



Serious Games For Heritage Education: A Survey-Based Study On User Engagement And Educational Impact.

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Abstract: The current study investigates the association of serious games (SGs) preference with cultural heritage, community, educational, and sustainable development (SD). Quantitative and qualitative research methods were used to achieve this objective, and data were collected using the survey technique. An original and historical HTML5 memory serious game was developed to give the audience at the museum a fast, informative look at the dinosaur era in Egypt. The study's sample consisted of 104 students residing in different countries. The reliability of the questionnaire was evaluated via Cronbach Alpha (0.953), showing data authenticity. The results obtained from the survey showed significant associations ($P \leq 0.05$) of students' preference after playing that SG on community and educational development, cultural heritage (CH), and SD via chi-square test. The study concluded that SGs are now associated with community and educational development, SD, and CH. The results also concluded that it should be designed for a wider audience with low violence, positivism, responsible gaming, and educational value. Hopefully, the results of this study will help develop games incorporating users' recommendations for SGs.

Keywords: serious games; sustainable development; educational development; cultural heritage; serious games preference.

1. Introduction

Serious games (SGs), as an emerging field, have gained significant attention in recent years due to their potential for combining entertainment with educational and learning outcomes. Almost 85% of video games available on the market feature some sort of violence. Nonetheless, there has been a great deal of variation in how the impacts of violent video games are interpreted, which has added to the public discussion over these effects (Association, 2020). Instructional designers and video game designers can work together to improve video games by lowering violence and adding more educational content, nearly converting them into SGs. It can be done by ensuring that the instructional material is pertinent and seamlessly included in the gameplay; instructional designers and designers should collaborate to establish and define the game's learning objectives. It will also be possible to help players better grasp the instructional material and hone their gaming abilities. By working together, instructional designers and game designers can guarantee that the game effectively meets its educational goals and draws players in during an iterative assessment and improvement process. By working together, instructional designers and video game designers can create SGs that are enjoyable and educational, effectively leveraging game technology to enhance learning outcomes and promote cultural heritage (CH) education (Kepple, 2015).

SGs are a digital game that has received widespread praise for their ability to fascinate and instruct users across various areas. They act as a bridge between the worlds of education and entertainment. These games are methodically constructed with a significant emphasis on achieving educational objectives, which include knowledge distribution, skill, and community development, and understanding enhancement. Their use spans a wide range of areas, with CH education being one that has significantly benefited from their incorporation (DaCosta & Kinsell, 2022). According to a review that Ekin and colleagues conducted, much research on the use of video games in educational settings was published in the 2000s when there was an increase in the number of people using the internet, and it became more widespread. Surprisingly, SGs have consistently ranked among the top three trends for over three decades. According to a review that Ekin and colleagues conducted, there was much research on the use of video games in educational settings when there was an increase in the number of people using the internet, and it became more widespread. Surprisingly, SGs have consistently ranked among the top three trends for over three decades (Ekin et al., 2023).

Incorporating gaming elements into the educational process can allow for a more interesting and interactive learning environment, improving memory and comprehension. Consequently, educational institutions and groups devoted to protecting CH have recognised that SGs are an efficient means of teaching history and developing a profound appreciation for CH (Kara, 2022). These educational games serve as a gateway, engaging players in historical and cultural settings and promoting discovery, learning, and the development of a deeper understanding of the importance of CH (Bouzayen et al., 2010). In addition to other applications for CH, SGs have been used in museums, virtual heritage, and location-based games (Mortara et al., 2014b). Cultural legacy is vital for societal growth because it encompasses a rich tapestry of traditions, customs, historical locations, objects, and activities that collectively define a community's identity. Beyond its tangible components, cultural legacy is a repository of a society's collective memory and a source of information and inspiration. As a result, the preservation and transmission of cultural legacy emerge as critical imperatives, addressing the requirements of both current and future generations (Mason & de la Torre, 2002). SGs assume a significant role in shaping and fostering education and cultural values within individuals, effectively linking them to their CH through an engaging and entertaining medium. Wang's research shows that playing SGs impacted community development, cultural awareness, cultural transmission, and cultural learning (Wang, 2021). CH education instils a sense of responsibility and reverence for the past, bridging the gap between sustainability principles and advocating for the responsible use and preservation of cultural resources. As such, it is a pillar in the symbiotic link between CH, sustainable development (SD), and societal well-being (Mortara et al., 2014b). The study evaluates the relationship of SGs preferences with community and education development, CH, and SD.

