Predisposition of In-Service Teachers to Use Game-Based Pedagogy

Sonia Palha[1] and Ljerka Jukić Matić[2]
[1]Faculty of Education, Amsterdam University of Applied Sciences, The Netherlands
[2]Department of Mathematics, University of Osijek, Croatia

s.abrantes.garcez.palha@hva.nl
ljukic@mathos.hr

Abstract. Digital game-based learning (DGBL) can be regarded as a promising teaching pedagogy to prepare students for challenges of the 21st century. However, the incorporation of digital games into K-12 curricula remains limited. Research suggests that a comprehensive understanding of barriers and motivational factors that teachers face when implementing DGBL is needed to ensure that teachers can receive the support required. To delineate suggestions for tailored curricula on game-based pedagogy in teacher education programs, we conducted a study to gain insight into in-service teachers' perception of DGBL in relation to their previous experience in teaching with DGBL. To achieve our goal, we examined the factors that impede and promote the implementation of DGBL among in-service teachers who are presently pursuing master's level education programs, having in mind that this group of teachers is different from pre-service teachers. Data was collected using an online survey with open- and closed-ended questions. The sample consisted of in-service teachers (n=37) who were enrolled in a master's course in math education. The data analysis conducted was of a qualitative nature. One significant finding derived from this study is that the level of pedagogical experience in utilizing games as a teaching tool appears to be a crucial factor in understanding the inclination of in-service teachers towards game-based pedagogy. Pedagogical factors were mentioned by teachers at all stages of experience with DGBL, and differences were observed between teachers at different stages. For instance, in-service teachers with experience with DGBL (intermediate and advanced stages) were concerned about being able to maintain focus on the math concepts, the need to adapt the game lesson to students, and the ways to evaluate student learning less experienced teachers were essentially concerned about ways to control the classroom during DGBL and whether the pupils would receive adequate practice in this learning mode. Differences were also noted for other factors between teachers at different stages. Advanced stage teachers did have concerns about game appropriateness for the intended learning; teachers with less experience were concerned about the lack of games (technical factors). Dealing with an existing curriculum and high workload were common aspects for teachers with no or some experience but only teachers with some experience mentioned obstacles related to school organization (structural factors). Teachers with few and some experience referred to the lack of knowledge and competence (personal factors) and that pupils would not take the lessons with games seriously (social factors). This research supports DGBL-practice (i) by adding new knowledge on the factors that can support or constrain the integration of DGBL and its implications for the development of curricula on game-based pedagogy; (ii) by providing suggestions to design and implement meaningful curricula on digital game-based pedagogy for teaching education and training programs.

Keywords: Game-based pedagogy, Digital game-based learning (DGBL), Teacher education, In-service teachers, Teachers' perceptions of DGBL, 21st Century

1. Introduction

Digital game-based learning (DGBL) is a pedagogical approach employed in educational contexts, wherein digital games are utilized to effectively attain specific learning outcomes. These outcomes encompass knowledge acquisition, skill cultivation, and attitude formation (Hussein et al., 2022). Currently, many teachers employ digital games and incorporate game elements within their instructional practices. According to An and Cao (2016), digital games have the potential to enhance the cultivation of higher-order thinking abilities and 21st-century skills while also increasing the overall enjoyment of the learning process. Digital games can facilitate experiential learning and the acquisition of practical skills that can be applied in real-life situations. This surpasses the conventional instructional methods that tend to prioritize rote memorization (An and Bonk, 2009; Siew, 2018). From this standpoint, DGBL can be perceived as a potentially effective instructional approach aimed at equipping students with the necessary skills and knowledge to tackle the complexities and demands of the contemporary era.

Teachers' attitudes toward new teaching methods such as DGBL contribute to their subsequent implementation and influence students' learning motivation (Martín-del-Pozo, García-Valcárcel, & Hernández Martín, 2019) Games and DGBL can only be effective in K-12 education if teachers and students view them as valuable teaching and learning tools (Bourgonjon et al., 2010). So far, the incorporation of digital games into K-12 curricula remains limited (Hébert and Jensen, 2019; Takeuchi and Vaala, 2014). In some cases, teachers use informal means to acquire knowledge on ways to teach with digital games, for example through trial and error or seeking ideas from peers (Takeuchi and Vaala, 2014). Professional development opportunities that guide teachers in the systematic use of games for teaching, learning, and assessment are lacking (Jukić Matić, Karavakou and Grizioti,

Reference this paper: Palha, S. and Matić, L.J. 2023. Predisposition of In-Service Teachers to Use Game-Based Pedagogy, The Electronic Journal of e-Learning, 21(4), pp 286-298, available online at www.ejel.org

2023; Martin-del-Pozo et al., 2019; Spiteri and Chang Rundgren, 2020). Further, in cases in which professional development initiatives consider game use, they rarely address pedagogy for teaching with DGBL (Hébert and Jensen, 2019). From a pedagogical perspective, this poses a considerable problem because teachers play a key role in designing and delivering learning content that supports DGBL, including customizing content to meet different learners' needs.

Teacher education in game-based pedagogy is burgeoning. Teacher education programs and higher education can play a more active role in its growth (Nousiainen et al., 2018), such as through developing game-based pedagogy curricula or by using DGBL in teaching (Foster and Shah, 2020). Equipping teachers with specific knowledge regarding the pedagogical activities involved in teaching with games is necessary because it requires knowledge and competence that is not intuitive for most teachers (Nousiainen et al., 2018). To develop curricula and professional development opportunities that can be effectively applied in higher education, a more in-depth understanding of in-service teachers' needs is required, along with the pedagogical knowledge and skills necessary for effective DGBL use. Hébert and Jensen (2019) note that a comprehensive understanding of barriers that teachers face when implementing DGBL is 'important for ensuring not only that the benefits of DGBL are translated into practice, but that teachers receive the support required to make DGBL a possibility within their classrooms' (p. 308). In this perspective, for teacher education and training programs to design meaningful curricula for game-based pedagogy that meets (prospective) teachers' needs, it is essential to understand what these needs are.

