

DEVELOPING GOOD PRACTICES TO FACILITATE THE INTEGRATION OF DIGITAL GAMES IN THE CLASSROOM: A DESIGN-BASED RESEARCH

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Abstract

Research shows that primary school teachers find it hard to select good educational games, and to find out how they can integrate these games in learning activities in the classroom to optimize learning for all pupils. Therefore, our research focuses on clarifying how to integrate digital games in the classroom. We conducted a design-based research in 4 primary schools in Flanders, involving 10 teachers and about 200 pupils. After analyzing the current situation, teacher design teams were put together for the co-design of learning activities integrating digital games. After an evaluation we iteratively improved these learning activities. This procedure led to 10 good practices and 4 design guidelines, that can help future teachers when developing learning activities with games.

Keywords: games, primary school, design-based research, co-design.

1 INTRODUCTION

Although primary school teachers in Flanders share a positive attitude towards ICT and believe in its positive impact on pupils' motivation, their use of educational games is rather rare ([1], [2]). Research shows that teachers lack pedagogical-didactical knowledge and support, which is necessary for the effective and efficient use of educational games in the classroom ([1], [3]). Teachers find it hard to select good educational games, and to find out how they can integrate these games in learning activities in the classroom to optimize learning for all pupils ([2]).

Therefore, our research focuses on clarifying how to integrate digital games in the classroom. As teachers explicitly need guidelines about this integration, our research does not focus on the development of games themselves, but on the design of learning activities including these educational games. Through this process of designing and testing learning activities, we aim to derive guidelines for teachers as well, to help them in the future when developing learning activities with games.

2 METHODOLOGY

The research approach used to fulfill the proposed research objective is the design-based research methodology, a well-known method in the field of learning sciences ([4]–[6]). This approach was chosen for three reasons. First of all, it was our aim to deliver both guidelines for the integration of digital games in the classroom and a set of learning activities including educational games. Therefore, the design-based research approach was seen fit given its goal to deliver both theoretical knowledge and a societal contribution ([7]–[9]). Second, throughout all phases of the design-based research, a collaborative partnership between researchers and practitioners takes place [10]. This characteristic was especially useful for us to bridge the gap between researchers and teachers when it comes to the use of digital games in the classroom. Finally, the research needs to be conducted in real educational contexts, and not in lab-settings [10], which we found appropriate to obtain the goals of our study.

2.1 Procedure and Participants

The procedure of design-based research, iteratively involves four sequential steps [8]: (1) the analysis of practical problems, (2) the development of solutions based on existing knowledge, (3) evaluation research of the solutions in practice, and (4) reflection to produce design principles. We conducted these four sequential steps involving 4 primary schools in Flanders, 10 teachers and about 200 pupils. This procedure is depicted in Fig. 1.

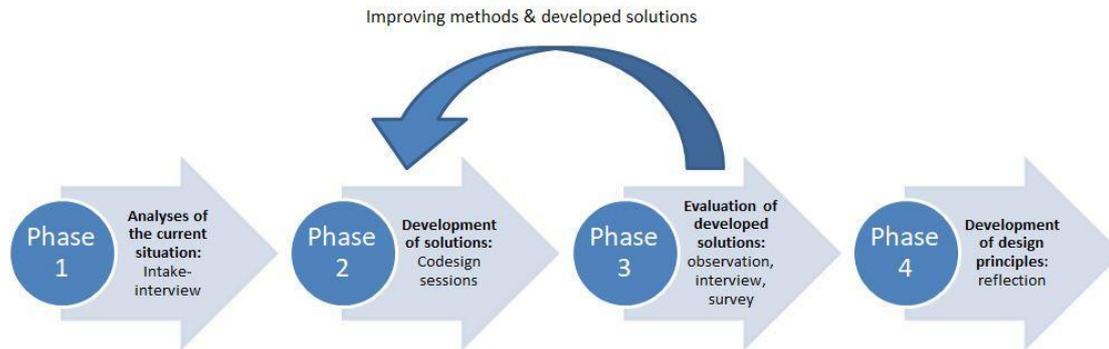


Figure 1. Procedure of the study.

2.1.1 Phase 1: analysis of the current situation

In a first phase, we analyzed the current situation and needs of these teachers by conducting an individual intake-interview in every school. In this interview, we tried to find out their current situation with regard to the use of digital games in the classrooms, the available digital infrastructure at the school, the available (ICT) support at the school, the (educational) needs of the teachers and the school, and the availability of professionals who could join the co-designsession in the second phase of the study.

