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CHANGING THE LEARNING ENVIRONMENT: TEACHERS AND STUDENTS' COLLABORATION IN CREATING DIGITAL GAMES

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ABSTRACT

Aim/Purpose	The current study examines the impact of an intervention program to train teachers to collaborate with their students while creating digital games.
Background	Teachers seem unable to leverage the potential of ICT to present students with a rich learning environment. ICT integration is usually at a relatively simple and concrete level without changing the traditional teacher-student paradigm.
Methodology	The study is both quantitative and qualitative. Participants were 63 active teachers studying in the M.Ed. program at a teacher education college. The teachers responded to a series of pre- and post-questionnaires and wrote a concluding reflection.
Contribution	Teaching based on creating digital games, combined with teacher-class collaboration, is a viable and real alternative of constructivist teaching, adapted to different learners.
Findings	The SEM path analysis showed that it was only after the intervention that the lower the teachers' resistance to changing teaching patterns, the higher their intrinsic motivation to learn an innovative pedagogical-technological program and likewise the sense of mastery of 21st-century skills, resulting in a positive attitude towards classroom collaboration. The qualitative findings

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	reveal eight categories dealing with two main themes: the first is professional development, including conceptual, behavioral and emotional change, and the second is the teachers' perception of the learners.
Recommendations for Practitioners	Teacher training should be ongoing in order to change teaching-learning processes and promote an active approach based on constructive principles, 21st-century skills and collaboration between teachers and students in a computer environment.
Recommendation for Researchers	Future studies should start by sampling teachers and education professionals who have convenient access to technology in their teaching-learning environment.
Impact on Society	Collaboration between teachers and students in creating learning games in a computer environment and teacher-class collaboration, in general, require very different training than that which exists today. Hence there should be some rethinking of teacher training. The proposed pedagogical model is one such idea in the right direction.
Future Research	A larger study with a greater number of participants, including a control group, should be conducted.
Keywords	collaboration, digital games, 21st-century skills, teacher training, professional development, intrinsic motivation, resistance to change

INTRODUCTION

During the second decade of the 21st century, a clear trend of incorporating ICT (information and communication technologies) into teaching and learning is becoming ever more apparent (Pérez-Sanagustın et al., 2017; Selwyn, 2013; Voogt, Knezek, Christensen, & Lai, 2018; Wasserman & Migdal, 2019). One of the challenges is to bring about a fundamental change in the perception of education while moving from traditional learning to adapted and relevant learning (Howard & Mozejko, 2015). Technological tools are powerful because of their ability to present different levels of abstraction and demonstration in the teaching process, thus enabling learning and learning improvement in a variety of ways. However, studies show a lack of consistency in improving the teaching methods, students' learning habits and academic success in the different disciplines following the adoption of these technologies. Teachers seem unable to leverage the potential of ICT to present students with a rich learning environment. ICT integration is usually at a relatively simple and concrete level (Halverson & Smith, 2010; Simsek & Sarsar, 2019; Voogt & Knezek, 2008; Voogt et al., 2018), without changing the traditional teacher-student paradigm. Therefore, the purpose of this study to prepare teachers to take advantage of the potential of ICT through a new mode of teaching, which breaks away from the traditional structure of teaching and learning; that is, to create a shared learning environment for teachers and students. The study examined an innovative training program that was part of the M.Ed. curriculum, based on the principles of the constructivist approach, where the teaching practice was learning based on the creation of digital games through educational game generators. The program aims to offer innovation in learning and teaching beyond disciplines and age groups. The main program goals were to promote active and meaningful learning among students by creating digital games and to examine the implementation of a pedagogical model in which students and teachers collaborate to design and create digital games. The importance of the research lies in transforming the game generators from teaching tools in the hands of the teachers into a collaborative learning environment for them and their students. So far, few studies have been conducted to provide evidence of the impact of educational innovations based on game creation on the development of skills and abilities (An, 2018; Wu, 2018b); the aim here was to assess their intrinsic motivation and their sense of mastery of 21st-century skills vis-à-vis teachers' resistance to change. The assumption was that these variables can predict the degree of collaboration between teachers and their

students in creating digital games. In addition, the reflections written by the teachers at the end of the intervention program may provide insight into the responses and feelings of the students after their experience in the program.

LITERATURE REVIEW

TEACHING AND LEARNING THROUGH EDUCATIONAL GAME GENERATORS

The importance of creating teaching/learning games in new environments has been discussed quite a bit over the past decade (Connolly, Boyle, Boyle, MacArthur, & Hainey, 2012; Kim & Park, 2018; Schrier, 2018; Whitton, 2014; Wu, 2018a). As mentioned above, integrating game creation into learning enables one to harness the game for teaching purposes and add it to the K-12 learning continuum (Prensky, 2008). According to Kafai (2006), it is possible to distinguish between two approaches to teaching in combination with game generators in learning. One is an instructional approach in which students play a game prepared for them by their teacher or by a content specialist. In this approach, the game is designed for the practice of specific content knowledge. The game environment provides a goal for a game that is not the learning itself, but rather the success at playing the game. To succeed at the game provided by the teacher, students need to use various skills and show that they are knowledgeable about the subject being taught or practised through the game. The second approach is based on constructivist principles; that is, students create their own game using a game generator. The game environment presents a set of intuitive rules and tools that enable learners to understand the rules of the work environment relatively quickly and easily and to build a custom game activity together that is appropriate for a certain purpose and audience. Integrated learning activities through digital games call for a wide range of learning skills, such as training and practice, independent search for and location of information, research and knowledge construction, and the acquisition of higher-order thinking skills (Jong, Lee & Shang, 2013; Romero, Usart & Ott, 2015). Whereas the use of pre-prepared game learning may be limited in terms of its ability to implement the acquired knowledge in new and variable situations and in terms of its ability to provide students with opportunities for creating knowledge, the use of game generators allows independent development of educational games by the learners and thus expands the potential inherent in integrating games into studies.

The proposed development of digital games is done through educational game generators (such as Kahoot!), which are tools that allow users to create games on a template database into which you can 'pour' content and change as needed (Baytak & Land, 2010; Wu, 2018a). Having students create games turns them from simply reacting to a stimulus, from "practicers" and trainees, to developers and creators, that is to say, from information consumers to information producers. The learning of the students and the teachers through the creation of games is active by definition, combining process and product and implementing constructivist principles such as the transfer of responsibility to the learner (Weitze 2015; Yang & Chang 2013; Yiannoutsou, Kynigos & Daskolia, 2014), and therefore develops the joy of creativity as well as original and critical thinking (Ejsing-Duun & Karoff, 2015; Lim, 2008; Liu, 2018; Prensky, 2008; Yang & Chang, 2013).

21ST-CENTURY SKILLS

Teaching and learning in the current study were tested through the application of an innovative pedagogical model combining guided development of six skills required in the 21st-century:

(1) *Collaboration*: the extent to which students are required to share responsibility and make substantive decisions with other people; the extent to which their work depends on each other.
(2) *Knowledge construction*: the extent to which students are required to construct and apply interdisciplinary knowledge and information.
(3) *Self-regulation:* the extent of long-term active learning and the extent to which students plan and evaluate their work and correct it based on feedback.

(4) *Communication skills:* the extent to which students are required to communicate with peers and express their ideas about a concept or subject, the extent to which the media requires the support of means and appropriate design for the intended audience.
(5) *Use of ICT for learning*: the extent to which students use ICT to support knowledge construction and the extent to which students design an ICT product for an appropriate audience.
(6) *Problem solving and innovation*: the extent to which students are required to solve real and authentic problems and the extent to which the solution is innovative.

