Smartzoos - Learning through creating artefacts with mobile learning application

Kadri Mettis, Terje Väljataga

Abstract—In education it is common to use mobile applications for learning at school and maybe even at museums or parks near the school. However, using technology for outdoor activities in an uncommon environment, for instance at the zoo, is challenging especially for teachers and also for students. It is important to equip them with means that support their learning in this complex situation. Two case studies were conducted where students and teachers evaluated their experience about activities that were carried out at the zoo with Smartzoos app. The results of these two cases show that Smartzoos has a potential to be implemented with high school and university students despite some typically occurring technological and administrative challenges. However, the learning design must be re-considered in order to reduce students’ challenges and to provide meaningful learning experiences. Designing and developing a few additional functionalities for the piloted mobile application can eliminate the majority of the reported challenges of teachers and students.

Index Terms—mobile learning, outdoor learning, mobile apps

I. INTRODUCTION

A variety of mobile technologies such as smart phones, tablets with thousands of dedicated applications, various measuring devices (Globisens, Vernier sensors, etc.) allows students to take learning outside the classroom walls and support inquiry about different phenomena in authentic contexts. Bringing mobile technologies into education new forms of learning emerge opening up innovative contexts and ways for creating and constructing knowledge individually or in groups [1]. Mobile technologies are personal, thus intriguing users to take control over their activities and guide them to create or curate different artefacts on their own.

Like in classrooms, taking learners outside also requires structure and frame for designing learning experiences in different locations with a variety of tasks, etc. For that purpose a mobile application is needed that allows to create learning experience in authentic settings by teachers, but also by learners themselves. Within the context of a SmartZoos project (funded by the Interreg Central Baltic Program), which aimed at developing zoos of the Central Baltic region (Helsinki Zoo, Tallinn Zoo, and Skansen) a web-based and location-based application for creative adventure and authentic learning with mobile devices was developed.

The study focuses on the following research questions:

- How to design a mobile application that facilitates learning through creating artefacts?
- How to support students in the learning process?

II. LEARNING THROUGH CREATING ARTEFACTS WITH MOBILE APPLICATIONS

Mobile learning is defined as learning that combines interpersonal communication, use of technology, location and context choices [2]. Mobile learning allows to take learning activities outside the classroom to discover various authentic physical environments. Many studies about the use of mobile learning have shown positive results [3], [4], [5], [6]. Mobile devices bring along a set of different phenomena to education such as individuality, connectivity, context sensitivity, mobility, content setup, collaboration, games, and data collection [7] providing new ways of socializing, networking and knowledge acquisition [8]. As mobile technology is inherently personal, it expands learners’ control and ownership over goals and learning experiences [9], supports situational and site-specific learning experiences [1] and learning in and about and through context [10]. Although mobile technologies have a great potential to change learning and teaching practices and support various learning activities, such as exploring, discussing, recording, capturing data, building and modeling, sharing, testing, adapting, reflecting, creating, curating etc. [1], however, the majority of mobile application designs follow traditional, behaviourist pedagogical models [11], [12]. According to [13] it is important to integrate the aforementioned activities into learning and teaching practices giving an active role to learners. In that way learners become knowledge creators instead of knowledge receivers.

The concept learning through creating is not new and similar concepts such as learning through the authoring of user-generated content [14], [15] etc., learning through making [16], learner as a creator and designer [17], [18], [19], [20], learning through collaboratively constructing artifacts of various kind (ideas, practices, models, representations, etc.) [21]. The aforementioned approaches emphasize learners as active participants in knowledge building, in which learning happens through curating, modification or authoring digital or physical artifacts individually or in groups. According to [22], knowledge building stresses the importance of an idea (conceptual artifact) advancement, expansion and improvement; and the ability of students to develop cultural or conceptual objects. In this way learning will be more personalized and at the same time engaging for learners as they have obtained control over their knowledge acquisition process.

