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Digital vs. Hybrid: Comparing Two Versions of a Board Game for Teacher Training

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Abstract: This study compares two versions (one digital, one hybrid) of a serious board game for teacher training called the "4Ts game". Teachers play the game in groups to learn about—and directly engage in—the joint design of collaborative learning activities for their students by choosing the Tasks to be proposed, the Timing of activities, the Technologies to be used, and the Team composition, in an iterative process of decision making. The game comes in three versions: fully tangible, digital, and hybrid. This paper focuses on the interaction design of the digital and hybrid versions. In both cases, teachers pick cards up from four decks, read the prompts provided in the cards, and place them on a board to design a learning activity together. Their decision-making process is scaffolded by the digital or hybrid game versions, which provide feedback and suggestions and guide teachers toward the creation of a coherent design. The user experience is quite different in the two formats. In the hybrid game, teachers physically manipulate tangible cards on a tabletop board, and the board status is replicated on a laptop application that displays automatic feedback and guidance. By contrast, the digital version is played using an Interactive Whiteboard with touch-screen capabilities, thereby allowing teachers to manipulate digital cards on a digital board. The game was used in the context of two training initiatives targeting in-service school teachers (N = 42). Data were collected on acceptance of the model upon which the game is built, acceptance of the game itself, overall user satisfaction, and knowledge gains. Results show that teachers generally liked both versions of the game, especially the opportunity provided for receiving guidance in the design process. Additionally, teachers' knowledge about learning design and collaborative learning increased significantly between the pre- and post-test for both the digital and the hybrid game groups. However, few significant differences were found between the groups that used the digital and hybrid versions of the game: the digital version was perceived as being slightly easier to use ($p < 0.001$). Overall, the study suggests that both versions of the game have the potential for teacher training, while the user interface of the hybrid version should be further refined to fully harness the game's potential.

Keywords: hybrid game; board game; serious game; learning design; teacher training

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1. Introduction

Board games and games, in general, have been attracting a lot of attention in the last few years, especially as the spread of ICTs and mobile devices has dramatically increased access to digital games, both in terms of the increased number of people able to use the devices, and in terms of increased time spent by single users on devices. According to [1], millions of Europeans turn to video games every day for leisure and entertainment; this has rapidly transformed the video game ecosystem into a huge market, whose value at the European level was estimated by the European Parliament to be EUR 23.3 billion in 2021.

Besides games in purely digital format, the games industry has recently started offering games in a "hybrid" format, i.e., combining an app or website with material components [2].

From a technical point of view, these hybrid games usually integrate digital technologies such as virtual and augmented reality, near-field communication protocols, Bluetooth and wireless networks, smartphone cameras, or scannable QR codes [3]. Such hybrid games are attracting a lot of attention within the research community as well as in the recreation industry. Some researchers claim that the board game sector is not taking full advantage of the possibilities provided by technology [4]. Others are investigating the impact of the hybrid format on the gaming experience [5], often in an attempt to propose new design models [6] or design principles [3,4].

Moreover, games are also a subject of growing interest in the education sector. In particular, "serious games", i.e., games designed primarily for a purpose other than pure entertainment [7], are becoming more and more popular in class as a means for promoting learning in a broad range of subjects [8,9]. There are also some studies in the literature devoted to classroom adoption of board games in class for learning purposes [10].

However, the potential of serious games for teacher training has rarely been recognized, even though it is a consolidated principle that the way teachers are introduced to innovative teaching approaches should be aligned with the pedagogical approach being promoted.

In this paper, we present a serious game for teacher training on collaborative learning techniques in two versions, fully digital and hybrid (i.e., partly tangible and partly digital). In the next section, we will theoretically frame the use of serious games in teacher training. We will then present the "4Ts game" and the theoretical model on which the game is based, emphasizing the differences in the game mechanics between the two versions. Finally, data collection on the usability and perception of teachers is presented and the results are discussed.

2. Background

According to a recent literature review [11], there is a dearth of research investigating the impact of serious games on teachers' professional development. Indeed, the authors only managed to retrieve a few relevant studies and concluded that not all of them report knowledge development outcomes, while—as far as teachers' attitudes are concerned—they report mostly positive impacts. Interestingly, the authors point out that most of the games are targeted at prospective teachers as part of initial teacher education (ITE), while it seems in-service teachers undergoing continuous professional development (CPD) are not a target of the retrieved studies.

