Bridging the gap between location-based games and teaching

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Abstract

We present a 6-step didactic planning framework for the integration of location-based games (LBGs) into practical teaching, aiming at a conceptual approach to the dissemination of LBGs for scientific and educational users. We combine approaches from location-based mobile learning with didactic concepts and determine different procedures for the design of a LBG for four learning paradigms. Our framework is practice-oriented and includes considerations to be made during each step in order to ensure a gapless integration of the LBG into the syllabus. We conclude that LBGs offer teachers a method of conceptualizing classes with sustainable learning effect by means of a ludic, versatile, and creative approach.

Keywords: Location-based mobile learning, location-based games, geogames, context-aware computing, learning paradigms.

1 Introduction

Location-based games (LBGs) require players to move between and act at certain places in the real world according to the game rules [16]. Previous work has discussed how to design the rules and spatial footprint of a LBG in a way that ensures players will be visiting and spending time at selected places, such as tourist points of interest [9].

This opens up interesting perspectives for applying LBGs in teaching: from research on location-based mobile learning (LBML) – also known as situated learning or contextual learning – it is well-known that teaching content at a place where this content can be perceived in situ can improve the learning effect [14]. A LBG could motivate learners to visit certain locations and learn about content related to that location, thus blending the motivational aspects of games with the advantages of LBML. Because of high versatility, LBML could convey an endless range of topics, always combined by exploring the world outside.

However, LBGs have not yet found their way to real teaching. LBGs are sparsely traceable on educational servers, and, if available, it is not guaranteed that they also match to given didactic circumstances. Obviously, many teachers avoid using LBGs in their classes. Reasons for that could be found in a missing affinity to technology, in a high expenditure of time, in absence of LBGs in the syllabus, in a fear of failure, and in a lack of creativity. In addition, it might not be evident to choose a suitable didactic approach depending on the planned LBG. With this paper, we would like to propose an application-oriented framework for the planning of classes with LBGs while considering didactic aspects for sustainable learning. The framework presented should unlock the potential of planning diverse LBGs, motivate teachers to integrate them in their own didactical concept, and provide educational scientists a foundation of further research on this topic.

2 Related Work

2.1 Learning paradigms

Human learning depends on a strategic and communicative approach the learner is exposed to. This can range from strictly driven behaviorism, over finding-based cognitivism, to self-dependent constructivism. In this section we shortly introduce the three most established learning paradigms and one hybrid form.

Behaviorism encompasses the learning of behaviors through conditioning. Therefore, teaching contents are split up in checkable steps, repeated often, and evaluated immediately. Students who solved a given task properly are rewarded with extra points and are allowed to pass to the next task or level. Even though behaviorism fosters a certain behavior pattern, it does neither focus on comprehension nor on metacognition [3]. However, the hybrid form *cognitivist behaviorism* preserves behaviourist characteristics by adding efforts to understand

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relations between phenomena [4]. As students repeat tasks, teachers expect them to correctly interpret and explain linkages.

In contrast, *cognitivism* depends on insight-based learning. Teaching contents are complex and inter-connected with the aim of stimulating the thinking process. Thus, cognitivism focuses on operations that support the understanding of phenomena: identify, analyse, combine, organise information, solve tasks, combine observations, and develop ideas, with the aim of enabling students to transfer knowledge to new situations. Finding a balance between the conveyed and the developed knowledge is equally crucial as the right choice of the learning environment [3].

Last, *constructivism* assumes knowledge to be actively built on experience. Since knowledge is neither universal nor objective, learning must take place individually. Thus, building up knowledge from conveyed teaching contents is not recognised to be successful. Instead, knowledge is seen as an intrinsic construction of the perceived reality, while every new interpretation of a phenomenon requires an adjustment of the inner model. Therefore, learning from own mistakes is constructivist and thus sustainable. Because of deep involvement with the subject matter during self-reliant learning, contents are sustainably born in mind. Furthermore, constructivism broadens teaching concepts by promoting collaborative, exploratory, and research-based learning [3].