The aim of this research is to gain insight into in-service teachers' perception of DGBL in relation to their previous experience teaching with DGBL. The hypothesis in this study is that in-service teachers with less or more DGBL experience will view DGBL implementation differently and will have different concerns regarding aspects of the learning environment. Understanding the concerns and the factors that encourage and hinder them can provide valuable input for developing a meaningful curriculum. Thus, the following research questions were formulated:

RQ1: What factors hinder and encourage in-service teachers with different game-based pedagogical experiences to adopt DGBL?

RQ2: How can this knowledge be used for the development of game-based pedagogy curricula in teacher education?

2. Theoretical Background

2.1 Teacher's Predisposition to use DGBL in Practice

DGBL in mathematics education is the use of digital games within the context of learning mathematics (Byun and Joung, 2018). DGBL can also be defined in a broader way, as an approach in which educational objectives and tasks are integrated into gaming activities with the aim of motivating students to learn in an enjoyable and interactive learning environment (Hussein et al., 2022; Prensky, 2001). In this study, DGBL was used in the broader sense as this better fits the way it is used in secondary mathematics education.

Teachers' perceptions and motivational factors regarding the integration of DGBL into their instruction have been examined in relatively few studies (Hayak and Avidov-Ungar, 2020). Several factors influence a teacher's predisposition to use DGBL. Its perceived usefulness is a significant determinant of teachers' attitudes toward it. Specifically, when teachers perceive DGBL to be highly useful, their attitudes toward digital games tend to be more positive (Sánchez-Mena, Martí-Parreño, & Aldás-Manzano, 2017). The limited availability of curriculum-aligned games is an obstacle that teachers identify as impeding DGBL implementation in the classroom (Takeuchi and Vaala, 2014). Other factors that hinder digital game adoption include rigid curricula, fixed class schedules, and short lesson duration (An and Cao, 2016; Baek, 2008; Kaimara et al., 2021). The lack of financial resources is also a barrier for DGBL; teachers are unable to afford high-quality educational games and appropriate classroom technology (Baek, 2008; Jukić Matić, Karavakou and Grizioti, 2023; Kaimara et al., 2021). Despite that many students own smartphones, not all educational games are compatible with them.

A teacher's personal beliefs and experience can be both a motivating and a demotivating factor in using DGBL. The teachers' anxiety can be a barrier to DGBL adoption. According to a literature review, teachers are concerned about students becoming addicted to gaming through classroom game use and about the violence in digital games (Baek, 2008; Easterling, 2021; Ince and Demirbilek, 2013). This relates to the perceived negative side effects of classroom gaming that could lead to excessive competition and a lack of classroom control.

Teachers' pedagogical experiences have also influenced their DGBL use. Hayak and Avidov-Ungar (2020) found that teachers with more teaching experience (in the advanced career stage) implemented DGBL using more

meaningful methods and inquiry-based, collaborative learning as well as the flipped classroom strategy. Teachers with less teaching experience (in their early careers) used DGBL in a more limited way, as a pedagogical tool to help students internalize and review the material. In contrast, Hsu et al. (2017) found that teachers with less than 10 years of experience were more proficient in integrating DGBL in their instruction, were more motivated to do so, and had a better understanding of DGBL-related content and pedagogy than their more experienced counterparts. These contradictory outcomes may be partially attributed to educational policy's role as an influential variable. In countries where educational policies are aligned with aspirations for fostering innovation in schools in general and digital games in particular, there exists a well-defined set of objectives for attaining digital proficiency that are widely recognized and supported by key stakeholders. This suggests that teacher education colleges and universities are already providing training on incorporating technology into educational practices, including digital games (Avidov-Ungar and Hayak, 2023). With no policy, implementation is likely only carried out by experienced and/or enthusiastic teachers, leaving beginning teachers to struggle with enforcing classroom discipline.

2.2 Five Categories of Factors

Hayak and Avidov-Ungar (2020) examined teachers' perceptions regarding the integration of DGBL in their instruction, and five categories of factors emerged from their data: pedagogical, structural, personal, technical, and social (Figure 1).

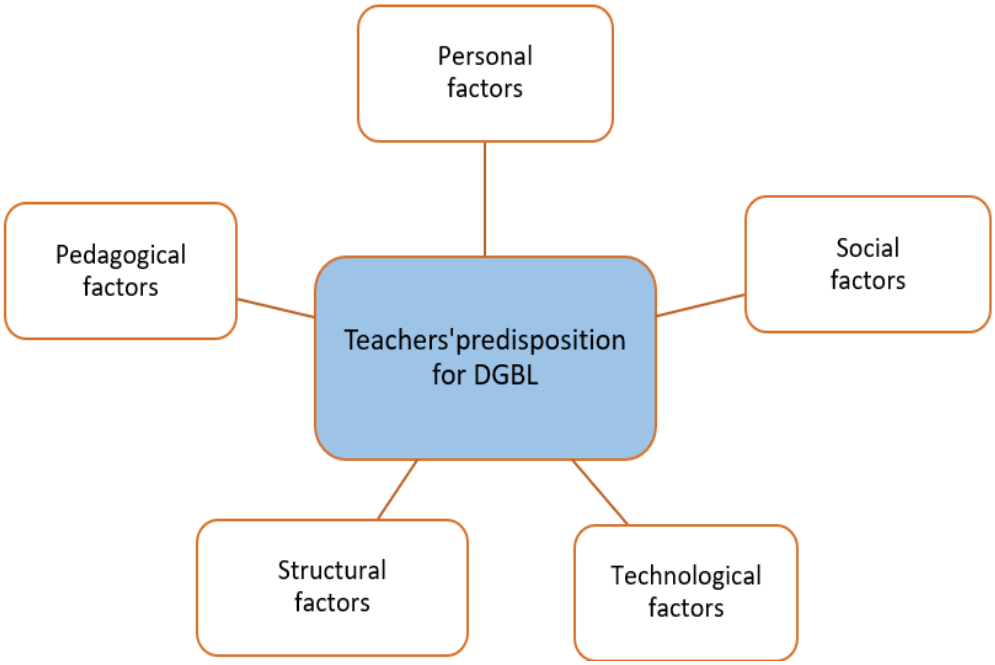

Figure 1: Factors that influence teachers' perceptions regarding the integration of DGBL in their instruction

Pedagogical factors refer to issues of discipline in the classroom, such as establishing 'control' and 'position', aspects related to adapting DGBL to particular students and the subject being taught, preparation time, and the need to search for games.

