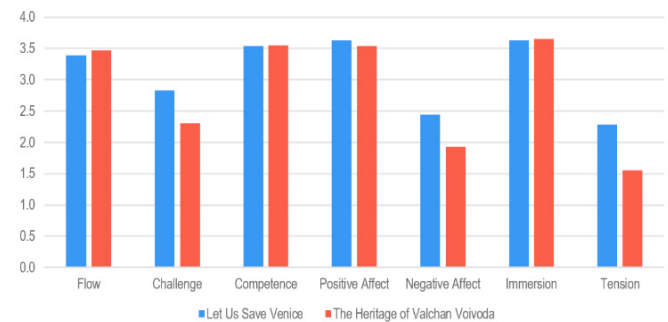


Figure 7. Factors of game experience.

Finally, Table 2 provides the correlations between the seven factors of the game experience for “The Heritage of Valchan Voivoda.” The found correlations are similar but stronger than the ones reported in (Bontchev et al., 2022). As expected, flow strongly and positively correlates with competence, positive affect, and immersion. Also, positive affect is strongly correlated with challenge and competence. The negative affect is negatively correlated with flow, competence, and immersion, and the positive effect positively correlates with tension. On the other hand, immersion positively correlates with all the factors except negative affect.

Table 2. Correlations between game experience attributes

	Flow	Challenge	Competence	Positive Affect	Negative Affect	Immersion	Tension
Flow	1						
Challenge	0.33901	1					
Competence	***0.72748	0.34194	1				
Positive Affect	***0.70032	***0.60956	***0.86672	1			
Negative Affect	**0.55675	-0.11407	**0.50002	*0.45649	1		
Immersion	***0.87709	***0.64990	***0.62376	***0.75935	-0.51959	1	
Tension	-0.39204	0.23187	-0.27310	-0.19186	***0.64730	-0.19739	1

* $p<0.05$, ** $p<0.01$, *** $p<0.001$, **** $p<0.0001$

5. DISCUSSION

Serious games that combine cultural heritage topics and immersive computer technologies can represent, enhance, and transform cultural heritage knowledge, extend the dissemination of cultural heritage, and promote effective interactive teaching and learning. The introduction of gaming technologies gives significant advantages to the whole cultural heritage domain, enabling users to experience tangible and intangible cultural heritage in a completely new way.

The authors found significant differences in assessing the developed maze games regarding game experience and learnability. The available informative feedback is better appreciated by children than university students, showing that children need more guidance while playing than older students. Another difference consists of different values of the

three components of game experience. K12 students reposted lower values of challenge, negative effect, and tension.

The answers to the research questions are valid, considering the specifics of the surveys conducted. One of the main limitations of both surveys is the small number of respondents ($N=24$). Another limitation is that most students are not used to playing video games for fun and learning. Thus, their answers are influenced by the lack of gaming experience.

6. CONCLUSIONS

Young people appreciate learning about cultural and historical heritage by playing SG. This study's findings revealed that both pupils and university students reported high values for all learnability attributes, as well as for flow, competence, positive affect, and immersion. Therefore, serious maze video games, as a part of digital culture, are an appropriate tool for students of different ages to learn cultural heritage, and they are well aligned with the United Nations' Agenda for Sustainable Development.

In future works, the authors plan to conduct new surveys reaching more respondents of different ages and with various levels of gaming experience. A further research direction is the creation of personalized and adapted maze games with virtual heroes (Naydenov & Adamov, 2021) to explore their effect on the learnability parameters and game experience.

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