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Intention to Adopt Digital Games for Safety Training in Young Farm Operators: The Role of Ease of Use, Perceived Usefulness, and Game Design Characteristics

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ABSTRACT

The development of digital games has proven particularly fruitful for the introduction of new forms of occupational safety training in various work sectors, but less is known about their use in sectors as hazardous as agriculture. In this study, we used a path model to analyze the triggers for the intention to use digital games as a safety training method in a group of young agricultural operators. A questionnaire was used to investigate participants' intention to use games as safety training tools, perception of usefulness, perception of specific game design characteristics, and perceived ease of use. Game design characteristics and perceived ease of use were positively associated with perceived usefulness, which, in turn, was positively related to the intention to use digital games. These results provided some insights into the most critical variables that can be influenced to increase young farmers' intention to use digital games for effective safety training.

KEYWORDS

Games in education; safety training; agricultural workers' perception; young workers

1. Introduction

Agriculture is one of the most dangerous production sectors in both developed and developing countries (International Labour Organization [ILO], 2015), with an incidence rate of fatal accidents almost double that of other sectors (ILO, 2017). Specifically, the high rate of fatal or non-fatal injuries is caused by the variability of the work farmers have to perform, the variety of machinery and tools they use, and the very different and sometimes adverse weather and climate conditions they have to work with (Day et al., 2009). The literature widely points to the crucial role of targeted information and training measures in improving farmers' protective and safety behavior (Coman et al., 2020; Hanvold et al., 2019). Safety training for farmers mainly relies on conventional training methods such as lectures and classroom activities, where instructors usually display boards, brochures, and posters to supplement their verbal explanations. However, these methods are considered passive and less engaging with limited effectiveness in improving safety knowledge and performance (Burke et al., 2011).

In recent decades, digital solutions have proven to be an essential contributor to the implementation of new forms of more engaging training in various fields. In the current literature, systems such as Brain-Computer Interface (BCI), eye-tracking, and virtual and augmented reality (VR/AR) are particularly mentioned. BCI is a neural rehabilitation application based on the hypothesis that motor learning promotes motor recovery after a stroke (Mascaro et al., 2019) and has been used mainly in the medical field, thanks to the good results of this tool in patients with motor paralysis (Brocal, 2023). Eye-tracking and VR are applied in occupational safety in the manufacturing and construction industries (Fu & Li, 2023; Taieb-Maimon et al., 2023) to thoroughly understand the mechanisms of workers' hazard awareness and reactions by observing and evaluating their visual patterns under different conditions.

Previous research has found that BCIs offer broader applications in training and education by providing users with new and exciting ways to interact with virtual environments and learn new skills (Filiz & Arslan, 2020; Saha et al., 2021). Some prototypes have already been developed that allow users to navigate in virtual scenes or manipulate virtual objects using only their brain activity, recorded via EEG electrodes on the scalp (Lécuyer et al., 2008). However, this type of system faces limitations in terms of commercialization, as it is mainly proof-of-concept (Filiz & Arslan, 2020). Krol et al. (2017) used both eye-tracking and real-time EEG analysis to support touchless human-computer interaction. As a result, the study showed that the player's level of relaxation controlled the speed of the game, and the more relaxed the player is, the slower the game moves. To avoid making the exercise more difficult, the user must always remain calm after a mistake. In addition, the use of VR has previously been considered to explore methods to better support vision testing and training. For example, Dæhlen (2022), based on 2D exercises, investigated the development of three-dimensional exercises in VR to collect relevant information about eye movements for vision screening. An analysis of the user experience between 2D and 3D

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screening applications showed that the application created with VR was considered functional, suggesting that VR technology can offer great promise for supporting the current vision screening battery. As well as the use of specific programming language and Language-Integrated Query (LINQ) associated with eye tracking devices, queries can be used to enhance the collection of eye movement data and its subsequent processing and analysis (Katona, 2021).

