

## Students as Game Designers vs. 'Just' Players: Comparison of Two Different Approaches to Location-Based Games Implementation into School Curricula

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### **Abstract**

This paper compares two kinds of educational treatment within location-based game approach; learning by playing a location-based game and learning by designing a location-based game. Two parallel elementary school classes were included in our study (N=27; age 14-15). The 'designers' class took part in the whole process of game design except the technical part (programming and content implementation), the 'players' class did not get any special treatment but played the game made by their fellow-students. The study describes possibilities and limitations of those two implementation approaches and measures effectiveness of knowledge acquisition and future interests in the game topic. The data revealed positive effect of the active approach (designing location-based game) within the knowledge acquisition. The further qualitative study showed that the active approach brings some unique benefits to the students and could be widely supported by the teachers and national educational systems.

### **Keywords**

location-based games; situated learning; mobile learning; school curricula

## I. Introduction

Location-based games developed during past decade rapidly, and nowadays they deserve a serious consideration in educational field and formal educational system in particular. Mobile devices allow educators to bring additional information and new immersive activities to "terrain" - nature environment, archaeological or historical sites or "just" out of school. The data and multimedia layer mediated by a mobile device over the physical space create so-called augmented reality (AR), "(...) *the situation in which a real world context is dynamically overlaid with coherent location or context sensitive virtual information.*" (Klopfer & Squire, 2008).

Augmented reality user experience becomes complex and fluid in the same time; the environment, technology and device create continuous 3-sided interaction whose diffusions and consequences are hard to predict. On the other hand in a well modelled and contextualized augmented environment can occur highly stimulating and knowledge-rich experiences (Chou & ChanLin, 2014, Gaved et al., 2014, Etxeberria et al., 2012, Klopfer & Squire, 2008, Rosenbaum et al., 2007).

### a. Mobile devices in Location-Based Learning

Mobile devices provide some new opportunities to their users as well to the learning process itself. Klopfer et al. (2002) emphasise the (1) portability, (2) high openness to social interactions, (3) context sensitivity, (4) connectivity and (5) individuality (customization). Moreover widely available free authoring tools (e.g. ARIS, Taleblazer) allow educators to easily create location-based interactive storytelling, an important feature for learning motivation and engagement (Gee, 2003, Juul, 2005). Those and many others aspects need to be considered in the design process to assure learning opportunities and a good quality 3-sided interaction; user-real-and-virtual environment (Rosenbaum et al., 2007, Sintoris et al., 2013, Melero et al., 2015).

### b. Theoretical Basis for Location-Based Learning

Most studies focusing on location-based learning build on the theory of situated learning that draw on many similarities as a rich interaction within real-like situation. Within such situation "(...) *all learning takes place within a specific context and the quality of the learning is a result of interactions among the people, places, objects, processes, and culture within and relative to that given context*" (Squire, 2010). The central claims of this theory are followings: (1) action is grounded in the concrete situation in which it occurs; (2) knowledge does not transfer between tasks; (3) training by abstraction is of little use; and (4) instruction must be done in complex, social environments (Anderson et al., 1996). Situated learning extends as well other learning theories such as social learning theory and social development theory.

Anderson et al. (1996) point out that not all those characteristics support better knowledge acquisition and transfer as it is overstressed (Squire, 2010, Alnuaim, 2014). Surely some cognition is partly context-dependent, but there is also a huge part of it which is context-independent. Some studies reminded by Anderson et al. (1996) showed that at some situation abstract (theoretical) instruction led to higher knowledge acquisition than a concrete instruction, the same for social context from which some performances benefit but others do not.

Despite those facts some evaluation studies show promising data on location-based games use in different areas of learning, for example context-aware language learning (Holden & Sykes, 2011, Liu, 2009), knowledge acquisition (Facer et al., 2004; Huizenga et al., 2009; Chou & ChanLin, 2014), academic competencies (Squire & Jan, 2007) and specific learning motivation (Cabrera et al., 2005; Huizenga et al., 2009; Chou & ChanLin, 2014).

### c. Research Objective and Questions

In our study we focus on two different approaches to the use of location-based games in school curricula: engaging students in design of educational location-based games and immersing students into educational location-based game-play. Some authors propose positive aspects of the active learning approach; Klopfer and Sheldon (2010) are convinced that authoring AR games gives students a great opportunity to see information in context. Moreover it provides a platform through which they can creatively explore content by designing and exploring scenarios through the lens of games. Carolyn Yang and Chao-Hsiang (2013) demonstrated significant improvements in critical thinking skills and academic achievement in the group of students empowered to design their own digital games.