In a similar vein, as early as 2016, Meredith [12] conducted a literature review to investigate the impact of game-based learning (GBL) in professional development opportunities for practicing K-12 teachers and concluded there is a "lack of published research showing the educational effects of using GBL in teacher professional development" (p. 499). Interestingly, the author highlights three distinct patterns in the use of GBL in teacher training: (1) "having teachers play games as a method of developing proficiency in a particular digital game, so that they could implement it in their classrooms"; (2) "convincing and/or persuading teachers and administrators of the potential benefits of GBL in the classroom", like for example in the experience described in [13]; and (3) "playing games to learn to design them" [12] (p. 499), such as in Dinç [14] or DeCoito and Briona [15].

In addition to the three patterns highlighted by Meredith [12], it is worth pointing out that experiences have also been conducted in which games are used to simulate real classroom experiences. These are aimed at engaging teachers in realistic simulated situations or role-playing games that feature natural interactions in the classroom, so as to prepare trainee teachers for class management issues [16,17]. In any case, Meredith's [12] conclusion is that "published research only approaches this topic from a 'train them to use [GBL] in the classroom' perspective, rather than using GBL to teach teachers" (p. 500).

Another very recent systematic mapping review [18], conducted some years later with respect to [11,12] and focusing on the use of serious games in teacher training, has confirmed this field of research is understudied.

Interestingly, these authors also point out that—as far as the game format is concerned—hybrid games are not mentioned at all: most of the games presented in the retrieved papers are based on 2D environments, while the 3D seems to be still underused. There are attempts to use virtual and augmented reality environments, but those are still few in number. According to [4], the hybridization of board games is a relatively unexplored area. As a consequence, to the best of our knowledge, no experiences are reported regarding the use of hybrid games in teacher training, where the tangible and digital components are strictly integrated in such a way that the digital component enriches with computational power the tangible one. In addition, there are no cases of the same game developed in two formats, allowing direct comparison of their effect.

Moreover, if we focus on *board games*, according to [18], there seems to be an emergent interest in the use of these games (albeit not necessarily technology-enhanced), but this is still at its initial stages and still quite limited. Recognizing this gap, Sousa [19] has very recently proposed a framework to help teachers use, adapt, and develop modern board games for their students. But, even in this case, it seems the ultimate target of board games is students, while teachers are only encouraged to profit from them in order to enhance their general game culture for the students' benefit, rather than for their own learning.

Having said that, the present study can be located at the intersection between two research fields. On the one hand, it aims to contribute to the study of the possibilities offered by using serious (board) games in teacher training contexts. On the other, it contributes to the study of hybrid games in an effort to define effective models of interaction design that favor player experience and engagement. In order to provide these contributions and to fill some of the mentioned gaps, the authors developed and then evaluated a serious game. The game was intentionally designed for teacher training purposes and took the form of a board game; to the best of our knowledge, these two features make it quite innovative. Moreover, the game was originally developed as a tangible board game [20]. That version proved effective, and interactions with its tangible cards and board were particularly welcome, but the lack of feedback on players' moves turned out to be a shortcoming. As a consequence, a full digital format was implemented, which however lacked the added value of manipulating tangible cards. Finally, the game was also made available in a hybrid format, combining the tangible and digital components [9]. This additional feature of being available in both digital and hybrid formats, makes the game quite unique in the current scientific panorama, as described above.

Thus, the overall aim of the study is to provide evidence of the adequacy of the board game for teacher training contexts (in terms of user satisfaction and knowledge gains derived from experimental use) and to inform about differences in interaction with the digital and hybrid formats, to contribute both to research in game-based teacher training and to research in interaction design.

Accordingly, the paper is structured in the following way: The next section briefly illustrates the theoretical model underpinning the game and describes the game itself in its digital and hybrid formats. Then, the contexts in which the game was tested are presented, along with the methods used for data collection. In the subsequent sections, we present and discuss the results. In the Conclusions section, we draw some lessons learned in an attempt to contribute to the current scientific debate in the research threads mentioned above.

