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Pre-Service Teachers' Attitudes toward Integrating Digital Games in Learning as Cognitive Tools for Developing Higher-Order Thinking and Lifelong Learning

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Abstract: The purpose of this study is to examine how pre-service teachers' training influences the integration of digital games into teaching. In a quantitative and qualitative study, pre-service teachers' perceptions of their techno-pedagogical knowledge were examined along with their attitudes about games as effective cognitive tools for developing higher-order thinking and lifelong learning. A sample of 108 pre-service teachers followed a 2 × 2 research model distinguishing between those who had or had not received training and those who did or did not teach using digital games. Results showed that teaching with digital games and attitudes toward integrating them into the classroom were positively correlated. Additionally, a higher level of techno-pedagogical knowledge was perceived by those with direct experience with digital games. Teaching with digital games enhances students' thinking processes and lifelong learning skills, according to pre-service teachers. Theoretical knowledge about lifelong learning and higher-order thinking, accompanied by hands-on experience in implementing digital games, should be applied to pre-service teacher training programs.

Keywords: digital game-based learning; teachers' education; cognitive skills; higher-order thinking; lifelong learning

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1. Literature Review

1.1. Digital Games in Education

The term edutainment describes a variety of media-based tools that provide information, cognitive and emotional learning opportunities along with enjoyment and entertainment [1]. One such tool is educational digital games that are integrated into educational plans [2]. The benefits of educational digital games are well known to educators and researchers [3], and they have been successfully incorporated as learning and training tools across a broad range of areas [4]. They especially enable context-based, collaborative, and interactive learning. Digital games present innovative pedagogical approaches that leverage these advantages to develop more effective literacy skills and language proficiency. A key idea highlighted is that games and digital tools allow exploratory, experiential learning and problem-solving, facilitating cognitive development [5].

Game-based learning is a teaching approach integrating gamified elements into the learning process, containing elements of competition, involvement, and immediate reward. Through the playing/learning process, player–learners receive immediate feedback, enabling them to compete with a computer or other player–learners to achieve educational goals. A game-based environment invokes a sense of challenge and is characterized by high levels of intrinsic motivation [6], including a narrative framework that helps the player–learner in the educational activity while simultaneously facilitating skill-building and knowledge growth [7]. The digital game-based learning (DGBL) approach arises from the continued use of computer games and applications of educational value [8]. Studies report strong educational potential using digital game-based learning, citing the enjoyment and interest they inspire, enhancing concentration, critical thinking, and academic achievement [9]. As well, game-based learning can enhance student engagement, and improve overall experience [10]. Additionally, it was discovered that the interest levels of students who utilized games were higher compared to their conventionally trained counterparts, except for students who performed poorly [11].

Although games are supposedly separate from reality, they nonetheless enable learners to acquire lifelong learning skills and 21st century skills. Through digital learning games, one can develop digital literacy and learning skills, learn skills relevant to the job market, develop social and interpersonal skills, and even develop personal cognitive skills such as creativity, self-discovery, and critical thinking. Indeed, digital games have considerable potential regarding lifelong learning skills [12]. However, to realize this potential, it is important to distinguish between two types of digital education games: those developed specifically for educational purposes and those initially designed for entertainment and then adapted for educational purposes. In this article, we focus on the former. In addition, a distinction is needed between games created by professionals and those created by teachers or students [13]. This research studies games created specifically for educational purposes and implemented by teachers.

There are two approaches to integrating games into learning systems to encourage cognitive development: In the first, the instructionist approach, students play a game developed by a teacher/professional to practice and assimilate information on a certain subject. Some teachers prefer to use the game solely as an introduction for the class, others use it as the main element of the class, while others use it to conclude the class or assign it as homework. Games can be integrated into an individual or group setting, inside the classroom or outside [14,15]. In the second, the constructionist approach, students design games themselves in a creative. authentic and personal manner, as part of the learning process, exploring and understanding the learning material through designing and playing the game [16,17] thereby developing and enhancing their thinking skills.