The model is based on the international 'Learning Design in the 21st Century' program, which aims to help teachers in planning lessons that integrate the development of 21st-century skills in various disciplines (SRI, 2016). Studies indicate that the program promotes meaningful learning and academic achievement (Fullan & Langworthy, 2013). A study involving 203 teachers found that the process of structuring student knowledge in an online environment is influenced by the teacher's mastery of ICT skills (Magen-Nagar, 2016). Another study found that the teachers realized that digital games could help students develop 21st- century skills, and therefore teachers should be involved in the process of game design (An & Cao, 2017). The structure of the pedagogical model is shown in Figure 1.

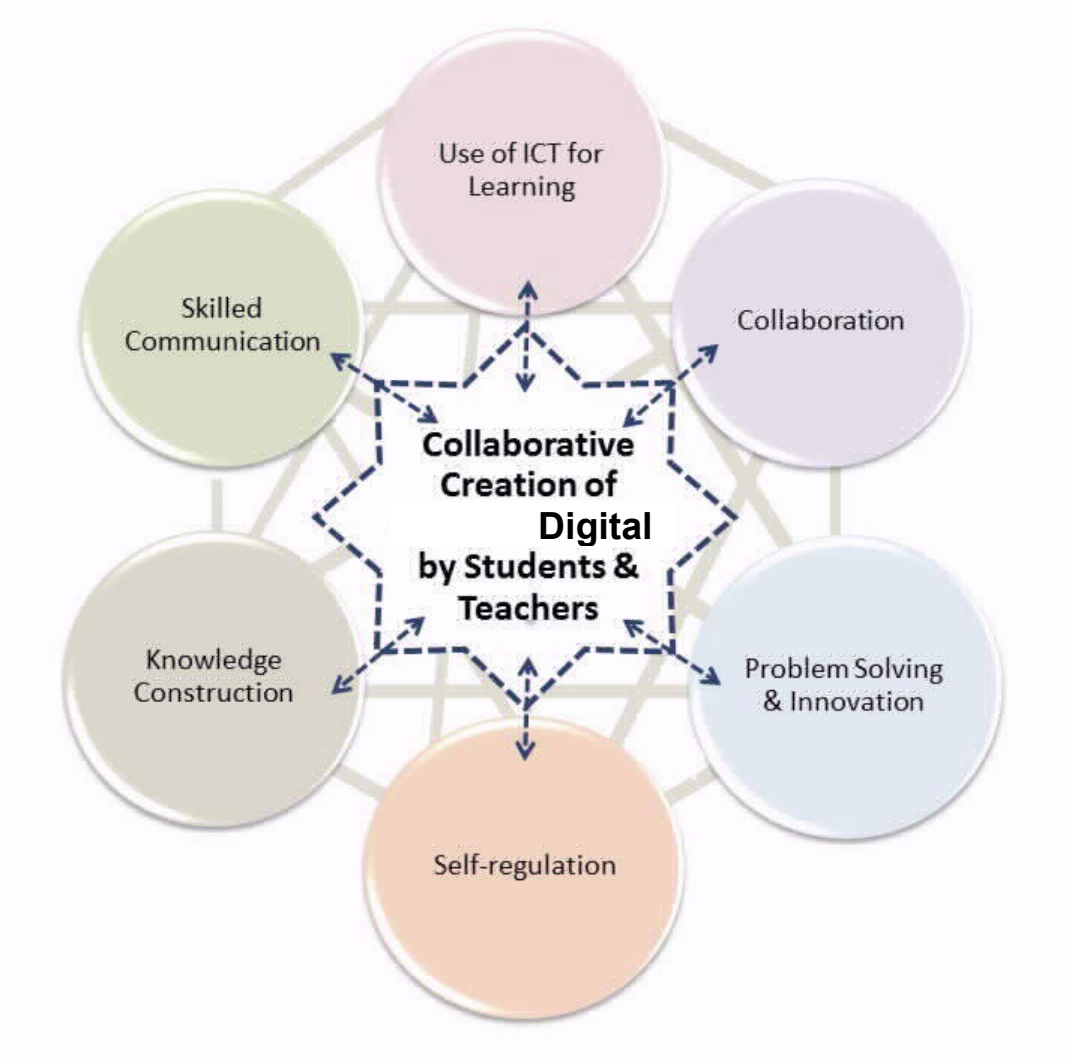


Figure 1. The pedagogical model

Collaboration

According to Johnson and Johnson (1999), cooperative learning has five interrelated characteristics: positive interdependence, personal accountability, useful interaction, social skills and a group process. Cooperative learning usually occurs in a small group of students. In this study, cooperative learning occurred in a small group, which included students and their teachers. Naturally, the cooperation that took place between teachers and students presented opportunities for discourse and communication that was unlike traditional discourse, since they occurred within a different kind of activity and relationship.

Collaborative learning is constantly on the rise due to technological changes (Shonfeld & Gibson, 2019). Previous research also found that computer use affected the level of collaborative learning (Magen-Nagar & Steinberger, 2017). The assumption in the present study is that the use of ICT by students and teachers through digital games using generators enables the development of the six 21st-century skills (including ICT). A meta-analysis of 629 other studies found that in situations of positive interdependence, students' achievements and motivation increased relative to situations of negative interdependence or non-dependence (Johnson, Johnson, Roseth & Shin, 2014). The level of interdependence results largely from the quality of the interaction between the teacher and each student and between the members of the student group.

Previous research found that peer assessment discourse among children improves the development of the game they create, promotes motivation and 21st-century skills (Hwang, Hung & Chen, 2014). The combination of creating digital games based on game generators and developing collaborative skills is a unique component of the pedagogical model proposed here. In the process of creating the game, the learning group, teacher and students, deal with specific knowledge in the discipline studied, and process it into content units in the game. The teachers and students use cognitive and metacognitive thinking skills requiring decision making, choices and planning at various levels, such as content or categories to be included in the game; the level of difficulty/complexity of the game; how to present the game content (pictures, texts, illustrations, etc.). In such a process, the teacher learns how the students think and inserts questions and explanations accordingly, and the students learn how to construct knowledge in the discipline in question. The game generator environment is one where students use computer skills and information, including skills in the generator environment (e.g., reading and writing) and other computer tools (such as sketching with the Paint tool, searching for photos online, doing calculations in Excel and managing folders to store content to be included in the game).

Intrinsic Motivation

Intrinsic motivation is assessed according to the theory of self-determination (Ryan & Deci, 2000), based on the humanistic approach. The theory explains the processes that lead learners to persevere with their studies and assumes that all people have three basic psychological needs: the need to connect and belong, the need for a sense of efficacy and the need for a sense of autonomy. Meeting these needs leads to the development of people who have intrinsic motivation, which enables them to function optimally, attain personal growth and social development. Teachers were tested for their motivation to use innovative learning and teaching according to indices of intrinsic motivation: pleasure and interest, a sense of efficacy, a sense of autonomy and a sense of calm. Studies engaged in designing digital games by students have shown that intrinsic motivation and a sense of efficacy in 21st-century skills were significantly associated (Baytak & Land, 2010; Hwang et al., 2014). A study of teachers' experiences in developing digital games found that interaction with other teachers contributed to developing a better understanding of digital games (An, 2018). According to the theory of cognitive evaluation (Deci & Ryan, 1985), which is a sub-theory of the theory of self-determination, interpersonal events such as communication, discourse, and feedback, can contribute to a sense of competence during an activity, and can enhance the intrinsic motivation to action by addressing the

basic psychological need for competence (Deci & Ryan, 2012). We can, therefore, assume that collaborative activities can enhance intrinsic motivation.