2.1.2 Phase 2: co-design sessions

The co-design session involved the participation of one or two researchers, one or two teachers, and the (ICT)-management if possible. This way, we conducted 5 co-design sessions, one for every separate participating class.

Based on the results of the intake-interview, a specific starting point was taken for the next phase of the study, i.e. a co-design session to design learning activities with integrated digital games. The possible starting points were: (1) a narrowly defined subject that teachers preferred to teach (e.g., clock reading) (2) a broad learning goal (e.g., language learning) or (3) a specific game (e.g, minecraft education). In the first two cases, the co-design session was carefully prepared by the researchers, by a search for several digital games on the subject (about 10 games for every subject). These games were shown to two pupils of every participating class, to have an idea of their evaluation of these games. The results of these evaluations were included in the co-design session. When the starting point was a specific game, the researchers prepared the co-design session meticulously by exploring the opportunities of this particular game on didactical, pedagogical and technical aspects (e.g., accounts, installation,...).

The co-design session was organized using an adapted version of the appreciative inquiry methodology [11], starting from the following 4D-circle: Dream, Discover, Design and Deliver. At the start of the co-design session, all the participants first had to write down their *Dreams*: why would they use games in the classroom? Secondly, they had to *Discover* the list of games presented by the researchers, and analyze these games using a SWOT-analysis (strengths-weaknesses-opportunities-threats). This way, they had an idea of possibilities when the actual co-design session started. In this session, they had to *Design* a learning activity including at least one of the games they discovered and based on the dream they put forth. This learning activity included a description of the starting situation, the learning goals put forth, the separate lesson phases, the didactical formats used, and the media used. The co-design session was guided by the researcher, using cards with didactical information, that could be used to evaluate the designed learning activities (e.g., is the activity illustrative, activating, motivating, differentiating,...). Finally, a full learning activity was *Delivered*, which could be tested in the following phase of the design-based research.

2.1.3 Phase 3: evaluation research of solutions in practice

In a third phase, we carried out and evaluated these designed learning activities in the teachers' own, real-life classrooms. The evaluations were based on observation of the classroom activities, an

interview with the teacher and a short survey for the pupils. Moreover, we asked the teacher to have a discussion with their pupils, as to know whether they liked the learning activity, to have as much and as honest information as possible.

If possible, a non-participative observation was used, in which we focused on the involvement of the pupils, the motivation of the pupils, the problems encountered, the extent to which the lesson plan could be followed, and the timing. In some cases, the teachers did not feel comfortable giving the prepared learning activity. In these cases, we used a participatory observation, in which the researcher helped organizing the learning activity in the classroom. Moreover, every learning activity that was executed was filmed to allow the researchers to revise.

Based on these evaluations, we repeated phase 2, organizing another co-design session to improve the designed learning materials.

2.1.4 Phase 4: Reflection to produce design guidelines

Finally, based on all the results found, we propose some guidelines for teachers to integrate games in the classroom.

3 RESULTS

3.1 Phase 1: analysis of the current situation

We did an intake interview in every school. The results of these intake interviews can be seen in Table 1.

Table 1. Results of the intake interviews

| School | Age of pupils | Characteristics | Needs | Starting point |
|------------------|---------------|--|--|--|
| A (2 classes) | 9-12 | Huge diversity of pupils A lot of newcomers who speak a foreign-language Level groups for mathematics/language | Non-verbal, visual games. Seperate, individualized routes for pupils. | Game: minecraft education to integrate mathematics and world orientation |
| B (4 classes) | 9-12 | Traditional school with a lot of diversity between pupils. | Innovation Using games in class, during lessons. | Narrowly defined subject: clock reading, word classes |
| C (2 classes) | 10-12 | Alternative education Focus on self-regulated learning | Focus of the current and next year: languages. Problematic scores on the strands 'shapes and spaces' and 'measures' | Broad learning goal: language learning |
| D (2 classes) | 10-12 | Traditional education Ipad for every pupil | Efficient use of the tablets. | Broad learning goal: world orientation |

3.2 Phase 2: Co-design-session

3.2.1 School A

The teachers in this school, chose to start from a game, i.e. Minecraft education. They dreamed of using games to work on differentiation and self-regulated learning. The learning activity they designed was a course that consisted of Minecraft building assignments in which they practiced what was learned before: frontal view, side view, top view, groundplan. The assignments were given individually, with an increasing difficulty level.