Structural factors concern the development of a compulsory curriculum, support from the school's management for DGBL integration, and availability of resources for managing integration.

Personal factors relate to the perceptual challenges that teachers experience in integrating DGBL into instruction. It can be experienced as a perceptual barrier; for example, they might need to leave their comfort zone as a teacher and change their teaching approach. It can also be perceived as an agreeable change and an opportunity for professional development. Some teachers in Hayak and Avidov-Ungar's (2020) study noted that they were enthusiastic and experienced self-efficacy when developing new digital games and sharing them with their colleagues.

Technical factors refer to technical difficulties and challenges, such as with logistical planning and technical know-how to properly operate the necessary equipment.

Social factors relate to whether pupils find DGBL interesting and relatable to their world.

We adapted the five categories proposed by Hayak and Avidov-Ungar (2020) as analytical lenses to examine in-service teachers' predisposition for integrating DGBL into their teaching. In Hayak and Avidov-Ungar's (2020) study, the teachers were all practicing DGBL and were in primary education, while in this study, some were not practicing DGBL, and all participants were in secondary education; despite the differences in the target group, the data could be organized in a meaningful way using these five themes.

2.3 Game-Based Pedagogy in Teacher Education

Implementing DGBL in mathematics teaching is also dependent on teachers' understanding of how games can be utilized in the classroom setting. Nousiainen et al. (2018) investigated how primary teachers successfully integrated game-based pedagogy and found that four areas of pedagogical competencies are required for its implementation: pedagogical, technological, collaborative, and creative. *Pedagogical* competencies include curriculum-based planning, tutoring during gameplay, and assessment. *Technological* competencies are concerned with overcoming technological challenges and analysing technological tools, including games. The *collaborative* area covers teachers' ability and readiness to share and communicate content, ideas, practices, and technological know-how. *Creative* competencies include the teacher's ability to take a playful stance, explore, and improvise as well as their creative approach toward their own professional growth. These areas of competence could be addressed in teacher education and regarding teachers' predisposition for integrating DGBL. For example, in-service teachers who face technological concerns should develop competence in the technological area.

Few studies have focused on developing and investigating teacher education programs for teaching with games (Foster and Shah, 2020). These studies show that exploring games and game-playing experiences can help pre-service and in-service teachers better understand the affordances of using games and identify and understand the practical issues in integrating games into the school context. From a design perspective, in-service teachers are a largely diverse group, and some teachers have no experience using DGBL, while others have considerable experience. Given that people are not blank slates and that learning comprises a process of construction in which people build on their previous knowledge, the development of curriculum for game-based pedagogy should consider teachers' previous knowledge of the area.

3. Materials and Methods

3.1 Context and Research Strategy

This study is part of broader research in which in-service teachers' use of game-based pedagogical activities, their predisposition to engage in these activities, and the role they see for teacher education in game-based pedagogy were examined. The research is part of the 'Game-Based Pedagogy in Teacher Education' project, which aims to develop a curriculum for game-based pedagogy at the–Amsterdam University of Applied Sciences, also seeking to develop knowledge in this new pedagogical area in teacher education. This paper reports on the research aspects relating to teachers' predisposition for DGBL and its implications for the development of curricula on game-based pedagogy. An online survey including open- and closed-ended questions was conducted. By using open-ended questions and qualitative analysis procedures, this study aimed to develop a deeper understanding of practicing teachers' actual knowledge, competence, and needs for education on game-based pedagogy. When using the qualitative inquiry approach, the intent is not to generalize findings to a given population but to develop an in-depth understanding of a central phenomenon; thus, the researcher purposefully selects individuals to form the study sample (Creswell, 2002), as in this study.

3.2 Participants

The phenomena examined in this study are teachers' predisposition for game-based pedagogy and the role that teacher education can play therein. Thereby, in-service teachers participating in a master's course on math teaching constituted the study sample because these teachers are acquainted with two contexts important for this study: school practice and the teacher education program. When teaching at school, they have direct or indirect exposure to DGBL and the possibility to apply it. The participants were in-service teachers from three teacher education institutes in The Netherlands and one in Croatia.

The Dutch participants were associated with universities that were involved in a collaborative initiative focused on a joint game-based pedagogy project. Furthermore, a collaborative effort between AUAS and the University of Osijek was undertaken with the aim of implementing digital game-based learning. These collaborative efforts provided valuable insight into the commonalities and disparities among the participants in both institutional and national contexts. Hence, given the shared focus on digital games and the utilization of DGBL as an instructional

strategy, it was considered suitable to collect data from the students enrolled in these educational institutions. On one hand, this phenomenon exemplified the potential for data collection while simultaneously posing a constraint on the sample size.

In both countries, it is possible to teach mathematics in middle school with a bachelor's degree. However, to be able to teach mathematics in high school, one must have a master's degree, which the participants had decided to pursue because it would increase their future employment opportunities. The participants provided informed consent. They were informed by the course teacher educator about the research purpose and invited to answer the questionnaire during the lesson or on their own time. The participants could complete the questionnaire anytime between May and August 2022, and participation was anonymous and voluntary. A total of N_1= 30 Dutch students were provided with a survey link, and among this population, n_1= 22, actively engaged in the survey. Similarly, in Croatia, a total of N_2 = 20 students were given access to the survey, and n_2 = 15 took part. A total of n = 37 responses were collected.

3.3 Data analysis

The online questionnaire consisted of 12 open- and closed-ended items. The closed-ended questions were followed by open questions for which the participants could explain or describe their answer. In the first section of the questionnaire, participants were asked to provide background information (*Where do you study? How many years of experience do you have as a teacher? To what extent do you have experience with the use of games and gamification in your teaching practice?*). In the second section, they were asked for information about their teaching experience with games (e.g. *Can you name three aspects that make the efficient use of games and gamification in teaching practice difficult?*). The third section focused on the role of teacher education. The results reported in this study were based on participants' answers to questions in the second section. Responses to items in the first section were used to determine participants' stage of experience with game-based pedagogy. Participants were categorized into three groups based on their level of experience in using games. They were posed the question 'To what extent do you have experience with the use of games and gamification in your teaching practice?' They could respond on a five-point Likert-type scale (1=not at all to 5=a lot). Participants' answers were clustered into three groups: beginners (no experience; participants who selected Option 1), intermediate (some experience; participants who selected Options 2 or 3), and advanced (more experience; participants who selected Options 4 or 5). This resulted in 11 beginner, 20 intermediate, and six advanced. Considering the questionnaire's anonymous nature, the ability to authenticate the data's accuracy was limited. However, notably, the responses provided by the participants for the open questions were coherent with their assigned expertise levels, thereby suggesting the reliability of the acquired data. Furthermore, given that the survey was completed voluntarily by participants who wanted it to participate, the responses were deemed valid.