This categorization is important due to the level of cognitive thinking it encourages in students. Bloom's Taxonomy of cognitive skills [18] provides a helpful model in this context. The original model proposed six categories of cognitive skills ranging from lower-order skills requiring less cognitive processing to higher-order skills requiring deeper learning and more cognitive processing. Responding to findings of cognitive science, the order of the cognitive processes was later changed, repositioning synthesis rather than evaluation at the highest level of the hierarchy [19]. In this revised version, the levels are remembering, understanding, applying, analyzing, evaluating, and creating. Moreover, this revision adds a new dimension across all six cognitive processes, defining four types of knowledge that can be addressed by a learning activity: factual (terminology and discrete facts); coherence (categories, theories, principles, and models); procedural (knowledge of a technique, process, or methodology); and metacognitive (including self-assessment ability and knowledge of various learning skills and techniques). Bloom's Taxonomy has been used to create and align objectives, lessons, and assessments to achieve all cognitive levels in the traditional classroom [19,20], and has been validated in e-learning [21] and virtual learning environments [22,23]. Bloom's Taxonomy provides a valuable tool for educators to enhance students' performance and learning outcomes in various academic disciplines [24,25].

We posit that a constructionist approach includes higher levels of thinking, unlike an instructionist approach that results in lower levels of thinking. In constructionist teaching, learners construct their own experiences to produce understandings that make sense to them, while in the instructionist approach, learners practice what they were taught.

Online game generators can now quickly and easily create games with high levels of functionality and design using existing digital platforms [14]. These require no prior coding knowledge since they are editing tools for generic templates into which different types of content can be entered. These generators enable the swift creation of simple yet accessible and streamlined games, that include low-order strategic practice and, more importantly, data recall and basic understanding. The transfer of the creative process to the learners allows them to use higher-order strategic thinking for strategic planning, decision-making, comparison, data presentation, problem-solving, critical thinking, and collaborative learning [26]. Additionally, the use of game generators generates high engagement of learners in the learning process, as found in the study by Deater-Deckard (2013) and her colleagues. They examined the relationship between students' engagement levels in educational games and their learning outcomes. The researchers analyzed how different game features and challenges influence cognitive thinking based on Bloom's Taxonomy. They found that higher engagement was associated with higher-order thinking skills required to solve complex in-game tasks. The authors concluded that thoughtful game design, which promotes sustained engagement, curiosity and regulates difficulty appropriately, can foster the development of critical thinking and problem-solving abilities. This provides insights into how educational games, when optimized effectively, can tap into deeper learning processes [27].

1.2. Teacher Education and Digital Games

Teacher preparation for the knowledge society demands workers who can think critically, pose and solve problems, and work collaboratively—abilities not readily developed in classrooms [28]. As well, teaching with games requires adaptive expertise that is not necessarily intuitive for all teachers [29]. According to the Technical Pedagogical Content Knowledge Framework (TPACK) model, in order to guide students through this complex technologically-inclined educational process, teachers must combine pedagogical-content knowledge and technological knowledge suited to the learning plan and educational requirements [30,31]. Specifically, teachers need a clear vision of teaching and learning [32], a positive attitude towards the subject of digital games, and technical-pedagogical capabilities, including familiarity with digital games platforms. Examining the principles emerging from teacher education in game-based learning [33] identified six principles for guiding research and practice in teacher education for game-based learning (GBL): (a) teachers play an active role in GBL environments; (b) games are an integral part of the curriculum; (c) GBL is a way of facilitating learning; (d) games are not contextually or pedagogically neutral; (e) teachers' knowledge of GBL evolves over time; and (f) teachers' professional identities have an impact on GBL practice.

Considering these findings, we argue that pre-service teachers must undergo the appropriate training processes. Teaching with games would include examining practices involved before, during, and after game-based interventions [33,34]. Teachers should be able to educate and cultivate self-learning, and need to draw on numerous skills when embarking on developing student games: familiarity with numerous game-generating platforms; the ability to instruct and guide group educational processes; and the ability to guide students to make decisions regarding the game application best suited to their needs.