Despite the high potential of these technologies for training purposes, they are quite complex and require specialized equipment, which can be expensive and not universally available among workers (Filiz & Arslan, 2020). Less complex digital solutions in the form of digital games (DGs) have been implemented in the field of safety training, providing an engaging, cost-effective, and more flexible solution in terms of time management (Fanfarová & Mariš, 2017). Furthermore, DGs have the advantage of focusing workers'/players' attention on specific tasks (Mohd et al., 2019) while remaining in a "safe" virtual environment (Mohd et al., 2019).

Recently, there has been growing interest in the use of DGs for safety training in agriculture (Pietrafesa et al., 2020), and some initial results have shown the effectiveness of using ATV safety games in promoting operational knowledge among young drivers (Schneider, 2015). Nevertheless, there is still little empirical evidence of farmers' intention to use DGs to improve their safety knowledge and behavior. To promote the adoption of DGs, it may be useful to understand whether the variables that proved to be critical for the adoption of these technologies in other areas or for other types of technological interfaces may also be effective predictors of farmers' intention to adopt DGs. Similarly, it could help to understand whether the initiatives taken in other sectors can be used effectively in the agricultural context or whether more targeted initiatives need to be developed.

Based on these considerations, in the present study we have built on the Technology Acceptance Model (TAM, Davis, 1989) and game design theories (e.g., MDA framework and the basic element of game design; see Schell, 2008) to develop and empirically test a mediated model aimed at predicting young farmers' intention to adopt DGs for agricultural safety training, as a function of perceived ease of use of DGs and game characteristics, with the mediation of perceived usefulness of DGs. This analysis may identify critical areas of intervention in terms of user-centered design of DGs for training purposes and targeted information interventions to support and encourage the adoption of DGs by agricultural operators.

1.1. Conceptual framework

The TAM is one of the most widely used models for predicting individuals' acceptance of technological innovations, mainly as a function of perceived usefulness (PU) and perceived ease of use (PEoU). PU refers to "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320), while PEoU refers to the "degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). Previous studies on the use of information technology and technological innovation have shown that PEoU can strengthen PU (Kuo & Yen, 2009). In addition, high levels of PEoU have been shown to increase the perception of games as tools that provide positive learning opportunities (Bourgonjon et al., 2010) among teachers (Sánchez-Mena et al., 2017), students, and workers in different industries (Abdul Razak et al., 2017). However, there is no empirical evidence on whether these variables are crucial for predicting DG adoption in the agricultural sector.

Game design characteristics have been shown to play a crucial role in accepting and adopting technological interfaces (Cyr et al., 2006; Tractinsky, 2004). In the current game research literature, the terms often overlap or even contradict each other (Junior & Silva, 2021), so the terms "game design features," "game design elements" or "game design characteristics" (Clark et al., 2016; Bharathi et al., 2016; Rodrigues et al., 2017) are used to describe similar groups of things that are needed to develop a digital game. In the present study, the term Game Design Characteristics (GDCs) is used to encompass the aesthetics of the game (Niedenthal, 2009) and its visual, graphic, and narrative characteristics (Zhao & Fang, 2009), and all elements that promote the emotional experience between the player and the game components (Guardiola, 2019), including the narratives, the visual elements, the dialogues, and some relevant mechanics (e.g., points, badges, and levels) and dynamics (e.g., rewards, status, and achievement, see Salmon et al., 2017).

Few previous studies have investigated how GDCs can influence PU and PEoU (Deng & Cho, 2022; Pantouw & Aruan, 2019; Rafdinal et al., 2020). These studies analyzed the use of GDCs, such as rewards, points, and leaderboards in gamified applications such as e-banking applications and e-business contexts or looked at the design aesthetics of websites and their user experience elements, which typically include text, images, graphics, interactivity, animations, and motion (Cyr et al., 2006; Rahi & Abd Ghani, 2019; Rodrigues et al., 2017). However, none of these referred to the DGs for safety training or to the agricultural sector.