3.2.2 School B

In this school, 2 design-teams were organized: one for the pupils of the 5th and 6th year of primary education (10-12 years old) starting from the narrowly defined subject 'word categories', and one for the pupils of the 4th year of primary school (9-10 years old), starting from the narrowly defined subject 'clock reading'.

In the first co-design team, the teachers dreamed of using games to facilitate the independent acquisition of information by the pupils and to differentiate between pupils. They developed a course consisting of 2 parts. In the first part, a minigame with instruction on word categories was played by the pupils. They had to signalize when finished, and wait for the teacher to control their results (summarized by the game) and to give them a go to start with the second part. The second part of the lesson consisted of a commercial game, in which a digital pizza needed to be made step-by-step. The accompanying assignment was differentiated over pupils. Those pupils having a high score in the first part of the lesson had to write a recipe of the pizza, and highlight words of all different word categories in this recipe. Those who had a lower score on the first minigame had to write words from the game in columns depending on their word category (e.g., tomato in the column of the nouns).

In this learning activity, it was tried to use the motivational aspects of a commercial game, and the educational aspects of a regular assignment.

The other design team designed a learning activity on clock reading. The teachers dreamed of using games to differentiate between pupils. Therefore, they designed a learning activity with 6 corners, some of which included minigames on clock reading (but not all of them). This created a blended learning situation, which allowed the pupils to choose a corner with an assignment in congruence with their own interests and preferences.

3.2.3 School C

In this school, the design team started from a broad learning domain, i.e. the Dutch language. They organized an activity that could be planned in an hour of independent working for all pupils. During this hour, half of the pupils (6 to 9 pupils) could play several minigames on several subjects (grammar, spelling, use of verbs,...) on a tablet, while the others independently made regular exercises. Those pupils who played the games, had to write the score of every exercise of the minigame on a piece of paper to inform the teacher about their progress. Afterwards, they switched places with the other pupils in the class. They were all free to choose between several minigames.

3.2.4 School D

The teachers dreamed of using games to motivate students and to let them work together in groups. Therefore, an activity was designed in which pupils had to work in groups of two with one tablet. The activity took 50 minutes, starting with a short demonstration of Geoguessr. In an educational conversation, they learned which criteria can help them to search for a certain place. Next, using GeoGuessr, they were 'dropped' somewhere in the world, and they had to find out where they were. For every place they were dropped, they had to fill out accompanying questions and tasks: mark this place on a blank map, write down the type of landscape and the earned points. At the end of the lesson, they had another educational conversation to discuss which criteria had helped them to find out where they were, followed by a short evaluation moment. During this whole lesson, the teacher guided the pupils, asked questions and motivated the pupils and their cooperative work.

3.3 Phase 3: Realization and evaluation of the designed activities

3.3.1 School A

The Minecraft building assignments learning activity was received well by the pupils of the two classes who participated. They liked the activity, especially using the computer and Minecraft education. The combination of play and learn (practice what they already learned) was very motivating. The pupil involvement and activity during the lesson was very high. Moreover, both the teachers who guided the learning activity were enthusiastic.

However, there were three main limitations for this learning activity. First, the group dynamic in the classroom was not good. Pupils destroyed each other's buildings. Second, the lack of ICT-materials at school caused a lot of technical problems. Some of the computers were outdated, as a result of which Minecraft did not work properly, increasing the importance of (technical) support during the class. Third, it was noted that the evaluation of the Minecraft building assignments took a lot of effort and was very time consuming for the teacher.

3.3.2 School B

The reception of the learning activity on word categories (i.e. minigame + pizzagame) in general was positive, both by pupils and teachers. Especially the use of the commercial minigame, which was much more 'game-like' for pupils than a minigame with gamified exercises, was evaluated as 'fun'. We conclude that it is possible to use 'fun', commercial games for educational purpose, if there is an accompanying assignment that increases the educational value.

However, it should be noted that the focus of this learning activity, i.e. independent acquisition of information, was not met by this learning activity. The instructions on word categories which were included in the minigame were not read by the pupils. Instead, they skipped all text parts and only read the gamified exercises. We conclude that it is at least necessary to develop a certain attitude on reading instructions if you want pupils to do this independently, even when a game is used.

One teacher also reported that the use of games during a full lesson is not desirable, and that a blended approach would be more appropriate.