Resistance to Change

Resistance to change is a common phenomenon in schools, mainly because of the profusion of proposals and programs for change as well as the profusion of technological innovations that teachers must adopt. This resistance is seen in the literature as a complex phenomenon that requires attention when attempting to identify its sources, some of which may be overt and others covert (Oplatka, 2015). In many situations, we can identify more than one possible resistance factor, for example, difficulty in coping with information overload (Chen-Levy & Shahar, 2015). This requires investment at the stage of teacher training (Howard & Mozejko, 2015), since the teacher training frameworks themselves are characterized by limited time and information overload and are often accompanied by latent objections that may lead to a decrease in learners' motivation. Thus, it seems that one of the ways to reduce resistance and stimulate motivation is to accompany teachers in the practice of technological development and its operation in active and collaborative learning environments. Studies that examined the impact of training for digital game integration in the classroom found that after the intervention program, the teachers were more motivated and less resistant or afraid to use games (An, 2018; An & Cao, 2017; Liu, 2018).

The Role of Digital Games in the Teaching-Learning Process

Although there is evidence that many teachers are opposed to the intensive use of technology, the research literature attests to the increasing use of digital games (Reinders, 2012; Voogt et al., 2018). Researchers believe that this is because digital games mediate between five key concepts: teaching goals, interaction, feedback, context and motivation (Reinhardt & Sykes, 2014). Their argument is that digital games can be powerful tools and can provide an alternative learning environment for complex thinking activities (Ke & Grabowski, 2007; Kebritchi & Hynes, 2010). Through the game, the activity becomes experiential, creative and enriching, and yet it is still an integral part of the learning process (Robertson & Howells, 2008). With digital games, learners can participate in fun activities that help them engage in challenging assignments without worry, derive support from personal, immediate and rewarding feedback from the game system. The varied games they create allow other students to learn independently anytime and anywhere, while receiving feedback and a pace for playing, which helps them think about effective solution strategies. In general, digital games are agents of innovation (Boyle, 2011) and are a central part of critical processes of creating, establishing, building and applying significant knowledge in different disciplines. Consequently, game-based learning is a powerful pedagogical strategy that can be integrated into the curriculum, but only if teachers receive the necessary training and support (Martins & Oliveira, 2018).

The Intervention Program (Teacher Training)

The study's intervention program is based on a multi-stage process that combines teacher training and training of students in developing digital games that match the curriculum. The teacher training was conducted as part of an academic course for a master's degree in learning theories. The process had three stages. First, teachers were taught how to plan innovative teaching-learning-assessment activities based on learning theories (such as constructivist, cognitive and connectivist theories), which are meaningful for understanding the level of game (Connolly et al., 2012; Wu, 2018a). The teachers were introduced to the pedagogical model of the study and learned to use digital game generators and to develop a variety of learning games using them, with no time limit or room to play. Second, the teachers planned activities that integrated the use and creation of digital games through the generators in their classes, taking into consideration the elements of the pedagogical model described above. In the third stage, the teachers implemented the model and developed games with students, which constituted a designated infrastructure for the collection of information in different disci-

plines. As stated, the teacher training was for all age groups and included preschool teachers. Although the training was intended for people who work in education in general, we should point out the differences between preschool teachers and school teachers, because in terms of both the children and the teachers, these are two different and completely separate age groups and two different learning environments (Bassok, Latham & Rorem, 2016; Uibu, Kikas & Tropp, 2011). This factor was taken into account both in the program and in the study.

The Research Goals

The training program was accompanied by the research presented here, which focused on two goals. The first was to examine the impact of a teacher training program on learning together with students by creating digital games. The second was to examine the teachers' perception of the training process and their subsequent experience with the students.

The research hypotheses were: (1) The level of resistance to change in teaching patterns will be lower after the intervention than at its start; the level of intrinsic motivation for learning an innovative technological-pedagogical program and the sense of mastery of 21st-century skills and classroom collaboration (among preschool teachers and with other teachers) will be higher after the intervention than at its start. (2) As teachers reduce their resistance to changing teaching patterns, so will they raise the levels of their intrinsic motivation for learning an innovative technological pedagogical program and feel they have mastered 21st-century skills, and thus, classroom collaboration (among students and with the teacher) will increase.

METHOD

The study was conducted in one college of education, following an internal case study approach, in which one can learn about a general phenomenon from a particular case that has been studied extensively (Stake, 2006). The research setup resembled an intra-subject experiment, integrating both quantitative and qualitative methodology. The qualitative part complements the quantitative research and may expose those internal factors that often remain hidden in quantitative research, or that find no expression in it (Eckert, 2013; Frank, 1998). The combination of the two research methods may contribute to a profound and meaningful understanding of the pedagogical change examined here.

Participants

The participants in the study were 63 teachers, of whom 62 were women and 1 was man, all were students in the M.Ed. Learning Theories course. The teachers were all professional and already teaching preschool and up to high school. About one-third of the teachers (38%) taught preschool, more than one third (40%) taught in elementary school and a quarter (22%) taught in middle and high school. Most of the teachers taught in the general education system (78%) and the rest in special education (22%). Fifty-four teachers were Jews (86%) and 9 teachers were non-Jews (Muslims and Christians) (14%). Most of the teachers taught in Jewish schools (75%) and the rest taught in Arab and Druze schools (25%). The average seniority in teaching was 9.86 (SD = 1.25).

Research Tools

In order to achieve the first objective of the study, four questionnaires were used:

(1) *Resistance to change questionnaire* - based on resistance to change and developed by Goldrat (2001). The questionnaire contained 16 statements. It was adapted to the needs of the study and examined teachers' level of resistance to implementing the pedagogical-technological model in the classroom. The reliability of the questionnaire at the beginning of the intervention was α =.88 and after the intervention α =.86. Free factor analysis was carried out, raising three indices: lack of confidence in the pedagogical model, lack of personal desire to use the model and difficulty in adapting to it.

(2) *Motivation questionnaire* - based on Ryan's shortened intrinsic motivation questionnaire (Ryan, Koestner & Deci, 1991) and containing 22 items. It was adapted to the needs of the study and examined the participants' level of motivation to take part in the training program. The original questionnaire has four indices: 1. Pleasure and interest. 2. A sense of efficacy. 3. A sense of autonomy. 4. A sense of calm. The reliability of the questionnaire at the beginning of the intervention was α =.89 and after the intervention .α =.92.

(3) *21st-century skills questionnaire* - developed as part of the research and based on the definition of skills in the 'Learning Design for the 21st Century' international program (SRI, 2016), on which this research is based. The questionnaire examined the teachers' sense of personal mastery of 21st-century skills: collaboration, interpersonal communication, self-regulation, knowledge construction, using ICT in learning, problem solving and innovation. The reliability of the questionnaire at the beginning of the intervention was α =.95, and after the intervention -.α =.95. Free factor analysis was carried out and raised three indices: problem-solving and smart use of ICT, information processing and collaboration in the group.

(4) *Cooperative learning questionnaire* - developed as part of this study and based on collaboration questionnaires (Capdeferro & Romero, 2012; So & Brush, 2008). The questionnaire examined the teachers' attitudes towards the nature of cooperative learning in their classroom during the process of creating digital games. The reliability of the questionnaire at the beginning of the intervention was α =.75 and after the intervention α =.87. Free factor analysis was carried out and five indices emerged: collaboration between students, teacher support, communication difficulties among the children, the quality of the group work and the nature of communication between the teacher and the group.

The extent of the respondents' agreement with the statements in all the questionnaires was based on a five-point Likert scale (1 - I do not agree at all, 5 - I agree to a very great extent). In addition, teachers responded to demographic questions, such as gender and seniority in teaching.

Reflections written by the teachers at the end of the intervention program were used to achieve the second goal of the study.

Research Procedure

The study was conducted during the 2017-18 school year as part of an M.Ed. semester-long distance course in the Department for Teaching, Learning and Training entitled 'Learning Theories'. The study accompanied the course curriculum, which was built by researchers specializing in teaching and learning. The intervention program of the study was presented to the students in the course and was implemented once their consent had been obtained. The students were asked to complete the online self-report questionnaires at the beginning and end of the intervention. Completion of the questionnaires took about 20 minutes.