1.2. Research questions and hypotheses

Based on the state of the art and the relevance of promoting new and more engaging training methods in the high-risk sector of agriculture (ILO, 2017), in this study we aimed to answer two main research questions. First, how are GDCs and PEoU related to PU of DGs among young farmers? (RQ1). Second, how is PU related to young operators' intention to use DGs for agricultural safety training? (RQ2). Moreover, recent statistics showed that women are increasingly interested in using DGs (Alserri et al., 2018; Interactive Software Federation of Europe [ISFE], 2021) and an increasing feminization of the agricultural sector can be observed (Allan et al., 2019). Accordingly, we developed an additional research question: does the decision-making process we analyzed vary across genders? (RQ3). The relevance of this last question relates to the possibility of identifying

the critical variables that need to be addressed with targeted interventions to promote users' intention to adopt DGs between genders.

To answer the above questions, we hypothesized the following. Regarding RQ1, based on Wang et al. (2017), we expected that GDCs would show a positive association with PU of DGs for agricultural safety training (H1). In addition, based on Bourgonjon et al. (2010) and Kuo and Yen (2009), we expected PEoU to show a positive association with PU of DGs for safety training in agriculture (H2). Regarding RQ2, based on Davis (1989), we expected PU to have a positive association with the intention to adopt DGs for agricultural safety training (H3). As no solid theoretical and/or empirical bases were available, we did not develop specific hypotheses regarding the possible differences between men and women in the parameters examined.

2. Materials and methods

2.1. Research design and participants

To test the above hypotheses, we projected and conducted a survey research design. The survey was conducted with a sample of young Italian farmers, for two reasons. On the one hand, young farmers represent the "farmers of the future," who have a wide range of digital tools and platforms at their disposal to train themselves on various work-related issues (Caffaro & Cavallo, 2019). On the other hand, they need to be properly trained on safety issues from a young age and early in their careers, so that they can make proper safety practices an integral part of their experience and common sense (Alwall Svennefelt & Lundqvist, 2020).

It is challenging to reach young farmers as they are usually scattered over wide geographical areas and have different working hours (Pilgeram, 2011). However, the new generation of farmers is increasingly continuing their education at universities (Plana-Farran et al., 2022). We then contacted various professors at different departments of agricultural sciences throughout Italy and asked them about the possibility of involving their students in the study. Lecturers in agricultural mechanics hosted the first author during their online courses. At the end of the lectures, the researcher introduced the context and aim of the study. Participants were asked to think about games related to farm health and safety education. Regardless of whether the participants have already played a game on these topics or not, they were asked to imagine having to play such a game. They were asked to imagine how they would like it to be structured and developed to make the game as enjoyable as possible and to answer to the questionnaire. It was pointed out that the research was only intended for students already working in agriculture, e.g., farmers, contractors, or helping family members. After the researcher's explanations, participants could ask questions if they were curious or had doubts. The questionnaire was administered using Google Forms, and then completed by the students on their mobile phones. On the first page of the online questionnaire there was an information sheet used by participants to confirm that they belonged to one of the three categories of farmers mentioned above and to give their consent to participate in the study by checking a box at the end of the page. The information sheet also emphasized that the responses would be kept confidential and not shared with third parties.

The online questionnaire was designed based on items and scales from previous instruments (Bourgonjon et al., 2010; Salmon et al., 2017). Following Bourgonjon et al. (2010), the questionnaire was developed to include both current and non-current players by asking non-players to answer the questions by thinking of a hypothetical DG they would like to play. The questionnaire consisted of four sections as it was part of a wider project. Only the two sections containing the questions relevant to the aim of the present study are discussed below.

In the first section, participants were asked to think of a game for agricultural safety training and give their opinion on: (a) the usefulness of games as safety training tools (9 items, e.g., "DGs would help to cope with difficult tasks" or "DGs are useful to improve learning," from Bourgonjon et al., 2010); (b) the importance of certain game design characteristics for conveying safety information (7 items, e.g. "DGs should have a good storyline" and "DGs should have better rewards at a higher levels," from Salmon et al., 2017); and (c) the ease of use of the game (2 items, e.g. "It will be easy for me to learn how to use DGs" and "It will be easy for me to play with different types of DGs," from Bourgonjon et al., 2010). All responses were given on a four-point scale (from 1 = *I strongly disagree* to 4 = *I strongly agree*). A measurement model, tested using confirmatory factor analysis, showed the expected factorial structure: three factors, respectively labeled GDCs, PU, and PEoU, $CFI = .92$, $TLI = .91$, $SRMR = .06$. The parameters of the model are displayed in Table 1.