2.2 Context-aware computing as an activity of Situated learning

In [2] it is described that knowledge is situated, being in part a product of the activity, context, and culture in which it is developed and used. Learning methods that are embedded in authentic situations are regarded to be essential [2], inter alia because in situ sighting offers the possibility "to provide, develop, save, share and process information" [7]. Nowadays the situated learning theory in [12] can be used as a framework for designing computer-supported learning activities which take place on the field, enabled by the recent advancements in mobile, wireless and positioning technologies. An interesting subset of this kind of learning systems is the set of applications that makes intensive use of geo-referenced information, when the knowledge being acquired is strongly related to a geographical location [12]. The two following implementations for developing geo-collaborative applications were highlighted in [18]. In *learning with patterns*, students took the role of a measurer by capturing sensor and geo-positional data. In *learning with simulations*, the student's role changed to that of a network planner who had the task of choosing a right network model for a given situation at a certain place.

Context-aware computing relies on the gathering of information from the environment which provides a measure of what is currently going on around the user and the device. Activities and content that are particularly relevant to that environment can then be made available. Context-aware mobile devices can support learners by allowing a learner to maintain their attention on the world and by offering appropriate assistance when required [1].

2.3 Learning with location-based games

One of the earliest works suggesting LBGs for LBML reports that participants of an orientation game enjoyed the game, being moved "into a state where they are mentally ready for learning" [17]. However, a real learning effect could not be demonstrated.

In the game *Savannah*, learners were supposed to achieve a conceptual understanding of animal behaviour by acting as lions themselves in a mobile game [5]. Phases of playing as a lion and reflective phases (in the so-called "Den", a classroom-like area different from the game field) alternated. The authors report that

> *"the greatest failure of the study to date was the failure to maximise the opportunity for the children to act as self-motivated learners in the Den setting, reflecting on and developing strategies for improved games play. Instead […] we offered children the opportunity to act as players outside, and then in the Den requested that they act 'as pupils' and listen to useful information."*

This highlights the importance of the didactics concept for LBG-based learning throughout all phases of teaching.

A larger study investigated the impact of LBG-based learning on the acquisition of factual knowledge on the one, and an increased motivation for the subject History on the other hand [8]. The results showed that pupils playing the game learned more knowledge than a test group who received a regular lesson, whereas no significant differences were found for motivation towards the subject. The authors argue that playing the game once might not be enough to establish a motivational effect. This demonstrates another issue around LBML: it should not be considered a one-shot affair, but be integrated into regular lessons [18]. This requires that teachers can easily integrate LBGs into their lessons and combine it with their didactical concept.

The ubiquitous game *Weatherlings* [10] was developed to encourage the use of particular skills, such as critical thinking and problem solving, while also embedding those skills in a setting that rewards students for learning particular science content. The authors concluded that designing such games requires an understanding of elements of game design, learning sciences, and the real-world logics of students' existences, namely the technology available to them in and out the classrooms. A study with Weatherlings showed that students were eager to play casual educational games in their spare time.

Game editing tools that support the semi-automated localization and content design for LBGs can help teachers in integrating LBGs into their lessons[1]. The user of such tools can be either the teacher or students themselves (designing games for other students). In terms of the three-layered framework suggested in [15], these tools support the game design on the ludic and narrative level, i.e., the levels of game rules, game mechanics, and location-based tasks. The third, the performative level of LBG design for teaching concerns the connection of the LBG to the learning goals and didactic concept. This is the level we focus on in this paper.

[1] An example is the CityPoker Game Designer (last visited 12 March 2015): http://www.geogames-team.org/designer/

3 A framework for teaching with location-based games

The framework presented on Fig. 1 combines didactic concepts with application-oriented planning and is structured chronologically. After describing didactic and practical prerequisites, a 6-step guideline explains the deliberations that should be taken into consideration for the planning of LBGs.

3.1 Prerequisites

Initially, content-based prerequisites lead to the demarcation of the learning contents and thus form the basis of all following decisions. Fundamental questions refer to the target audience, the age group, and to the learning content. The latter can be demarcated using a cascading process in which following questions are approached: what is the subject? Which topics and indicative targets are provided by the syllabus? Which prerequisites do my students have? Besides content-based demarcation, practical prerequisites set decision limits. On the one hand, available resources (e.g., material, expenditures, time) are also dependent on the chosen location and must be budgeted. On the other hand, due to unequal prior knowledge with the handling of mobile devices, a general complexity range must be set in order to guarantee learning progress for good as well as for weak students.

3.2 Process sequence

Next, the framework comprises six steps which lead to a LBG seamlessly embedded into a given syllabus.

I. Set scope

First, broad learning goals are defined depending on the target topic. Subsequently, the approximate location is determined, and the extent of the study area is limited based on these considerations in order to reduce complexity.

