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# Digital literacy games: a systematic literature review

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This paper presents the results of a systematic literature review of academic publications about digital literacy games. We have analyzed a total of 30 papers and book chapters published in English, Spanish, Portuguese and Dutch between 2005 and 2021 and stored in Scopus. The results of this literature review report on: (1) the topics of the games discussed in the publications; (2) the digital literacy competencies supported by the games studied in the publications; (3) the effects of these games; and (4) ten game design considerations for digital literacy games collected from the results of the publications. This paper also provides detailed access to the original sources by reporting on which paper addressed what.

KEYWORDS
digital literacy games, media literacy competencies, systematic literature review, serious games, serious games effects

## Introduction

For decades, digital literacy has been an important topic in the research agendas of public policy institutions in and across countries (Livingstone, 2004; Opree, 2017; Opree et al., 2021). The widespread access to the internet at the turn of the century has given people new opportunities to exchange knowledge, communicate with others, and to produce and receive entertainment. However, these new opportunities also come with issues concerning fake news, radicalization, and cybercrime (Berkhout, 2018; Opree et al., 2021). Citizens in current and future societies need digital skills to participate fully in society. At an individual level, these skills facilitate well-being in the widest sense (social, economic, cultural, and political), and at a national level digital skills are necessary to ensure a diverse and sustainable economy and equitable participation (Van Deursen and Helsper, 2020). Thus, with an increasing digitization of our society it is becoming more pressing than ever for everyone to remain digitally-savvy.

Research in the past decade has shown, however, that children and young people were less digitally literate than the label of "digital natives" (Prensky, 2009) suggested (Dirkx et al., 2013; Kennisnet, 2017; Nieuwelink, 2020). In concrete, two studies showed that only 51% of the children in the age group of 10 to 12 (Mediawijzer.net, 2018), and 36% in the age group 13 to 18 years were digitally literate at a level that could be expected of them (Plantinga and Kaal, 2018). Taking into consideration that the early childhood process of learning takes place through learning while playing, and playing while learning, several studies claim that the introduction of the use of technology at a young age should be done through play (Andersen and Mirrels, 2014; Naranjo-Bock and Ito, 2017). Furthermore, there is also extensive academic literature on the potential of digital games as tools that can be used for and within education

(Egenfeldt-Nielsen, 2006; Gee, 2006; Dahalan et al., 2023). For this reason, digital games have been recognized as interesting tools to gain digital literacy skills at a young age (Qian and Clark, 2016; Rakimahwati and Ardi, 2019).

Taking into consideration the relevance of digital literacy and the role digital games can play in fostering it, this study presents an overview of current academic knowledge on the topic by analyzing the content of academic publications about digital literacy games. The resulting literature review provides a comprehensive summary of the state of knowledge about how digital literacy is addressed in these games and what the potential effects are of playing them. It also provides insight into game design considerations advocated in these publications. Before we discuss the background, methodology and results of our literature review, we highlight that this review is confined to publications *about* digital literacy games and does not report on a study of the games themselves. The reader is referred to the recent study by Glas et al. (2023) for a critical analysis of games in the domain of digital literacy.

## Defining digital literacy

The term digital literacy emerged in the late 1990s responding to the development and popularization of digital technologies. The term was coined by Glister (1997), who defined digital literacy as "the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers" (1997, p. 1). Glister focused on critical thinking as a core competence of digital literacy, giving less prominence to the technical skills necessary to use the technology (Martin and Grudziecki, 2006).

Almost a decade later, Martin and Grudziecki (2006) included far more aspects by defining digital literacy as:

> [...] the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyze and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process (2006, p. 255).

The authors also propose a three-level conceptual model for digital literacy including digital competence in the first level (i.e., skills, concepts, approaches, attitudes etc.), digital usage in the second level (i.e., professional/discipline application), and digital transformation in the third level (i.e., innovation/creativity) (Martin and Grudziecki, 2006, p. 255).

Following Martin and Grudziecki, other authors have proposed new definitions (e.g., Tabusum et al., 2014; Buckingham, 2015; Walton, 2016) driven by (amongst other reasons) a constant evolution of digital technologies and the way people interact with them. What is clear is that all these definitions approach digital literacy's multiple dimensions, combining technical and cognitive skills, competencies, as well as a certain level of social interaction and ethical awareness (Martin and Grudziecki, 2006; Rosenblit, 2011).

For this study, we follow the definition proposed by Reddy, Sharma and Chaudhary who define digital literacy "as an individual's ability to find and evaluate information, use this information

TABLE 1 Definition digital literacies.

| Information literacy: using digital technology to find, locate, analyze, and synthesize resources, evaluating the credibility of these resources' appropriate citation techniques, abiding the legal and ethical issues surrounding the use of these resources and formulating research questions in an accurate, effective and efficient manner. |
| --- |
| Computer literacy: an understanding of how to use computers, digital technologies, and their applications for practical use. |
| Media literacy: having the ability to use digital technologies to access, analyze, evaluate and communicate information in a variety of digital platforms. |
| Communication literacy: using digital technologies to communicate effectively as individuals and work collaboratively in groups, using publishing technologies, the Internet and Web 2.0 tools and technologies. |
| Visual literacy: having the ability to use digital technology to 'read,' interpret, and understand information presented in pictorial or graphic images communicate this information and convert the information into visual representations. |
| Technological literacy: having the ability to use digital technology to improve learning, productivity, and performance. |

Source: Reddy et al. (2020, p. 84).

effectively, create new content using this information and share and communicate this newly created information using appropriate digital technologies" (Reddy et al., 2020, p. 83). Inspired by Covello (2010), this definition comes with a useful itemization of six different sub-literacies, outlined in Table 1 below.

We therefore understand digital literacy as an umbrella concept within which the six sub-literacies are included: information literacy, computer literacy, media literacy, communication literacy, visual literacy and technological literacy. Taking into consideration this understanding of digital literacy as an umbrella concept, we have looked for academic publications that study the use of digital games to support digital literacy or any of the six sub-literacies identified by Reddy et al. (2020).

## Methodology

Based on the discussion of the defining qualities of digital literacies as discussed above, we have conducted a systematic literature review of academic papers published on the topic of digital literacy games. After initial sampling, we selected and analyzed a total of 30 papers published between the years 2005 and 2021 and stored in Scopus. Web of science was explored as a complementary database but did not result in adding additional papers to the corpus of 30.

### Literature search

As we understand digital literacy as an umbrella term in which six sub-literacies are contemplated, in our initial search of academic papers about digital literacy games, we included in our search string references to these different sub-literacies to make sure we got access to all papers written about this topic. Our search string in Scopus followed the Pico search strategy (Sayers, 2008) complemented with the advanced search options of the database. The search string that took title, abstract and keywords into account is the following:

(TITLE-ABS-KEY("Video game*" or "Game design" "Serious game*" or "Applied game*" or "Persuasive game*" or "Gamifi*" or "Educational game*" or "Board game*" or "Mobile game*" or "Game-based learning" or "Civic game*" or "Digital game*" or "Computer game*" or "Electronic game*")) AND (TITLE-ABS-KEY ("digital literacy" or "media literacy" or "digital media literacy" or "digital skills" or "computer literacy" or "itc skills" or "computing skills" or "digital competence" or "cybersecurity" or "games literacy" or "technolog* skill*" or "digital literate" or "21st-century skills" or "citizenship" or "Critical thinking" or "Computational thinking" or "Information literacy" or "Online safety" or "Fake news")))

The initial search yielded 1746 potentially eligible publications including many that were not relevant. To sort out the relevant publications in order to create a high-quality corpus, we applied the inclusion and exclusion criteria listed below:

- Inclusion criteria: (1) Qualitative or quantitative studies that report on the use of digital literacy games; (2) Written in English, Spanish, Portuguese or Dutch; (3) Academic journals, book chapters, conference papers.
- Exclusion criteria: (1) Studies that report on game jams; (2) Studies that report on co-design projects; (3) Use of games for computer programming classes; (4) Studies focused on assessing computational thinking; (5) Studies that focus on gamified contents or experiences rather than games; (6) Theoretical publications.