III. SMARTZOOS - A MOBILE APPLICATION FOR CREATING OUTDOOR LEARNING TRACKS

A SmartZoos mobile application was developed within the project SmartZoos (funded by the Interreg Central Baltic Program) for three zoos in the Central Baltic Region. The application consists of an
online tool for composing and conducting location-based GPS tracks that incorporate a selection of activity items with interactive questions and an online repository of created tracks and activity items (Figure 1).

The users have two options: 1. to choose one of the ready-made tracks with location points and going through it by solving tasks in every location point (Figure 1) or 2. design a track by themselves (Figure 2). Here the user either selects suitable tasks (activity items) from the repository and reuse them to form a track (activity) or creates tasks by themselves for every location point to turn them later into a meaningful track.

In order to help users to create tasks, the application offers ready-made templates. An activity item consists of a set of information: a title, illustrating image (optional), an option to choose interactive question type, question formulation, an option to choose a location of the activity item on the map, an option to choose language of the activity item. The application offers 7 types of ready-made templates for question types: one correct answer, multiple correct answers, freeform answer, match pairs, embedded content, information, and photo (Figure 2).

The users can either select one of the ready-made tracks to follow or create a track by themselves. To create a track the user either has to select activity items from the repository or create new activity items. In order to facilitate the process of finding an activity item from the repository to include that into a track, the SmartZoos application has a search option, which is based on location, keywords, language, and content type. The users can choose the location points on the map while creating a track. The tracks can be also differentiated by the difficulty level: high, medium, low or by the time one possibly spends on while playing. The track creator can also choose the zoo where the track can be played (Skansen in Sweden, Helsinki Zoo in Finland and Tallinn Zoo in Estonia) and define the proximity of the location point when it gets active for the player and the player can submit an answer. The SmartZoos technical solution is based on the PHP framework Laravel, Node.js and Gulp. The Google Maps API is used for the maps layer and the user interface is based on Bootstrap.

The emerging notion of “students as creators” and related conceptual frameworks like “trialogical learning” and “knowledge building” with mobile devices has been the basis for developing and designing the SmartZoos application. The design of the application has been complemented with gamification elements allowing users to experience entertainment through tracks as learning tools: Gameplay- While playing the track in the SmartZoos application, the tasks in every location can be considered as challenges, which require active interaction and participation. In case of creating a track, the challenge is designing tasks (activity items) as game elements; Goals and achievements - every learning activity has a goal, although the specific achievement elements are not explicitly designed into the mobile application, depending on the creativity of a track designer, the track can involve various achievement systems, such as collection of points, speed of finishing the track, etc.; Reward- In the case of the SmartZoos application, currently learners can collect badges after completing the track successfully. While being in the role of the creator, the reward can be players’ feedback and positive experience or the satisfaction of creating difficult challenges for peer students; Emotions- The SmartZoos application design provides positive emotions through the feeling of having control over the learning process (either playing the track or creating one). As mentioned previously, a lot depends on a designer of the track.

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IV. METHODS

The overall methodological framework for designing and developing a mobile application for learning in zoos followed a research-based design approach [23]. The approach consists of a series of steps (Figure 3):

1) an in-depth contextual inquiry - a rapid ethnographic assessment [24] with visitors in the zoos was combined with an extensive literature review on outdoor mobile learning and location-based mobile applications to define the context, preliminary design challenges of the application, potential design constraints and its underlying pedagogical assumptions.

2) a series of participatory co-design sessions - the goal was to get input from various stakeholders (natural science teachers, students, zoo educators, researchers, education experts, developers) with direct focus on practical design of the application, its potential affordances and functional elements.

3) prototype development - results from the contextual inquiry and particularly from the participatory co-design sessions and pedagogical concepts from the literature were translated into a working prototype of the application.

4) finalizing production of software as hypothesis - a potential working solution to the design challenges.

The two case studies presented in this paper were carried out with two age groups of students: case 1 was piloted with 9 high school students and 3 biology teachers and case 2 with 15 university students. Teachers were interviewed about their challenges and experiences while taking an active role in a learning process steps (Figure 5).

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For case 2 the teacher designed a script for using the SmartZoos application (Figure 5). First, the teacher introduced the application in the classroom setting and then students in groups created some location points with questions, which were formed into a track. Then students moved to the zoo to follow a track another group had created. For the case 2 a semi-structured questionnaire was answered by the students at the end of the creation process to explore the students’ learning experiences and occurring challenges while taking a role of the creator.

