Using Geogames to Foster Spatial Thinking

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Abstract

This paper deals with the implementation of the Geogame Neocartographer in a theoretically based developed learning environment for secondary education, using the design-based research methodology (DBR). The research interests in this context are to which extent motivation can be created, and how it affects the students' performance, as well as the effects of the game on aspects of spatial thinking.

1 The Use of Mobile Devices in Geographic Education

The rapid spread of digital mobile devices among teenagers makes it advisable for teachers to reflect on possibilities of how to integrate those media into their didactical concepts, instead of banning them from class. Mobile devices such as smartphones and tablets which have become an integral part of our daily routine offer plenty of possibilities for their utilization in geography teaching. They can be applied especially for excursions and field work because many of their technological functions and apps, such as GPS, compass, altimeter, (digital) maps, video and photo camera, dictaphone, and sound level meter, offer interesting substitutes for traditional geographical tools. A further advantage lies in their usability for location-based learning as these devices enable the connection between a geographical location and curricula which refer to that location. When interlinking the potential mentioned above with the motivational potentials of digital game-based learning a promising form of an educational scenario emerges, which contains a great possibility for sustainable learning. One example of such a learning environment will be described in the following text.

2 The Neocartographer-project

2.1 Description of the game

The game Neocartographer is embedded in the context of a series of games called Geogames which have been developed at the University of Bamberg (Computing in the Cultural Sciences) since 2004 (cf. KIEFER & SCHLIEDER 2006; see SCHLIEDER 2014 for a conceptual overview and discussion of the rule set).

For staging the game, a class is divided into several teams ranging from 2 up to 5 members. One on one, teams compete with each other in parallel game sessions. The purpose of the

Vogler, R., Car, A., Strobl, J. & Griesebner, G. (Eds.) (2014): GI_Forum 2014. Geospatial Innovation for Society.

game is to occupy virtual areas moving around outdoor on a real world gameboard. The board and the position of the team are displayed as a semantic overlay of a map on the screen of the mobile device which each team uses. The players have to find certain geographic locations on site to occupy these areas, i.e. the areas are marked in the colour of the specific team after they have solved a game task and are not accessible to the other team any more. Areas are derived from defined locations by attaching all points in space that are closer to that specific location than to any other, to a centre location (Voronoi segmentation). For the purpose of balancing the game temporarily at each location, a specific task must be solved to occupy the area (cf. KIEFER et al. 2007). This task can be knowledge-based, it can be verbalized as an exploration task, or it can meet the function to collect (subjective) geo-data, e.g. referring to the quality of one´s stay in a certain place. With these or other location-based data, maps can be composed in the post-processing stage. A combination of multiple tasks in one location is also possible. Each team can view on their screens the areas already occupied by the opposing exteam, and therefore must adapt their strategic decisions. In one of the possible game configurations the team which conquered the largest area wins (see fig. 1). It is advisable to subordinate the game with all its content under a geographical central question or central topic.

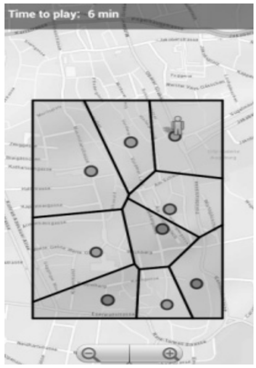

Fig. 1: Screenshot of a possible winning configuretion for team “orange”

2.2 Motivational aspects of the game

The presumption behind this game concept is that during the game a high degree of motivation is created on site. Aspects such as the feedback given by the game, the use of mobile devices, or the competition arising during the game can have effects on the presence of motivation. Based on the self-determination theory (SDT), which assumes that all human beings are endowed with three separate basic needs (competence, relatedness, autonomy) which serve as indicators for the prediction of motivation (cf. DECI & RYAN 2002,. 8/9), it could be proven that learning motivation based on self-determination leads to a high quality of learning (cf. RUSTENMEYER 2011, 33). SDT has been used to research gaming (Ryan et al. 2006). In this context it is our aim to create a theoretically based developed learning environment for secondary education which possesses a high potential in the motivation of students and therefore provides a sustainable experience on site. Our presumption is that the potential motivational power of the game can be used primarily to make pupils more willing to spend time on previously unknown paths, and thus to discover places they wouldn’t have explored otherwise. Explicitly, the pupils gain geographical knowledge from solving spatial tasks at each game location. Implicitly, this increases place knowledge (e.g. referring to a teaching content) and spatial orientation skills.