The data collected through open-ended questions were analysed in two phases. In the first phase, the data were subjected to thematic coding analysis (Gibbs, 2018) guided by the first research question. This analytical procedure is used to identify text passages that express equal or similar meaning, combine these passages into categories, and define themes that emerged. In the second phase, the five factor categories (pedagogical, personal, structural, technological, and social) defined by Hayak and Avidov-Ungar (2020) were used as an analytical lens, clustering the codes emerging from the first stage in a meaningful and manageable way. Analyses in both phases were performed by two researchers and this paper's authors. The first author is the main researcher of the larger study; the second is the teacher of the course on math teaching in Croatia. Differences in coding were discussed, and when needed, the codes were adapted or changed from a particular category and/or the data were classified with a different code.

4. Results

Results from the thematic analysis revealed 14 hindering and 11 encouraging factors, which were assigned to one of the five aforementioned categories. We examined the hindering and encouraging factors the teachers mentioned at each of the three stages. The results of the analysis are presented in the ensuing sections. For each group, the hindering factors are described, followed by the encouraging factors. An overview of these results is presented in Table 1.

Table 1: Factors that hinder and encourage teachers with few, some or much experience with DGBL

Categories	Beginners (N=11) (-) Hindering factors (n=9) (+) Encouraging factors (n=3)	Intermediate (N=20) (-) Hindering factors (n=19) (+) Encouraging factors (n=18)	Advanced (N=6) (-) Hindering factors (n=5) (+) Encouraging factors (n=3)
Pedagogical	(-) Less control over the classroom (-) Poor learning quality (learning objectives out of sight) (-) More preparation time (-) Difficulty in using active learning (+) Learn about math	(-) Less control over the classroom (-) Poor learning quality (extracting the math out of the game) (-) More preparation time (-) Difficulty in using active learning (+) Learn about math (+) Facilitates learning (active learning) (+) New ways to teaching/learning math (+) Learning other skills	(-) More effort (-) Poor learning quality (keeping pupils focus on the math) (-) Evaluating learning (+) Discovery learning (+) Facilitates learning (+) Know more about pupils' learning
Structural	(-) Predefined curriculum (-) Full/inadequate program (-) High workload	(-) Predefined curriculum (-) Full/inadequate program (-) High workload (-) School organization	
Personal	(-) Feeling unprepared (-) Few knowledge and/or competence (+) Interest (to learn about it)	(-) Few knowledge and/or competence (+) Interest (to learn about it) (+) New knowledge (+) Belief (that is important)	
Technical	(-) Lack of appropriate games (-) Dependence of devices/internet	(-) Lack of appropriate games (-) Dependence of devices/internet (+) Knowing new games (+) Attention for both digital and physical games	(-) Dependence of devices/internet
Social	(-) Pupils engagement (not seriously) (+) Pupils engagement (fun)	(-) Pupils engagement (not seriously) (+) Pupils engagement (fun, motivation (+) Sharing with other teachers	

4.1 Beginner Stage

Beginner teachers have *pedagogical concerns* (n = 5), such as difficulty in classroom management, poor learning quality, and need more preparation time: 'It causes a lot of noise during the lesson; it also takes a lot of preparation, and it is more difficult to keep pedagogical control' (S016). Concerns with learning quality were related to difficulty meeting the learning objectives and supporting pupils' learning: 'I don't see how the use of a game form can guarantee that students practice enough' (S014). Two teachers (S014 and S006) referred to finding it difficult to 'use active learning' and 'guide pupils in their activities'.

Teachers' *personal concerns* (n = 4) involved doubts about having competence and knowledge to implement DGBL. One teacher explains that they feel unprepared for such teaching: 'Feels pretty unguided since I don't know how it works. Can't really prepare myself for it' (S006). Some teachers noted *structural concerns* (n = 3), such as the need to adhere to an existing curriculum and lesson materials, high workload, and school restrictions. One teacher stated that DGBL might not be achievable in every school due to the lack of basic values: 'So, be aware that it is not possible in many schools; you need a certain order, safety, trust, and stable foundation' (S004). Two teachers referred to the lack of appropriate games and computer-related problems *(technical concerns)*: 'I don't know where to find material for it, and making material myself takes a lot of time' (S014). One teacher referred to pupils' engagement *(social concerns)*: 'Students get angry because they want to get a passing grade and don't tread side paths. It can also cause a ruckus in the classroom or even unsafe situations' (S004). Few teachers mentioned encouraging factors (3 out of 11), sharing that DGBL should be about math (*pedagogical factors,* n = 2) and noting that it engages pupils and is fun (*social factors,* n = 2): 'Many students find it fun, want to win competitively (...)' (S005). One teacher mentioned finding the topic interesting and wanting to develop knowledge on it (*personal factors*, n = 1): 'There are so many amazing games. If you can use this in the lessons, it would be a lot of fun! (…) I think it would be great fun to learn more about this' (S017).

4.2 Intermediate Stage

A total of 19 of the 20 intermediate teachers mentioned hindering factors. These teachers have *pedagogical concerns* associated with difficulties in classroom management and the need to adjust the pedagogy. They were more specific in their concerns than beginners, relating to their actual experience teaching with DGBL. Teachers mentioned difficulty in extracting learning from the game: 'The students could focus too much on the game and forget the learning outcomes' (S104). One teacher (S002) referred to finding it difficult to 'ensure discipline in the learning process to do things through planning and make a clear distinction between "having fun" and "school" in this process'. Furthermore, one teacher (S115) expressed negative views regarding using games in the classroom: 'In the classes I teach, I tried this form of teaching, but it did not prove to be successful in those classes, so I switched to other forms of teaching'.