3. Materials and Methods

3.1. Serious Games for Training Teachers

3.1.1. The 4Ts Model

The 4Ts game is built upon a theoretical model called "the 4Ts model" [20], as briefly explained below. The 4Ts model defines and frames collaborative learning activities in terms of four elements: TASK (activities that students are requested to carry out); aggregation in TEAMs (student groupings for performing the task); TIME (task phases and scheduling); and TECHNOLOGY (the environment in which the activities takes place, with its tools and resources). According to this model, any time teachers begin to design a

collaborative learning activity, they first need to define the intended learning objectives to be achieved by the students, identify the contents to be addressed, and analyze the context (in terms of contextual constraints and characteristics of the target population). Once these fundamental aspects are established, they can then choose a Task to be assigned to students, the Technologies that will be used to accomplish the Task, the social structure of the class (organization in Teams), as well as the Time schedule. Any choice made on one of these variables necessarily impacts all of the others, so the design process is iterative in nature.

In the 4Ts game, examples of Tasks include the following: preparing a document (textual or hypermedial); reading and studying; preparing a list of questions; commenting on others' work; carrying out an assignment; solving a problem; and conducting an interview (with an expert). Examples of Teams include individual learners, dyads, small groups, medium-sized groups, large groups, and plenary. Examples of Technologies include Forum, PowerPoint/Prezi or other presentation tools, Wiki, Classroom Interactive Whiteboard (IWB), Video-conference, the web, and Text/video editor. The Time component is reified by means of the game board (see example in Figure 1): each column in the board corresponds to a time slot, which the player can ascribe as lasting a day, week, month, or any other timespan considered appropriate given the granularity of the design. Timewise, learning paths can also be organized in one or more phases (see example in Figure 1).

Week 1		Week 2		Week 3		Week 4	
Pyramid – phase I				Pyramid – Phase II		Pyramid – Phase III	
Studying	Individual learners	Solving a problem	Pairs	Solving a problem	Small groups	Solving a problem	Plenary
Selected Study material		Forum		Forum		Forum	

Figure 1. Example of an online Pyramid according to the 4Ts model.

In order to support teachers in the design of collaborative learning activities, it is possible to use "collaborative techniques" [21], i.e., patterns, or models, of already existing collaborative activities. These are content-independent and can be adapted to specific contents and contexts. The collaborative techniques available in the game include Brainstorming, Discussion, Peer Review, Case Study, Role Play, Jigsaw, and Pyramid.

Any collaborative technique can be described in terms of the 4Ts (Task, Time, Team, Technology). As an example, in Figure 1 you can see an online Pyramid described using the 4Ts model within the game (in the light blue cells you can find the Technique phases, in the red cells you can find the Tasks envisaged for each phase, yellow cells contain the Team sizes for each Task, and green cells contain the Technologies to be used to accomplish Tasks).

All the notions mentioned above (Task, Team, Time, Technology, and Technique) are used in the 4Ts game, as explained in the sections below [22].

3.1.2. The 4Ts Game

The 4Ts game this study investigates has been developed over a number of years by researchers at Institute of Educational Technology of the Italian Research Council;; an overview of the game development process in its various formats can be found on the site: https://sites.itd.cnr.it/4TsGame/, accessed on 18 December 2023.

The game is a means to engage teachers in an iterative, collaborative process of co-decision making revolving around the four elements (the four Ts) and the relationships among them. As already mentioned, the game is available in three different formats:

- a paper game (full tangible format)
- a digital game (full digital format)
- a hybrid game (integration of the tangible + digital versions).

In all three versions, the game is composed of a board and four decks of cards. The board represents the Time component (in the case shown in Figure 2, four columns = four weeks) and also hosts descriptions of the learning objectives, the contents, and the context, as defined by the teachers.