In addition, at the end of the intervention program, the teachers were asked to write their reflections and send them to the course instructor via the course's Moodle website. It was made clear to the teachers that there was no obligation to participate in the study and that the use of the data would be solely for the purposes of this study and that no further use would be made of it.

Results

Part 1 - Quantitative

To examine the research hypotheses, first Pearson correlations between the research variables were calculated at the start and the conclusion of the intervention (Table 1).

Table 1. Pearson coefficient matrix for the research variables at the start and conclusion of the intervention (N=63)

		Resistance to changing teaching patterns	Intrinsic motivation to learn innovative pedagogical-technological program	Sense of mastery of 21st-century skills
Start of intervention	Resistance to changing teaching patterns			
	Intrinsic motivation to learn innovative pedagogical-technological program	-.555**		
	Sense of mastery of 21st-century skills	-.441**	.498**	
		-0.23	.515**	.303*
End of intervention	Resistance to changing teaching patterns			
	Intrinsic motivation to learn innovative pedagogical-technological program	-.719**		
	Sense of mastery of 21st-century skills	-.625**	.627**	
		-.501**	.541**	.500**

**P<.05; **P<.01*

Table 1 shows that there were strong significant correlations between most of the research variables at the start of the intervention and that at the end of intervention these correlations had strengthened.

In order to test the first research hypothesis, i.e., that following the intervention the level of resistance to change would be lower than at the start, and that levels of motivation and the sense of mastery of 21st-century skills would be higher than at the start, two way ANOVA for Repeated measures–Mixed design measures were conducted. One independent variable, "between-subjects" was type of participant (preschool teachers/teachers) and another independent variable, "within-subjects" was time (start/end). The basic goal of a two way ANOVA mixed design is to examine if an interaction between the "within variable" and the "between variable" on the dependent variable can be found (resistance to change, intrinsic motivation and sense of mastery of 21st-century skills). The results of the variance analyses are presented in Tables 2 and 3.

Table 2 shows that there are significant differences in the resistance to changing teaching patterns, intrinsic motivation to learn an innovative pedagogical-technological program and classroom collaboration between the start and the end of the intervention for all participants. The level of resistance to changing teaching patterns was lower following the intervention. Also, the levels of intrinsic motivation to learn an innovative pedagogical-technological program and teacher-student classroom collaboration were higher after the intervention than at its start. No significant difference was found for the sense of mastery of 21st-century skills at the start and end of the intervention.

Table 2. Results of repeated measures at the start and end of the intervention (N=63)

	Start of intervention		End of intervention		Gap effect	
	M	SD	M	SD	**F** (1,61)	η^2
Resistance to changing teaching patterns	1.71	0.48	1.60	0.43	8.56**	*0.123*
Intrinsic motivation to learn innovative pedagogical-technological program	3.63	0.55	3.74	0.64	5.49*	*0.083*
Sense of mastery of 21st-century skills	4.14	0.54	4.10	0.54	.09	*0.01*
Classroom collaboration	3.34	0.36	3.44	0.49	4.39*	*0.067*

**p<0.05, **p<0.01*

Table 3. Results of the interaction between the type of participant and the difference between at the start and end of the intervention

	Preschool teachers (N=24)				Teachers (N=39)					
	Start of intervention		End of intervention		Start of intervention		End of intervention		Participant type X gap	
	M	SD	M	SD	M	SD	M	SD	**F** (1, 61)	η^2
Resistance to changing teaching patterns	1.81	0.52	1.61	0.49	1.65	0.45	1.60	0.39	3.26	*0.051*
Intrinsic motivation to learn innovative pedagogical-technological program	3.63	0.59	3.90	0.52	3.62	0.54	3.64	0.70	4.22*	*0.065*
Sense of mastery of 21st-century skills	4.14	0.58	4.20	0.55	4.13	0.51	4.05	0.53	1.52	*0.024*
Classroom collaboration	3.39	0.36	3.53	0.42	3.31	0.35	3.38	0.53	.41	*0.007*

**p<0.05*

The effect of the interaction between the type of participant and the gap between the start and end of the intervention was found to be significant for intrinsic motivation. In other words, the gap in intrinsic motivation between the start and end of the intervention was greater among preschool

teachers compared to teachers. As to the variables, the gaps found between the start and end of the intervention for the preschool teachers are similar to those for the teachers. One can see that among the teachers the sense of mastery of 21st-century skills did not change between the start and end of the intervention compared to the other variables. Figure 2 illustrates the interaction between the type of participant and intrinsic motivation to learn an innovative pedagogical-technical program.

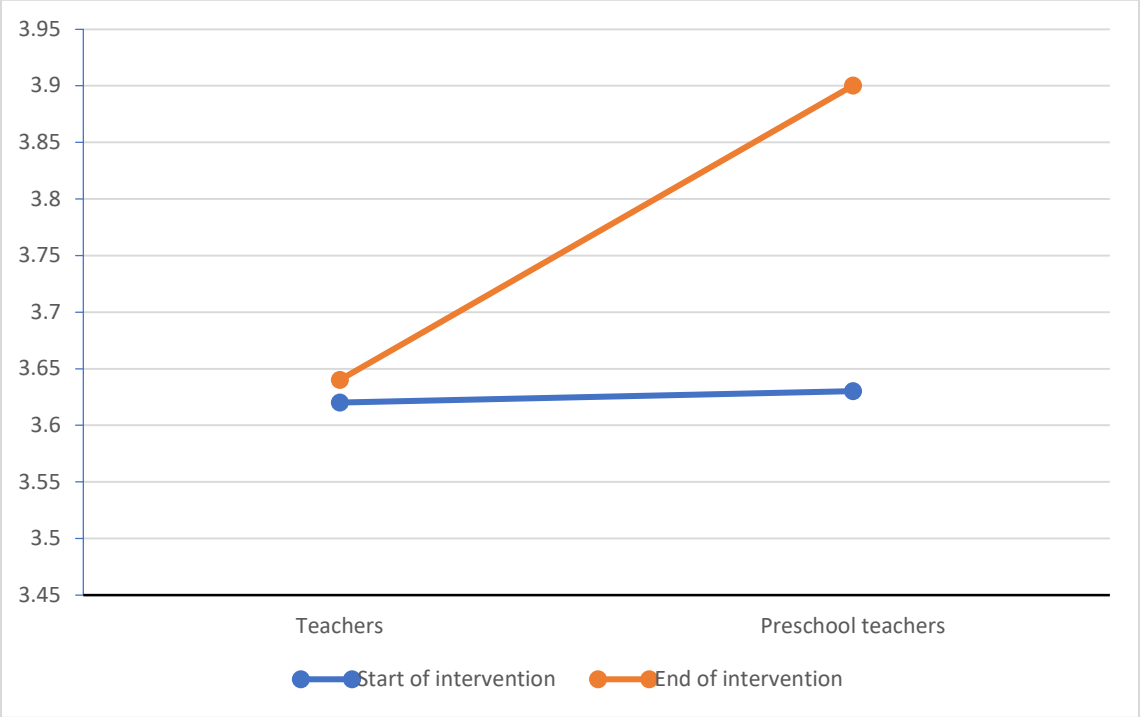


Figure 2. Interaction between participant type and intrinsic motivation

In order to examine the second research hypothesis concerning the impact of the training program for teachers on collaborative learning with their students through the creation of digital games at the start and end of the intervention, two SEM path analyses were conducted using AMOS (Analysis of Moment Structures) 25.0 statistics software (Arbuckle, 2017; Blunch, 2008). This analyzes multivariate data in a graphic environment and is used to test a complex model containing a number of variables or a range of dependencies between the variables (Byrne, 2010). The model was built based on the literature review. The variable of 'resistance to change' was defined in the model as independent; 'intrinsic motivation' and 'sense of mastery of 21st-century skills' were defined as mediators and the dependent variable was 'collaboration'. The analysis examined the contribution of the independent variable and of each of the mediating variables to predicting classroom collaboration.