Teachers' *structural concerns* were related to the workload, the need to adhere to school organizational rules (e.g. lesson duration), and managing a full program. Teachers' *technical concerns* included the lack of games connected with the mathematical content that students are learning and the lack of devices/internet connection. They also mentioned the need for technical support to ensure that the digital games used in the lessons work efficiently. They experienced a lack of competence and felt that they did not have adequate theoretical knowledge about how to implement DGBL (*personal concerns)*: 'This is the result of trying out in my teaching practice; it is not based on a theoretical background' (S019). *Social concerns* referred to pupils not taking lessons with games seriously.

Encouraging factors were mentioned by 18 of the 20 teachers. *Personal factors* included teachers' interest in game-based learning (broader than DGBL) and their view that it is important to be aware of and have knowledge about it: 'Game-based learning is motivating for students. It seems interesting to me to learn more from this' (S019); 'Unknown implies unloved. I think it's important to let everyone come into contact with it' (S009). *Pedagogical factors* included game-based learning (broader than DGBL) as a pedagogy that enhances other skills important for pupils' future and other assessment approaches: '(...) I, as a teacher, also get feedback on how much and to what extent they have mastered the learning content' (S113). It can thus be determined that the pupils are active learners. *Social factors* primarily involved stimulating pupils' engagement:

> *I support games in mathematics teaching. They are always interesting and stimulating for students (….). The students really like this form of work because they work together and discuss a certain problem, and what I really liked as a teacher is that the weaker students participate much more than usual, while the other students help them, and at the same time, a positive atmosphere develops in the class. (S113)*

Technical factors concerned knowing about more games and paying particular attention to digital and physical games. One teacher suggested creating a database to share games for their teaching practice.

4.3 Advanced Stage

Five of the six teachers at the advanced stage mentioned hindering factors. Similar to the teachers in the intermediate stage, their concerns are related to their game-based pedagogical experience. The *pedagogical factors* they referred to included having to make more effort to adapt the game lessons for students (i.e. the lessons require a greater investment of energy) and difficulty evaluating students' learning: 'Students could form misconceptions about the subject to be learned through the game without my realizing it or being able to easily address it (as a teacher)' (S011). Teachers at the advanced level did not mention hindering factors related to the structural and personal dimensions. *Technical factors* concerned the lack of good quality games and the lack of devices/internet connection. *Social factors* referred to difficulty with pupils' engagement in learning (e.g. children's boredom due to the excessive use of video games). Encouraging factors were mentioned by three teachers and were all of a *pedagogical* nature. Teachers emphasized the way DGBL facilitates learning by allowing students to play a more active role in their learning and that this makes the lessons more interesting and motivating: 'By going through different types of quizzes/games over a period of a few months, you can see what interests and motivates children and what doesn't' (S108).

5. Discussion

5.1 What hinders and encourages in-service teachers to use DGBL?

A main finding from this study is that pedagogical experience teaching with games is a key variable when examining in-service teachers' predisposition for game-based pedagogy. Notably, despite the variations among the countries from which the participants come, there exists a shared concern and preference among the participants. Teachers at all stages of experience with DGBL mentioned pedagogical factors, and differences were observed between teachers at different stages; differences were also noted for other factors between teachers at different stages. Several obstacles mentioned have also been reported in other research (e.g. Marklund and Taylor, 2016; Watson and Yang, 2016). These results support these previous studies and complement them with insight into the differences and commonalities among teachers at different stages of teaching experience with DGBL, which, to the best of the authors' knowledge, has not been systematically explored previously.

Regarding pedagogical factors, in-service teachers with DGBL experience (intermediate and advanced stages) were concerned about being able to maintain focus on the math concepts, the need to adapt the game lesson to students, and the ways to evaluate student learning; these are particularities of the game-learning process typically related to game-based pedagogy (Kangas et al., 2017). In contrast, in-service teachers with no experience did not mention these aspects and were essentially concerned about ways to control the classroom and whether pupils would receive adequate practice in this learning mode. These findings are similar to those of An and Cao (2016), who found that distractions caused by games and focusing on playing the games (rather than learning from them) were among teachers' major concerns when using digital games in the classroom. The findings also showed that these concerns decreased after teachers were involved in a game design experience, which can be considered a form of game-based pedagogy (Nousiainen et al., 2018). In this study, the differences in pedagogical concerns among the teachers at different stages are because pedagogical competence can be developed during the process of teaching with games. Therefore, teachers with experience (intermediate and advanced stages) have already overcome these obstacles and are facing new ones. However, the results also showed that a previous negative experience teaching with games (such as the case of S115) can prevent teachers using DGBL in future practice. These results support and complement the findings of Watson and Yang (2016), who only reported the positive effect of previous experience teaching with games.

Preference for traditional teaching methods and stereotypical perceptions about the value of digital games (Kaimara, Fokides and Oikonomou, 2021) were reported by very few teachers. Some encouraging aspects from the pedagogical perspective were mentioned by the teachers, emphasizing the value of DGBL as an innovative pedagogical approach, namely, one in which pupils are active learners, learn skills other than the main math content, and engage in new ways to learn math and teachers learn more about pupils' learning.

Technical concerns such as a lack of devices and internet connection were mentioned by teachers at all stages. Lack of information and communications technology (ICT) infrastructure and training have also been noted in other studies as concerns among educators in DGBL implementation (Baek, 2008; Hayak and Avidov-Ungar, 2020; Ince and Demirbilek, 2013). Teachers with no or some experience (beginner and intermediate stages) also

had concerns regarding the lack of appropriate games, another factor mentioned in previous research as an aspect that hinders teachers' use of games in the classroom (Baek, 2008). Teachers from Ince and Demirbilek's (2013) study mentioned the inability to judge game appropriateness to match curricular needs as a hindering factor. Advanced stage teachers did not mention the lack of games as an issue; however, they had concerns regarding game appropriateness for the intended learning, particularly that pupils would develop misconceptions in their learning. A notable finding regarded the suggestion to use analog games, which was interpreted as an encouraging factor to implement DGBL. Even with many schools actively using computers today, teachers seemingly find it important to also conduct lesson activities without computers (as students already spend substantial time on the computer).