II. Select learning paradigm

Second, teachers choose an appropriate learning paradigm by taking into account its pros and cons [3]. The decision tree shown in Fig. 1 implies two subsequent questions that help choosing the suitable learning paradigm based on the desired approach. Different colors in Fig. 1 indicate different learning paradigms.

III. Select places

Third, representative places in the study area are selected based on a hermeneutical filtering process between theory-based preparation and in-situ reconnaissance. Potential places can be determined by literature study, by seeking information on educational servers, by own experience, and by other sources.

IV. Select class structure

Following, the lesson containing the LBG must be projected. Based on indicative targets and on broad learning goals, short-term goals are defined comprising fine learning goals with a cognitive aspect, practical skills, and affirmative goals. In consideration of these short-term goals, teachers configure the LBG w.r.t. several parameters, focusing on following questions: how is the LBG arranged? Which rules must be complied with? How is the LBG expected to proceed? Further, aspects as time limit, group size, used material, and number of levels must be likewise considered in order to create specific tasks.

V. Develop learning materials

Next, a complex sequence of decisions to create tasks is made. In Fig. 1, grey boxes show universal instructions while colored boxes depend on the learning paradigm and might overlap (gradient colors). It is expected that all tasks always comply with the syllabus and that variation in the task types used is aimed at (see brown boxes in Fig. 1). Because of the repetitive approach of behaviorism, we expect that games in this learning paradigm are mainly repetitive, competitive, little cognitive and thus, dominated by performance goals. With regard to Bloom's revised taxonomy categories [11], behavioristic tasks use taxonomy category 1, i.e., *remembering*, *recognizing*, and *recalling*, whereas cognitivist behaviorism is characterized by linking contents, thus incorporating also tasks of taxonomy category 2 [4], e.g., *interpreting*, *comparing*, and *explaining*. Therefore, we suppose for behaviorism many repetitive tasks with low complexity and increasing difficulty. Additionally, tasks affected by cognitivist behaviorism should incorporate some relationships between phenomena. Because of the repetitive character, rating should occur immediately, thus input fields which only can be true or false (e.g., multiple choice variations, clozes or input fields) are likely to be chosen here.

In contrast, cognitivist and constructivist tasks focus on the recognition of relationships and thus, require the concentration on mastery goals. Also in these two paradigms, tasks of taxonomy categories 1 and 2 are used, though category 3 or above (e.g., *applying*, *analyzing*, *evaluating*, and *creating*) are primarily sought. Therefore, we suppose for both analytical tasks with high complexity and strong connecting content. Additionally, tasks affected by constructivism should incorporate exploratory approaches and might be collaborative. Because of the emphasis on exploring and on describing relations, rating should be reviewed by a teacher where a qualitative feedback is required. Therefore, input fields with interactive properties or qualitative answering (e.g., place markers, drag and drop, interactive assignments or input fields) fit best with this learning paradigm.

Once the tasks have been created, the solutions must be defined. This is particularly challenging for cognitivism and constructivism where it must be defined which qualities of the response prove sufficiency or either proficiency. Next, an overall threshold defines the number of answers that must be correct to prove comprehension and thus to step one level further. To conclude the development of learning contents, learning materials are designed or applications are developed.

VI. Seamlessly embed in syllabus

The last step describes the planning of a seamless embeddedness in the syllabus. Students must understand that the LBG performed is essential for comprehending the formerly learned content as a whole. Therefore, didactic transitions to the LBG are equally crucial as a debriefing after the LBG [18]. To ensure homogenous learning improvement and to avoid knowledge lost, teachers can provide e.g., a summarizing quiz or an announced test. Moreover, the LBG must be introduced so interestingly that the participants are eager to achieve the set goals and to sustainably learn essential parts of the intended learning content.

3.3 An example of a LBG on soil science

Based on the described learning paradigms we created four LBG concepts for a high school class in geography with approximately 16-year-old students. The topic covers soil science and biogeography in the field and requires previous knowledge of climatology, geology, chemistry and ecology. As objective, interrelations between soil types, forest communities, microclimate, and geology should be recognized. Locations and outcrops are representative of showing specific phenomena.

3.3.1 Behaviorism

As objective, students are instructed to identify and to classify different soil types and forest communities with an app containing decision trees, maps and fact sheets. Different horizons are examined by pH measurement, by height measurement and by optical inspection. Once a multiple choice question has been interpreted correctly, students get a point and progress to the next level at another place. The group with the most points achieved within a specified time limit wins the competition.