The second learning activity (i.e., corners on clock reading) was also rated positively. We noticed a huge enthusiasm on the didactical approach. We also noticed that, as expected, not all pupils were drawn to the minigame-corners. Therefore we conclude that a blended approach is interesting if you want to use games to motivate pupils.

Moreover, we noticed that these kinds of learning activities require a responsible attitude of pupils, necessary to make independent choices on which corners they go to. This attitude should be developed and cannot be expected in young children without any consideration.

Finally, we noticed that the preparation time for this activity was huge, and the organisation was highly unrealistic in a classroom with one teacher if no researchers are attending.

3.3.3 School C

Pupils were very enthusiastic about the minigames, resulting in an active involvement during the lesson. The gamification of the minigames and the immediate feedback they receive for every exercise (e.g.: green check mark when a right answer is given) even increases this motivation. They are also motivated to ask for help if necessary.

However, again some pitfalls were noted. Pupils attach great importance to the score of the game, thereby being disappointed when random facts influence this score (such as accidental errors, accidental proceeding by touching keys,..). Moreover, the teacher noted that these games are not linked to learning goals, scores cannot be kept in easy minigames without accounts, and the teacher is absolutely necessary to support as there is no extra help or guidance when making mistakes.

3.3.4 School D

Pupils really liked the Geoguessr assignment and found it to be challenging. We noticed that they played it voluntary afterwards when they had some free time to work independently. The game allows the teacher to attain certain learning goals, such as map skills and problem solving, in an informal way. However, it is a bit harder to evaluate the learning progress of the pupils.

3.3.5 *General*

After this first round of co-design sessions, we could also evaluate our research methods. This is necessary because design-based research is characterized by the use of varying methods to meet new needs and issues that emerge during the process [11]. We noticed that the co-design sessions were very time consuming. We prepared a long list of games that could be used during the design session, but only discovering those games already took a long time for the teachers. Therefore, they often screened the games only shallowly. Moreover, they were often unwilling to proceed with new co-design sessions of the same length, forcing us to change our used methods.

Secondly, we noticed that teachers expected not only suggestions of the researchers, but they expected a ready-to-use learning activity. We therefore needed to find the balance between giving suggestions and allowing them to give input in the co-design sessions themselves.

3.4 **Phase 2 revised: improving the learning activities**

3.4.1 *School A*

The Minecraft learning activity was adapted to encounter the three limitations that were reported in the evaluation. To encounter the bad group dynamics in the classroom, two measures were taken: (1) all pupils worked in one Minecraft-world, and had to work together to build a city, with one computer for every two pupils, and (2) explicit rules were made about working together and about which buildings they should make (taking into account different functionalities), what measures they have, and where they should put them in the city. These adaptations of the organization of the Minecraft-assignment aimed to increase their social skills.

To encounter the technical problems, the course was well prepared: all computers were ready to use when the pupils entered the classroom. This improved the flow of the learning activity. Moreover, since there was one computer for every two pupils, the demands of ICT-infrastructure were lower than in the previous activity.

Finally, the effort for evaluation was also lowered by assigning tasks to duos of pupils instead of having individual tasks to evaluate. Moreover, at the end of the lesson, pupils had to present their results in front of the classroom and the city plan they made was evaluated based on the functionalities and the criteria that were put forth. Again, this decreased the evaluation effort for the teacher.

This activity was tested in the classrooms as well. Pupils were very creative, and took into account the rules about working together as a group. The activity appeared to be very interesting and informative. However, the activity took 75 minutes, which is too short to finish all the buildings in time. Moreover, the biggest problem was again technical: to work in one Minecraft world, all computers needed to have the same Minecraft version, which was not possible given the ICT-materials available at the school. A good preparation, so that all computers are ready to use and all pupils are logged in to start their assignment, is necessary to finish this activity in time.

3.4.2 *School B*

The teacher, who felt that a full lesson of games was a bit too much, designed new activities integrating games in one part of the lesson. In a co-design session, we developed a learning activity integrating the use of Hangman to revise French vocabulary at the start of a lesson, and another learning activity using Plickers to revise French Vocabulary at the end of the lesson (as evaluation). In both situations, a traditional classroom is sufficient to use the game (only a digiboard is needed for Hangman and a smartphone/tablet and a beamer for Plickers), while all pupils are simultaneously involved in one game. For Hangman, they were playing in teams (blended: they say a letter and the teacher taps the letter on the board), for Plickers they were playing individually (raising a Plickers-card in the classroom which is scanned by the teacher). Both activities were received very well by both pupils and the teacher.