The objective of this study is to compare effectiveness of knowledge acquisition within two educational treatments: learning by designing an educational location-based game (experimental group) and learning by playing an educational location-based game (comparison group). Thus the research questions are following:

- (1) Will students who learn by designing educational location-based game demonstrate greater knowledge acquisition, as compared to students who learn by playing educational location-based game?
- (2) Will students who learn by designing educational location-based game demonstrate greater interest in a given area, as compared to students who learn by playing educational location-based game?
- (3) Have creating location-based games within school curricula some other advantages or disadvantages? Would other teachers participate?

## II. Method

In order to test the above research questions, a quasi-experimental design was adopted. The research methods are described in detail in the following sub-sections.

### a. Participants

For our study we chose the Edvard Beneš elementary school in Čakovice. This elementary and lower secondary school is located in the suburb of Prague. Currently there are more than 800 pupils, aged from 6 to 15. Free Wi-Fi connection is available in the whole area of school, IWB in almost all classrooms, three computer labs, 65 iPads. Students also often bring their own devices to engage in schooling.

In our study two parallel classes were involved. One class with a total 18 students was randomly selected as the experimental group; while the second class with a total 19 students was assigned as the comparison group. In the present study we work only with a limited sample (N=27; age 14-15), with the students present for evaluation session (experimental group, N=11) and game-play session (comparison group, N=16).

The experimental group designed their own educational location-based game with our external help, for our study purposes we call them 'designers'. The parallel class (control group) did not get any special treatment but played the finalized game of their fellow-students, thus we call them 'players'.

Thanks to great school IT facilities and mainly very active teachers' team the students are habituated to use touch screen applications on mobile devices in classroom on regular basis however the location-based game was implemented into their schooling practise for the very first time.

## **b. Independent and Dependent Variables**

The independent variable in our study was the educational treatment strategy: designing an educational location-based game vs. playing an educational location-based game. Most of the time, the experimental group spent by collaborative brainstorming, planning and designing the game narrative, outdoor challenges and logic puzzles.

The comparison group played the game made by their fellow-students (M77, 2015) after the official release. To assure a good quality educational experience for the comparison group, we supervised whole process of the game design and instructed the students in the crucial principles of efficient educational location-based games (Melero et al., 2015, Alnuaim, 2014, Gaved et al., 2014, Klopfer & Squire, 2008, Facer et al., 2004). Course activities for the experimental group are detailed in Section 2.3.1.

The dependent variables outlined by the research questions (see Section 1.3) were knowledge acquisition and interest in a given area. To evaluate students' knowledge acquisition and interest we used questionnaire described in greater detail in Section 2.5.1. The last research question was explored by qualitative questioning the 'designers' group and teacher involved, the process is described in Section 2.5.2.

## **c. Research Procedures**

The experimental group activities are described in the following Section (2.3.1), the comparison group activities in Section 2.3.2.

### *i. Experimental Group*

During 12 weeks (from February till May 2015) we organized four workshop sessions for 'designer' class in their schooling time. Those were led by external professionals from M77, the local NGO long-acting in the area of digital technologies for culture and education. The students received a short introduction into location-based games and mobile devices for situated learning, and within the following workshops they spotted the locations, measured GPS coordinates, outlined the story, created the location-based interviews, recorded sound and designed illustrations for them

(see Figure 1).



Figure 1. Students' work - locations spotting, recording session and illustrations  
One teacher from the Edvard Beneš elementary school controlled students' activities between the workshops, motivated them for further activities, supplied them by additional historical sources and supported them through individual consultations

The NGO provided students by final application and implemented students-made content. In the end the 'designers' organized the public release where other students played the game on the school' or their own mobile devices (the game is freely available on Google Play store). The outreach event was a success and was enjoyed by both the community attendees and student participants.

Students were instructed to create a game with an educational potential but the thematic was undefined. After the first brainstorming session 'designers' decided to narrate the tragic story of their town Čakovice which was bombed by allied forces (US) during the last days of the World War II. To immerse players they brought in the story a little girl Ann that virtually guided the players through the locations.