- a semi-structured questionnaire to students in the end of the learning experience,
- screen recordings of the students’ creation process with the SmartZoos application (2 groups of high school students). The aim of the screen recordings was to get a better understanding of how students manage to create meaningful and subject-related learning tasks. Screen recordings gave a good overview about what kind of problems the students had to tackle during the creation process and how they overcame these problems. Screen recordings were transcribed, and emerging problems were grouped based on creation process steps (ICALT conference proceeding),
- students’ created tracks (3 groups of students) to analyze the content (number of location points, type of questions and selection of answers, etc.) of the tracks and evaluate the quality and meaningfulness of the tracks. First, the created activity items were divided into three groups, taking into account the procedure one has to follow while creating it. An activity item was considered completely correct when the question type, the type of answers and the location point were all correctly formed. The activity item was marked as partly correct when the question and the selection of answers were correct, but location was wrong and vice versa. The activity item was incorrect when both aspects were faulty. Secondly, the questions in the activity items were coded and grouped based on their content and their association to the studied topic to determine how many of them were meaningful and related to the actual topic. Three groups were formed: high (straight connection to the topic, definitions used), medium (indirect connection to the topic, definitions not used but predictable idea is connected to the topic) and low (imperceptible or no connection to the topic).

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The two described cases were different to see if previous zoo experience gave an advantage to students during the creation process. As the two groups were of very different ages and they learned also different topics therefore only the questions about their experience and opinions about the learning design and Smartzoos app were merged and analyzed together. The data from the semi-structured questionnaires and screen recordings was merged and data was categorized in the following themes: students’ challenges while creating the track; statements related to learning experience, suggestions for the next development phase of the Smartzoos application.

V. RESULTS

A. Outcome From The Students’ Creation Process

Tracks were created during the time when students were studying a topic Ecology and Evolution in biology classes. The students were divided into 3 groups and each group created one track. Total 23 interactive questions were created. Students formed 11 one correct answer, 6 multiple correct answers, 4 freeform answers and 2 informative types of questions. All three groups defined their track difficulty level as “medium”. Estimated playing time from the creators’ point of view varied from 25-90 minutes. Featured image option as an illustration of the track was used only by one group. Proximity of the location points when they become active for a player was used by one group and was set to 25 meters. Other groups decided not to use that feature, because they were not sure of the locations.

During the analysis process, the activity items created by the students were divided into three groups to determine how many of them were correctly formed. 13 activity items out of 23 were completely correct and 10 were partly correct. 7 out of 10 partly correct activity items had a wrong location but the question and the answer were correct. There were no completely failed activity items. The questions from the activity items were also analyzed and grouped based on the question type. There were 11 questions with one correct answer, 6 questions with multiple correct answers, 4 questions with freeform answers and 2 were informative type. The questions were also evaluated based on the relation to the topic. There were 7 questions with high relation to the topic, 10 questions with medium relation to the topic and 6 questions with low relation to the topic. Students were also asked about how helpful the app was for their learning and 8 out of 9 students from the first case study found that used app was helpful for learning [28].

Although the Group 2 and 3 proved that it is possible to create a meaningful track (correctly located activity items and relevant questions) without going to the zoo, the questionnaire data revealed that both the university students and high school students reported that while creating the tracks and marking the location points on the map from distance (being at home or in the classroom) was challenging because they were not so familiar with the zoo layout and its habitants. Previously reported issue is the reason why 75% of the respondents considered the creation of the track as a complicated activity.