The search was done in March 2022 and there were no exclusion criteria in relation to the year of publication. The language inclusion criteria relate to the language proficiency of the researchers involved in the study.

After the exclusion of duplicates and papers not meeting the criteria on language and the type of publication, 1,530 publications remained. After screening the titles and abstracts of these remaining publications, we excluded another 1,322 papers based on our inclusion and exclusion criteria. We then proceeded to retrieve complete texts. In this phase a total of 60 publications could not be retrieved. We read the complete texts of the remaining 148 papers to determine their eligibility by again applying the inclusion and exclusion criteria. After this phase a total of 30 papers were selected as the final corpus for the literature review (see Figure 1) and were stored in Atlas.ti. The complete list of papers analyzed is included in Further reading.
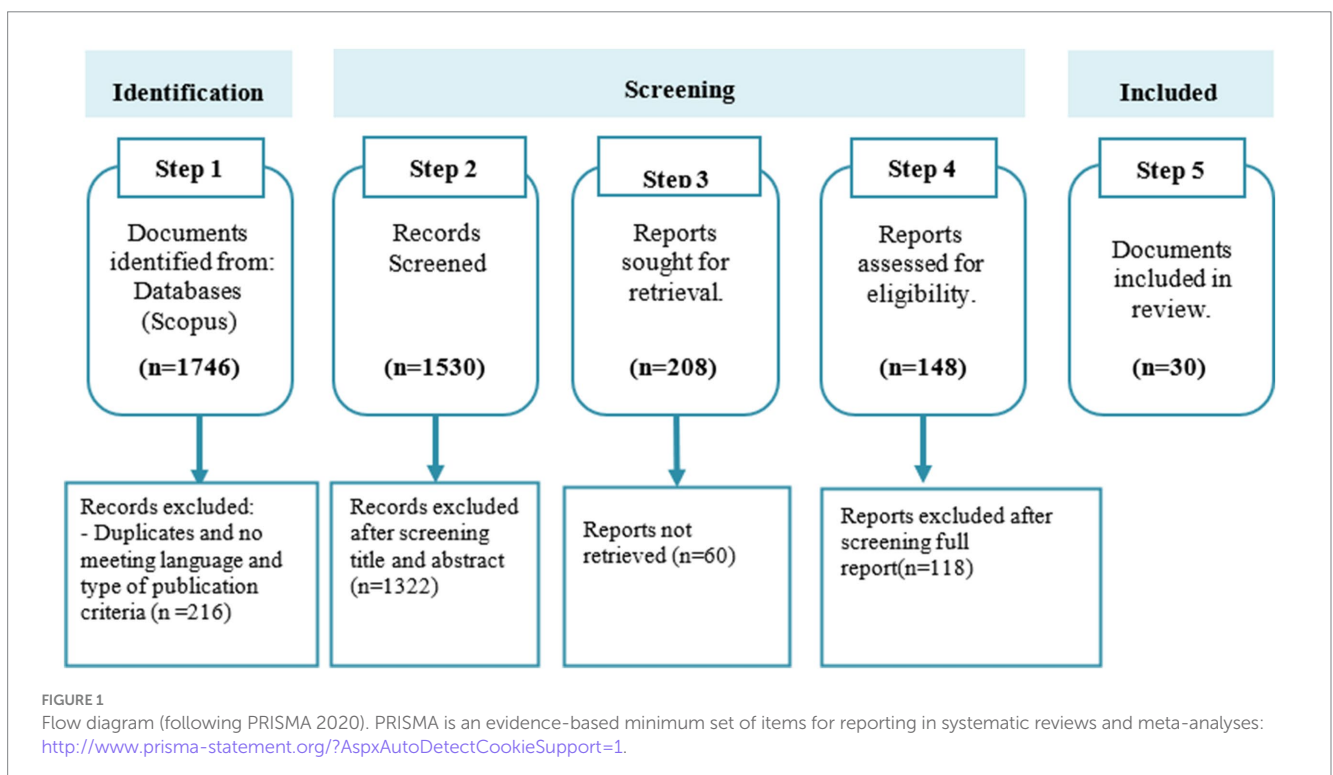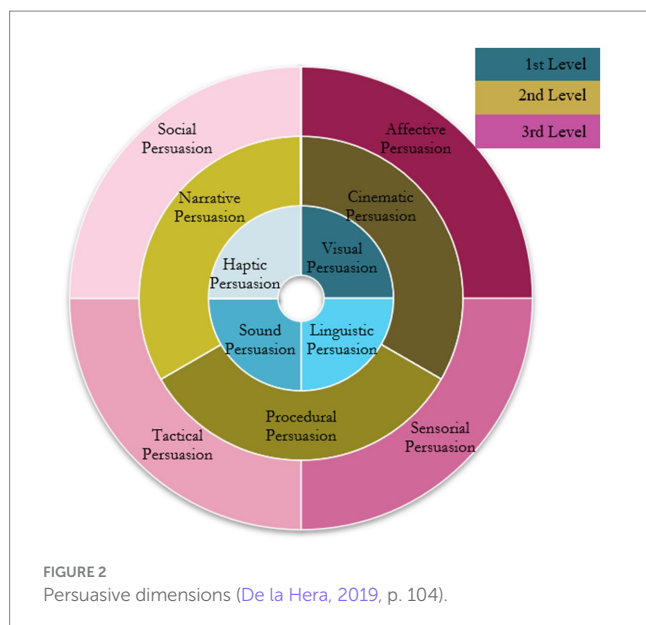
## Data analysis and operationalization

For the analysis of the content of the 30 publications in the corpus we stored them in Atlast.ti and conducted an initial superficial analysis in which we coded year of publication, target group, and topic and genre of the game(s) (following Wolf (2005) categories) used in the research and methodology of each publication. This allowed us to get a good general overview of the types of research within the dataset.

This was followed by a second coding phase in which we coded the effects of the games analyzed as reported in the publications as well as design considerations reported in the publications analyzed.

In the next step, we followed a theory-driven approach to analyze:

1. Which sub-literacies as discussed by Reddy et al. (2020) are supported by the games analyzed within the publications studied.
2. Which digital literacy competencies acquisition are supported by the games analyzed according to the publications. To choose



**FIGURE 1**
Flow diagram (following PRISMA 2020). PRISMA is an evidence-based minimum set of items for reporting in systematic reviews and meta-analyses: http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1.

FIGURE 2
Persuasive dimensions (De la Hera, 2019, p. 104).

the theoretical approach for this we analyzed recent categorizations of concepts related to digital literacy, including the DIGCOM report (de Vries et al., 2022), the DigComp2.2 (2022) framework of the European Union (Vuorikari et al., 2022), and the media competency model by the Dutch media literacy network (Netwerk Mediawijsheid, 2020). The comprehensive terminology of the latter model fitted our purposes best and we applied it to digital literacy competencies. The model distinguishes eight core competencies: to operate devices and software, to explore applications, to find information, to create, to connect, to discuss, to understand, and to reflect.

3  Which persuasive strategies are used in the design of the games analyzed according to the publications. For this purpose, we used the theoretical model proposed by De la Hera (2019). This model identifies eleven persuasive dimensions divided within three persuasive levels that can be used within digital games with persuasive purposes (see Figure 2).

4  Which game objectives are used in the design of the games analyzed according to the publications. For this purpose, we used the conceptual model proposed by Hussain et al. (2020, page 415). This conceptual model differentiates between five categories of game objectives that are commonly used in digital literacy games. These are:

a  capacity-building: skills, training, awareness and practice
b  decision-making: critical
c  engagement:  cooperation,  information  sharing, communication, coordination
d  incident management: incident response, risk management
e  testing: plans, procedures, processes, identify, preparedness and improve

In the fourth phase of the analysis, we looked for co-occurrences between the digital sub-literacies, digital literacy competencies, persuasive strategies, game objectives, target groups, game topics and game genres. The results of the analysis were divided into four sub-sections reported in the next section: (1) digital sub-literacies, (2) digital literacy competencies, (3) the effects of the games analyzed on

players' digital literacy; and (4) considerations with respect to designing digital literacy games T.