Structural concerns such as adherence to an existing curriculum (program too full or inappropriate), high workload, and school constraints have also been mentioned in other studies (Hayak and Avidov-Ungar, 2020; Marklund and Taylor, 2016). Contrary to the findings of Kaimara, Fokides and Oikonomou (2021) and Baek (2008), none of the in-service teachers in this study mentioned a lack of financial resources. Dealing with an existing curriculum and high workload were common aspects for teachers with no or some experience (beginner and intermediate stages), but only teachers with some experience (intermediate stage) mentioned obstacles related to school organization and the difficulty of integrating a game with the traditional teaching approach. The difference among teachers at different stages can be explained by an important fact: only when experimenting with teaching with games in their own school setting will they be able to discover the constraints likely to emerge in their workplace. Similarly, teachers may need to experience teaching with DGBL to determine whether the pre-defined curriculum will become an obstacle.

No teacher mentioned encouraging aspects regarding structural factors (school organization, curriculum). This was puzzling, as in the past decades, substantial investments have been made in innovating schools, renovating the curriculum, and equipping schools with technological novelties and resources. In a prior study in which game-based learning was successfully implemented (Nousiainen et al., 2018), the teachers and headmasters together created 'school-specific plans for applying GBP to address particular pedagogical goals, interests and challenges' (p. 74). It is surprising that, in this study, none of the teachers mentioned any of these aspects as encouraging factors and that structural factors were only considered obstacles. On one hand, this result may be influenced by the data collection method; it would be interesting to examine this aspect in more detail in future research using different methodologies, such as through interviews. On the other hand, the lack of encouraging structural factors may be linked to educational policies in both countries. If educational policy endorsed digital games as an innovative and effective approach to teaching and learning, it is likely that support from schools and school principals regarding the integration of digital games into teaching and learning would be available and mentioned by teachers.

Teachers at the beginner and intermediate stages mentioned personal factors. They referred to the lack of knowledge and competence as hindering factors. Only beginners reported feeling unprepared. One teacher at the intermediate stage reported feeling a lack of creativity. Lack of knowledge and competence aligns with Nousiainen et al.'s (2018) results, which also refer to creativity as a helpful competence for overcoming obstacles in the process of game-based learning. Therefore, it is not surprising that only one teacher who had experience teaching with DGBL reported experiencing the lack (or presence) of creativity.

Social factors were related to pupils' engagement (beginner and intermediate stages) and sharing with other teachers (only the intermediate stage). Few in-service teachers referred to sharing and collaborating with other teachers. This is consistent with Nousisainen et al.'s (2018) findings: 'Teachers still have much to learn regarding mutual sharing of practices and ideas' (p. 74). The authors state that collaboration within and outside the school might be necessary to introduce game-based pedagogy into school culture and make it a sustainable practice.

5.2 Development of Game-Based Pedagogy Curricula in Teacher Education

The above results suggest that the obstacles that teachers describe are possible symptoms of a deeper problem. Their views that DGBL takes more preparation time and effort, leaves them with less control over the class, and could lead to poor learning quality (pedagogical concerns) are likely related to the fact that the pedagogy involved in DGBL is more learner-centred and different from that practiced by teachers. In this case, they need to adjust their classroom pedagogy. The need to adjust the pedagogy was reported by teachers at all three stages. However, this was implicit at the beginner stage and more explicit at later stages because the teachers could refer to concrete experiences in their teaching.

An overly full/inappropriate program and school constraints (structural concerns) do not facilitate pedagogy adjustment; intermediate-stage teachers, in particular, reported experiencing this problem. Through their individual experiences, teachers at the advanced level may have manoeuvred through these challenges associated with school organization and curriculum management. The concerns noted by advanced-stage teachers were connected to practical DGBL use, which involved a lack of resources (technological aspects) and the integration of gameplay (pedagogical factor). If a pedagogy change is needed for DGBL to advance, then higher education and teacher education programs should play a more active role in this process, a finding echoed in earlier studies examining teachers' competences regarding game-based pedagogy and advocating a comprehensive approach to developing teachers' competence (Bado, 2022; Foster, Shah and Duvall, 2015);

Our results align with findings from these studies that suggest the need for a more comprehensive approach to game-based learning in teacher education that guides in-service teachers in examining game-related pedagogy. Foster and Shah (2020) note that game-playing experiences and exploring games can help prospective teachers better understand the affordances of using games or identify practical issues related to their integration into the school context. However, this might not be sufficient, as some studies have shown that participating teachers remain unsure of how to incorporate games into the classroom. The results suggest that previous experience teaching with games can be a key variable to consider when designing curriculum for game-based pedagogy. For example, one can use the knowledge of teachers at different stages to set up different teacher profiles to better connect the instruction with teachers' specific needs. Moreover, differences in participants' views can be intentionally used in a collaborative assignment to trigger critical reflection and challenge beliefs. In some cases, a concern factor for teachers at one stage is an encouraging factor for teachers at another stage (e.g. active or discovery learning). Knowledge of differences in perspectives can be exploited by course developers or teacher educators.

5.3 Suggestions for Tailored Curricula on Game-Based Pedagogy

Playing and exploring the learning aspect of games

Teachers with no experience have more doubts regarding DGBL's educational value, feel more unprepared to teach with games, and worry about being unable to manage the classroom. For these teachers, knowledge of the particularities and processes in DGBL can be too far from their zone of proximal development. More adequate tasks for these teachers could involve playing and exploring the learning aspect of games. However, Sanchez-Mena et al. (2017) caution that perceived ease of use has little effect on teachers' attitudes toward digital games. Thus, teacher training programs should encourage teachers to utilize digital games not because they are easy to use in the classroom but because they can be a helpful resource to employ.

Designing games and instruction for learning by making games

Involving teachers in designing their own games can help develop a more positive attitude and self-efficacy regarding the use of digital games in the classroom (An and Cao, 2016). The utilization of a framework that supports the development of a game from the perspective of both a game designer and an educator is recommended in this process. Tahir and Inge Wang (2019) introduced a comprehensive framework that offers robustness in its application for the analysis, design, and evaluation of learning games.