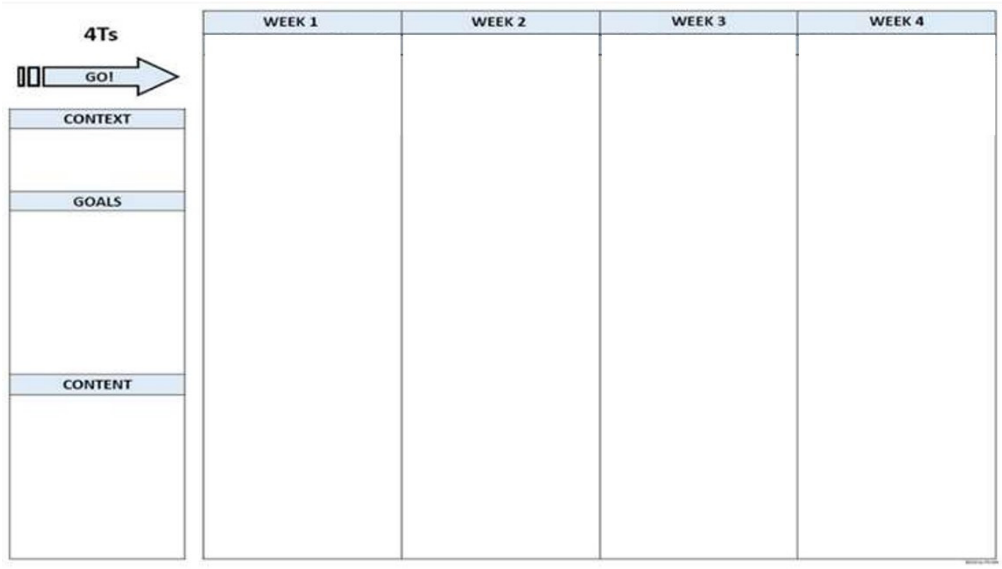

Figure 2. The game board.

The four colored card decks contain cards indicating the Tasks (red), Team configurations (yellow), Technologies (green), and Techniques (light blue) (see Figure 3). All the cards, regardless of the deck they belong to, share a common structure: they contain a short description of the particular element they represent, and highlight suitable associations with cards in other decks. For instance, the Forum card in the Technology deck suggests appropriate team configurations and some learner tasks befitting the use of a discussion forum.

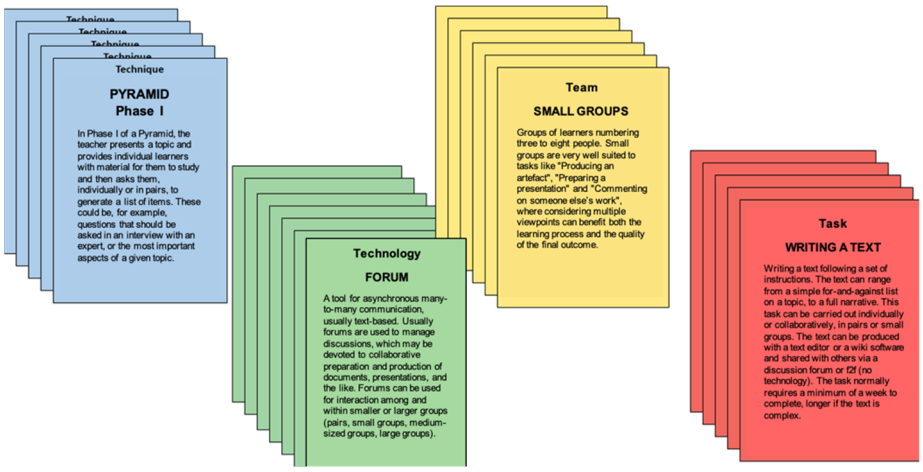

Figure 3. Cards of the game.

The two technology-enhanced versions of the game, i.e., digital and hybrid, were developed after the initial paper-based release, to provide an automatic feedback mechanism with respect to the choices made by the players, thus making the game independent of the presence of a human tutor to assist the players.

To play the game, teachers grouped in teams of 4–6 players gather at a board, be it tangible (tabletop) or digital (projected on an Interactive Whiteboard—IWB). They start by collaboratively defining the context, objectives, and contents of the nascent student learning activity, inserting this information in the related fields on the left-hand side of the board (see Figure 2).

They then start looking through the cards together, reading, discussing, and analyzing them. They negotiate suitable design decisions and select the appropriate cards to place on the board. As card after card is added, a coherent collaborative learning design emerges from group discussion. The output resulting from a session of the 4Ts game consists of the state of the board, with all the Technique, Task, and Technology cards appropriately positioned in the board slots.

The game setting differs depending on the version of the game being played (see Figure 4). As mentioned, in the digital version game interaction takes place exclusively on an Interactive Whiteboard (Figure 4A). By contrast, the hybrid version comprises a tabletop board and tangible cards, each with an identifying QR code; a camera positioned above the board on top of an adjustable stand reads these QR codes and their positions on the board, and replicates the whole configuration on a computer screen (Figure 4B).