## Results

In this section we present the results of the analysis of the corpus of 30 publications. The discussion of results is divided into the four subsections as described in the previous section. In the first subsection we present the results related to the sub-literacies supported by the games analyzed within the publications studied. Next, we present the results in relation to the digital literacy competencies supported by the games that were studied in the publications. The third subsection concerns the effects of these games on digital literacy skills acquisition. Finally, we present the fourth subsection, concerned with game design considerations of digital literacy games collected from the conclusions of the publications in our corpus. All results reported in this section are based on the content of the publications in our corpus. We did not play the games ourselves to identify the digital literacies supported by the games. Rather, our results concern how the authors of the publications analyzed the digital literacy games themselves.
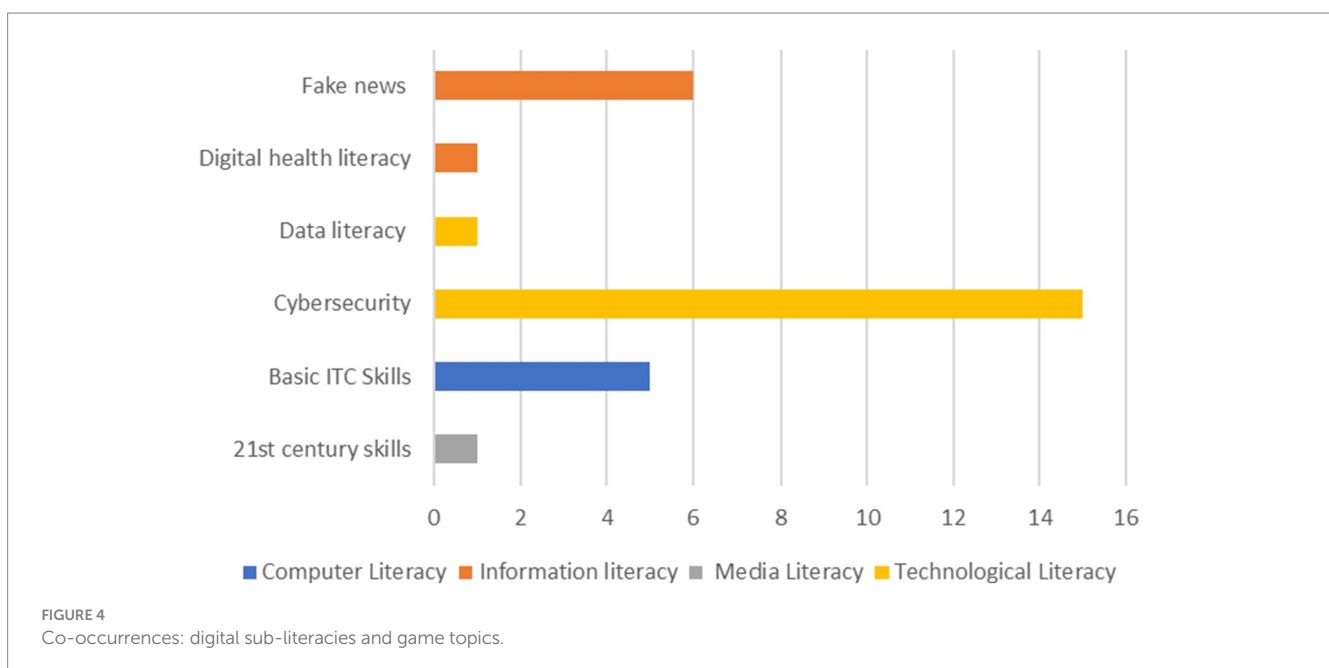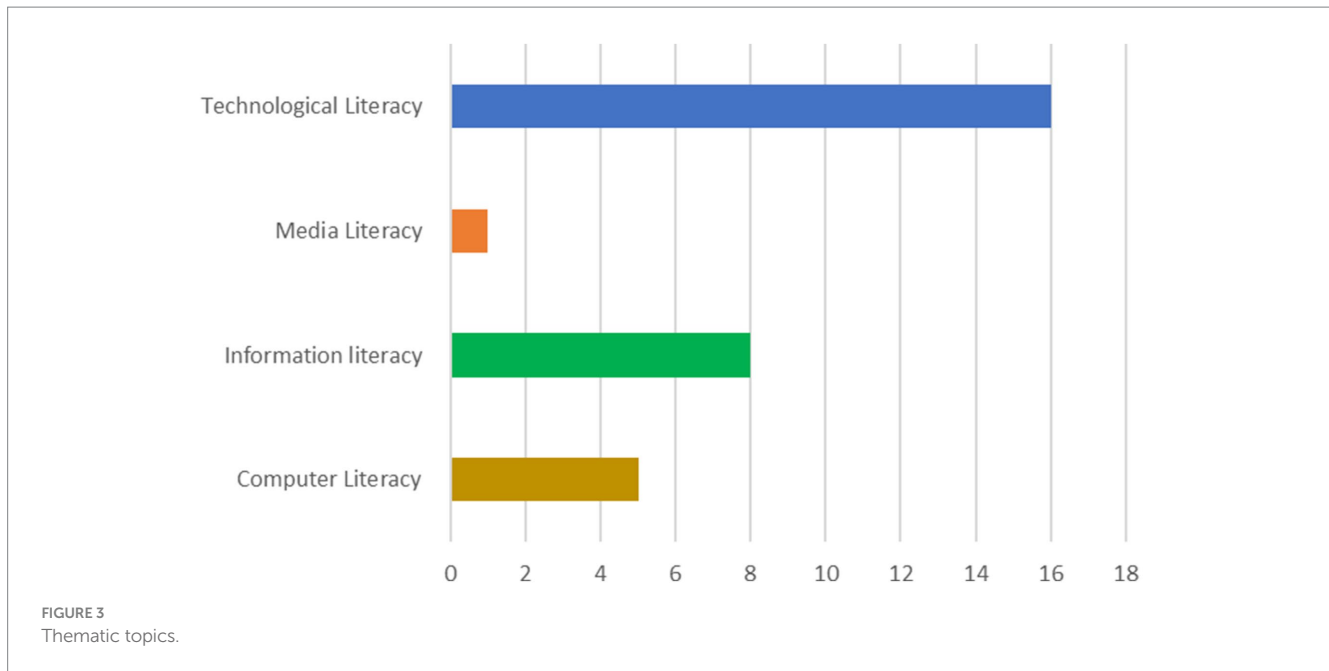
## Digital sub-literacies

When analyzing the sub-literacies supported by the games discussed within the publications studied, we noticed that a vast majority concentrate in three different sub-literacies: technological literacy (16/30), information literacy (8/30) and computer literacy (5/30) (see Figure 3). Other literacies such as media literacy or communication literacy become less relevant in the corpus. Furthermore, we did not find any publication that addresses digital literacy from a broad perspective, therefore trying to understand how digital games leverage on different sub-literacies.

### Co-occurrences: digital sub-literacies and game topics

When looking at co-occurrences between digital sub-literacies and the topics addressed, we noticed that within the sub-literacy of technological literacy the a vast majority of publications concentrate on fake news (6/8). On the other hand, within the sub-literacy of technological literacy, the vast majority of publications concentrate on cybersecurity (15/16). The academic study of digital literacy games on fake news and cybersecurity represent therefore two thirds of the publications analyzed in this study (see Figure 4 and Table 2).