There is a wide gap between prevailing policies promoting educational technology-related reform and classroom reality, and it appears that teachers have largely not embraced the use of technology [35]. Usually, teacher education programs lack modules dedicated to the process of creating digital educational games. [36] find that, on average, what is often called "planning, organization, management, and appraisal of learning" in education colleges comprises just 18% of the curriculum, noting that any references to developing online games are haphazard and result from initiatives of a particular lecturer. Commonly, this important aspect of pre-service education may be merely an appendage to courses about study planning or integrating digital tools into teaching. Previous research has found a correlation between the education student's practical experience in this field, and their initiative in practically integrating digital games into their classes [37].

This study aims primarily to contribute to the existing theoretical and practical knowledge in the context of teacher training to cultivate lifelong learning skills and 21st century skills, which, we argue, will develop much-needed higher-order thinking skills through task-based learning. We further suggest encouraging teachers to approach these aspects of their practice positively to achieve these goals.

2. Research Questions

This study examines the influence of pre-service teachers' training on teacher attitudes toward integrating digital games into education. We examine the attitudes of pre-service teachers possessing technological–pedagogical knowledge (TPACK), including their views on games as tools for potentially developing cognitive higher-order thinking and lifelong learning. We also analyze whether educational experience in integrating digital games affects these variables. We hypothesize that those pre-service teachers who have *learned* about integrating games in education will present more positive opinions concerning all variables than pre-service teachers who have not. Likewise, we hypothesize that pre-service teachers who have *taught* using the development of digital games in the classroom will have a more positive opinion about all variables than those who have neither *learned nor taught* games instruction.

This study seeks to answer the following research questions:

A. Technological–Pedagogical Knowledge and Attitudes Towards Digital Games
   - A.1. What are the connections between the perceived TPACK regarding digital games, opinions about using digital games, cognitive higher-order thinking, and lifelong learning skills of pre-service teachers?
   - A.2. What are the differences between pre-service teachers who have learned about digital games and pre-service teachers who have not regarding technical–pedagogical knowledge, beliefs about thought development, and life skills in the context of integrating digital games into the classroom?

B. Knowledge and Experience Teaching with Digital Games
   - B.1. What are the differences between pre-service teachers who have taught using digital games and those who have not regarding technical–pedagogical knowledge, beliefs about thought development, and life skills in the context of integrating digital games into the classroom?
   - B.2. What are the differences between those who have learned about incorporating games into their teaching and those who have taught using games regarding their attitudes about whether digital games develop higher or lower thinking skills? What are their attitudes regarding games as tools for developing cognitive higher-order thinking skills?

3. Methodology

This study adopts a mixed methods research approach, drawing upon a quantitative method with several complementary qualitative questions. Using a 2×2 research array between participants, they could have learned or not learned about digital games, or taught or not taught the subject. Data for all research questions were collected from an online questionnaire distributed to groups of students. For the answers to the open-ended questions dealing with the description of the characteristics of the lesson-incorporated digital games by the pre-service teachers, a content analysis was carried out. Then, in order to reveal the ranking of components reported as significant, we coded and counted prevalence after thematic mapping [38].

3.1. Sampling

Participants included 108 pre-service teachers from the Regev Excellence Program, 44% from the program and 56% from standard education teacher training programs. The survey answer rate was 83%. Eighty percent of the participants were women and 69% were aged between 18–25, 20% between 26–30, and 11% over the age of 30. The sample showed that 28.1% *had not learned* about digital games at all, while 71.9% *had learned*, either through several classes or a full course about digital games. Among participants, 59.3% *had taught* digital game development during their teaching practicum while 40.7% *had not*. No differences were found between those that *had learned* about digital games and those that *had not learned* about digital games regarding their age group ($Chi^2_{(4)}$ = 1.17, p = 0.88) and gender distribution ($Chi^2_{(1)}$ = 1.10, p = 0.32). In addition, no differences were found between those that *had taught* using digital games and those that *had not taught* using digital games regarding their age group ($Chi^2_{(4)}$ = 7.51, p = 0.11) or gender distribution ($Chi^2_{(1)}$ = 1.38, p = 0.24).