The biggest issue currently seems to be the Smartzoos application user interface design for creating activity items with questions and tracks and the terminology used in the application. On the other hand, these challenging situations encouraged the students to find solutions, enhanced their content-related knowledge through discussions and joint creation process, and advanced their digital competences. Designing learning activities outside the classroom, for instance in the zoos, students’ groups will be physically distributed and help-seeking as a manifestation of self-regulated learning takes another meaning and form. The role of the teachers’ and students’ changes, and peer students become a more important source of help than a teacher. In these types of scenarios, the students can take control and responsibility for their activities and find their own ways to solve occurring problems, thus reflecting their metacognitive and domain specific skills and knowledge, their attitudes about learning, their achievement goals [25], and their epistemological beliefs [26]. The collected data demonstrated that in most of the cases the university and high school students were able to solve their technological issues by asking help from classmates (58,3% of respondents) or solving it by themselves (41,7% of respondents).

The data the questionnaire showed a few important design aspects that need to be considered in the next development phase of the SmartZoos application:

The university students reported that a functionality which allows otherwise miss, helped them to learn and investigate many new things as the application provided some structure. The data from the screen recordings detected some fruitful group discussions during the creation process about the actual study topic and how the students successfully approached the emerging problems. Although the focus of this pilot study wasn’t on exploring the impact of our intervention on students’ actual knowledge building, the design of this type of learning experience proved to facilitate knowledge sharing within the groups.

“S1: Oh I have a question. What are tigers: carnivores, herbivores, omnivores? S2: What is that? S1: That is biology. Herbivores only eat plants, carnivores only eat meat. Omnivores are us, eating everything. So, the right answer is what? S3: Omnivores? S1: No Carnivores, they eat only meat.”
to view the whole track after finishing creating the track, is important. Currently this feature is not available and the whole track can be visually displayed only when starting the track. Therefore, currently the creator doesn’t have a final whole track view option to check it’s overall layout logic and distance of the location points from each other.

While creating questions in location points it turned out to be rather challenging to edit the question later. The need for editing the questions emerged from the fact that the templates provided by the SmartZoos application were not so self-explanatory for the university students, which was interestingly not the case with the high school students. Here, the university students suggested that the application could provide examples for every question type to understand the meaning of these types.

In addition, the university students proposed that there should be the possibility to identify and choose in which order the questions open and when extra information appears. Some of the university students noted that it was difficult to find some points and that movement trajectory could take into account Zoo’s pathways not direct movement. This is a feature, which has two sides, on the one hand showing the actual path from one location point to another one defines students routes, on the other hand, if the route is left open, the students can choose the shortest or the most interesting one to the next location point. This way the students perceive freedom to make decisions and control over their learning activities.

Another proposal by the students creating a track in groups was to create a groupwork platform. The fact that only one person could make an account of the SmartZoos and actually create and modify the track, creates a situation where one person has to fiddle with the application and other group members could only take a role of the advisor.

VI. CONCLUSION AND FUTURE DIRECTIONS

The goal of this pilot study was to explore and understand the affordances and challenges of SmartZoos app during outdoor learning at zoos. Despite of the emerging challenges, the pilot study with two cases demonstrated that the SmartZoos application has a potential to structure digitally-facilitated location-specific learning experiences, in which students learn through co-creating their own context and a shared artefact, i.e. a meaningful track with location points and questions in them. To what extent these learning experiences actually contributed to students’ knowledge building will be discussed and reported elsewhere. Likewise, the case studies showed an easy-to-use possibility for teachers to support them while organising these experiences in outdoor, authentic settings.

Nevertheless, the evidence from the pilot study suggests a list of additional functionalities that would probably reduce some of the students challenges while learning with the support of the SmartZoos application: a joint group work space and orchestration module for teachers. The joint groupwork space for creating the tracks would engage students more and would make groupwork more efficient. At the moment only one person could make an account of the SmartZoos and actually create and modify the track, creating a situation where one person works with the application and other group members could only advise. Also, orchestration module for teachers that would allow teachers to monitor students progress while playing and creating and also for feedback and communication would give better opportunities for supporting learners during these activities.

Also whole track view and possibility to edit the activity items in an easier way would be helpful for the students in the creation process. Possibilities to show extra information and control over listing the questions should be added. The next round of co-design and development will take these functionalities into consideration. The findings provided by the two case studies equipped us with a better understanding of the challenges students face in outdoor settings and enable us to develop further a mobile application that would facilitate students through the process of authoring and developing shared artefacts as a knowledge construction and building process.

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