### Co-occurrences: digital sub-literacies, game topics and target groups

When analyzing the co-occurrences between topics and target groups (see Figure 4) we noticed that the publication discussing the use of games in preschools and elementary schools (e.g., Salazar et al., 2013) focuses on technological literacy and in concrete on the topic of cybersecurity. For the elderly group, the use of games for supporting computer literacy, and in concrete, the acquisition of basic ICT skills is explored in two papers (Jurczyk-Romanowska et al., 2014; Blažič et al., 2018). The sub-literacy of information literacy, including fake

FIGURE 3
Thematic topics.



FIGURE 4
Co-occurrences: digital sub-literacies and game topics.

news, is dominant in studies involving high-school students (Paraschivoiu et al., 2021), university students (Pimmer et al., 2020) and adults (Jeon et al., 2021), see Figure 5.

## Co-occurrences: digital sub-literacies and game genres

It is also noticeable that studies reporting on the use of digital literacy games focus mostly on exploring the use of two game genres: simulation games and strategy role playing games (see Figure 6). In publications exploring the use of games for supporting information literacy the most common game genre is strategy role playing games (Blas, 2016; Basol et al., 2020; Gonzalez-Rodríguez et al., 2020; Literat et al., 2021; Paraschivoiu et al., 2021). Contrastingly, in studies focused

on technological literacy the most explored game genre is simulation games (e.g.: Olano et al., 2014; Jin et al., 2018; Chen et al., 2020; Abu-Amara et al., 2021). The sub-literacy that shows more variety in the type of game genre is computer literacy.

## Digital literacy competencies

The second cluster of results concerns how digital literacy games support the acquisition of digital literacy competencies. In the papers analyzed we only found mentions of four of the eight digital literacy competencies of the Dutch Media Literacy Competency Model 2021 (Netwerk Mediawijsheid,