The first stage of the SEM analysis is the assessment of the measurement model via the four indices of χ^2, RMSEA, NFI and CFI, which serve to test the model that best fits reality (Bentler & Bonett, 1980). The lower and non-significant the value for χ^2, the better the model fits reality (Hoyle, 2012; Kline, 2010). When the RMSEA value is 0.05 or lower, it indicates a good fit, when the value is 0.08 or higher, it indicates an error in the structure, and when the value is higher than 0.1 the model must be rejected. The closer the NFI and CFI values are to 1, the better the fit (Byrne, 2010; Hoyle, 2012). The results of the measurement model are presented in Table 4.

Table 4. Fit measurements of the model to predict classroom collaboration

Fit measurements	Recommended	Measured	
		Start of intervention	End of intervention
χ^2	p > .05	0.651	0.943
χ^2 / df	< 5	0.651	0.943
CFI	>.90	1.000	1.000
NFI	>.90	0.990	0.991
RMSEA	<.08	0.000	0.000

The fit indices presented in Table 4 show that the models are very good and suited to the research data at the start and end of the intervention. In the second stage, the SEM model was evaluated to classify the effects between the variables as shown in Figure 3 at the start of the intervention and in Figure 4 at the end of the intervention. Above the rectangles appear the percentages of explained variance (R^2) and above the arrows appear the standardized effect coefficients (β). Table 5 summarizes the standardized effect coefficients (β) between the model variables.

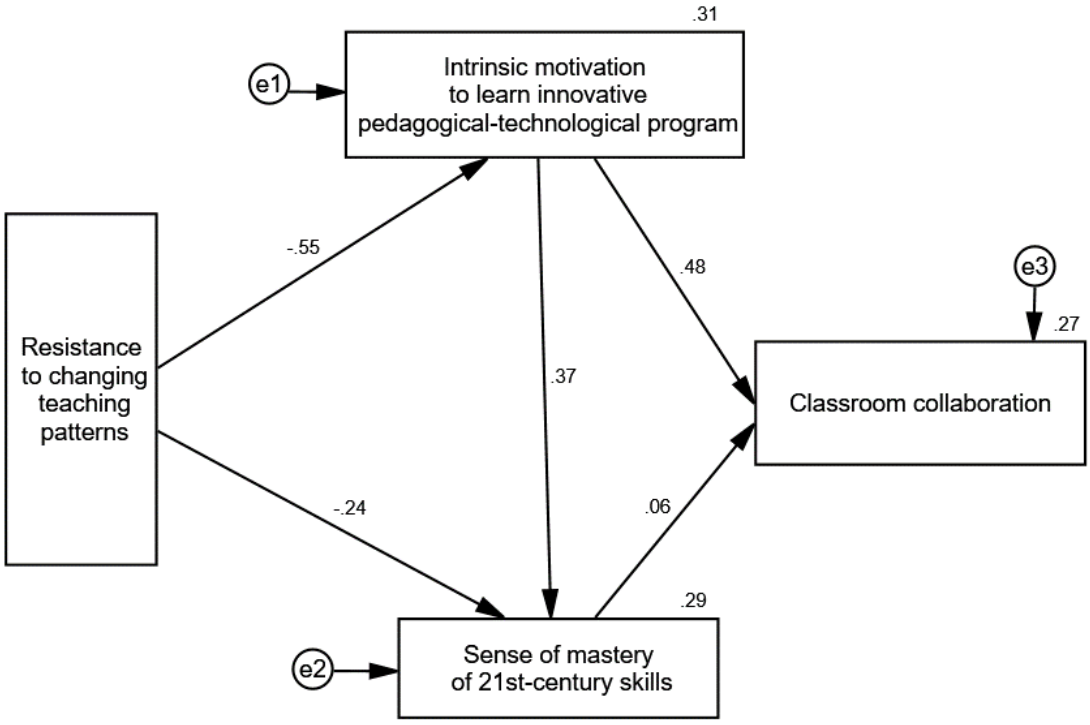


Figure 3. Path analysis results at the start of the intervention

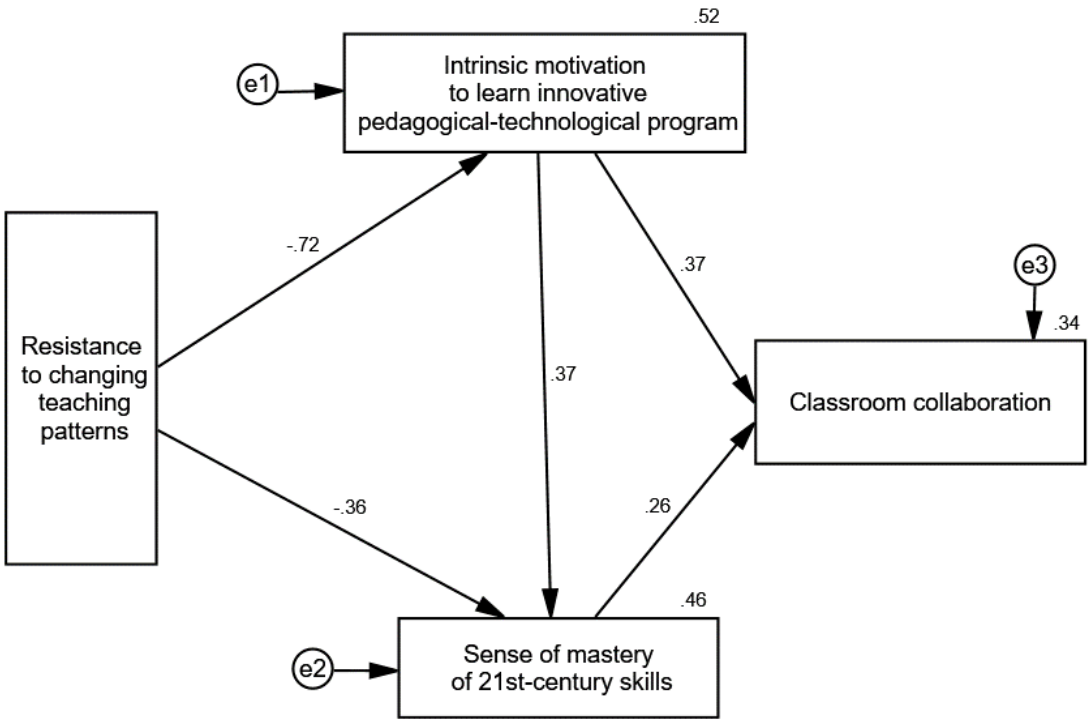


Figure 4. Path analysis results at the end of the intervention

Table 5. Direct and indirect effects between model variables – standardized effect coefficients (β) at the start and end of the intervention

	Resistance to changing teaching patterns		Intrinsic motivation to learn innovative pedagogical-technological program		Sense of master of 21st-century skills	
Intrinsic motivation to learn innovative pedagogical-technological program	Start of intervention -0.55***	End of intervention -0.72***				
Sense of mastery of 21st-century skills	Start of intervention -0.24	End of intervention -0.36**	Start of intervention 0.37**	End of intervention 0.37**		
Classroom collaboration			Start of intervention 0.48***	End of intervention 0.37**	Start of intervention 0.06	End of intervention 0.26*

Figures 3 and 4 show that the percentage of explained variance for each of the variables is higher after the intervention than at its start. At the start of the intervention, resistance to change explained about one-third of the explained variance of intrinsic motivation (31%) and following the intervention it explained about one half of the explained variance for intrinsic motivation (52%). At the start of the intervention resistance to change and intrinsic motivation together explained close to one third of the explained variance of the sense of mastery of 21st-century skills (29%), while following the intervention they explained together almost half of the explained variance of the sense of mastery of 21st-century skills (46%). Moreover, at the start of the intervention, intrinsic motivation and the sense of mastery of 21st-century skills explained together about one-quarter of the explained variance for classroom collaboration (27%), while following the intervention they explained about one-third of the explained variance for classroom collaboration (34%). Hence we may say that the factors included in the model explain at a good level (start of intervention) to a very good level (after intervention) each of the model components for predicting classroom collaboration.