3.2. Research Tools

The survey included open and closed questions; the latter were divided into several clusters:

(1) Demographic questions—six items were asked about the demographic background of the participants: age, gender, sector association, college, and specialization.

(2) Teacher knowledge level—Seven items estimated personal knowledge levels based on the TPACK model of the pre-service teachers themselves [39,40]; i.e., "I know how to choose online games that contribute to my students' learning"; "I know how to teach integrated online games lessons in my field of teaching.". Previous studies found the TPACK questionnaire valid for measuring teachers' self-perceived technological competence in teaching and their knowledge in incorporating technology tools [41] Studies showed high content validity for measuring the knowledge tested [42], and high face and content validity [43].

(3) Attitudes—Eleven items asked about the attitudes of the pre-service teachers to use digital games for teaching and learning, e.g., "The use of digital games improves my teaching." This questionnaire was developed specifically for the current research and its content and face validity was checked prior to the research by academic experts.

(4) High-order thinking strategies—Thirteen items represented the importance of digital games in developing a variety of higher-order thinking strategies, including comparison, asking questions, representing knowledge, argumentation, and more. This questionnaire was developed specifically for the current research and its content and face validity was checked prior to the research by academic experts.

(5) Cognitive level—Six items aimed at measuring attitudes toward digital games' ability to develop higher and lower thinking levels according to Anderson and Krathwohl [44] taxonomy. Three items measured attitudes towards the ability of digital games to develop lower thinking levels, e.g., "remember" and three items measured attitudes towards the ability of digital games to develop high thinking levels, e.g., "create". The questionnaire was developed for the current research.

(6) Lifelong learning skills—Thirteen items asked about acquiring lifelong learning skills defined by the OECD [45], i.e., teamwork, problem-solving, and creative thinking. The questionnaire was developed and validated by [46] and had been found suitable for research.

All the close-ended items were on a 7-point Likert scale. For each construct, an average of the all the items was calculated. The internal reliability measured by Cronbach's alpha presented in Table 1 is satisfactory.

Table 1. Correlation between perceived TPACK, attitudes about using digital games, and their influence on lifelong learning skills among all participants (n = 108).

Dependent Variables	1	2	3	4	5	6	7	8
Attitudes (1)	0.67							
Knowledge (2)	0.33 ***	0.90						
Thought Processes (3)	0.41 ***	0.47 ***	0.81					
Ways of Working (4)	0.37 ***	0.40 ***	0.71 ***	0.70				
Life Skills (5)	0.38 ***	0.36 ***	0.78 ***	0.66 ***	0.64			
Tools (6)	0.22 ***	0.43 ***	0.59 ***	0.42 ***	0.43 ***	0.76		
Lower-order Thought (7)	0.36 ***	0.32 ***	0.59 ***	0.53 ***	0.53 ***	0.43 ***	0.74	
Higher-order Thought (8)	0.35 ***	0.34 ***	0.62 ***	0.49 ***	0.62 ***	0.39 ***	0.65 ***	0.84

Note: The reliability of research variables according to Cronbach's alpha is presented on the diagonal. *** $p < 0.001$.

The survey also included eight open-ended questions allowing for descriptions of attempts to integrate digital games in teaching, including challenges faced and examples of lesson plans.

4. Results

To answer the first research question, correlations were calculated for the study variables. Table 1 presents the correlations between the research variables: perceived TPACK, opinions about using digital games, and lifelong learning skills.

Table 1 shows positive correlations between the research variables. Higher technological–pedagogical variables correlate directly with higher results in opinions concerning digital games and their contribution to lifelong learning skill development.