TABLE 2 Publications per topic.

| Sub-literacies | Topics | Publications |
|---|---|---|
| Media literacy | 21st century skills | Maqsood (2018) |
| Computer literacy | Basic ICT Skills | Jurczyk-Romanowska et al. (2014), Kordaki et al. (2016), Tsalapatas et al. (2017), Blažič et al. (2018), and Pinheiro & Pinheiro (2021) |
| Technological literacy | Cybersecurity | Salazar et al. (2013), Olano et al. (2014), Giannakas et al. (2016), Usoro et al. (2016), Jin et al. (2018), Alqahtani and Kavakli-Thorne (2020), Chen et al. (2020), Hussain et al. (2020), Kido et al. (2020), Thornton and Turley (2020), Abu-Amara et al. (2021), Allers et al. (2021), Gordillo et al. (2021), and Maqsood and Chiasson (2021) |
| | Data Literacy | Diez & Melcer (2020) |
| Information literacy | Health Information Literacy | Gonzalez-Rodríguez et al. (2020) |
| | Fake News | Blas (2016), Urban et al. (2018), Basol et al. (2020), Pimmer et al. (2020), Jeon et al. (2021), Literat et al. (2021), and Paraschivoiu et al. (2021) |



FIGURE 5
Co-occurrences between sub-literacies and target groups.
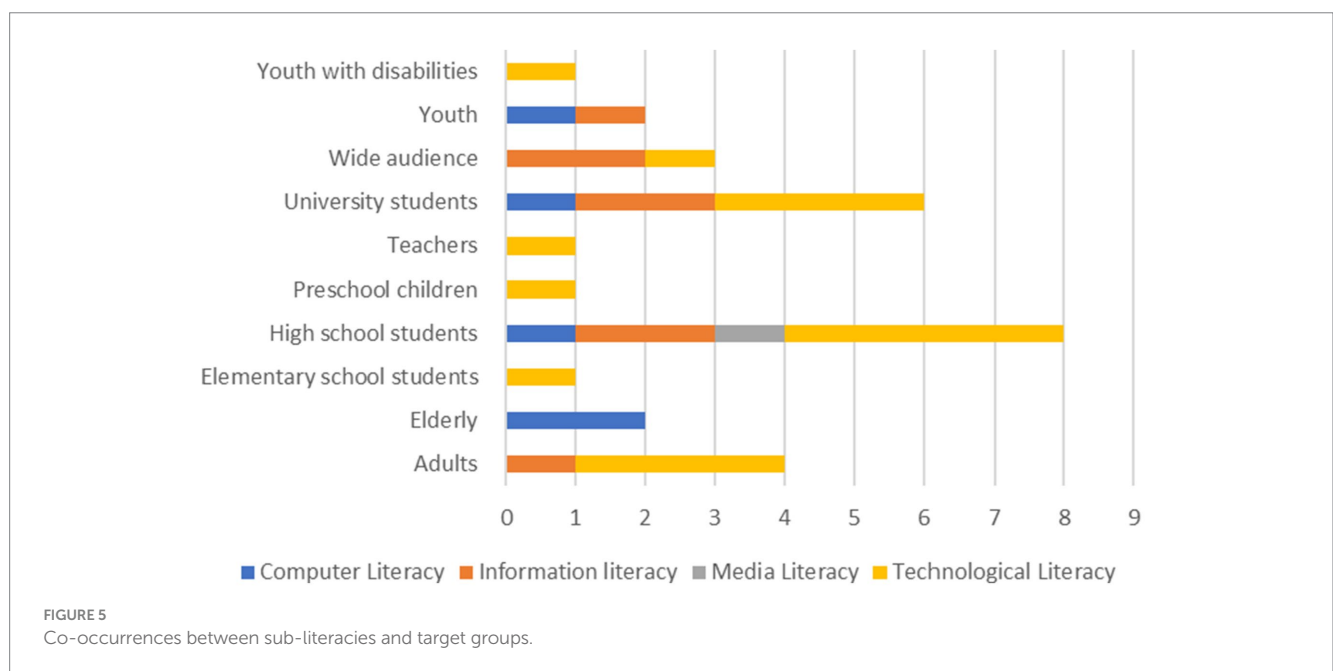
2020). In concrete the most frequently discussed competency in the corpus was *understanding media* (18/30) followed by *reflect on media usage* (15/30). This means that the publications focused mostly on exploring the capacity of these digital literacy games to help players better understand media and media usage and reflect on it, rather than exploring their potential to promote behavioral change. In our corpus we did not find any publication exploring the potential of these games in fostering the competencies of "create with media" or "connect through media" (Figure 7).
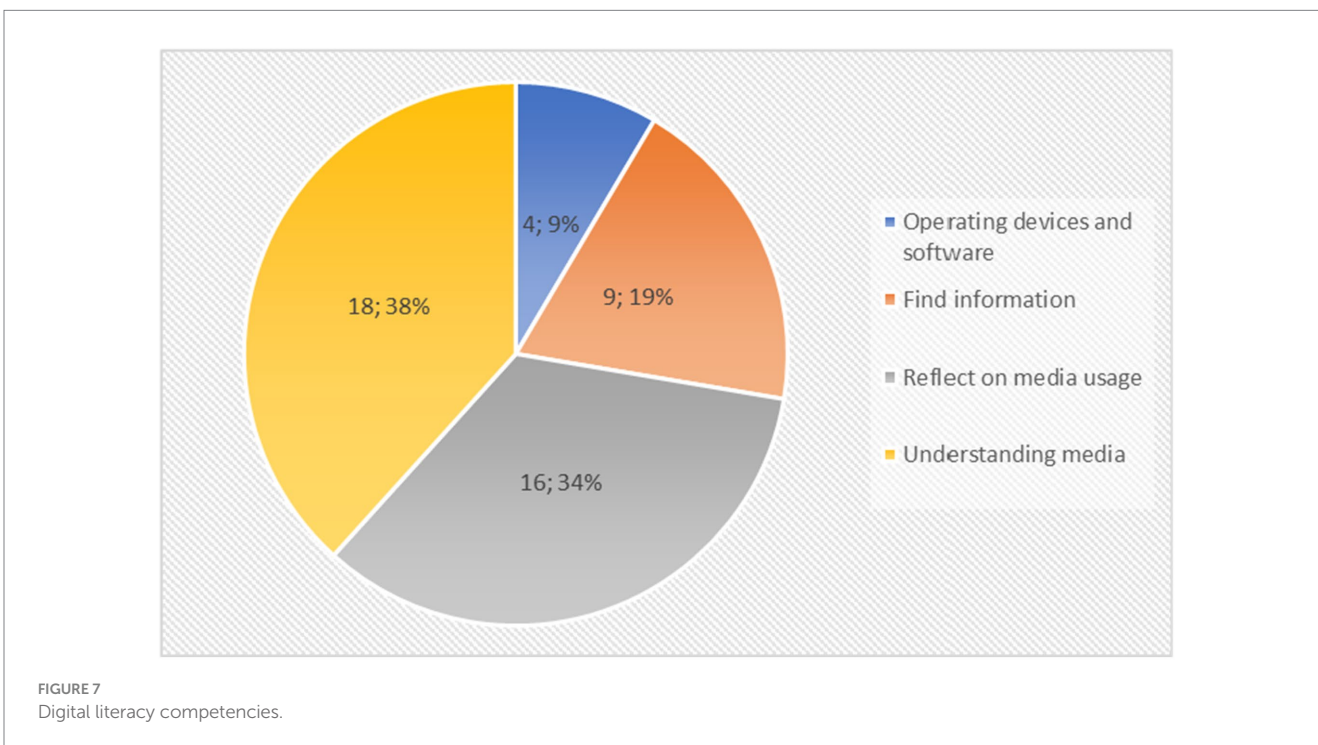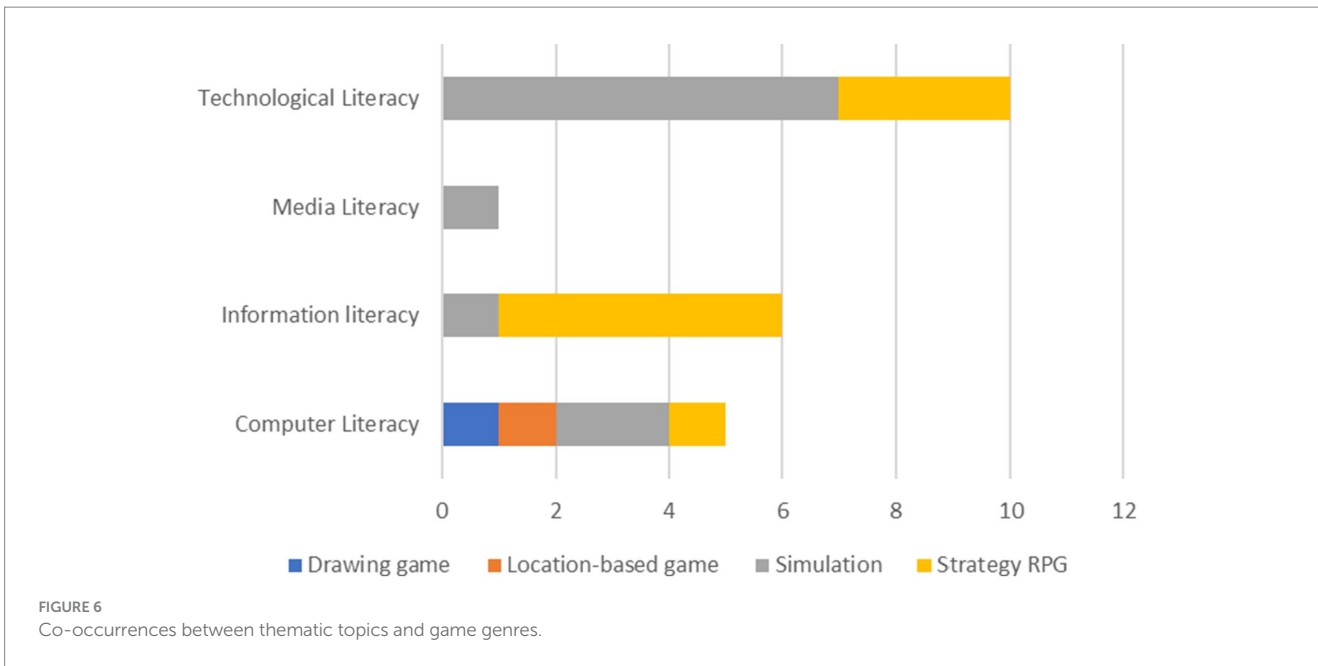
## Co-occurrences: digital literacy competencies and sub-literacies