Read, discuss, and reflect on particular pedagogical activities for DGBL (and opportunities to apply this knowledge at work)

Teachers with some or a great deal of experience express concerns regarding the particularities of the game-based learning process (Kangas et al., 2017) such as planning, gameplay, and evaluation. Therefore, suitable learning activities for these teachers could address knowledge regarding particular pedagogical activities and opportunities to apply this knowledge in their practice as well as opportunities to develop/reflect on game-related areas of competences, such as the pedagogical, collaborative, technological, and creative areas (Nousiainen et al., 2018). Sometimes, a concern factor for beginners is an encouraging factor for advanced teachers. This is the case for 'active or discovery learning'. A course designer can build on this information by creating collaborative course assignments that encourage participants to explore, discuss, and experiment with different game examples, such as games with specific learning goals, with broad learning goals, for practicing a single mathematical skill, and games that involve complex learning goals. The exchange of experiences and ideas on these matters among teachers at different levels can trigger critical reflection of one's own and others' views on DGBL and, consequently, lead to a change of attitude or view on game-based pedagogy.

Prepare, experiment with, and discuss lessons with DGBL

Typical concerns from more experienced teachers such as being able to maintain focus on the math concepts, extract the math from the game activity, and adapt the game lesson to students cannot be properly addressed in lecture form due their practical nature. More adequate for this aim are course assignments in which participants need to prepare, experiment with, and discuss lessons with DGBL, preferably in the context of their own practice and school. The planning and discussion elements of the assignment can be carried out in a collaborative setting involving the three stages and exploiting the variety in participants' DGBL experience. Beginners and some intermediate teachers may find the experimentation part of the assignment too challenging and could be given the alternative assignment of collaborating with other teacher or observing a more experienced teacher conducting the experiment. Moreover, the use of modelling assignments is a suitable way to address the implementation of DGBL in practice (Foster and Shah, 2020). Modelling assignments refer to the situation in which the course leader or one of the participants tries to conduct a lesson with DGBL in an exemplary way while the other participants participate in the activity as students.

Exchange and reflection in heterogeneous learning teams: Overcoming structural obstacles

Teachers with some experience struggle with obstacles of a structural nature and may need some support in developing specific competences, such as adapting the game goals to the learning goals in the pre-defined curriculum or implementing DGBL within the established structure of their own school organization. Support can be provided in the form of learning teams in which teachers with few experience can learn how to overcome structural obstacles from teachers with more experience. This activity can be extended to the technical, personal, pedagogical, and social factors as well.

6. Conclusion

A novel undertaking in this study is the investigation of in-service teachers' perception of game-based pedagogy in relation to their previous experience in teaching with DGBL. A main finding of this study is that pedagogical experience seems to be a key variable when examining in-service teachers' predisposition for game-based pedagogy. Pedagogical, structural, personal, technical, and social factors differ given the teacher's experience stage and necessitate careful consideration when developing supportive curriculum for in-service teachers in the context of DGBL. Gaining an in-depth understanding of how to support in-service teachers in developing game literacy is essential for DGBL to progress (Foster and Shah, 2020; Hanghøj, 2013; Marklund and Taylor, 2016). Higher education can play a much more active role in its development: 1) through the application of game-based pedagogy in multiple courses and 2) by creating specific courses related to game-based pedagogy and examining what and how in-service teachers learn as well as the extent to which this impacts their work in the classroom. Five concrete suggestions can be derived for the application of game-based pedagogy for teacher educators and curriculum developers that exploit the knowledge of in-service teachers' predisposition for DGBL:

- Playing and exploring the learning aspect of games
- Designing games and instruction for learning by making games
- Read, discuss, and reflect on particular pedagogical activities for DGBL
- Prepare, experiment with, and discuss lessons with DGBL
- Exchange and reflection in heterogeneous learning teams: overcoming structural obstacles

Further research should develop and investigate specific content and assignments connecting or extending the suggestions above as well as how in-service teachers develop game-based pedagogical competence in relation to them.

Some limitations of this study must be acknowledged. First, purposive sampling and a small sample size limit the generalizability of the findings to all in-service teachers. Additionally, caution must be exercised with conclusions regarding the teachers at the advanced stage, as there were only six in this group. Second, the data collection was limited to a questionnaire. While this enabled the collection of data in a relatively short time and with little cost, while providing a considerable number and variety of responses, further research is recommended complementing the questionnaire with other methods (e.g. interviews) that could provide deeper insight into the reasons behind the responses obtained in this study.

Further research could employ different techniques for data collection, such as conducting in-depth interviews. The proposed approach would enhance a more holistic comprehension of the diverse stages and provide insight into teachers' viewpoints concerning said stages. Additionally, further research should investigate the time-based evolution of these stages and identify the primary factors that contribute to this progression. It would be

valuable to investigate the activities employed by teachers at various stages. Based on the aforementioned findings, the support that teachers require for the implementation of DGBL can be explored more deeply.

Disclosure statement

The authors report there are no competing interests to declare.

Funding

This work was supported by the Netherlands Initiative for Education Research (NRO) under Grant Comenius Program, Teaching Fellows. Grant number: 40.5.22865.176

References

An, Y.-J., and Bonk, C. J., 2009. Finding that SPECIAL PLACE: Designing digital game-based learning environments. *TechTrends,* 53(3), pp. 43-48.

An, Y.-J., and Cao, L., 2016. The effects of game design experience on teachers' attitudes and perceptions regarding the use of digital games in the classroom. *TechTrends,* 61(2), pp. 162–170. https://doi.org/10.1007/s11528-016-0122-8

Avidov-Ungar, O., and Hayak, M., 2023. Education and games: Teachers' professional knowledge in integrating digital games into instruction in school. *IntechOpen*. https://doi.org/10.5772/intechopen.109594

Bado, N., 2022. Game-based learning pedagogy: a review of the literature. *Interactive Learning Environments,* 30(5), pp. 936-948. https://doi.org/10.1080/10494820.2019.1683587

Baek, Y. K., 2008. What hinders teachers in using computers and video games in the classroom? Exploring factors inhibiting the uptake of computer and video games. *CyberPsychology & Behavior,* 11(6), pp. 665–671. https://doi.org/10.1089/cpb.2008.0127

Bourgonjon, J., Valcke, M., Soetaert, R., and Schellens, T., 2010. Students' perceptions about the use of video games in the classroom. *Computers & Education,* 54(4), pp. 1145–1156. https://doi.org/10.1016/j.compedu.2009.10.022

Byun, J., and Joung, E., 2018. Digital game-based learning for K–12 mathematics education: A meta-analysis. *School Science and Mathematics*, 118(3-4), pp. 113-126.