2.3 Methodical and didactical characteristics

The game offers the possibility to discover a small segment of space in a playful way, and therefore fosters the ability of spatial thinking, e.g. orientation in real spaces, the constructiveness of space, subjective mapmaking or different spatial perceptions. That is a range of competences which is often referred to as the unique characteristic of the subject geography, but whose advanced levels of education are seldom reached.

During the game the position of the players is tracked at an interval of five seconds. These footprint data traced by the mobile devices can be displayed on a map (see fig. 2) so that itinerary decisions and the course of the game are made visible. In a following-up process in class these geodata are further discussed and processed. Spatial and navigational decisions can be critically reflected (cf. KREMER et al. 2013). Modern surveillance practices can also be explained and discussed such as the chances and risks that come with modern tracking technologies. The students´ own data, gathered during the game, are used for the construction of their personal maps which offer another wide range of topics that can be reflected on and should be an integral part of a teaching unit. In essence, by using the game with its rules and game narrative, students will visit places they never visit in their everyday routines and they will observe them in a way they wouldn't have done otherwise. This leads to a growing sense of spatial thinking.

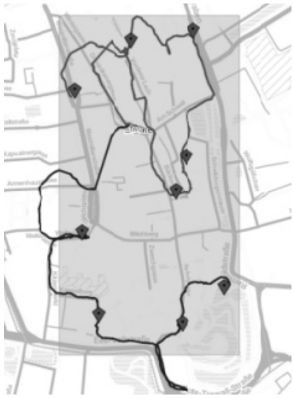

Fig. 2:
Motion tracks of students playing the Geogame Neocartographer

With a high degree of self-controlling and student-centering, several other competences such as the acquisition of subject-specific knowledge, communication and negotiation practices (in spatial situations) or team building strategies can also be improved. Furthermore, students acquire new functional knowledge with respect to the operation of the mobile devices, and experience the range of media in an advanced context.

3 Creation and Evaluation of a Learning Environment to Grow Spatial Thinking

3.1 Applying design-based research

In order to study the exact effect of motivation on the course of the game and the spatial orientation competence, the learning scenario is to be examined with the design-based research (DBR) methodology. DBR follows an iterative cycle in the course of which an intervention is repeatedly developed based on theory, implemented, and analyzed. DBR is used for the testing of educational innovation and frequently for studies about mobile technologies (cf. ANDERSON & SHATTUCK 2012).

In our case, a geography teacher for secondary education cooperates on the iterative development of the design and intervention. So far, we gathered experience by testing and evaluating several implementations of different types of Geogames with pupils in an explorative way. Bearing in mind the lessons learned, we will gain the direction to redesign our prototype for the next DBR iteration, which will be carried out at the end of July. In further steps the design will be revised.

3.2 Empirical findings

Some additional mini-theories, e.g. CET (Cognitive Evaluation Theory) by DECI & RYAN (1985) have often been used to evaluate computer games. The great majority of researches concerning the imparting and motivational potential of digital games are centred on desktop based games and not on outdoor applications. Nevertheless, we applied the PENS scales (= Player Experience of Need Satisfaction) for an explorative evaluation of the latest implementation of Neocartographer. Within our small sample of 20 students, all indicators show a high overall value for motivation.

Open feedback from the students revealed that it was the learning situation itself that was perceived as positive, not the playing around with a smartphone app. Furthermore, they were excited having visited previously unknown places in a well-known area only by means of the game. Regarding the increase of knowledge, we found no significant difference between pupils playing Geogames and pupils on an excursion. KREMER et al. 2013 show in detail that students' experience of competence contributes most to the enjoyment of the game, unlike classical excursions where enjoyment arose only from the absence of stress. Furthermore, experienced competence arises mostly from the various spatial choices that are possible during the game.

4 Conclusion and Outlook

First results indicate that Geogames can be used in education scenarios for many purposes (cf. chapter 2.3). Results from motivational research imply that the games foster many competences at the same time, while providing the students with high motivation what is yet to be verified by larger investigation samples. The next interventions are to examine the motivation, depending on time elapsed during the game (e.g. through participant observation, recording students' speech), to test place awareness before and after the game and further aspects of spatial decision making.

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