When we identified co-occurrences between the digital sub-literacies covered by the games analyzed in the publications, in relation to how the publications discuss the different digital literacy competencies supported by the games, we see that the competency of *find information* is linked to those games related to information literacy, while games on technological literacy are studied in relation to their capacity to foster the ability of players to understand media and reflect about media. The study of the capacity of digital literacy games to support the ability of players to *operate devices and software*, coincides with games designed to support computer literacy (see Figure 8).

## Co-occurrences: digital literacy competencies and game objectives

When we looked, however, into the game objectives as discussed in the publications in our corpus we concluded that there is potential: the games are able to support more competencies than the ones reported in the publications. For example, those studies that explore the capacity of these games to foster players' media understanding, report also that the games discussed do have game objectives that go beyond capacity building and testing knowledge, referring to game objectives related to decision-making and incident management. While this was not tested in the publications themselves, this suggests that these games might also foster competencies such as "explore applications" and "operate devices and software." Contrastingly, those studies that explore the capacity of

**FIGURE 6**
Co-occurrences between thematic topics and game genres.



**FIGURE 7**
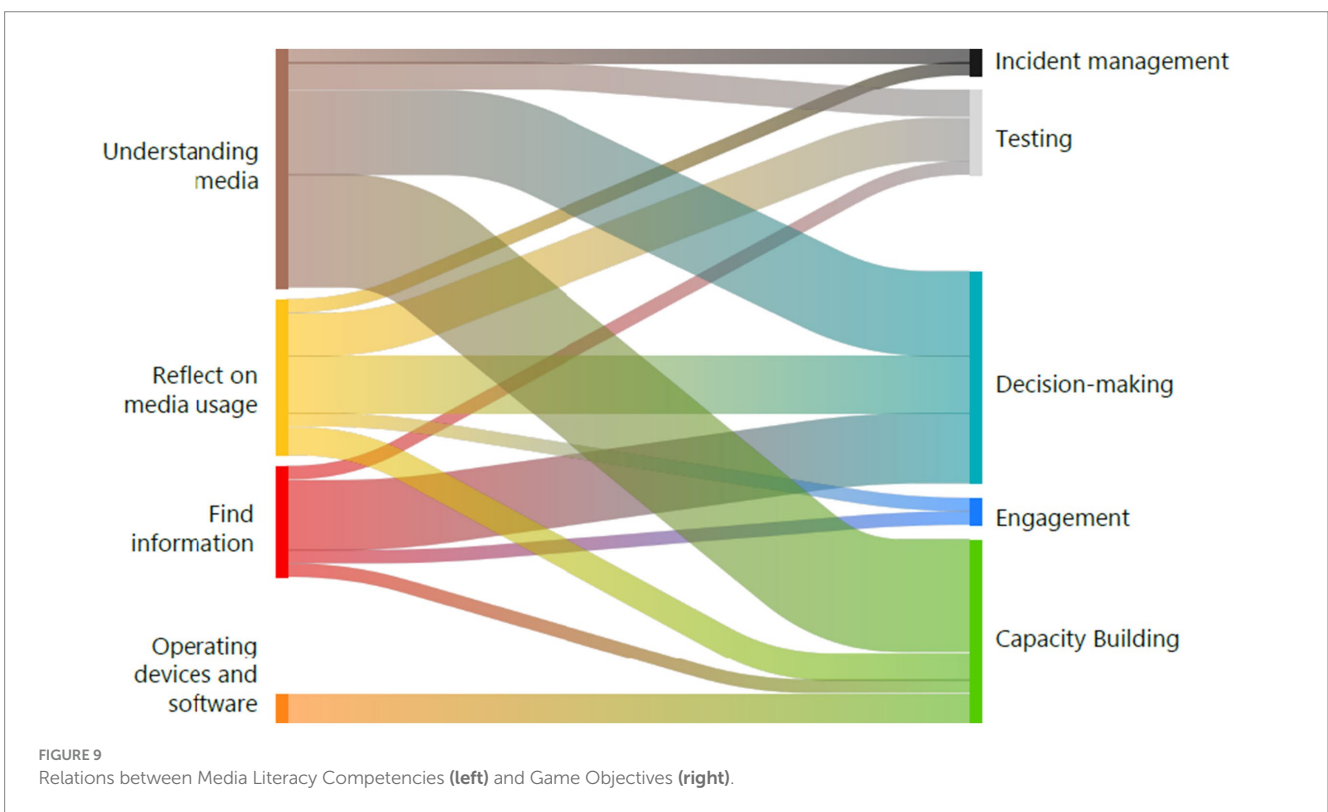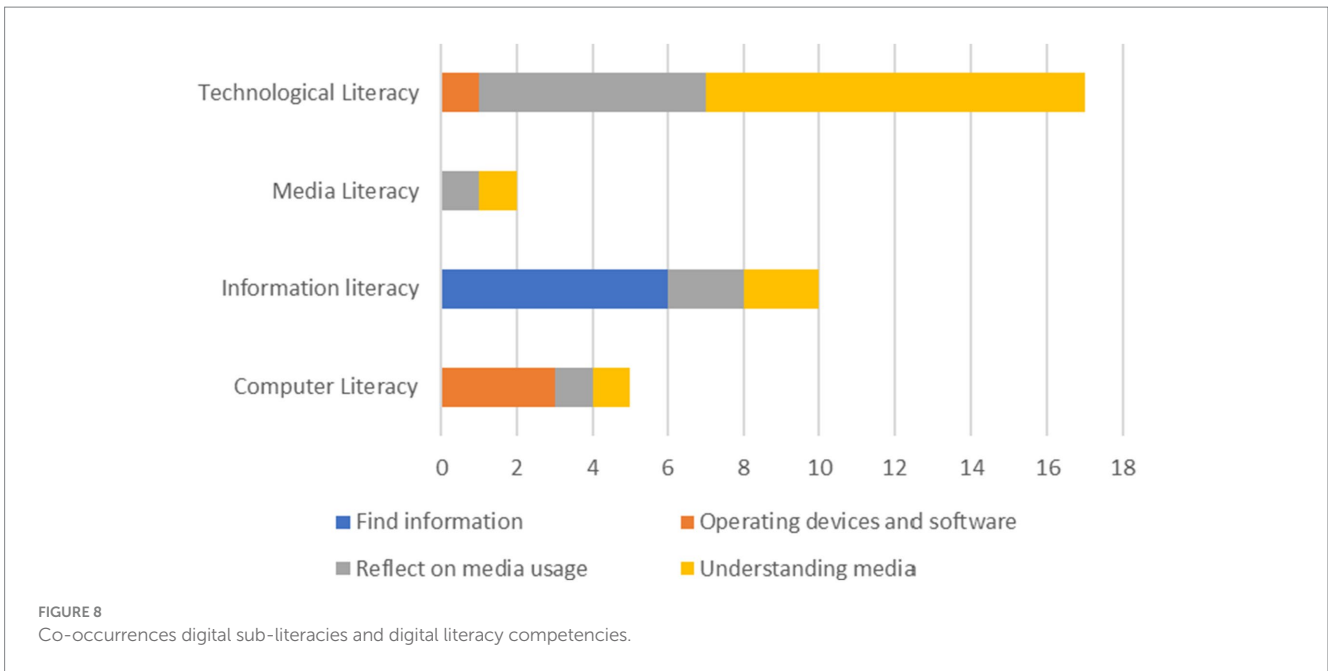Digital literacy competencies.

games to foster the competency of operating devices and software use games whose objectives are just linked to capacity building, and do not include game objectives that allow the player to for example test the knowledge acquired (see Figure 9).

## Co-occurrences: digital literacy competencies and persuasive strategies

Despite the different game genres, there was no major difference in the persuasive strategies included in the games that were analyzed in the publications. Figure 10 shows that all games use a combination of narrative, procedural, visual and textual persuasion, regardless of the

game's genre and regardless of the digital literacy competency they aim to support. Just in one case there is a reference to the use of cinematic persuasion as a strategy to foster digital literacy competencies, as an extra strategy used in combination with the other four. The use of persuasive dimensions such as haptic persuasion, sound persuasion, social persuasion, sensorial persuasion, or affective persuasion cannot be inferred from the description of the games and the strategies used in the papers analyzed. This does not mean that the games do not use at all any of these persuasive dimensions, but if they do, the dimensions have not been designed and analyzed on purpose within the studies discussed in the papers of the sample.

FIGURE 8
Co-occurrences digital sub-literacies and digital literacy competencies.



FIGURE 9
Relations between Media Literacy Competencies **(left)** and Game Objectives **(right)**.

## Effects

The third cluster of results reports whether the publications using in our corpus reporting on quantitative experimental studies discuss the effects of the digital literacy games (see Table 3).

### Co-occurrences: effects and game objectives

Figure 11 shows the co-occurrences between the use of specific game objectives and the reported positive effects. Game objectives that include decision-making and capacity building are related to, in both cases, seven out of the eight positive effects reported on the use of digital literacy games. Game objectives that allow players to test their knowledge have been also reported to be connected to increased self-awareness, increased behavioral intent and improved self-efficacy. The strategy of incident management has also shown to have a positive effect on players' self-awareness.

Other studies have reported that games that included the strategy of decision-making did not have significant effects on the ability to
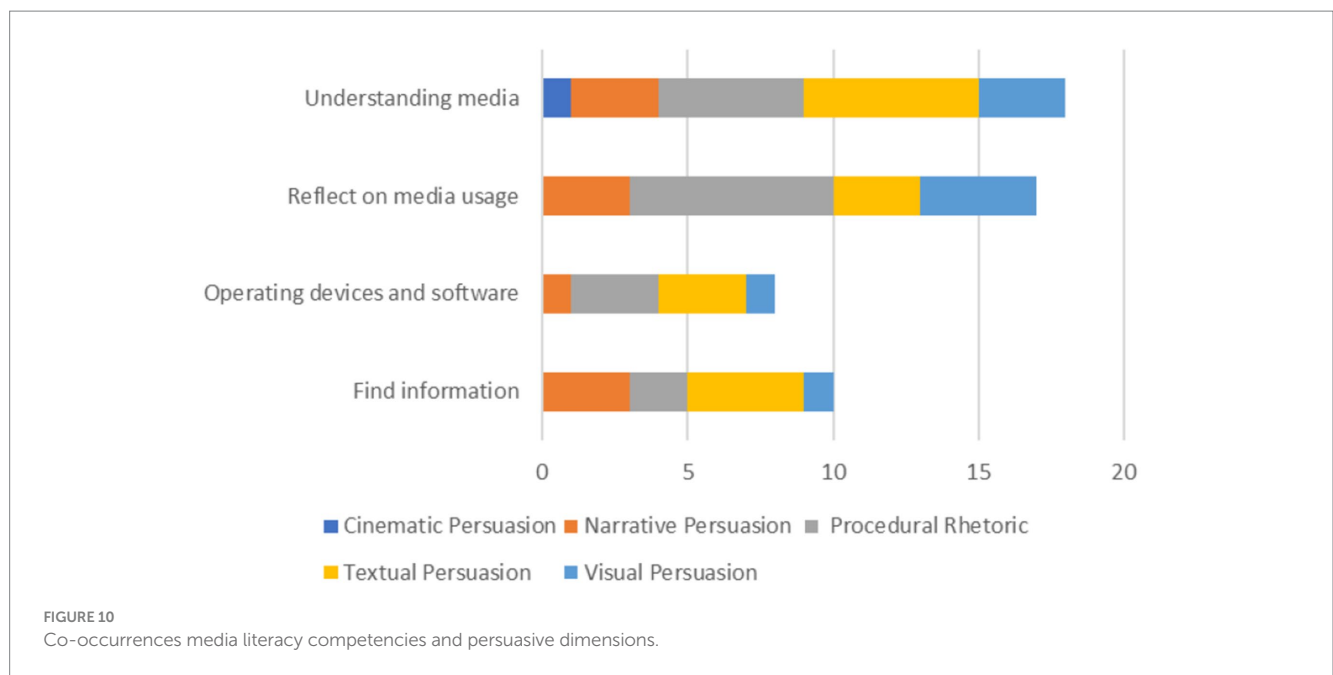
FIGURE 10
Co-occurrences media literacy competencies and persuasive dimensions.