'Designers' activities can be divided into following steps:

- Brainstorming game thematic and its specification: in small groups of 2-3 'designers' discussed and presented their game thematic proposals. After this they collectively decided for one core theme.
- Specification of educational goals: after a short background research 'designers' defined important information that should be delivered to the players.
- Game narrative: an immersive story leading players through locations and the chosen thematic was defined.
- Locations spotting: based on educational goals and the narrative, 'designers' went through and indicated locations where players will be assigned playful challenges and logic puzzles. GPS coordinates for programmers were registered.

- Location-based content: each location was assigned to one group of 2-3 that wrote text of interactive interview with a character virtually standing on the location. Moreover almost each location contained some logical puzzle or game challenge (e.g. geocache with hidden game information, a quiz question or logical rebus that can be solved by observing the location surroundings, important information hidden in game encyclopaedia or a virtual character's quote). All the content was written in Czech and English.
- In-game encyclopaedia content: done as well in groups.
- Audio-visual content: for each location and encyclopaedia entry 'designers' took a photo, in addition one student draw illustrations for the location-based interviews (see Figure 1.). We managed a special recording session where all the interviews were dubbed by students so the players received text-picture-sound content on each location.

## ii. Comparison Group

The 'players' class received full educational treatment widely considered while using location-based games, i.e. short introductory session involving 'players' into the activity and if needed the mobile devices' technical specifications, individual or group-based game-play session and short debriefing session with teacher to wrap-up and summarize the experience (Melero, 2015, Wouters, 2013, Rosenbaum et al., 2007, Squire & Jan, 2007, Klopfer et al., 2002).

For the game-play session we motivated 'players' to form into small groups up to four persons as the small group-sized effect was observed for its positive influence on learning engagement in location-based games (Melero et al., 2015), but they were free to choose if they will play on their own or in a small group. Some students used their personal mobile devices other students used the devices provided by school.

### d. Technical Details

The NGO managed all the technical tasks and endeavoured to minimally constrain the 'designers' work. The provided platform worked with offline Open Street Maps ensuring good functionality as well in the locations that are not well covered by wi-fi signal or mobile network.

Game interaction was based on the multimedia content triggered by locations or QR codes; when the player approximates to the area of marked GPS coordinates or read a hidden QR code, the application signals (vibration and sound) that there is a new content. Players can after shift the story through interactive interviews consisting of image (mostly virtual character connected with the place), text and multiple choice where player can answer and thus unwind a customized version of the story (see Figure 2). The brunching empowered players to partly choose their path and storyline but all possible branches finally flew into unique ending allowing the explanation of bombarding historical and political background and consequences.