In terms of the path coefficients, we can see in Figures 3 and 4 and in Table 5 that:

1. The 'resistance to change' variable had a significant and strong negative effect on 'intrinsic motivation' at the start of the intervention (β=-.52***) and that after the intervention this grew stronger (β=-.72***). In other words, at the start and the end of the intervention, the lower the teacher's resistance to changing their teaching patterns, the higher their intrinsic motivation to learn an innovative pedagogical-technological program.
2. The 'resistance to change' variable had no effect on the 'sense of mastery of 21st-century skills' variable at the start of the intervention (β=-.24), but afterwards there was a moderately strong negative effect (β=-.36**). In other words, it was only after the intervention that the lower the teachers' resistance to changing teaching patterns, the stronger their sense of mastery of 21st-century skills.
3. The 'intrinsic motivation' variable has a similar moderately significant effect on the variable of the 'sense of mastery of 21st-century skills' both at the start and the end of the intervention (β=-.37**). In other words, both at the start and the end of the intervention, the higher the teachers' motivation to learn an innovative pedagogical-technological program, the stronger their sense of mastery of 21st-century skills.
4. The 'intrinsic motivation' variable has a strong and significant positive effect on the 'classroom collaboration' variable at the start of the intervention (β=-.48***), which is slightly weaker after the intervention (β=-.37**). In other words, at the start and the end of the intervention, the higher the teachers' motivation to learn an innovative pedagogical-technological program, the more positive their attitude towards the nature of classroom collaboration.
5. The variable of the 'sense of mastery of 21st-century skills' had no effect on the 'classroom collaboration' variable at the start of the intervention (β=-.06), but after the intervention, a weak significant positive effect was found (β=-.26*). In other words, only after the intervention was it found that the stronger the teachers' sense of mastery of 21st-century skills, the more positive their attitude towards the nature of classroom collaboration.

The SEM analysis also shows the indirect effect of the 'intrinsic motivation' on the 'classroom collaboration' variable by way of the 'sense of mastery of 21st-century skills' variable; at the start of the intervention there was no effect (β=-.06), but after it there was a significant effect (β=-.37**). Thus, we can say that at the start of the intervention the variable 'sense of mastery of 21st-century skills' was not a mediating factor between 'intrinsic motivation' and 'classroom collaboration'; in contrast, after the intervention the 'sense of mastery of 21st-century skills' variable was a direct and indirect factor for the level of collaboration in the classroom.

PART 2: QUALITATIVE

In order to learn about the participants' feelings during the training program in greater depth, they were asked to write a reflective letter at the end of the program about the stages of the process they had undergone. The 63 letters submitted underwent content analysis. Firstly, all written statements were counted, where a statement was considered to be a unit of content with a clear beginning and end. In total, there were 714 statements. In the second stage, the statements were sorted into categories with similar content. The sorting process was carried out by two readers independently of each other. The agreement between them was at approximately 89%. The third stage consisted of discussion about the content, resulting in a change of placement for ten of the statements. The final agreement between the readers reached 96%. The sorting process yielded eight categories. Table 6 presents the categories, example statements, the number of statements in each category, and the percentage of statements in that category in relation to the total number of statements. Figure 5 is a graphic presentation of the categories and their frequency percentage.

Table 6. Content analysis results of the teachers' written reflections

Category	Example statements	Number of statements	% of total statements
The students benefited from the experience scholastically, socially and emotionally	Constructing the game made the children feel more mature, smarter, more talented…; there was a very noticeable difference in their level of concentration on a digital assignment compared to a standard assignment in class; the generators are very helpful in learning, especially among students who find writing difficult;…the children corrected their friends' assignments, and verbally evaluated them for how they presented the generator, for their instructions, planning and execution; they undoubtedly underwent a change…, our interaction has become more personal, they were bolder about asking questions in class and about raising their hands when they didn't understand something.	166	23.25%
Anticipation of technical and pedagogical difficulties	It's hard to create technological games when you don't have the possibility; I found it hard to let go and allow them space. I kept directing all the time; with all the advanced technology, it's still hard for Grade 3 children to apply the technology in such an application; the major difficulty is change itself, new habits;…how to mediate the task without meddling so much, how to give them the assignment and allow them to conduct the process; we need more teachers in a classroom; we were short of time.	126	17.65%
Teachers' surprise on discovering students' abilities, motivation and insights	I was surprised to see the collaboration between the kids; I learned that they could plan their learning; I learned that they had a great motivation; I noticed that the kids were thirstier for a challenge while learning than I thought they would be; what I had not anticipated was that working together	120	16.81%

Category	Example statements	Number of statements	% of total statements
	would promote new interactions, which later became friendships.		
The experience constituted professional learning	I learned that you have to allow them to make choices in their learning process, show them you believe in them; the ability to accept criticism and move on, and sometimes develop your own critical thinking is an important skill for life; the program makes you come out of the box of books and notebooks; I got some ideas (from the children) and learned other things through them; the learning process is about connecting the theories with what's in the field. And I could distinguish between the real and the ideal.	112	15.69%
Self-discovery and self-reflection	I learned that I'm a perfectionist; I learned about myself things that are no less important: I know now that even if I have concerns, I'll still be able to perform the task; nothing happens if you lose control a bit; I learned that I was a bit afraid of activities and lessons where I don't have control over what will happen and how it would actually work, but while preparing the generator I let go a little and allowed the students to lead with me as one of them, and focus on the process and method, not just on the result; I learned I was very excited by what the children were creating, their energy motivates me much more than when I bring them things I initiated.	75	10.50%
Shifting role from teacher to peer	You don't have to know everything, you can learn with the children; I enjoyed listening to their insights; I enjoyed having them see me not as a teacher standing in front of 30 students and lecturing, but as a group member; we cooperated closely…; they saw that I, too, didn't know things and I, too, was learning and could make errors, and they found it surprising and fun.	70	9.80%
Sharing with parents	Some children included their parents in preparing the games; I felt that the students' and the parents' engagement with the task united them as a group; I invited the parents to see and try out the learning products of the whole class.	30	4.20%
Post-activity student feedback	In order to improve the process, I recommend getting feedback at the end of the work; I would also ask for an emotional feedback at the end of the activity. The students might be having other difficulties than those that we, the teachers, can	15	2.10%

Category	Example statements	Number of statements	% of total statements
	see or observe.		
Total		714	100%