The second and third research questions examined differences between pre-service teachers who *learned about* digital game integration and those who *had not*, as well as differences between pre-service teachers who had *taught* using digital game integration and those who *had not*. To answer these questions, nine 2-way ANOVA analyses were conducted concerning the relevant variables. Table 2 presents these analyses.

Table 2. Differences between pre-service teachers who learned or did not learn, and those who taught or had not taught using digital games, concerning perceived TPACK, attitudes about using digital games, and their influence on lifelong learning skills development.

Research Variables	Taught	Did Not Learn	Learned	Total	Main Effect-Learned F(1,104) (Eta^2)	Main Effect-Taught F(1,104) (Eta^2)	Interaction Effect F(1,104) (Eta^2)
Attitudes	Did Not Teach	3.19 (0.48)	3.67 (0.38)	3.53 (0.46)	7.65 ** (0.07)	14.98 *** (0.13)	5.41 * (0.05)
	Did Teach	3.77 (0.44)	3.81 (0.45)	3.80 (0.45)			
	Total	3.53 (0.54)	3.76 (0.43)	3.69 (0.47)			
Techno-pedagogical Knowledge	Did Not Teach	2.88 (0.71)	3.41 (0.86)	3.25 (0.85)	3.99 * (0.04)	37.50 *** (0.27)	2.04 (0.02)
	Did Teach	4.04 (0.54)	4.13 (0.65)	4.10 (0.63)			
	Total	3.55 (0.84)	3.84 (0.82)	3.76 (0.83)			
Thought Processes	Did Not Teach	4.08 (0.49)	3.95 (0.73)	3.99 (0.67)	0.52 (0.05)	9.42 ** (0.08)	3.22 ^ (0.03)
	Did Teach	4.23 (0.48)	4.54 (0.47)	4.45 (0.49)			
	Total	4.17 (0.48)	4.30 (0.66)	4.26 (0.61)			

Table 2. *Cont.*

Research Variables	Taught	Did Not Learn	Learned	Total	Main Effect-Learned F(1,104) (Eta^2)	Main Effect-Taught F(1,104) (Eta^2)	Interaction Effect F(1,104) (Eta^2)
Ways of Working	Did Not Teach	3.75 (0.76)	3.65 (0.87)	3.67 (0.84)	0.37 (0.01)	13.69 *** (0.12)	1.58 (0.02)
	Did Teach	4.11 (0.54)	4.39 (0.59)	4.31 (0.59)			
	Total	3.96 (0.65)	4.09 (0.80)	4.05 (0.76)			
Lifelong Learning Skills	Did Not Teach	3.88 (0.58)	3.76 (0.83)	3.80 (0.76)	0.67 (0.01)	6.35 * (0.06)	2.61 (0.03)
	Did Teach	4.03 (0.78)	4.41 (0.69)	4.30 (0.73)			
	Total	3.97 (0.69)	4.15 (0.81)	4.10 (0.78)			
Tools	Did Not Teach	4.27 (0.70)	4.37 (0.86)	4.34 (0.53)	1.93 (0.02)	1.74 (0.02)	0.45 (0.01)
	Did Teach	4.36 (0.48)	4.66 (0.54)	4.57 (0.53)			
	Total	4.32 (0.57)	4.54 (0.69)	4.48 (0.66)			
Lower-order Thinking	Did Not Teach	4.10 (0.57)	4.02 (0.64)	4.04 (0.61)	2.17 (0.02)	5.45 * (0.05)	4.48 * (0.04)
	Did Teach	4.13 (0.53)	4.58 (0.56)	4.45 (0.59)			
	Total	4.12 (0.53)	4.36 (0.65)	4.29 (0.63)			
Higher-order Thinking	Did Not Teach	4.03 (0.74)	3.80 (0.80)	3.86 (0.78)	1.81 (0.02)	1.82 (0.02)	7.75 ** (0.07)
	Did Teach	3.80 (0.88)	4.46 (0.63)	4.27 (0.76)			
	Total	3.89 (0.82)	4.19 (0.77)	4.10 (0.79)			

^ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

4.1. Differences between the Pre-Service Teachers Who Had and Had Not Learned about Teaching with Digital Games

There was a significant difference in the attitudes toward the use of technology and in techno-pedagogical knowledge between pre-service teachers who had and those who had not learned about teaching with digital games. The pre-service teachers who did learn about the use of digital games in instruction displayed a more positive attitude towards the use of games and possessed more techno-pedagogical knowledge than those who had not learned.