TABLE 3 Publications per reported effects.

| Effects | Publications |
| --- | --- |
| No significant effect on ability to transfer knowledge | Pimmer et al. (2020) |
| No significant effects on knowledge acquisition | Paraschivoiu et al. (2021) |
| Not motivating for learning | Gordillo et al. (2021) |
| Decreases confidence in technology | Salazar et al. (2013) |
| Facilitates understanding of abstract concepts | Kordaki et al. (2016) and Diez and Melcer (2020) |
| Improved self efficacy | Alqahtani and Kavakli -Thorne (2020), Basol et al. (2020), and Chen et al. (2020) |
| Increases ability to transfer knowledge | Tsalapatas et al. (2017), Jin et al. (2018), Pimmer et al. (2020), Thornton and Turley (2020), and Pinheiro and Pinheiro (2021) |
| Increases assimilation of knowledge | Jurczyk-Romanowska et al. (2014), Giannakas et al. (2016), Tsalapatas et al. (2017), Alqahtani and Kavakli -Thorne (2020), Maqsood and Chiasson (2021) |
| Increases behavioral intent | Olano et al. (2014), Jeon et al. (2021), and Maqsood and Chiasson (2021) |
| Increases Self-awareness | Salazar et al. (2013), Jin et al. (2018), Alqahtani and Kavakli -Thorne (2020), Thornton and Turley (2020), Abu-Amara et al. (2021), and Jeon et al. (2021) |
| Increases Self-reliability | Jurczyk-Romanowska et al. (2014), Basol et al. (2020), Chen et al. (2020) |
| Learning becomes more enjoyable | Usoro et al. (2016) |

transfer knowledge (Pimmer et al., 2020) and have contributed to a decreased confidence in technology (Salazar et al., 2013). The decrease in confidence in technology has been reported also in relation to games using incident management and capacity building strategies (Salazar et al., 2013).

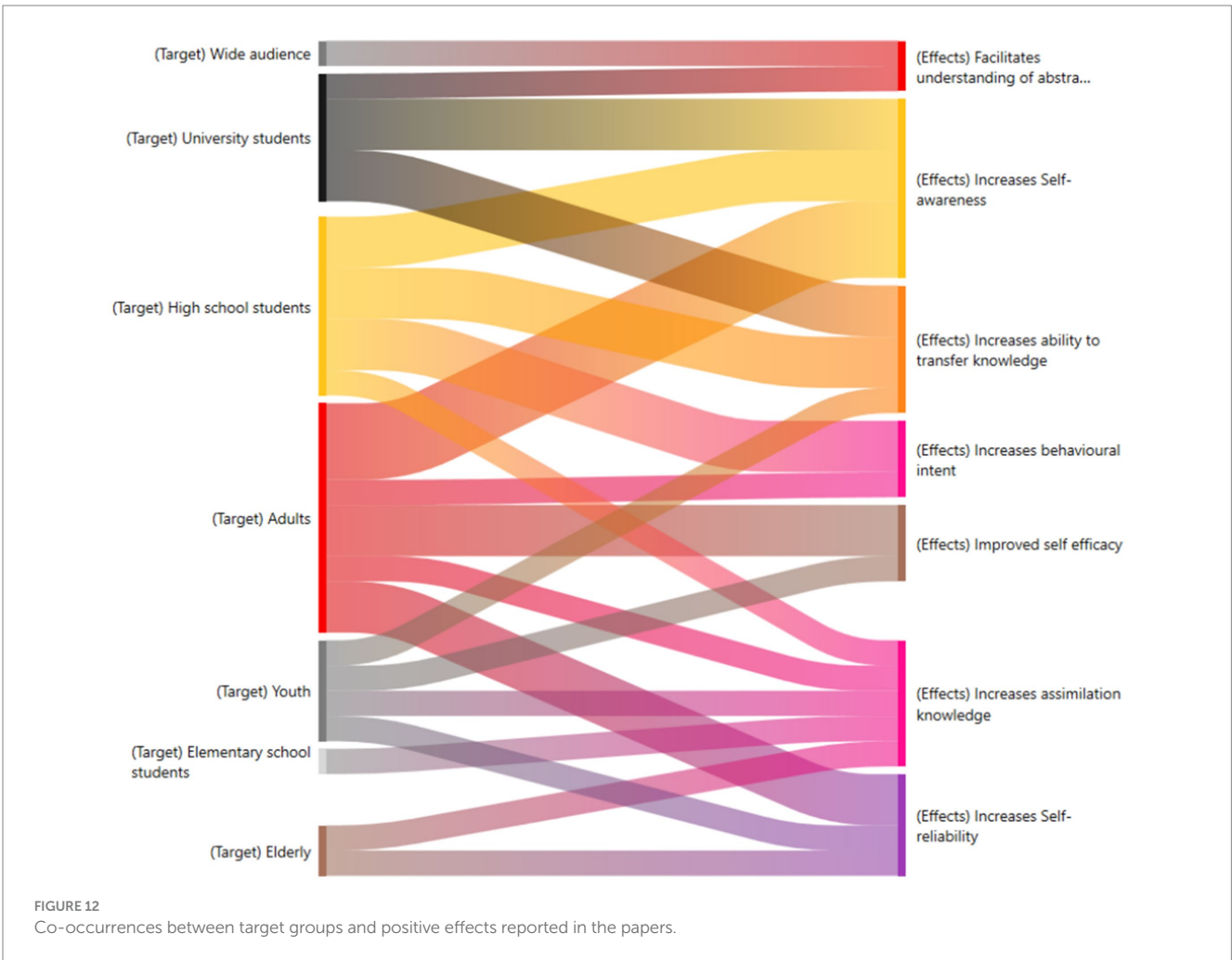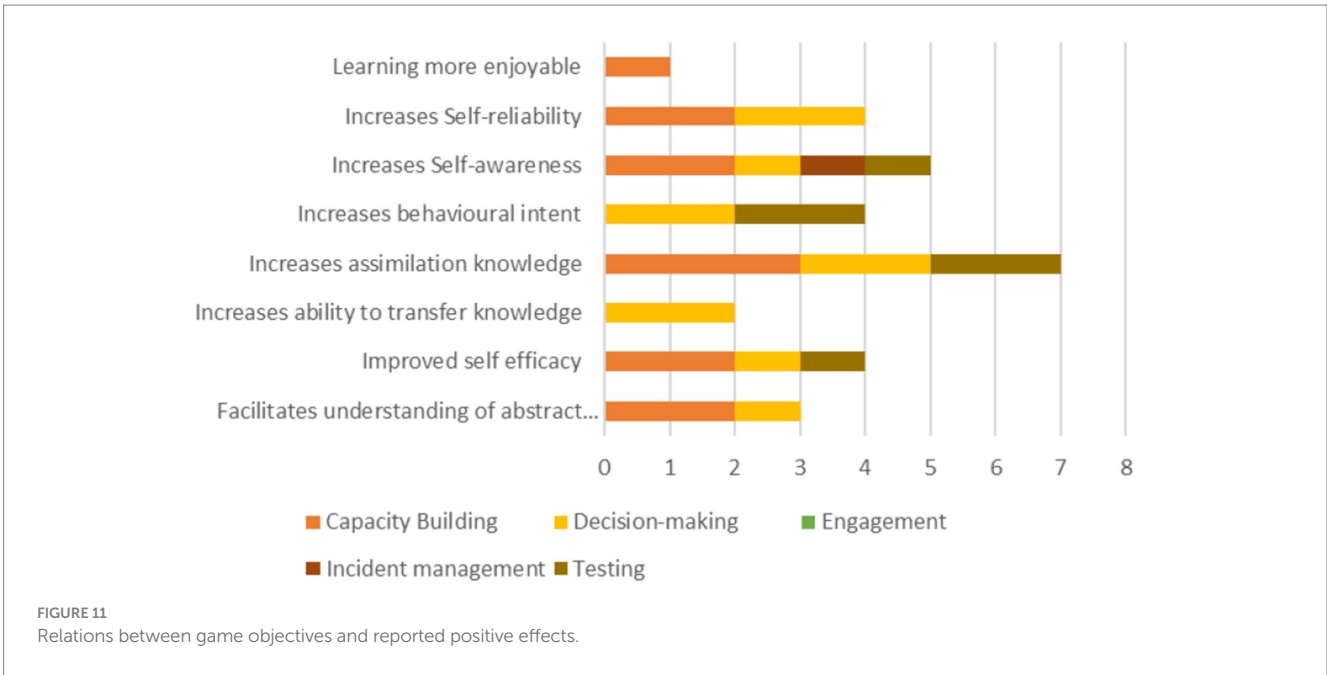## Co-occurrences: effects and target groups