1.1. Literature Review

Not all researchers agree on the descriptor "serious" because these SGs are not without entertainment; the rationale for that designation is related to the theme of the contents and the usage of these SGs in areas such as health care, engineering, education, CH, defence, city planning, or politics (Ouariachi et al., 2019). Various researchers have examined quality criteria for SGs, such as the educational and game aspects, and focus on the balance between education and entertainment (Caserman et al., 2020; Laamarti et al., 2014). SGs' potential for education and training in various subjects is becoming more widely recognised. The emergence of sophisticated online games holds promise for facilitating various community advancements in web-based environments. These games serve as a platform for immersing players in historical and cultural contexts, fostering engagement, and facilitating the exploration of knowledge, thereby facilitating the cultivation of a more profound appreciation for CH (Doughty & O'Coill, 2008). However, research shows that there is currently a shortage of approaches, guidelines, and best practices for developing effective SGs and integrating them into actual learning and training processes (Catalano et al., 2014). As a result, various previous studies presented a framework for evaluating various dimensions of SGs by selecting and combining appropriate quality parameters and providing the audience an enjoyable experience similar to playing a game (Abdellatif et al., 2018; Lu & Ho, 2020).

Bampatzia *et al.* developed five social SGs to promote CH via gaming through museums and applications and introduced museum items and themes so that users can learn about culture online (Bampatzia et al., 2016). Mortara and colleagues provided a comprehensive description of the current availability of SGs in the cultural sector, emphasizing the educational goals of games in this domain and studying the complicated

relationships between genre, the context of use, technological solutions, learning effectiveness, and further demonstrating their potential for community development (Mortara et al., 2014a). Andreoli and coworkers' evaluation showed that the SGs were effective in information acquisition, that participants enjoyed it, were highly engaged in the immersive experience, and positively rated the idea of employing it for CH education (Andreoli et al., 2017b). Video games can present CH by combining art, storytelling, and digital technology, according to Bontchev's research. It discusses amusement and serious CH games and illustrates its approach and uniqueness (Bontchev, 2015).

Different researchers have worked on analysing the role of SD in SGs, as presented in the literature review of Stanitsas (Stanitsas et al., 2019). Saitua-Iribar also examined using a collaborative learning methodology through SGs in the university setting to increase students' knowledge and the importance of the SD Goals (Saitua-Iribar et al., 2020). Santos investigated the current state of the art of SGs for sustainability, identifying and discussing the most common applications (Santos et al., 2019). Ouariachi showed that the SGs have achieved cognitive and affective engagement, giving players practical insight into energy possibilities, being concerned about the complexities and urgency of a sustainable energy transition, and experiencing the negotiation and collaboration needed to achieve (Ouariachi et al., 2018).

Various studies have evaluated the effect of SGs on education, CH, and SD. However, this survey-based study aims to investigate the complex relationship between people's preferences for SGs. It also assesses the impact of users on education and SD after engaging with the straightforward historical SG that I have developed (<https://drive.google.com/file/d/181vSBVobBcmun5-ovCfv0lzDqQygkOyt/view?usp=sharing>). The goals were to investigate the extent of SG preferences across diverse demographics, evaluate the educational effectiveness, investigate its role in CH education, investigate how gamification improves educational engagement, analyze how SGs' role in instilling a sense of responsibility for CH and comprehending their role in bridging CH and SD. By addressing these goals, our research adds to the scholarly debate on SGs preference for CH education and their relationship to SD.

2. Methodology

2.1. Game Creation

The researcher developed a historical SG, using a colour-coded card system to boost user recall. Aimed at providing museum visitors with a quick yet informative look into the dinosaur era in Egypt. The game, titled "Welcome to the Early Life" (<https://drive.google.com/file/d/181vSBVobBcmun5-ovCfv0lzDqQygkOyt/view?usp=sharing>), resulted from extensive visits to various museums, extensive readings of numerous books and papers, and acquiring programming skills to design and develop games. The researcher developed the game using HTML5 to make it more accessible across all types of devices and operating systems, including computers, tablets, and mobile phones.