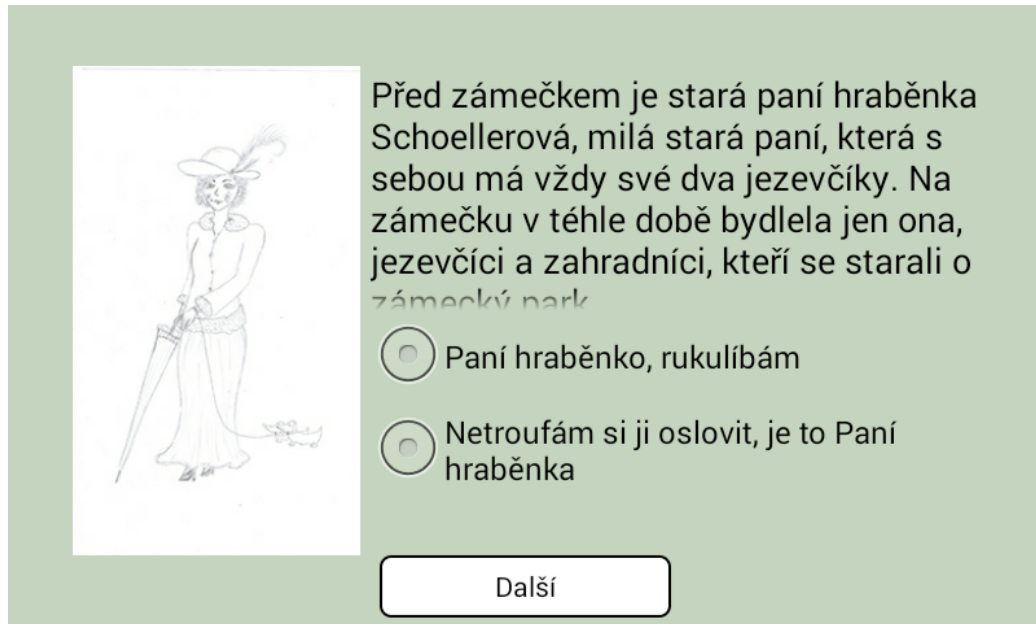


Figure 2. Interview screenshot

Based on our previous studies of location-based game user experience (Buchtova & Simkova, 2014) that uncovered only limited willingness of players to read the on-screen content, we enriched the interviews with audio, more precisely the text dubbed by students.

The players could navigate themselves as well with compass – the augmented reality tool adding a layer to the smartphone camera that shows direction and distance of other locations.

Last but not least feature was embedded encyclopaedia providing additional texts and images that help player to understand the historical background and to solve some game challenges.

## e. Final Evaluation

### i. Questionnaire

The questionnaire was distributed one week after the game-play session (the release). It consisted of nine knowledge questions and one additional question. The knowledge questions were build-up on the game content whereas all the questions except one could be answered correctly by following the storyline in the game interviews. The correct answer to one question was hidden in the game encyclopaedia, the game instructions navigated players there: "Check the encyclopaedia before continuing the game."

In the questionnaire students could answer through checking the multiple choice and completing the open ended questions, e.g.: q. no. 3 "Who took care of the Čakovice's chateau from the 1st half of 18th century? (a) genus of Václav from Knín; (b) genus Schindler, (c) genus Schoeller, (d) genus of F. J. Šlik"; q. no. 6 "The St. Remigius church is well known foremost... (a) because it is the only church of st. Remigius in the Czech Republic, (b) because it is the only church of st. Remigius in Europe, (c) because there are the heaviest bells in Europe, (d) because there are the heaviest bells in Prague and its surroundings"; q. no. 1 "When Čakovice was bombarded? ...please fill in the date"; q. no. 4 "Who was Jiří Beran and why he is famous today? ...please fill in"

To underline an influence of each educational treatment on future motivation to engage with the game thematic (the history of Čakovice in our case) - research question no. 2 - the last question focused on subjectively perceived interest in the history of Čakovice: "Thanks to the game, my personal interest in the history of Čakovice got (a) stronger (b) did not change, (c) got weaker."

Students were not informed about the test, they filled in the questionnaire within their class hours, on-line on the school iPads. They used an app called Socrative (its online version can be found at <http://socrative.com>). The whole test was student paced and students got immediately known if their answer was correct or not. Final data were administered and analysed in SPSS Statistics Data Editor.

ii. Designers' Reflexion and Teacher's Evaluation

To answer the last research question ("Has creating location-based games within school curricula some other advantages or disadvantages? Would other teachers participate?") we interviewed the teacher leading the students activities when the NGO team was not present (between the organized workshops). The teacher was asked about the process of her work, difficulties and spontaneous reflections of students' engagement and activities.

After the game release and the knowledge questionnaire, the group of 'designers' was as well asked to fill in a short qualitative questionnaire with nine open-ended questions: q. no. 1. *On which game designers' activities have you participated?*; q. no. 2. *What do you think you managed well within the project?*; q. no. 3. *What do you think you did not manage well within the project?*; q. no. 4. *What has surprised you on the work?*; q. no. 5. *What have you learned through working on the location-based game?*; q. no. 6. *Write three facts about Čakovice you remember from the work.*; q. no. 7. *By what mark would you evaluate your work on the location-based game?*; q. no. 8. *What would you do differently next time?*; q. no. 9. *What would you recommend to those who plan to design a location-based game in future?*

**III. Results and Discussion**

We are aware of very limited sample we work with thus we do not intend to generalize the outcomes on such complex phenomena. With our study we mostly aim to open an academic discussion about possibilities of active and/or passive approach to location-based game use in the school curricula.

**a. Questionnaire**

We analysed separately each dependent variable; knowledge questions (q. no. 1 - 9) and the question concerning the subjective evaluation of personal interest (q. no. 10). Descriptive statistics including means, and standard deviations for dependent variable knowledge acquisition are below (see Table 1), the score in those question could reach two possible values; 0 (wrong answer) and 1 (correct answer).