Figure 4. Different game settings. (**A**) Teachers playing with the digital version of the 4Ts game. (**B**) Teachers playing with the hybrid 4Ts game.

When playing the digital version, teachers use the touchscreen features to interact with the game and obtain feedback from the system. When playing the hybrid game, they manipulate paper cards on the tabletop board but receive input and feedback from a computer placed on the table alongside the board (see Figure 4B).

The type of feedback being provided by the system is determined by the level being played, which is chosen by players at the start of the game session. Level 1 (entry-level) features more system guidance and support and implies using (and starting with) the Techniques deck. In Level 1, the system expects players to follow a technique closely and provides feedback to ensure that players do not deviate from the technique (e.g., if they select the Pyramid, the system will expect progressively larger Teams). Additionally, the system provides feedback on theoretical incompatibilities between the Team, Task, and Technology cards (e.g., choosing individual study as a Task, but small groups as a Team, is considered an incompatible combination). Level 2 (advanced level) is less railroaded and involves skipping the Techniques cards and playing only with the Task/Team/Technology decks, with the system providing feedback on theoretical incompatibilities only among these card types. Level 3 (expert level) is not scaffolded and the design process is completely free of constraints.

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While the digital and hybrid game versions share the abovementioned features, obviously user interaction with the system is significantly different in the two modes: as already mentioned, in the digital format, interaction takes place through the touch screen functionality of the IWB (see Figure 4A), while in the hybrid format, players manipulate tangible cards and then look at the computer to check for feedback (see Figure 4B). Moreover, the digital format has a bespoke function for calling up "board checks". By contrast, in the hybrid format, players activate the same function by placing specific "action cards" on the board: this means they obtain the system feedback without having to use a mouse or touchscreen, in such a way that their gameplay experience is seamlessly tangible.

3.2. Context and Methods

The two instances of the 4Ts game investigated in this study have been developed and tested within the PLEIADE and SuperREDprojects, two recent initiatives funded under the EC Erasmus + program.

As part of these two projects, two training initiatives were held, targeting in-service school teachers. One took place in Sofia (BG) in October 2022 and the other in Genoa (IT) in November 2022. These also provided the (quasi-)experimental context for the game. As a consequence, the participant sampling was not at random, as teachers were volunteers, attending the training initiatives offered by the projects. We believe the wide geographical distribution of participants helped avoid cultural biases, while teachers' interest could have possibly generated bias in favor of game-based training, but not in favor of either of the formats compared in this study.

Overall, the cohort of participants was composed of 36 females and 7 males (43 participants). Participants were on average 41.6 years old (min = 23, max = 68) with an average of 14 years of teaching experience. In terms of educational qualification, 13 declared they have a bachelor's degree, 27 have a master's degree, 2 have a Doctorate/PhD, and 1 did not answer. Amongst the participants, 18 are primary school teachers, 14 teach at the Lower secondary school, 5 declared they teach at the Primary but also at the Lower secondary level, 2 of them teach at the Upper secondary and 4 of them did not specify the school level.

The two events shared similar objectives, contents, and structure. Specifically, they began with a project-team presentation about collaborative learning, after which participants were divided into groups (about 4–5 people each) and started playing the game. Both digital and hybrid settings were available and the assignment of groups to either setting was random.

Prior to the respective events, participants were asked to fill in a questionnaire to collect data about their profile and to capture their initial knowledge about how to design collaborative learning activities (pre-test). At the end of the event, a post-test was administered to collect data about participants' resulting knowledge. Additionally, a final survey was proposed to gather self-reported data concerning several factors: opinions on the 4Ts model (6 items on model acceptance); opinions on the game version they used (13 items on game acceptance, in terms of ease of use and usefulness); and overall user satisfaction (3 items). Survey responses were expressed on a Likert-type scale ranging from 1 (not at all) to 5 (completely). In addition, some open-ended questions were also included, so participants could provide personal comments on their game experience. Thus, both qualitative and quantitative data were gathered and subsequently analyzed following a mixed-method approach.

The pre- and post-tests were anonymous, but a code was used to associate individuals' pre-test and post-test data. Participants' consensus was obtained before any data collection, in line with current EU regulations. Overall, 15 teachers played the digital game and 27 played the hybrid version, so a total of 42 pairs of questionnaires were collected. In the following section, we present the results of our analysis.