Figure 12 on the target groups, showing the co-occurrences between target groups and the effects reported. Most positive effects are reported for the group of adults. The group of high school students also benefits from the use of digital literacy games, although for this group two studies

have also reported no significant effect on knowledge acquisition (Paraschivoiu et al., 2021) and a decrease in confidence in technology (Salazar et al., 2013). One paper reported that for teachers the game used in that study was not motivating for learning (Gordillo et al., 2021).

## Considerations for the design of digital literacy games

This fourth theme discusses game design considerations collected from the conclusions of the publications in our corpus. These game

FIGURE 11
Relations between game objectives and reported positive effects.



FIGURE 12
Co-occurrences between target groups and positive effects reported in the papers.

design considerations are proposed in publications that found a clear link between design aspects and positive effects of the game used in the research. In analyzing the publications, we found ten game design considerations that are discussed next.

## Visualization

The first design consideration is the use of visualizations to support understanding of abstract concepts. The study conducted by Diez and Melcer (2020) found that visualization is a powerful design resource to facilitate the understanding of abstract concepts in digital literacy games. In their study conducted on the purposely developed serious game *Cookie Mania*, the visual representation of cookies in the game has been used to help players understand the meaning of this abstract concept. The authors claim that the results of their study suggests that visual representation is an effective design approach to support assimilation of knowledge.

## Realism

The second design consideration is to use realistic simulations and representations. On the one hand, two papers found that realistic simulations played a significant role in identification of the player with the game character (Urban et al., 2018; Pinheiro and Pinheiro, 2021). On the other hand, it was found that familiarity with situations in the game and available resources to be used favor assimilation of knowledge and critical thinking (Pinheiro and Pinheiro, 2021).

## Scalability

The third design consideration is to allow scalability to leave room to new developments. Digital literacy is intrinsically connected to technological developments. For this reason, digital literacy games may become easily outdated. For this reason, Kido et al. (2020) found that designing games that use a flexible game design that allows scalability is an effective solution to ensure they can be adapted to new developments.

## Ethical decision-making

The fourth design consideration is to implement ethical decision-making to increase player motivation. It was found that implementing moments in the game in which players need to take decisions that involve ethical considerations foster further investment and care of players towards the game narrative (Diez and Melcer, 2020).

## Scenario injects

The fifth design consideration is to use scenario injects to challenge decision-making. Scenario injects (including time pressure, escalation, reputation and resource allocation) trigger critical thinking when players are expected to make decisions within the game (Hussain et al., 2020). This can be used in combination with ethical decision-making as discussed in the previous point.

## Diverse play or personalization

The sixth design consideration is to allow personalization to adapt to different player profiles. Two studies in the sample show that the effectiveness of digital literacy games seems to be mediated by players' previous knowledge (Diez and Melcer, 2020; Maqsood and Chiasson, 2021). These studies have also demonstrated that games that allow personalization and facilitate diverse play better adapt to different player profiles.

## Agency

The seventh design consideration is to give agency to players to favor transferability of knowledge. Pimmer and colleagues have conducted a study that shows that taking a constructionist learning approach where users create and not just select plays a role in transferability of knowledge (Pimmer et al., 2020).

## Facilitate review and debriefing

The eighth design consideration is to facilitate review and debriefing to foster critical thinking. Results of the study conducted by Maqsood and Chiasson (2021) show that games that promote discussion among players and facilitate a debriefing moment are successful in promoting critical thinking. Literat et al. (2021) also claim that the social aspect of the debriefing moment has a significant role in the effectiveness of digital literacy games.

## Testing knowledge

The ninth design consideration is to allow players to test their knowledge to foster self-reliability. The study conducted by Pinheiro and Girao has shown that to move from knowledge acquisition to transferability of knowledge it is important to foster self-reliability. According to the results of their study, allowing players to test their acquired knowledge within the game has an important role in fostering self-reliability.

## Quick and poignant feedback

The tenth design consideration is that in order to be effective, feedback within digital literacy games needs to be quick and poignant. A study conducted by Paraschivoiu et al. (2021) has shown that feedback, although relevant, is less important in the effectiveness of digital literacy games than other factors such as clear goals and challenge-skill balance. Urban et al. (2018) suggest, however, that providing quicker and more poignant feedback makes it more relevant for players.

# Conclusion

The purpose of this paper was to provide an overview of the state of the art of the academic study of digital literacy games. For this purpose, we have conducted a systematic literature review of 30 papers published between the years 2005 and 2021 and stored in scopus.

The results of this literature review show that more than two thirds of the publications on digital literacy games focus on three sub-literacies (technological literacy, information literacy and computer literacy). Papers on technological literacy deal with topics such as privacy and cybercrime. While most of the publications on information literacy are about fake news. We can conclude therefore that literature on digital literacy games has been focused on investigating the potential of digital games to support players in dealing with the most prominent threats brought by the penetration of the internet and the evolution of the digital society (United Nations, 2019). It would be relevant for future studies to pay more attention to how digital literacy games could support the opportunities of digital technologies, instead of just focusing on how to deal with the threats.

The results also show that previous studies on the topic of digital literacy games have concentrated on the study of the feasibility of the

use of these games for highschool students, university students and adults. Studies on preschool and elementary school children are scarce, although they seem to be among the most relevant target groups for this type of games. The reason behind this is probably linked to the ethical challenges linked to the study of younger children. It would be however relevant to fill this gap in future studies.

This study has also provided relevant insights through the analysis of co-occurrences between the digital literacy competencies that the games within the studies analyzed aimed to support, and the persuasive dimensions and game objectives used in these games. The analysis shows that in some cases the description of game objectives used in the games suggest that the games might be supporting digital literacy competencies that differ or complement the ones described by the authors of the papers. Furthermore, in many cases there are no coherent or thoroughly thought decisions for using specific game objectives or persuasive dimensions considering the digital literacy competencies studied.

One of the most relevant contributions of the study is a list of digital literacy game design recommendations compiled through the analysis of the conclusions of all the publications in the sample. These game design recommendations are of special value for future projects.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

## Author contributions

## Funding

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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