	M	SD	M	SD
Questions	(exp. gr.)	(exp. gr.)	(compar. gr.)	(compar. gr.)



1. When was Čakovice bombarded?	0.54	0.65	0.25	0.43
2. What was manufactured in AVIA factory during WWII.?	0.45	0.49	0.12	0.33
3. Who took care of the Čakovice's chateau from the 1st half of 18th century?	1	0	0.5	0.5
4. Who was Jiří Beran and why is he famous today?	0.09	0.28	0	0
5. In which style was St. Remigius church build?	0.27	0.44	0.31	0.46
6. The St. Remigius church is well known foremost...	0.36	0.48	0.81	0.39
7. What is "rajčur"?	0.81	0.38	0.37	0.48
8. What resistance activity was performed in Čakovice's refinery during WWII.?	0.27	0.44	0.18	0.39
9. In 1945 who bombarded Čakovice and why?	0.27	0.44	0	0

Table 1. Dependent variable, descriptive statistics - knowledge acquisition

For the second dependent variable descriptive statistics see the Table 2, the answers were scored on the scale from -1 to 1: positive influence (+1 point), no influence (0 point), negative influence (-1 point).

Questions	M (exp. gr.)	SD (exp. gr.)	M (compar. gr.)	SD (compar. gr.)
10. Thanks to the game, my personal interest in the history of Čakovice got: (a) stronger (+1 point) (b) did not change (0 point), (c) got weaker (-1 point)	0.36	0.77	0.12	0.33

Table 2. Dependent variable, descriptive statistics - interest in a given area

Before conducting further statistical analyses, Pearson correlations were calculated to evaluate the relationships among the dependent and independent variables. Weak negative correlations (experimental group labelled as 1 and comparison group labelled as 2) were found with Pearson coefficients ( $r$ )  $-.25$  (for knowledge test score) and  $-.21$  (for the subjectively apperceived interest),  $p < .00$ . Pearson coefficient ( $r$ ) in individual knowledge test questions varied from negligible relationship (one question), through weak negative relationship (four questions), to strong negative relationship (four questions).

One-way between subjects ANOVA was conducted, its results for dependent variable interest in a given area revealed no significant difference between active ('designers') or passive ('players') approach to the use of educational location-based games in school curricula; at the  $p < .05$  level [ $F(1, 25) = 1.12$ ,  $p = 0.300$ ].

In the knowledge acquisition, a significant positive effect of the active ('designers') treatment was revealed at the  $p < .05$  level within five questions; q. no. 2. "What was manufactured in AVIA factory during WWII.?" [ $F(1, 25) = 3.95, p = 0.058$ ], q. no. 3 "Who took care of the Čakovice's chateau from the 1st half of 18th century?" [ $F(1, 25) = 10.19, p = 0.004$ ], q. no. 6. "The St. Remigius church is well known foremost..." [ $F(1, 25) = 6.59, p = 0.017$ ], q. no. 7. "What is 'rajčur'?" [ $F(1, 25) = 5.94, p = 0.022$ ], and q. no. 9. "In 1945 who bombarded Čakovice and why?", [ $F(1, 25) = 5.56, p = 0.027$ ]. Within one question ANOVA revealed no effect and in three questions there was a positive but not significant effect of the active (designers') treatment; q. no. 1. "When was Čakovice bombarded?" [ $F(1, 25) = 1.84, p = 0.187$ ], q. no. 4. "Who was Jiří Beran and why is he famous today?" [ $F(1, 25) = 1.48, p = 0.235$ ], and q. no. 8. "What resistance activity was performed in Čakovice's refinery during WWII.?" [ $F(1, 25) = 0.26, p = 0.617$ ].