4. Results

4.1. Self-Reported Data

The survey data were analyzed using unpaired sample *t*-tests to compare responses from participants who played the digital game with those who played the hybrid version. The results, presented in Table 1, show that there are minimal differences between the two groups. Only two statistically significant differences were found. One is the perception that the 4Ts model could be useful for the systematic design of collaborative activities (learning paths), which is higher for participants who played the digital version ($t(36.91) = 2.61$, $p = 0.013$). The other is the perception that the game is easy to use, which is substantially higher for participants who played the digital version $t(33.96) = 3.75$, $p < 0.001$).

Table 1. Means, standard deviations, and *t*-test results for each survey question related to teachers' responses to the 4Ts model and game (Likert scale: low = 1, high = 5). ** = $p < 0.01$, *** = $p < 0.001$.

	Survey Item	Digital Game Group	Hybrid Game Group	t	df	*p*-Value
Acceptance of the Model	The 4Ts are easy to understand	4.25 ± 0.45	4.07 ± 0.87	0.83	35.93	0.414
	The 4Ts are useful to design effective collaborative activities	4.42 ± 0.51	4.19 ± 0.92	1.00	34.78	0.324
	The 4Ts are useful to systematically design collaborative activities	4.75 ± 0.45	4.15 ± 0.99	2.61	36.91	0.013 **
	The 4Ts are useful to design sharable collaborative activities	4.50 ± 0.52	4.19 ± 0.92	1.35	34.53	0.185
	The techniques are easy to understand	4.17 ± 0.83	4.04 ± 1.09	0.41	27.37	0.688
	The Techniques are useful to de-sign effective collaborative activi-ties	4.58 ± 0.51	4.26 ± 0.71	1.60	28.83	0.120
Acceptance of the Game (Hybrid and Digital)	Understanding how to play the game was easy	4.08 ± 0.67	3.81 ± 1.06	0.97	32.22	0.338
	Interacting with the game was easy	4.08 ± 0.90	3.69 ± 1.12	1.15	26.47	0.261
	Using the game is useful to design effective collaborative activities	4.25 ± 0.75	4.28 ± 0.89	0.11	25.45	0.916
	Using the game is useful to sys-tematically design collaborative activities	4.42 ± 0.79	4.12 ± 1.01	0.97	27.31	0.340
	Using the game is useful to design sharable collaborative activities	4.11 ± 0.78	4.08 ± 1.18	0.08	21.87	0.938
	The indications contained on the cards regarding possible links with other cards are easy to understand	3.56 ± 1.01	3.64 ± 1.19	0.20	16.49	0.840
	The indications contained on the cards regarding possible links with other cards are useful to produce coherent designs of collaborative learning activities	3.89 ± 0.93	4.04 ± 1.08	0.40	16.74	0.693
	The tips contained on the cards regarding inclusion are easy to understand	3.80 ± 0.45	4.00 ± 0.63	0.61	8.83	0.556
	The tips contained on the cards regarding inclusion are useful to trigger reflection on inclusion fea-tures/potential of the designs	3.80 ± 0.45	4.00 ± 0.63	0.61	8.83	0.556
	The layout of the board and the cards is easy to understand	4.42 ± 0.51	4.12 ± 0.99	1.23	35.35	0.227
	The game interface is easy to un-derstand	4.83 ± 0.39	3.96 ± 1.02	3.75	33.96	<0.001 ***
	The feedback provided by the game was easy to understand	4.42 ± 0.67	3.96 ± 1.19	1.51	34.72	0.139
	The feedback provided by the game was useful to produce coherent designs of collaborative activities	4.20 ± 0.92	3.89 ± 1.15	0.85	20.21	0.405
Satisfaction	Playing the game is engaging	4.50 ± 0.80	4.07 ± 1.11	1.36	28.92	0.185
	Playing the game motivates me to use the 4Ts	4.17 ± 0.83	4.07 ± 1.07	0.29	26.90	0.773
	I am satisfied with the support provided by the game to design collaborative activities	4.08 ± 0.90	4.11 ± 1.01	0.09	23.68	0.933

Analysis of the responses to the open-ended questions revealed a generally positive reaction to the game, especially the function of providing guidance in the design process, which is usually very complex:

"I like the game because it provides the teachers a guide to design the contents and the method for collaborative lectures." (GOA#r3)