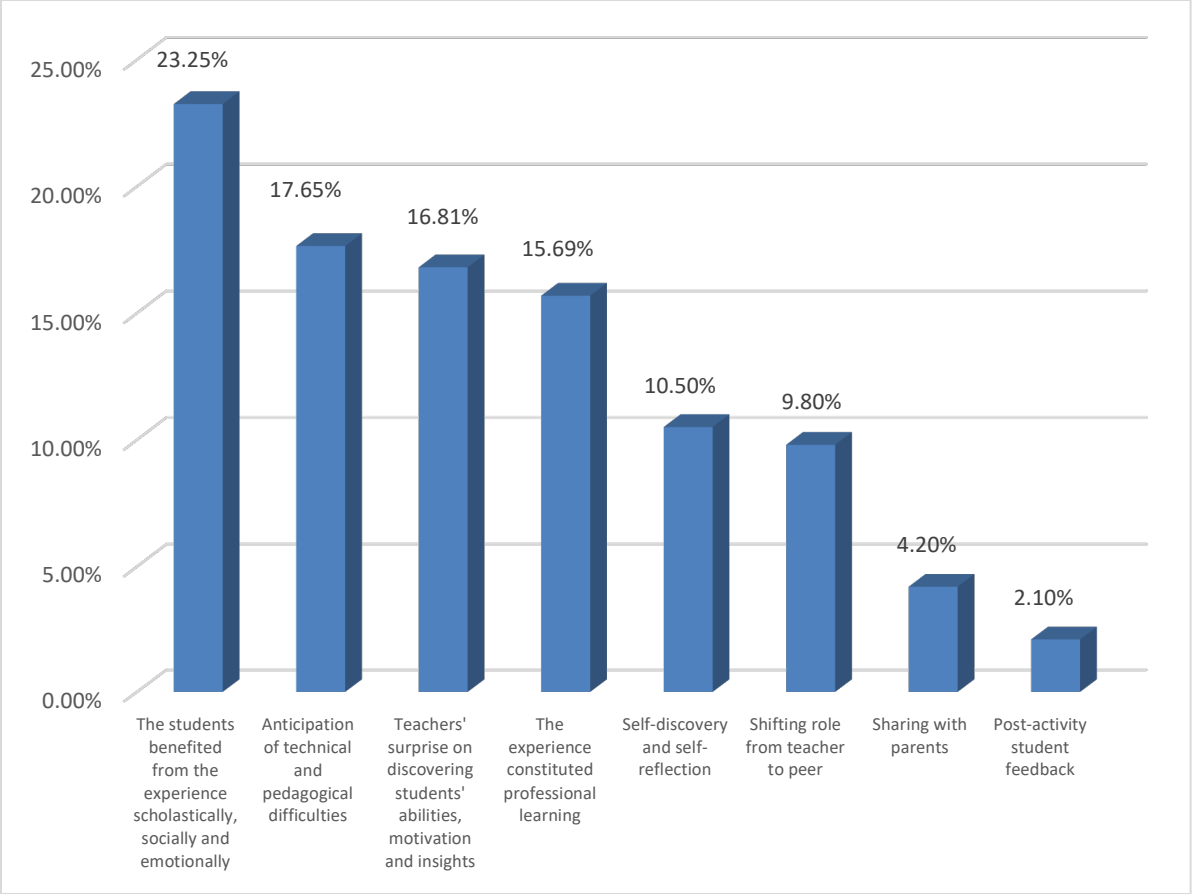


Figure 5. Category frequency of teachers' reflections

Table 6 and Figure 5 both indicate that the most prominent category in the analysis of teachers' reflections deals with the benefit that the students drew from the experience, and its frequency is the highest (23.3% of the statements). The next category with a relatively high frequency was 'technical and pedagogical difficulties' (17.7% of the statements). Another category with a relatively high frequency was 'surprise at the students' abilities, motivation and insights' (16.8% of the statements).

Students' Products – Games

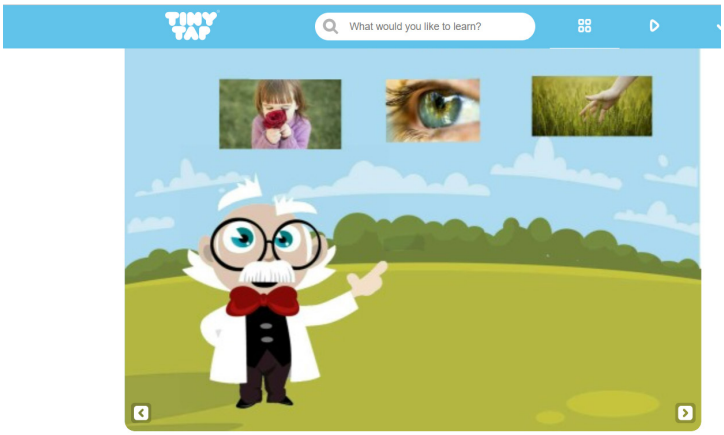
During the intervention program, the teachers and students produced 25 digital games in various disciplines such as language skills, tradition, mathematics and sciences. The generators used were: PowerPoint templates, Kahoot Quizizz, 100 to 1 , Quizalize ,Quizlet , ClassTools , Triventy , QRace , FlipQuiz , Jigsawplanet , Tiny tap , Trace & Go. It is clear that these generators are friendly and easy to operate, and sign-up is free of charge via Facebook, email and a password. Most of them appear in the mother tongue (Hebrew). In general, these games are designed to impart 21st-century skills (collaboration, communication problem solving, knowledge construction, computer use and self-regulation) and collaboration between the teacher and the students. The games produced were

designed to practice, apply and assess learning. The learning skills required ranged from the lower-order skill of recall to higher-order thinking of understanding and abstraction. Classroom activities involved several stages: 1. getting to know existing generator games and using them to learn content; 2. forming study groups according to areas of interest; 3. selecting a generator to suit the content and learning objectives; 4. defining the game objective; 5. writing game content; 6. creating the game; 7. assessing the game.

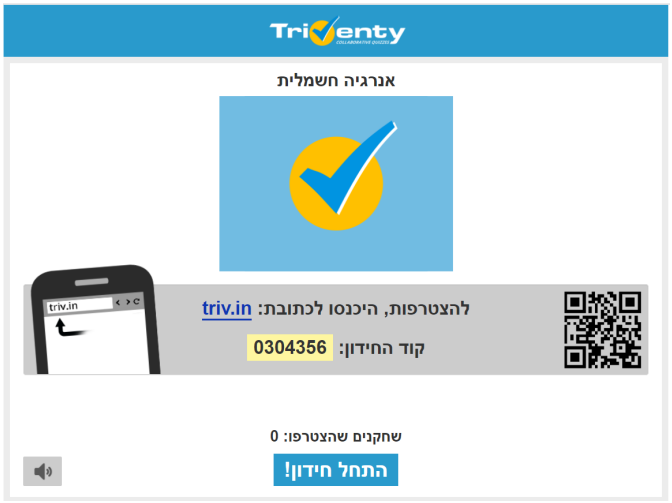
On average, 5 lessons were devoted to this activity, most of which took place in a computer lab or in a classroom with an iPad trolley.

Below are two examples of games:

1. Game topic: The body's sensory system (sciences)
    - Children's age/grade level: Grade 1, ages 6-7
    - Objective: students will know and recognize body organs and the five senses that help us interact with our environment
    - No. of students in group: 5
    - Game generator: Tiny tap
    - Technological device: iPad, tablet, mobile phone
    - Link to game: http://www.tinytap.it/activities/g2sz4



2. Game topic: Generating electricity (sciences)
    - Children's age/grade level: Grade 6, ages 11-12
    - Objective: students will answer new questions about sources and types of energy
    - No. of students in group: 4
    - Game generator: Triventy
    - Technological device: computers
    - Link to game http://www.triventy.com/host/0304356



DISCUSSION

Moving into an innovative pedagogical paradigm is a change in which the school adopts new patterns not previously encountered. The teacher, as a professional-pedagogical agent, is the first step in changing the perception of an innovative pedagogy (Selwyn, 2013; Wasserman & Migdal, 2019), and in the implementation of educational technologies (Hattie, 2009; Wu, 2018b).