## b. 'Designers' Reflections and Teacher's Evaluation

The teacher's answers and reflections supported strongly the active approach to location-based games use in the school curricula. Upon the quantitative part of our study she noted: *"This test was only testing a knowledge. Maybe more important is what students have learnt except it. Within the further reflection the students mentioned that they learned things like cooperation, collaboration, responsibility,... which are all 21st century skills. So working on this game helped students to gain many soft skills. I believe that it also helped them to become lifelong learners, too. This is the main benefit."* Talking about difficulties while managing such long-term school project, our teacher added: *"Yes, despite a lot of work that had to be done (by students but also by teacher) I would repeat it again. My role in this work was a facilitator, a guide, a helper. I also provided students by resources. To be honest, students didn't stay focused all the time, so I had to help them to find motivation."* For other teachers interested in implementing such projects she proposed: *"What could have been done and we didn't do it at all is that we could find a contemporary witness. He or she could answer students question about the topic of the game."*

The important part of such projects is for all teachers a question of implementing it into the school curricula, our teacher's overview was following: *"Working on this game was a complex work, too. It supports and can be supported by project based learning which our school is focusing on. It combines school and local community, too. Finally, it showed up that creating location-based game was very easy to implement into our school curricula, especially of these subjects: ICT, English, Czech, Geography and according to chosen topic also History. We also use project based learning in our school and creating this game was a part of it."*

The students' reflection revealed that the most favourite activity was the dabbing interviews (creating their audio version). They evaluated the whole project as a hard work but fun and from their comments is obvious that they were satisfied and in some cases even proud of their game. On the other hand students were completely aware of their weaknesses, as lower cooperation on some tasks as e.g. encyclopaedia creation etc., and they somehow regretted that. They reported that they learned things as: *"text comprehension, reading in maps, work with English text, teamwork and collaboration"*. Mostly important 21st century competencies (Trilling & Fadel, 2009) as also our teacher mentioned above. In most cases they realized that it is important to well organize the work within the team members (q. no. 9. *What would you recommend to those who plan to design a location-based game in future?*).

## IV. Conclusion

The objective of our study was to compare active and passive approach to location-based game use in the school curricula, we focused specifically on engagement and knowledge acquisition through learning by designing an educational location-based game and learning by playing an educational location-based game. Our research questions were formulated as followings: (1) Will students who learn by designing educational location-based game demonstrate greater knowledge acquisition, as compared to students who learn by playing educational location-based game?; (2) Will students who learn by designing educational location-based game demonstrate greater interest in a given area, as compared to students who learn by playing educational location-based game?; (3) Has creating location-based games within school curricula some other advantages or disadvantages? Would other teachers participate?

To test those research questions, we adopted a quasi-experimental study supported by qualitative questioning; to evaluate students' knowledge acquisition and interest (research questions 1 and 2) we used questionnaire with multiple choice and open ended questions; the research question 3 was explored by qualitative questioning the experimental group and their teacher.

Our sample consisted of pupils from one elementary school, more precisely two parallel classes were involved (N=27; age 14-15). The experimental group (N=11) designed their own educational location-based game with our external help. The parallel class (control group, N=16) did not get any special treatment but played the finalized game of their fellow-students. The experimental group was instructed to create a game with an educational potential but the thematic was undefined. After the first brainstorming session students decided to narrate the tragic story of their town which was bombarded by allied forces during the last days of the World War II.

Within the knowledge acquisition the data analysis revealed a positive effect (on more than half questions significant, less than half without a significance) of the active approach (experimental group). There was no between-group difference in the interest in a given area (history of the students' town in our case). Basically it seems that students can learn facts and engage with the given thematic very well while designing and "just" playing a location-based game. Furthermore we observed some positive effect in the active approach (designing) within the acquisition of the facts presented by game.

On the other hand there is a great deal of work on the teacher's side. Designing a location-based game is not only a long term project but desires a deeper involvement; the teacher needs to supply students by additional materials, mentor and motivate them during the work. In order to explore the possibilities and limitations of implementing location-based game designing activities into a traditional school curricula, we implemented the qualitative questioning (research question 3) of the students from the experimental group and their teacher. The teacher's answers and reflections supported strongly the active approach to location-based games use in the school curricula. She observed that her students learned soft skills like cooperation, collaboration and responsibility. As well complex project based activities are supported by national schooling curricula so it was easy to implement it into the class syllabus. What is important, she claimed that despite a lot of work that had to be done she would repeat the project again. The students' reflection revealed that the project was a hard work but fun and from their comments is obvious that they were very satisfied with the final game. They reported that they learned things as text comprehension, reading in maps, work with English text, teamwork and collaboration.

We are aware of very limited sample we work with thus we do not intend to generalize the outcomes on such complex phenomena. We aimed to open an academic discussion about possibilities of active and passive approach to location-based game use in the school curricula. From our data it seems that the active approach brings some unique benefits to students and could be widely supported by the teachers and national educational systems.

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