Game design is meant to be clean and straightforward. To fit the museum environment. That user takes from 2-3 minutes to solve and learn, so that more audience can experiment it through visit time

2.2. Participants

The study's population consisted of 104 participants from eight different countries. These participants displayed diversity in terms of gender, age, and education. They gave verbal consent and completed a questionnaire encompassing demographic, qualitative, and quantitative data. The instructions for completing the survey were clearly and effectively communicated to the participants. Notably, great care was taken to assure them that their identities would be kept strictly confidential and that their responses would be solely used for academic research.

2.3. Statistical Analysis

Statistical data analysis was performed using MS Excel 2016 and Statistical Package for the Social Sciences (IBM, SPSS Statistics v.27.0) software. The demographic and qualitative variables were evaluated using the proportion test. The quantitative data was analysed using different statistical tests to assess data reliability. The linear relationship between the factors was evaluated using Pearson Correlation for serious games preferences/likeness (V0) with Video games affecting badly mean (VGABM), Serious game for community and educational development mean (SGCEDM), Serious game developing sustainability in life means (SGDSILM), and Serious game for developing CH mean (SGDCHM). The significance level for correlation was

$P \leq 0.01$. In addition to correlation, the Chi-square test of independence was applied to find the association of V0 with other factors, with $P \leq 0.05$ as the significance level.

3. Results

3.1. Descriptive Statistics

This section delves into the descriptive characteristics of the individuals from whom the data was obtained, as shown in **Table 1**.

Table 1. Demographic characteristics of the participants.

Demographics	Percentage (%)	Frequency (N)
Age		
3 – 10	7.69%	8
11 – 20	11.54%	12
21 – 30	34.62%	36
31 – 40	26.92%	28
41 – 50	19.23%	20
> 50 years old	0.00%	0
Educational Level		
Illiterate	0.00%	0
School	7.69%	8
College	34.62%	36
Bachelor's	19.23%	20
Master's	23.08%	24
Ph. D.	11.54%	12
Higher than Ph. D.	3.85%	4
Gender		
Female	65.38%	68
Male	34.62%	36
Country		
Egypt	46.15%	48
UK	29.81%	31
USA	13.46%	14
UAE	6.73%	7
KSA	2.88%	3
Yemen	0.96%	1

N=104

Table 2 displays the participants' distribution according to the hours they devote to playing serious games each day.

Table 2. Participants' daily routine of spending time playing SGs per hour.

Hours	N
≥ 6	4
3 - 6	8
1 - 3	28
≤ 1	32

3.2. Inferential Statistics

This portion discusses the authenticity of the data collected via the survey and the tests applied to it for the desired research outcomes.

3.2.1. Reliability Statistics

The reliability of the questions was assessed through the Cronbach Alpha test, as shown in **Table 3**.

Table 3. Reliability analysis of the sample's responses.

Cronbach Alpha	0.953
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Cronbach Alpha results were further confirmed using the Factor Analysis, as indicated in **Table 4**.

Table 4. Analysis of the sample's factor via extractor method.

Factor	Extraction
V0	0.900
V1	0.630
V2	0.739
V3	0.837
V4	0.813
V5	0.907
V6	0.739
V7	0.883
V8	0.766
V9	0.898
V10	0.811
V11	0.828
V12	0.911
V13	0.866

V14	0.901
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3.2.2. Inferential Analysis

Pearson Correlation test was applied to evaluate the relationship between the factors so that they can be further analysed, and results are shown in **Table 5**.

Table 5. Pearson Correlation relationship between different factors related to serious gaming.