There were no remarkable findings of other differences in variables between the pre-service teachers who did and did not learn about the use of digital games for instruction.

4.2. Differences between the Pre-Service Teachers Who Had and Had Not Taught Their Subject Using Digital Games

The findings indicate many differences in several variables between pre-service teachers who had taught their subject matter through the use and development of digital games compared to those who had not. The pre-service teachers who had taught their subject matter using digital games self-reported positive attitudes, self-perception of high knowledge of techno-pedagogy, and a positive attitude toward the potential of digital games to cultivate lower-order thinking skills and to cultivate ways of working and lifelong skills.

Their attitudes contrast with those of the pre-service teachers who had not taught their subject through the development of digital games.

The findings reflect differences within the groups that believe that the integration of digital games can cultivate lower-level thinking. However, there were no differences detected in the group that believed that digital games can cultivate higher-level thinking.

4.3. The Combined Influence of Learning about the Integration of Games and the Teaching of the Subject through Games

Attitudes towards the use of digital games: Our research indicates that the pre-service teachers who learned through the direct experience of using digital games displayed more positive attitudes toward their integration into the classroom, regardless of whether they had undergone a course on the topic. Pre-service teachers who took a course on the integration of games in education, but who did not themselves integrate games into their teaching, exhibited less positive attitudes than those who had learned through first-hand experience. Pre-service teachers who did not learn about education using digital games and did not teach themselves the topic displayed the most negative attitudes toward digital games' use.

Lower- and higher-order thinking: The pattern of interaction between learning the topic (as a student) and teaching it actively (pre-service teachers who taught using games) indicates that those who both learned and taught using digital games believed more strongly that integrating such games into learning facilitates the ability to practice both lower- and higher-level thinking compared to pre-service teachers who had learned but had not taught, those who had taught but not learned, and those who had neither learned nor taught. Regarding the fourth research question, all questions on the questionnaire were open-ended. Respondents who taught using digital tools were asked to comment on the advantages and challenges they faced when doing so. In order to gain a better understanding of how future teachers experienced the lesson, we isolated the description words. We then categorized them into two main themes, one focusing on the lesson climate and the other on cognitive factors. Lastly, we calculated the frequency of the descriptive words used to characterize the experience of the learners in the lessons in which the pre-service teachers integrated digital games, which resulted in the findings presented in Table 3.

Table 3. Frequency of words describing learners' positive experience in the integration of digital games.

Category	Words Used to Describe a Lesson that Integrated Games	Frequency of the Answers (64)	Percent
Classroom climate factors	Fun/experience/enjoyment	13	20.3
	Dynamism/enthusiasm/liveliness	11	17.2
	Motivation/willingness	10	15.6
	Participation/active learning	8	12.5
	Collaboration/group work	8	12.5
	Curiosity/interest/light in their eyes	6	9.40
Cognitivefactors	Challenge/creativity	3	4.67
	Understanding demonstration/focus	3	4.67
	Independent learning	2	3.12

Table 3 shows that most of the words (87.5%) that the pre-service teachers chose to describe their experience relate to the classroom climate and a small number (12.5%) to the positive contribution to the cognitive factors in learning.

5. Summary and Discussion

The purpose of this study was to investigate the influence of elements of pre-service teacher training in order to learn about integrating digital games in teaching and practice teaching, as well as the attitudes of pre-service teachers toward the connections between teaching with digital games and cognitive higher-order thinking and lifelong learning. A mixed method was used of quantitative together with a qualitative component that provided additional details.