"I think it's very easy and useful. It helps in the design, which is often complicated. Thank you!" (GOA#r4)

"It is useful to organise an activity because it 'forces' you to think about a correct way to plan activities, tools and interactions." (GOA#r17)

"Enriched my knowledge about using new methods for designing lessons, that will be very useful in my pedagogical career." (SOF#r9)

In terms of teachers' acceptance of the game experience, they say the following:

"I think it is very funny and useful at the same time." (GOA#r2)

"I am completely satisfied." (SOF#r3)

"The game is very engaging and it is clear to use." (GOA#12)

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"The game is very engaging and it is clear to use." (GOA#12)

At the same time, one teacher points out an interesting aspect, by saying the following:

"It is not a game, but a tool, and as such, it's good." (GOA#r9)

4.2. Pre-Test Post-Test Data

As far as knowledge gain is concerned, items measuring knowledge were analyzed by counting the number of correct responses in the pre- and post-tests, for a total of five questions repeated in both tests, administered to the two groups at slightly different times. Blank or "I don't know" responses were coded as incorrect. The total scores from the pre and post-measurements were compared, with the version of the game used as a predictor of the extent of the change.

Knowledge increased significantly between the pre- and post-test for both the digital and the hybrid game groups. Specifically, for the digital game, we observe a pre-test score of 1.68, and a post-test score of 4.01, while for the hybrid game group, the scores are 1.48 and 3.45, respectively. While the difference between pre- and post-test is statistically significant ($F(1, 37) = 76.25$, $p < 0.001$), the interaction of game version used and time of measurement is not ($F(1, 37) = 0.52$, $p = 0.477$), suggesting that participants in both groups increased their knowledge, but neither group benefited from the intervention more than the other.

5. Discussion

This study presents a game that was created for and used in the context of teacher training initiatives to develop in-service teachers' learning design skills. The nature of this game is, per se, an innovative feature of this study, given the paucity of research outcomes in the field of games for training teachers (rather than teacher training on serious games), combined with the scarcity of hybrid serious games in general [11,12,18]. From an interaction design perspective, the hybridization of board games is a relatively unexplored area, and the few games produced so far predominantly "seem to simply propose the juxtaposition of devices and applications that move, or at best expand, the gaming experience to the digital context" [4]. This is certainly not the case for the 4Ts game.

In addition, we believe there are several considerations to be drawn from our experience that could contribute both to the educational research field, as well as to the scientific debate about hybrid board games, particularly when deployed in educational settings.

First of all, our results suggest that using games for teacher training does have potential, a potential that is rather unexplored, as testified by prior systematic literature

reviews [11,12,18], revealing a dearth of experiences in which games are used in the context of teacher training, not to speak of hybrid games.

Moreover, in contrast with the most common approaches described in Meredith [12], where it seems specific games are proposed in teacher training with the sole purpose of having teachers adopt the same games in the classroom, in this study, the game is used exclusively for training teachers and fostering the development of teachers' design skills. In addition, while the majority of studies reported in the three aforementioned literature reviews [11,12,18] target pre-service educators, the 4Ts game targets (and has been tested in) the field of in-service teacher training.

The collected data provide evidence not only at the level of teachers' attitudes and reactions to the game, but also regarding teachers' knowledge development. In this respect, our data show a significant knowledge gain after the experience and this indicates the game was useful for its intended purposes. No statistically significant difference in terms of knowledge acquisition emerged between those who used the digital game and those who used the hybrid version.

Nonetheless, we wish to point out one aspect that should be considered in relation to this result: given the nature of the training events, which were occasional, it was not possible to collect follow-up data to see, for example, whether, and to what extent, teachers' learning design practice benefited from the training. So, while the intervention was essentially aimed at triggering skills, we were able to collect quantitative evidence only about knowledge acquisition, and we acknowledge this is a weakness of the study.

With respect to teachers' attitudes and reactions towards the game, we observe that the board game was very well accepted, both in its digital and hybrid formats, and that this is in line with other studies reporting the positive impact of using games in teacher training [11]. This should encourage further adoption of games in such contexts.