Pearson Correlation Coefficient (r)		V0	VGABM	SGCEDM	SGDSILM	SGDCHM
V0	R	1	0.787**	0.677**	1.000**	0.862**
	P-value	-	0.000	0.000	0.000	0.000
VGABM	R	-	1	0.532**	0.787**	0.912**
	P-value	-	-	0.000	0.000	0.000
SGCEDM	R	-	-	1	0.677**	0.584**
	P-value	-	-	-	0.000	0.000
SGDSILM	R	-	-	-	1	0.862**
	P-value	-	-	-	-	0.000
SGDCHM	R	-	-	-	-	1
	P-value	-	-	-	-	-

****Correlation is significant at the 0.01 level (2-tailed).**

Pearson Correlation: r

Sig. (2-tailed): P-value

N=104.

The chi-square test was implemented on different factors to find their association. The P-values were < 0.05, as shown in **Table 6**, showing significant associations between the factors.

Table 6. Chi-square and post-hoc association between different factors related to serious gaming.

Factors	Value	Df	Chi-squares (χ^2)
V0*VGABM	95.550	4	0.000
V0*SGCEDM	64.341	1	0.000
V0*SGDSILM	47.667	1	0.000
V0*SGDCHM	77.341	1	0.000

The chi-square is significant at the 0.05 level (2-tailed).

3.3. Qualitative Analysis

These underlying incentives for SGs participation highlighted the various purposes and motivations among the gaming community in **Table 7**. Whereas **Table 8** describes the skills developed in users by playing the SG. Lastly, **Table 9** provides suggestions from respondents for converting video games to better games or SGs as video game developers.

Table 7. Factors underlying the decision for serious gaming.

Reasons for playing SG	N	%
For learning Purposes	37	36%
For fun	20	19%
To be stress-Free	15	14%
To be myself	10	10%
For time killer	9	9%
To try something new	7	7%
To make friends	4	4%
Don't like (Addictive)	2	2%

Table 8. Evaluations of the skills incorporated after playing the SG.

Factors	N	%
Rapid response	30	29%
Languages skills	25	24%
Problem-Solving	24	23%
Coordination	13	13%
Focus	12	12%

Table 9. Suggestion for converting video games to better games or SGs as a video game developer.

Factor	N	%
Low violence	30	29%
Increase Positivity	34	33%
SG Cessations	20	19%
Increase Educational purpose	20	19%

4. Discussion

The results in **Table 1** showed that many participants lie within the age category of their twenties, with a considerable representation among college attendees. The current study is in concordance with Boyle *et al.*, who explored the contributions of SGs to learning, skill development, and participation of young people over the age of 14, which shows that the young population is more engaged in SGs (Boyle *et al.*, 2016). There is

also a higher representation of females in our sample compared to males playing SGs, which concurs with the study of Stege and colleagues showing a significant interaction between females and motivation for SGs (Stege et al., 2011). It is crucial to highlight that our study reached respondents from varied geographical regions, representing a worldwide perspective on gaming behaviours. However, most of the participants were students residing only in Egypt.

Table 2 shows that 30.77 % do not play any SGs at all. 30.77 % of the sample also plays for under an hour. These results are supported by the work done in the research of Bourgonjon *et al.*, which evaluated that 12.8% of the students reported not playing video games at all, and 26% of the students indicated playing a maximum 1 hour a week (Bourgonjon et al., 2010). These evaluations are key to pondering that many people still do not prefer playing SGs. 26.92 % of the players play for between one and three hours, compared to 7.69 % who play for three to six hours. The lowest group, 3.85 %, spends six or more hours playing SGs. These findings offer information on the participants' gaming behaviours and may help determine the gaming habits of a particular population or help make judgments about gaming activities. The results obtained in **Table 3** showed that all the factors incorporated in the inferential statistics are reliable to analyse further as the Cronbach Alpha is greater than 0.5, indicating excellent data consistency. The results of **Table 4** indicated that each factor used in the study has great authenticity and reliability as all the values are close to 1. Thus, inferential statistics can be used in the study for further analysis.