5.1. Attitudes and Experience Regarding Digital Games

The experience of pre-service teachers in integrating digital games into subject matter teaching is more meaningful than learning about digital games in training or a course. Consistent with the study of [47], that sets the basics for the enhancement of experiential learning in higher education and suggest how it can be applied throughout the educational environment. Through direct experiences and personal meaning, learners construct their own knowledge. However, the combination of learning about the topic and applying it in their teaching showed the most positive influence on respondents' attitudes. This finding is supported by the qualitative analysis in which respondents used positive words to describe lessons integrating games (such as fun, motivating, and liveliness).

5.2. Techno-Pedagogical Knowledge

Pre-service teachers who took a course that specifically taught game integration reported a higher level of techno-pedagogical knowledge than those who did not. Similarly, pre-service teachers who incorporated digital games into their teaching reported higher levels of TPACK [39] than their counterparts who had not used these techniques. However, no association was found between teaching and learning about integrating games. Those who integrated games into their lessons showed higher techno-pedagogical knowledge regardless of learning about the subject or not. This may indicate that it is not necessary to both take a course and to teach it using digital games to obtain TPACK—either will suffice. Pre-service teachers who taught using games believed that they could design lessons and lead their colleagues in integrating digital games into their lessons and that they had the knowledge necessary to widely integrate digital games into teaching.

5.3. Lifelong Learning

There was a difference regarding the attitudes towards the ability of digital games to promote lifelong learning skills between those who had and had not taught using digital games. Those who had taught using digital games reported that they believed that the lifelong learning skills of their students improved as a result. The perception of the significance of teaching accompanied by digital games as promoting lifelong learning skills is essential for implementing those skills in the lessons, rendering the teaching visible [48]. Thus, a teacher who believes that digital games promote decision-making processes will dedicate time to teach pupils which digital platform is optimal for a game's purpose.

5.4. Lower- and Higher-Order Thinking

No significant differences were found in attitudes towards developing lower- and higher-order thinking skills between those who learned to incorporate digital games into teaching and those who did not. However, teachers who integrated digital games into their teaching reported that, while the games developed lower-order thinking skills, they did not necessarily contribute to the development of higher-order thinking skills. This finding should be interpreted with caution, as cross-sectional data present only a snapshot, versus demonstrating causality over time. Nevertheless, analyzing the pattern of interaction between learning and teaching revealed that those who both learned and taught believed more strongly that the use of games in learning develops higher- and lower-order thinking skills than did the pre-service teachers who had learned but not taught, taught but not learned, or neither.

Therefore, to encourage pre-service teachers to believe that digital games develop higher-order thinking skills, they need to learn how to incorporate games into teaching and have the opportunity to practice applying that knowledge [27,49].

In summary, the findings highlight the importance of pre-service teachers receiving training on how to incorporate digital games into their teaching practices. The findings further indicate that pre-service teachers should undergo general and specific training on how to use digital games as an effective teaching tool that promotes cognitive higher-order thinking and lifelong learning skills. As a result, improving cognitive higher-order thinking and lifelong learning skills will improve students' performance and learning outcomes.

Based on these findings, in order to assess the effectiveness of the training, it is recommended to conduct evaluation research and follow-up on how trained teachers integrate digital games during practicum and later as active teachers. To strengthen the required skills for optimal implementation, digital games should be integrated throughout the curriculum, including the clinical experience, and not just in one dedicated course. The establishment of professional learning communities that enable sharing of knowledge and experience between active teachers and teachers-in-training is advised.

6. Research Limitations

In this study, pre-service teachers expressed whether they would teach with digital games. Future research should investigate the extent to which the choice to undergo training creates a more positive attitude about integrating digital games into teaching among pre-service teachers. An experimental research paradigm, wherein the participants are divided into four groups, may result in a causative inference, deduction, or conclusion regarding the connection between the pre-service teachers' training and their attitudes regarding integrating digital games into instruction.

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