The findings of the variance analyses and repeated measurements showed that the level of resistance to changing teaching patterns was significantly lower after the intervention compared to its level beforehand; also, the level of intrinsic motivation to learn an innovative pedagogical-technological program and the level of classroom collaboration (among the students themselves and between them and the teacher) were higher after the intervention than they were beforehand. These findings complement other study findings (An & Cao, 2017; Liu, 2018). The findings indicate that the intervention program created a positive conceptual change compared to the pedagogy that the teachers were familiar with. Such a change might instigate a different kind of attitude towards teaching in general, and towards innovative work oriented to the era in which their students live, in particular. It appears that the pedagogical model presented to the teachers helped them reorganize their professional knowledge, and combined with significant hands-on practice, enabled them to implement effective classroom collaboration, both among the children themselves and between the teachers and their students. Moreover, learning the pedagogical model, followed by a spiral training process (experiential learning at the college, teaching in their classrooms, learning from experience and advancing in the college), contributed to the teachers' skills, according to their testimony, and to gaining new insights and changing old habits. Howard and Mozejko (2015) argue that educational change can succeed if there is institutional support and a culture of change. In our case, the teachers were supported by the team of lecturers in the course.

For the measurement of the sense of mastery of 21st-century skills, no differences were found between the beginning and end of the intervention. In other words, after the teachers had learned the pedagogical model and experienced teaching-learning, while aiming towards developing the required 21st-century skills in a computer game environment, the sense of personal mastery of these skills did not change. It may be that due to the high level of the sense of mastery the teachers reported at the start of the intervention, there was not much room left for improvement (the ceiling effect) at its conclusion, which was relatively fast. The teachers' sense of mastery included skills of collaboration, knowledge construction, self-motivation, communication skills, use of ICT, problem-solving and innovative thinking, and it may imply that these teachers perceive themselves as experienced and have faith in their skills, which they think helps them impart these skills to their students in the best possible way which had also been shown in the research conducted by Simsek and Sarsar (2019).

Further examination of the correlations and influences found that it was only after the intervention that the lower the teachers' resistance to changing teaching patterns, the higher their intrinsic motivation to learn an innovative pedagogical-technological program and likewise their sense of mastery of 21st-century skills, and as a result the classroom collaboration (among the students themselves and with the teacher) increased. These findings reinforce the teacher training process and support the claim that digital games are agents of innovation, based on generators that offer students a different, active way to learn (Yang & Chang, 2013; Weitze, 2015; Yiannoutsou et al., 2014) and for teachers in professional development courses (An, 2018; Martins & Oliveira, 2018). One may assume that the nature of learning the pedagogical model, with an emphasis on teacher-student collaboration, led the teachers to assume greater responsibility in assessing their students' capabilities and make more informed decisions about adjusting the learning process to suit their students. Apparently, the intervention program reveals the future role of teachers as initiators - creative developers of learning activities in a computer environment (Kim & Park, 2018; Magen-Nagar, 2016). Hence, teacher training should be ongoing in order to change teaching-learning processes and promote an active approach based on constructive principles, 21st-century skills and collaboration between teachers and students in a computer environment.

The findings of the content analysis of the reflection letters written at the end of the intervention completed the picture in understanding the training process the teachers underwent. The teachers felt that the intervention program contributed greatly to the children. The hands-on learning together and preparing games added to the children's experience and acquisition of knowledge. Most of the teachers mentioned that while conducting the intervention program, difficulties of different kinds arose, in terms of the nature of the task: creating a digital game, organizing the learners to perform the task, collaborating with their students and not just instructing them, students' diversity in the class, relating to strong students rather than the challenging ones, and teacher's knowledge of how to manage the activity. Some teachers reported having difficulty in letting go of the need to direct the children's work all the time and in allowing them real choice.

An interesting category is that the teachers were surprised by the abilities shown by students in all areas, starting with academic skills, moving on to negotiation skills and fruitful discourse among the students themselves, and ending with creativity. This testimony supports the claim that frontal teaching prevents the teachers from getting to know their students and their true capabilities. Furthermore, frontal teaching prevents teachers from accurately assessing their students and cultivating a helpful attitude towards them (Hwang et al., 2014). It was only when the teachers sat down with their students in a group as equals, listening to their discourse, that they realized how capable they were of studying, thinking, planning and conducting conversations. This testimony appeared in the teachers' letters almost regardless of the children's ages. From the pedagogical perspective, this may be one of the most important points of this research, because it implies a great loss for the children, who are actually invisible in traditional frontal teaching. One may assume that teaching based on creating digital games, combined with teacher-class collaboration, is a viable and real alternative of constructivist teaching, adapted to different learners.

Another category showed that teachers felt the process they had undergone constituted a professional learning experience. They reported that from this experience they learned to develop a new attitude and set of priorities in their teaching work. They also wrote that they had learned just as much as about themselves as they had about their students, e.g., a tendency to be perfectionist, confidence in their ability, and perhaps most importantly - that they were able to relinquish control. These findings indicate that a learning environment containing an emphasized element of collaboration in general, and of shared technological development of teachers and students in particular, could give rise to teachers with high professional self-awareness. Such awareness is considered to be of the utmost importance for doing valuable work with children (Shachar, 2018).

Overall, one can see that the categories are divided into two main themes. The first is professional development that includes conceptual change (teachers perceived the experience as professional

learning), behavioral change (shifting role from teacher to peer) and an emotional change (self-discovery and self-reflection); the second is the perception of the learners (the students benefited scholastically, socially and emotionally, teachers' surprise at discovering students' abilities, motivation and insights, including the parents, and students' feedback at the end of the process). The most frequent category testified that the students benefited scholastically, socially and emotionally. This finding reinforces a previous study that showed that games designed by teachers tend to establish current theories of learning when the student is at the center of action (Liu, 2018; Yiannoutsou et al., 2014). In this study, the games were created by the teachers and the students together, thus adding to a holistic contribution that might be useful to students in other realms. Apparently, learning through the pedagogical model indeed enables acquisition of 21st-century skills (Jong et al., 2013; Romero et al., 2015), which include not only learning aspects, but also meaningful social and emotional aspects as well, so that they contribute to the learners' development of useful skills later on in life. Students acquire learning tools and develop skills and capabilities that can serve them in unfamiliar situations.

Research Limitations and Recommendations for Future Research

As a pioneer study, the current study has its limitations. Some of the participants encountered technological difficulties, when the computers and internet did not work continuously in their classrooms. Therefore, future studies should start by sampling teachers and education professionals who have convenient access to technology in their teaching-learning environment, and thus avoid the difficulties resulting from a school's lack of access to technology, or alternatively - run a parallel experiment with a control group, which does not work with game generators and ICT, but deals with collaborative teaching around game construction, with technology not functioning as a major variable. This would allow a separate examination of collaboration as a major value in teaching and learning, and the drawing of conclusions regarding its importance, compared to the importance of using 21st-century skills. Such a study might reveal that collaboration is more significant than the use of digital game generators, which were part of this study. Overall, a larger study with a greater number of participants, which would also include a control group should be conducted.

Another limitation has to do with the great heterogeneity of the research population since it included school teachers, preschool teachers, Jews, Druze, Moslems and Christians. Perhaps if we had made a distinction between them, some of the findings would be different. Our recommendation for a future study is to make a distinction between the various populations.

Conclusions

A number of conclusions can be drawn from this study. Firstly, the teacher training program and the hands-on experience were based on an innovative pedagogical model which managed to organize the new set of concepts they learned in the course, and to favorably affect the teachers' willingness to use and believe in the model, to discover intrinsic motivation within themselves, to master 21st-century skills and subsequently show positive attitudes towards collaborative learning in class. Secondly, the collaboration between teachers and students in creating learning games in a computer environment requires different training than that which exists today, including, among other things, active experience and constructivist learning based on the involvement of students and teachers alike. Thirdly and finally, the training program and the hands-on experience contributed to a positive change in the teachers' professional development in the context of perceiving the teacher's role in the classroom and involvement in the learning process. These conclusions lead us to suggest that the education system would do well to invest some thought and resources in teacher training for the improvement and promotion of innovative teaching, with the pedagogical model presented here being one such idea in the right direction.

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