Results of **Table 5** show a strong positive correlation (> 0.5) of the V0 with VGABM, SGCEDM, SGDSILM, and SGDCHM, confirming that these variables are correlated and can be further evaluated. **Table 6** shows the association between V0 and VGABM (mean of V1, V2, V3, and V4), which was significant. These are in concordance with the study of Susi *et al.*, who explored the negative effects include physiological concerns, e.g., headaches, exhaustion, mood swings, etc. and psychosocial issues, e.g., depression, social isolation, less positive behaviour towards society in general, substitute for social relationships (Susi et al., 2007). In addition, the association between V0 and SGCEDM, which was the mean of V5 and V6, was evaluated, showing a significant association confirmed by the study of Chen & Lin, showing that SGs play an important role in education (Chen & Lin, 2016). Hanus and Fox evaluated that students are more motivated and excited about new learning methods via gamification (Hanus & Fox, 2015). At the same time, a significant association between V0 and SGDSILM was evaluated, which was the mean of V7, V8, V9, and V10. Researchers previously discussed the need to incorporate sustainability via SGs and provided related models (De la Torre et al., 2021; Moloney et al., 2017; Nguyen & Hallinger, 2021; Stanitsas et al., 2019). Few studies have been published related to the association of SGs and SD. The present study evaluated that SGs support SD, and the findings are inconsistent with the literature (Peña Miguel et al., 2020). Lastly, an association between V0 and SGDCHM (mean of V11, V12, V13, and V14) also showed a significant association supported by the study of Anderson *et al.*, who highlighted case studies on SGs illustrating the application of methods and technologies used in CH are presented showing CH association with SGs (Anderson et al., 2010). Previous studies are by the fact that SGs have a positive impact on learning CH (Andreoli et al., 2017a; Bontchev, 2015; DaCosta & Kinsell, 2022; Dagnino et al., 2017; Mortara et al., 2014b; Yilmaz et al., 2015). The study of Bellotti *et al.* also showed that users were motivated by new opportunities for learning about CH; hence, the current study showed a significant association of SGs with CH. Thus, users can learn CH through SGs (Bellotti et al., 2013).

Table 7 evaluates the various patterns and motivations for participation in SGs, revealing a diverse array of preferences and incentives for gaming. Notably, a significant proportion of participants (36%) engage in SGs for educational purposes, a finding supported by Chen and Lin's research, which demonstrated a positive impact on student's intention to incorporate mobile games into their educational environment (Chen & Lin, 2016). SGs are carefully developed to educate and immerse players in historical and cultural contexts. As a result, those who like learning through gaming may find great benefits in using SGs as powerful educational tools for studying CH. Although not as dominantly, a large number of respondents (19%) said they play SGs for the fun they provide, which agrees with the results of Giannakos *et al.* evaluating researchers' opinions regarding the "excitement" of the students during and after playing SGs (Giannakos et al., 2012). SGs can skillfully include elements of enjoyment and entertainment into the learning process, giving the educational endeavour a potent and engaging dimension.

Furthermore, a subset of participants (14%) seeks relief and leisure through gaming, which complements the ability of SGs to provide a serene and accurate setting. A portion of participants (10%) play SGs to express themselves, according to the study of Banfield & Wilkerson, who showed that SGs incorporate self-efficacy and motivation in users (Banfield & Wilkerson, 2014), while few play serious gaming for killing time (9%) which is not directly associated with educational objectives, yet this group's proclivity for gaming may inadvertently lead to exposure to instructional content inside SGs, particularly during leisure hours. However, some participants play with a preference for trying something new (7%), indicating a demographic interested in exploring SGs for novelty and experimental endeavours in CH. Although the social dimension is not the primary focus, a portion of the population (4%) recognises it, which may be explored through multiplayer elements in SGs. It validates Waytz & Gray's finding that educational SGs encourage social connection (Waytz & Gray, 2018). Finally, a small minority (2%) dislikes SGs as they are addictive. This evaluation for playing SGs demonstrates the diversity of preferences and underlying motivations throughout the gaming community.