The second section included questions about participants' gaming experience. Specifically, in this section participants were asked about the amount of time they spent gaming (hours per day) and whether they had ever played a game related to occupational safety and health issues (possible answers: *Yes* or *No*). The question on participants' intention to use a game for agricultural safety training purposes (i.e. "Would you be interested in playing a digital game related to farmers' health and safety?", 4-point rating scale 1= *Definitely not*, 4 = *Definitely yes*), concluded the section. A standard socio-demographic form, in which the age and gender of the participants were recorded, concluded the questionnaire.

Participation was voluntary; no incentives were offered and participants were free to withdraw at any time. The study was conducted in accordance with the Declaration of Helsinki and approved by the Research Advisory Group (RAG) of the CNR-STEMS (approval N. 2283, September 29 2020).

2.2. Data analysis

Descriptive statistics were calculated for the variables of interest. We tested our dependency hypotheses using a path analysis model. In addition, we tested the structural

Table 1. Measurement model: standardized factor loadings.

	GDCs	PU	PEoU
A digital game on occupational health and safety in the agricultural sector should …			
Have lots of game variety	.75***		
Have a good storyline	.77***		
Have a good music	.66***		
Have a good artwork	.72***		
Have better rewards at higher level	.76***		
Have characters that talk to me	.72***		
Have possibility to customize the look of my character	.69***		
Offer opportunities to experiment with knowledge		.88***	
Offer opportunities take control over the learning process		.89***	
Offer opportunities to experience things you learn about		.88***	
Offer the opportunities to think critically		.72***	
Improve my performance		.83***	
Help to manage difficult tasks		.83***	
Be useful for improving learning		.86***	
Motivate students		.85***	
Guarantee clear and understandable interaction with students in the classroom		.72***	
Be easy for me learn how to use it			.90***
Be easy for me to play using different types of DGs			.92***
Cronbach α	.89	.95	.91

Note. ***$p < 0.001$. GDCs: Game design characteristics; PU: perceived usefulness; PEoU: perceived ease of use.

invariance of the model across genders using Reise et al. (1993) approach. We first tested a baseline (B) model simultaneously among men and women. We then tested an invariant (I) model, in which all the parameters were fixed to be equal for both genders. We would have rejected the null hypothesis of non-invariance across genders if setting equal the parameters for men and women had led to a worsening of the fit of the model. In statistical terms, we examined the χ^2 differences between the I and B models for a number of degrees of freedom equal to the difference in degrees of freedom between the two models and concluded in favor of the invariance if these differences had not reached statistical significance. All analyses were performed using MPLUS (Muthén & Muthén, 1998–2017).

3. Results

One hundred and forty-three young farmers took part in the study. The age of the participants ranged from 18 to 36 years (M_{age} = 20.82, SD = 2.85), 65% of the participants were men and 35% were women. Their farming experience ranged from 2 to 15 years (M = 4.8, SD = 2.77).

Almost two-thirds (63.6%) of participants reported playing video games, but only 7% had played DGs related to occupational safety and health issues. In terms of playing time, 36% of participants reported playing DGs for less than an hour, 34% for almost 1 h, 20% for almost 2 h, and 10% for more than 2 h.

Regarding RQ1, the results of the analysis confirmed H1 and H2: GDCs and PEoU showed a positive association with PU. With regard to RQ2, H3 was also confirmed: PU was positively associated with the intention to use DGs. The direct associations between GDCs and PEoU on the one hand and the dependent variable on the other were not significant. They were, therefore, fully mediated by PU. Figure 1 shows the standardized parameters of our model. The fit of the model was satisfactory: CFI = 1.00, TLI = 1.00, $SRMR$ = .00.

To answer our final research question (RQ3, are the estimated parameters the same for men and women?), we tested the invariance of the model across genders. Table 2 shows the results of the test for structural invariance. Constraining the parameters of the model to equality across men and women did not worsen the fit of the model. Thus, we concluded that our model is invariant across participants' gender.