Another teacher liked the use of the minigames for exercising (more than for knowledge acquisition, as we found that pupils did not read instructions). Therefore, in a co-design session, we developed a learning activity in which the pupils could independently exercise French grammar (*passé composé*) using Verbuga in a classical situation (every pupil has a computer). Again, both pupils and the teacher were very enthusiastic about the ease and added value of implementing this game in the classroom.

3.4.3 School C

This school dropped out because of time constraints. No new co-design session was organized.

3.4.4 School D

Since pupils and teachers were very enthusiastic about the motivating role of Geoguessr in the classroom, which was the dream they put forth, they wanted to go a little bit further down the road of using games for motivation. In a co-design team, we designed a new learning activity on a new subject, with new games. More concretely, a learning activity was created about space, with a game to discover the planets on a tablet and a VR game that allowed pupils to walk through space wearing VR-glasses.

This activity was tested, but the results were not as positive as they were in the Geoguessr game. Although pupils liked the games, they were only fun for a short period of time and they were not informative. Pupils and teachers felt like there was no educational value and it did not meet any specific learning goals. We conclude that accompanying assignments are very important to increase the educational value of games that might motivate pupils because of their 'fun-factor'.

3.5 Phase 4: towards guidelines

As mentioned in our introduction, teachers need guidelines about how to integrate games in the classroom. Therefore, we did not stop our research with the design of good practices, but we also distinguished four design-guidelines that can be used for future development of learning activities with integrated games.

3.5.1 Prepare for technical problems

Technical problems before or during the lessons are a nightmare for teachers. We especially noticed this when designing learning activities with Minecraft Education. When using games that are technically demanding, one should reconsider and take into account the fact that a good preparation is absolutely necessary. This is time consuming and sometimes requires some technical skills. Support of ICT-management at the school, or tech-savvy colleagues and good ICT-infrastructure are sometimes no luxury. However, not all games are technically demanding. Some minigames or small commercial games are easy to implement and more of an option for a lot of teachers. In most of our activities, technological problems were non-existent.

3.5.2 The accompanying assignments are of crucial importance

It is possible to use 'fun', commercial games for educational purpose, if there is an accompanying assignment that increases the educational value. The learning activities with the pizza-game, Minecraft, Geoguessr and with VR-games are good examples. These accompanying assignments should be carefully designed, keeping in mind the learning goals one puts forth, especially since most games are not directly linked to learning goals. If the assignments are not well designed, there is not only a lack of educational value, but both teachers and pupils are also less motivated by the game. If well developed, creatively designed accompanying assignments allow teachers to use all kinds of fun games that directly link to the interests of their pupils.

3.5.3 Certain attitudes need to be developed with the pupils in advance

In all the activities, we noted that certain attitudes were necessary to be developed with pupils, to keep control of the classroom situation. Some pupils are overenthusiastic, or feel that the informal setting of a game allows them to throw all existing rules overboard. Special attention needs to be given to the development of these attitudes. When aiming for social goals, one needs to make rules about working together. If you want pupils to learn independently, they might need to learn how to read an instruction before starting a game. These are all attitudes that can be developed through all lessons, and non-developed attitudes should not stop teachers to use games in the classroom, but motivate them to start working on the development of these responsible attitudes of pupils.

3.5.4 Games do not replace the teacher

Although teachers tend to use games to allow pupils to work independently, the role of the teacher when using games in the classroom remains invaluable. The preparation needs careful consideration on technical, didactical and educational level (cfr. Assignments in 3.5.2). The guidance while playing

the game in the classroom is absolutely necessary, as pupils still have questions when playing, just as they have when making regular exercises. And while immediate, gamificated feedback is an important motivating factor, the evaluation still needs a human aspect. While games have their important added value (e.g. to motivate pupils and to increase moments of informal learning), they do not replace the teacher in any case.

4 CONCLUSIONS

First results of this study already led to 10 good practices: concrete lesson plans related to curriculum goals of primary education. In addition, we already formulated four design guidelines for future development of learning activities including digital games. Based on ongoing analysis, this amount will possibly increase. Finally, our study also shows that the development of learning activities including digital games is a very time consuming process. It seems unrealistic to expect from primary school teachers to integrate this process in their daily job description. The supply of educational games is large and volatile. Scanning all these games is lengthy procedure, obviously leading to a lot of resistance with teachers. Therefore, we suggest that online databases that are now offering only (educational) games should also include information about the integration of these games in the daily classroom activities of primary school teachers.

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