Table 8 shows the percentages of users who improved their educational skills by playing SG. The study of Koutromanos supports these results and has implications for using SGs for educational purposes (Koutromanos, 2023). The results showed that 29% of respondents experienced improved skills for rapid responses, which may boost users' capacity to react rapidly and effectively in challenging situations. These results are supported by (Bergeron, 2006). It also increased language skills in 24% of participants, demonstrating its educational benefits in language learning and proficiency. Nearly half of SG studies in the review article of Calderón & Ruiz examined learning effects; similarly, Dichev & Dicheva investigated positive results regarding learning improvements (Calderón & Ruiz, 2015; Dichev & Dicheva, 2017). Additionally, the game improved problem-solving skills for 23% of respondents, which promoted critical thinking and smart/decision-making. It concurs with the study of Boot *et al.* and Kara, who also evaluated the benefits of playing SGs extended to a broader range of cognitive abilities, such as memory and problem-solving (Boot *et al.*, 2008; Kara, 2021). On the contrary, fewer users reported coordination and attention skills (13% and 12%, respectively), which is supported by Arias-Calderón *et al.*, who found that students believe SGs boost motivation, commitment, confidence, concentration, and study time (Arias-Calderón *et al.*, 2022). These percentages showed that serious gaming improved these aspects, albeit less. This evaluation showed that serious gaming can build several talents, including rapid response, linguistic skills, and problem-solving, supporting the idea that SGs are effective entertainment and education tools that improve user skills.

The development and integration of SGs have a profound impact on the people involved in creating and playing them. Our data shows that SGs can significantly influence community dynamics. It's interesting to note that individuals who engage in aggressive gameplay may display increased aggression in their real-life interactions. This highlights the powerful role of game design in shaping how communities behave. However, these findings also present an exciting opportunity that we can purposefully harness the influence of SGs to make a positive impact. By designing games that not only entertain but also promote positive values and cooperation, developers can contribute to building a more harmonious and socially aware community. Creating games with a deliberate focus on fostering positive community engagement holds great promise. It allows us to shape the collective mindset towards a more constructive and interconnected society. By infusing games with values that inspire empathy and collaboration, we can encourage individuals to come together, understand each other, and work towards common goals. In this way, SGs have the potential to go beyond mere entertainment. They can become a powerful tool for social change, cultivating a community that is more conscious, compassionate, and united. By tapping into the influence of SGs, we can create a future where gaming experiences not only entertain but also inspire positive transformations in our society.

5. Conclusion

The study concluded that SGs have evolved to strike a balance between entertainment and education. In contrast to earlier findings, previous studies had noted a deficiency in the entertainment aspect of SGs, highlighting the necessity of enhancing the fun factor to engage users in playing SGs. As there is a literature gap regarding the reasons for adopting SGs for CH and SD, this study aimed to contribute by developing a simple historical SG and evaluating people's perceptions after using it. It may be used to propose a specific study model for properly converting normal video games into SGs, incorporating users' suggestions. Lastly,

based on the results obtained from the examined variables, users' preferences after playing SG had a significant association with community and educational development, CH, and SD. The results have significant implications for researchers, academics, and decision-makers in higher education institutions, particularly those whose focus lies on adopting SGs in the field of education for CH and SD. Finally, game developers may consider the study's recommendations to design SGs with low violence, positivism, responsible gaming, higher moral values and educational value for a wider audience.

6. Limitations

Although there are real challenges, it's essential to continue exploring new ways to engage people from diverse backgrounds in promoting cultural heritage (CH) and sustainable development (SD). That being said, this study had its limitations.

For starters, most of the participants in this study were students from Egypt, so the findings may not be applicable to people in other countries. Also, because we relied on participants' own reports, there could be some bias, whether intentional or not, in their answers. The researcher also focused on just a few factors and only tested one serious game. In the future, it would be helpful to examine additional variables and attempt to integrate CH and SD themes in a more comprehensive manner, while ensuring that the educational content is balanced with the level of fun in the game.

The researcher managed to create a working prototype of the game, but did so without any funding or a full team to assist. As a result, the game couldn't be as complex, scalable, or widely used as had hoped. Creating grand serious games requires a collaborative effort, bringing together developers, designers, educators, and experts in heritage. If museums and educational institutions want to make a real and lasting difference, they should establish serious game departments. That way, they can continue to come up with new ideas, maintain high quality, and keep pace with the rapid evolution of digital engagement in heritage education.

Declarations and Statements

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Conflict of Interest

This research and its components were tailored and designed for academic purposes.

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