4. Discussion

The present study combined the TAM with some game characteristics to investigate the critical factors influencing young farmers' intention to adopt DGs as training tools to improve their awareness and knowledge of occupational safety and health issues. PEoU and GDCs were positively associated PU, which in turn showed a positive association with the intention to use DGs for safety training in agriculture.

The positive association between PEoU and PU extends the findings of Bourgonjon et al. (2010) and Camilleri and Camilleri (2019) on students' preference for game-based learning in this area of study: if the system is easy to use, potential users perceive it as more useful. Thus, it seems that, as mentioned by Breyer et al. (2018), Pasqualotto et al. (2023) and Sauvé and Kaufman (2019) for other user populations and industries, design interventions aimed at creating understandable interface elements and making game controls and game goals more intuitive are the first step to promote the usefulness of DGs, also among young farm operators. The default user interface should be very simple and ensure that the majority of the screen is dedicated to displaying the game world, which is the virtual farm environment (Wanner, 2014). All buttons and controls should only appear in the corners of the screen. Some animations showing incorrect and correct behavior in agricultural activities can be implemented to make the game and its goal more understandable.

The ergonomics literature points out that the Human-Centered Design (HCD) approach (International Organization for Standardization [ISO] 9241-210, 2019, also

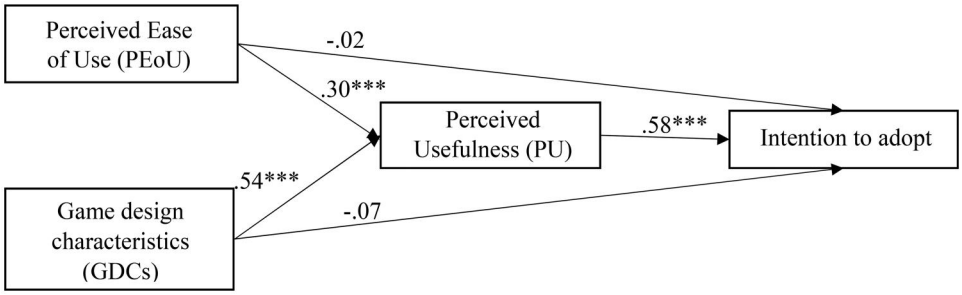

Figure 1. The standardized parameters of our model. *Note.* $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

Table 2. Structural invariance of the model across genders.

	χ^2	χ^2 difference
Baseline model	$\chi^2(0) = 0.000$, $p < 0.000$	
Invariant model	$\chi^2(5) = 4.875$, $p = 0.431$	$\chi^2(5) = 4.875$, $p = 0.431$

defined as User-Centered Design—UCD) should be adopted for the design of technological systems that are actually perceived as easy to use (Bednarik & Krohns, 2015). HCD (or UCD) is an approach to developing interactive systems that aims to "enhances effectiveness and efficiency, improves human well-being, user satisfaction, accessibility and sustainability; and counteracts possible adverse effects of use on human health, safety and performance" (ISO 9241-210, 2019, p. VI). The approach was presented in previous studies that emphasized user evaluation and testing to develop a game that is easy to use and then perceived as useful (Rienzo & Cubillos, 2020).

In the present study, GDCs were found to influence PU. Previous studies have typically associated GDCs with user enjoyment (Hamari & Keronen, 2017; Zhao & Fang, 2009), overlooking the role it might play in making DGs perceived as useful. A game designed specifically for the agricultural context should contextualize the game in a graphically appealing work environment. In addition, well-designed scenarios can assist the player in identifying specific hazards (Din & Gibson, 2019) by replicating the decision-making processes that operators encounter in different hazardous situations. For example, the main risks in agriculture—i.e., those related to maintaining the rollover protection device fitted on tractors in the folded down position, not wearing the seatbelt, not using personal protective equipment (PPE), the risk of falling when using ladders, the risk related to manual handling of loads, or driving tractors on steep slopes (see Komarek et al., 2020; Molina-Guzmàn & Rios-Osorio, 2020)—could be properly represented.