In addition, if we focus on the differences in reaction to the hybrid and digital game versions, we observe that statistically significant differences emerge for two survey items, namely (i) the perception that the 4Ts model is useful for systematically designing collaborative learning paths (higher for participants who played the digital version), and (ii) the perception that the game interface is easy to understand, which is substantially higher for participants who played the digital version. For all the other items, we observe there are a few survey items where the trend is for the hybrid game to be less favorably received than the digital version, and the mean score—although high—is below 4. These items are as follows: "Understanding how to play the game was easy"; "Interacting with the game was easy"; "The feedback provided by the game was easy to understand"; "The feedback provided by the game was useful to produce coherent designs of collaborative activities". While these findings suggest that the hybrid game interaction design was somehow less effective than the digital version, in none of the abovementioned items was the difference between the two formats statistically significant; we believe this may be due to the low number of participants in the study. So, in the future, we encourage further studies to collect more evidence so as to better understand the differences in acceptance (if any) between digital and hybrid games.

Overall, in the specific case of the 4Ts game, the survey items seem to suggest the digital game outperforms the hybrid version mostly concerning interaction design factors. In this regard, we should point out that the stage of development of the hybrid format was a bit less mature with respect to that of the digital, and this might have impacted—at least to some extent—the perceived ease of use of this format. In any case, this result should lead to caution in the field, as it should not be given for granted that the greater technological complexity of cutting-edge hybrid games does not always necessarily pay off in terms of ease of use.

6. Limitations of the Study

This study presents research conducted on a serious board game developed into two formats for the purpose of training teachers. The study presented some limitations:

- The sample was limited in number and participants were recruited following a convenience approach; this of course should be mitigated with other enlarged studies;
- The introductory lecture given to introduce participants to the notion of collaborative learning and to the 4Ts model did not cover the design choices the game is supposed to foster; nonetheless, we cannot exclude some of the participants' knowledge gains derived—at least to some extent—from this lecture and this suggests the necessity to repeat the experiment, possibly with a control group, who is only exposed to the lecture without game usage;
- Due to the one-spot nature of the training events, it was only possible to evaluate the participants' knowledge gain and not the improvement of skills (if any). This is also something we should try to improve with future experiments;
- The stage of development of the digital and the hybrid format was not equally leveled; during the experiments, the setting of the hybrid version revealed a couple of bugs that might have affected the perceived ease of use of this format; again, in this case, this should be mitigated with additional experiments.

To address these limitations, we are scheduling other experiments.

Moreover, in terms of future developments, we would like to point out we are currently working to integrate a scoring system in the game, aimed at making the game experience for teachers even more "playful" and engaging.

7. Conclusions

In this paper, we present an experience in using a board game in the context of teacher training. The game is intended to develop teachers' ability to design collaborative learning activities for their students.

The study was exploratory in nature: it was based on a quasi-experimental approach and the number of participants was not high, so it is not really possible to generalize the results. Nonetheless, we believe we can identify some interesting lessons learned and make recommendations for future research.

First of all, drawing both on the literature in the field and on our results, we believe the potential of using serious games in teacher training should be studied and exploited further, especially when games are created and used with the explicit purpose of triggering teachers' learning, engagement, and motivation. This should happen not only in the context of pre-service teacher training but also in in-service professional development initiatives. We also believe board games hold significant potential in this area, as in our experience, the activity was perceived to be not only useful for learning purposes but also fun (and therefore motivating).

In terms of interaction design, although participants did not explicitly mention any particular issue in using either the digital or the hybrid game versions, and the collected quantitative data did not point to any particular problem; it seems the hybrid version enjoyed slightly lower acceptance levels. It is too early, though, to attribute this result to the nature of the game, as the usability of the hybrid version was sometimes hindered by factors like the alignment of the camera with the board.

All in all, however, both versions were judged to be "transparent" enough to the user, thus allowing smooth interaction in both cases. Nevertheless, we should recognize the presence of tutors in both training events, who were on hand to help in case of technical issues, especially when bugs emerged with the setting of the hybrid game.

To conclude, the 4Ts game proposed in this study and positively received by teachers and can be regarded as an initial response to the gap identified in the literature about the lack of serious games (board games in particular) specifically developed for teacher training. The 4Ts game represents a board game to familiarize teachers with the design of collaborative learning; importantly, teachers, and *not* students, are the end users, making it an innovative tool for teacher training. The other added value that can be recognized in the game lies in it being one of the first experiences of the same game developed into two

different formats (digital and hybrid), thus allowing a comparison between the two and opening the doors to further research in the field of interaction design.

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