Creswell, J. W., 2002. *Educational research: Planning, conducting, and evaluating quantitative* (Vol. 7). Upper Saddle River: Prentice Hall.

Easterling, A., 2021. *Digital game-based learning: Teacher training, perceptions, benefits, and barriers*. PhD, St. Cloud State University. Available at <https://repository.stcloudstate.edu/edad_etds/78> [Accessed 16 November 2022]

Foster, A. and Shah, M., 2020. Principles for advancing game-based learning in teacher education. *Journal of Digital Learning in Teacher Education*, 36(2), pp. 84-95. https://doi.org/10.1080/21532974.2019.1695553

Foster, A. N., Shah, M., and Duvall, M., 2015. Game network analysis: For teaching with games. In: M. L. Niess, and H. Gillow-Wiles, eds. 2015. *Handbook of research on teacher education in the digital age*. Hershey: Information Science Reference. pp. 380-411. https://doi.org/10.4018/978-1-5225-0164-0.ch019

Gibbs, G. R., 2018. *Analyzing qualitative data*. London: Sage.

Hanghøj, T., 2013. Game-based teaching: Practices, roles, and pedagogies. In: S. de Freitas, M. Ott, M. Popescu, and I. Stanescu, eds. 2013. *New pedagogical approaches in game enhanced learning: Curriculum integration*. Hershey: Information Science Reference. pp. 81-101. https://doi.org/10.4018/978-1-4666-3950-8.ch005

Hayak, M., and Avidov-Ungar, O., 2020. The integration of digital game-based learning into the instruction: Teachers' perceptions at different career stages. *TechTrends*, 64(6), pp. 887-898. https://doi.org/10.1007/s11528-020-00503-6

Hébert, C., and Jenson, J., 2019. Digital game-based pedagogies: Developing teaching strategies for game-based learning. *The Journal of Interactive Technology and Pedagogy*, 15, pp. 1-18.

Hsu, C.-Y., Tsai, M.-J., Chang, Y.-H., & Liang, J.-C., 2017. Surveying in-service teachers' beliefs about game-based learning and perceptions of technological pedagogical and content knowledge of games. *Educational Technology & Society*, 20(1), pp. 134–143. https://doi.org/10.30191/ETS.201701_20(1).0012

Hussein, M.H., Ow, S.H., Elaish, M.M., & Jensen, E. O., 2022. Digital game-based learning in K-12 mathematics education: a systematic literature review. *Education and Information Technologies*, 27(2), pp. 2859–2891. https://doi.org/10.1007/s10639-021-10721-x

Ince, E. Y., and Demirbilek, M., 2013. Secondary and high school teachers' perceptions regarding: Computer games with educational features in Turkey. *The Anthropologist,* 16(1-2), pp. 89–96. *https://doi.org/10.1080/09720073.2013.11891338*

Jukić Matić, Lj., Karavakou, M. and Grizioti, M., 2023. Is digital game-based learning possible in mathematics classrooms?: A study of teachers' beliefs. *International Journal of Game-Based Learning*, 13(1), 323445, *https://doi.org/10.4018/IJGBL.323445*

Kaimara, P., Fokides, E., and Oikonomou, A., 2021. Potential barriers to the implementation of digital game-based learning in the classroom: Pre-service teachers' views. *Tech Know Learn*, 26, pp. 825–844. https://doi.org/10.1007/s10758-021-09512-7

Kangas, M., Siklander, P., Randolph, J., and Ruokamo, H., 2017. Teachers' engagement and students' satisfaction with the playful learning environment. *Teaching and Teacher Education, 63*, pp. 274-284. https://doi.org/10.1016/j.tate.2016.12.018

Marklund, B. B., and Taylor, A. S. A., 2016. Educational games in practice: The challenges involved in conducting a game-based curriculum. *Electronic Journal of e-Learning,* 14(2), pp. 122-135.

Martín-del-Pozo, M., García-Valcárcel Muñoz-Repiso, A., and Hernández Martín, A., 2019. Video games and collaborative learning in education? A scale for measuring in-service teachers' attitudes towards collaborative learning with video games. *Informatics*, 6(3), 30. http://dx.doi.org/10.3390/informatics6030030

Nousiainen, T., Kangas, M., Rikala, J., and Vesisenaho, M., 2018. Teacher competencies in game-based pedagogy. *Teaching and Teacher Education,* 74, pp. 85–97. https://doi.org/10.1016/j.tate.2018.04.012

Prensky, M., 2001. *Digital game-based learning*. New York: McGraw-Hill.

Sánchez-Mena, A., Martí-Parreño, J. and Aldás-Manzano, J., 2017. The effect of age on teachers' intention to use educational video games: A TAM approach. *The Electronic Journal of e-Learning*, 15(4), pp. 355- 366.

Siew, P. H., 2018. Pedagogical change in mathematics learning: Harnessing the power of digital game-based learning. *Educational Technology & Society,* 21(4), pp. 259–276.

Spiteri, M., and Chang Rundgren, S.-N., 2020. Literature review on the factors affecting primary teachers' use of digital technology. *Technology, Pedagogy and Education,* 25(1), pp. 115–128.

Tahir, R., and Inge Wang, A., 2019. Codifying game-based learning: Development and application of LEAGUÊ framework for learning games. *The Electronic Journal of e-Learning*, 18(1), pp. 69-87

Takeuchi, L. M., and Vaala, S., 2014. *Level up learning: A national survey on teaching with digital games*. The Joan Ganz Cooney Center at Sesame Workshop.

Watson, W., and Yang, S., 2016. Games in schools: Teachers' perceptions of barriers to game-based learning. *Journal of Interactive Learning Research*, 27(2), pp. 153-170.