Considering the training and educational purposes of the game and the non-standardized schedule of farmers (Komarek et al., 2020; Molina-Guzmàn & Rios-Osorio, 2020), a new DG for this sector should be playable in a short time and independently to acquire specific micro-skills (e.g., how to properly operate Rollover-protective structure, how to operate safely near machinery, what PPE is required to perform certain work activity, etc.). Based on the main storyline, the game could be developed to include a series of mini-games that must be completed to progress. When each mini-game is successfully completed, players receive a hint or reward for winning the game, and at the same time they can learn how to work safely in different agricultural working areas. In this way, the mini-games help to entertain players with additional variety and do not limit the game to a specific genre (Smith & Mateas, 2010).

Overall, the game content and storyline should be designed in such a way that it is familiar to the users and can be inspired by their daily life. Different tasks and game levels can be designed to train farm workers in various practical tasks and provide feedback to make players aware of the effects of the actions they performed in the field. Based on this, the game can show the consequences for farmers in case of incorrect behavior or incorrect operation of tractors and machinery, based on the most common consequences in real working conditions such as back pain due to incorrect posture, injuries due to lack of use of PPE or tractor overturning (see Molina-Guzmàn & Rios-Osorio, 2020).

Negative audio messages could also follow the video representation. In terms of sound, the availability of real-time feedback, as well as cues or graphics to increase interactivity, presented primarily in the form of visual popups (e.g. textual actions and informative messages) or auditory notifications (i.e. sound effects), could be particularly useful to engage and motivate players to play (Hall et al., 2021; Lee et al., 2011; Sauvé & Kaufman, 2019). Although notifications are already common in many games, they have the potential to increase significantly player engagement and retention metrics. Notification can, for example, be used to remind users to return to the DG after an interruption and to exercise safe behavior.

The present study found a significant positive association between PU and the intention to adopt DGs for safety training in agriculture. This confirms that PU is crucial in convincing farmers to adopt technological innovations, not only on-farm (Caffaro et al., 2020), but also in training activities. The association could be explained by the fact that safety training games are mainly intended for utilitarian goals, and research indicates that utilitarian systems are embraced primarily for their usefulness (Hamari & Keronen, 2017). This is in contrast to hedonic systems, which are primarily driven by enjoyment (Zhao & Fang, 2009). Therefore, we believe that when developing a game for training purposes, it would be advisable to ensure that users find the listening, speaking, reading, and writing components of the game system helpful (Liu et al., 2010). As regards the agricultural sector, to develop a useful game-based training, the wide variability of the tasks that operators must perform during working hours should be considered. Agricultural tasks are not strictly

standardized, since they depend on the crops, the work steps (sowing, weeding, harvesting, etc.), the machinery and tools used, and they must be performed under different climatic conditions and with changing daily and seasonal workload (Day et al., 2009). Game designers should explore each aspect in collaboration with the end users, taking an HCD approach, to ensure that the game characteristics are appropriately implemented. This approach would allow the learning process to be adapted to the needs and operational activities of farmers.

Overall, the results obtained in the present study could be used to train ICT engineers and software developers on the importance of considering the human perspective and the target users' perceptions when designing a new DG in order to meet the needs and leverage the most important factors for the adoption of decisions. The same conceptual framework used here could be fruitfully utilized to identify the key variables in developing DGs for training students in STEM disciplines who are likely to be employed in the ICT and software engineering sectors. Indeed, previous studies have indicated that the use of DGs as informal media for STEM education is a valid method to engage students and provide them with opportunities to practice skills that traditional methods (i.e., classroom lectures) may not provide (Bodnar et al., 2016; Ishak et al., 2021). STEM students could be involved in an exploration of the role of the variables considered here to develop a graphical interaction system that communicates scientific concepts to their peers in an enjoyable environment, making the learning process more effective (Cho et al., 2009; Wu et al., 2008). Other engineering disciplines could also benefit from the development of targeted DGs. In the study by Urgo et al. (2022), for example, students recognized the opportunity to explore and work on a realistic industrial plant, especially when this is not possible in a real factory. Other studies have shown that the extensive use of gaming technologies and game elements can create an ecosystem through which engineers can maintain their cognitive engagement and increase the level of satisfying interaction between the user and the computer (e.g., Kosmadoudi et al., 2013).

4.1. Limitations and future research

As is often the case, this study had some limitations, mainly due to its non-probabilistic sample, which did not allow us to obtain generalizable results. This is a classical criticism of work psychology studies. However, since we were interested in the relations between the variables and not in their absolute values, this limitation is less serious than it may seem at first glance. Nevertheless, future studies with probabilistic and larger samples could help to corroborate the results.

Our model was invariant across genders, suggesting that the factors influencing young farmers' intention to use DGs for safety training purposes are the same for men and women. This is a promising result if we consider the challenges associated with developing games in education that should be inclusive and attractive to all genders (Boyle & Connolly, 2009). Although the variables influencing intention to adopt DGs are similar for men and women, recent studies suggest the need to further investigate possible gender differences and similarities in specific game characteristics, particularly in relation to game genre. For example, adventure games and role-playing games are the preferred game genre for both genders, while men are more likely to prefer to play fighting, shooter, and action games and women are more likely to prefer educational, puzzle, fantasy games, as well as games that do not contain violence in its various forms such as death and destruction (Alserri et al., 2018; Vigoroso et al., 2023).

The fact that young people belong to the generation that grew up with technology and have a high level of digital literacy may explain their interest in using digital games and their success (Bourgonjon et al., 2010). Further, future research developments could therefore focus on older farmers, considering that interest in digital content declines with age (Procci et al., 2013) and that rural populations are aging worldwide (Kinsella, 2001). Therefore, future research should obtain detailed information about whether and why older farmers use DGs or not and what components might motivate them to play. In addition, the cultural diversity of farmers could be considered, as agriculture is one of the production sectors with a higher proportion of migrant workers and they are more often involved in accidents and injuries than local agricultural workers (International Organization for Migration [IOM], 2021). This may be particularly important as previous research has shown that training materials developed for migrant agricultural workers and based on visual content enable them to overcome language barriers and improve satisfaction with the training process (Vigoroso et al., 2020).

Furthermore, in the present study we referred to a limited number of game mechanics and esthetic aspects of the game (e.g., Salmon et al., 2017; Zhao & Fang, 2009). In fact, other relevant game characteristics (e.g., cooperative/competitive game, construction game, online game) could play an important role in influencing PU and usage intention and should be considered in future research. Social interaction in this specific learning context could also be further investigated as it can improve employee engagement and sustained use of the system (Fiş Erümit et al., 2021; Sengupta & Williams, 2021). This factor could be considered, bearing in mind that agricultural work is often carried out alone in the field (Irwin & Poots, 2015).

Given the increasing interest in the application of eye-tracking in digital games as a form of input that replaces or complements traditional input methods such as mouse, keyboard or joystick (Gu et al., 2022) and given the existing correlation between eye movements and the level of immersion in virtual game environments (Rappa et al., 2022), it may be interesting to further investigate how these technologies can be applied to different learning and training activities.

As suggested in Sun and Hsu (2019), in future studies it might also be useful to investigate whether eye-tracking systems implemented in a digital game can promote and improve the learners' self-efficacy and self-confidence in performing certain works.

5. Conclusions

In spite of the above limitations, we consider the results obtained in this study to be encouraging, as research in safety training DGs, especially in agriculture, is still in its infancy. The present study shed light on the need to understand users' perception of this type of safety training, in order to develop targeted design or informational interventions that support a wider adoption of DGs. Specifically, through the present research we were able to highlight the key variables that lead to the intention to adopt DGs among young farmers and the relationships between these variables, laying the foundation for further studies to promote innovative and sustainable training systems in the primary sector as well. In addition, we have tried to provide useful guidelines to understand how to address the critical variables for the intention to adopt an agricultural safety game. This would be very beneficial for workers employed in the sector and would also encourage the use of these types of games during training sessions. Moreover, it could be useful for companies to explore new markets and business opportunities, as the ability to appeal potential users is considered one of the most important factors for product success in a market that is expected to grow rapidly in the coming years thanks to the ubiquity of mobile devices (Christofferson et al., 2022; Luceri et al., 2022).

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Disclosure statement

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Data availability statement

Data will be made available on request.

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