3.3.2 Cognitivist behaviorism

Based on the behavioristic approach, the example above can be continued by implementing linkages between different factors. Additionally, connections between the soil types and the forest communities could be done. If the same connection between two factors appears at different locations, it might indicate a correlation. Students then are commissioned to analyze the locations and search factors relevant to deduce a connection between them. Extra points will be given for the correct determination of relevant location factors and linkages by multiple choice.

3.3.3 Cognitivism

Every team receives the target destination as well as information about the topic, the procedure, and the cognitive goals by mobile app. The virtual tutor explains the significance of indicator plants and provides fact sheets concerning the location factors of occurring plants. Students then analyze whether the observed location factors match to the respective soil profile in order to determine indicator plants. Once links have been found, the comparison with climatic and geological maps can be considered. Do soil type, forest community and indicator plant further match with the occurrence of a specific microclimate? Is it likely that their appearance is dependent on geological factors? In that way, knowledge can be transferred by creating tasks in which students should predict a specific soil type or forest community and then verify by observing and measuring at the next location. All groups that complied at least 75% of the demanded connections or that group with the most correctly predicted soil types win the game.

3.3.4 Constructivism

Groups are distributed over the study area and provided with goals, mobile devices, and tasks. Beside determining soil types, students prove chemical processes in each soil horizon in order to understand the underlying soil-building processes by own experience. In that way, previous knowledge is used to obtain new findings. By comparing in-situ observations about soil type and forest community with climatic and geological maps, students should draw conclusions as to the underlying relations between the factors. The acquaintance of knowledge relies on collaboration as major connections can only be found by the exchange of information through a platform, e.g., while entering the records about the soil type. Concept A: Those three teams win the game which analysed the locations most precisely or contributed most to the major findings by allocating the soil types or forest communities correctly. Concept B: Everybody is a winner if every team contributes to the major findings and exchanges the records. Thus, the system-theoretical approach ("the whole is more than the sum of its parts") can be directly assigned to the learning process.

4 Discussion

Lude et al. [13] present "didactic scripts" as an interacting 3-step approach to bridge the gap between LBGs and teaching. These steps contain the setting of goals and audience, the planning of the implementation, and the consideration of surrounding conditions. Although our framework takes into account similar ideas, we encourage teachers more to reflect about the appropriate use of the learning paradigms. Thus, taxonomy categories and specific tasks depend on the chosen learning paradigm. While Lude et al. describe four examples based on Frohberg, Göth, and Schwabe's concept of different levels of context [7], we implement these implicitly in step V (see third sub-step in the brown box in Fig. 1). In contrast to [13], our framework considers the seamless embedding into a syllabus and points out transition to and debriefing from the LBG.

A further point to discuss is whether LBML should provide also offline capabilities. In [6] it is argued that, based on the ubiquitous demand on and exchange of information, online use is sometimes not sufficient. However, our framework specifically includes games following a constructivist approach, as well as games played by groups in real-time. It is obvious that in these cases real-time interactions between peers (cooperation and collaboration) are a part of the game and thus mandatory.

5 Conclusion

This paper offers a framework for planning LBGs while considering different learning paradigms. Because the implementation varies among the chosen paradigm, we additionally characterized examples of LBG concepts that focus on four usual learning paradigms. The framework should offer teachers support during the planning process by listing relevant factors that need to be taken into consideration.

Because education and learning approaches strongly vary between countries, this framework is thought as a possible solution, though it does not claim general validity.

Furthermore, the examples listed do not claim to be the only possible solution. Instead, teachers must decide about the exact arrangement of their LBG. Because LBGs are versatile, teachers can get creative and design a diverse LBG that matches to the syllabus and helps students in achieving knowledge in a ludic approach.

6 Outlook

LBGs have a high potential to convey knowledge based on a ludic approach. However, only few studies about the cognitive efficiency of LBGs and of edutainment concepts exist so far. Since the present framework has not been tested yet, further research will be needed to prove its practicality. In order to close this gap, it is necessary to investigate whether the barriers for using LBGs in teaching can be lowered by using the framework. Teachers will need to conceptualize and design LBGs based on the presented framework, integrate them into their teaching, and report on their experiences with the approach. Certainly, the students' learning success needs to be evaluated as well.

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A. Appendix

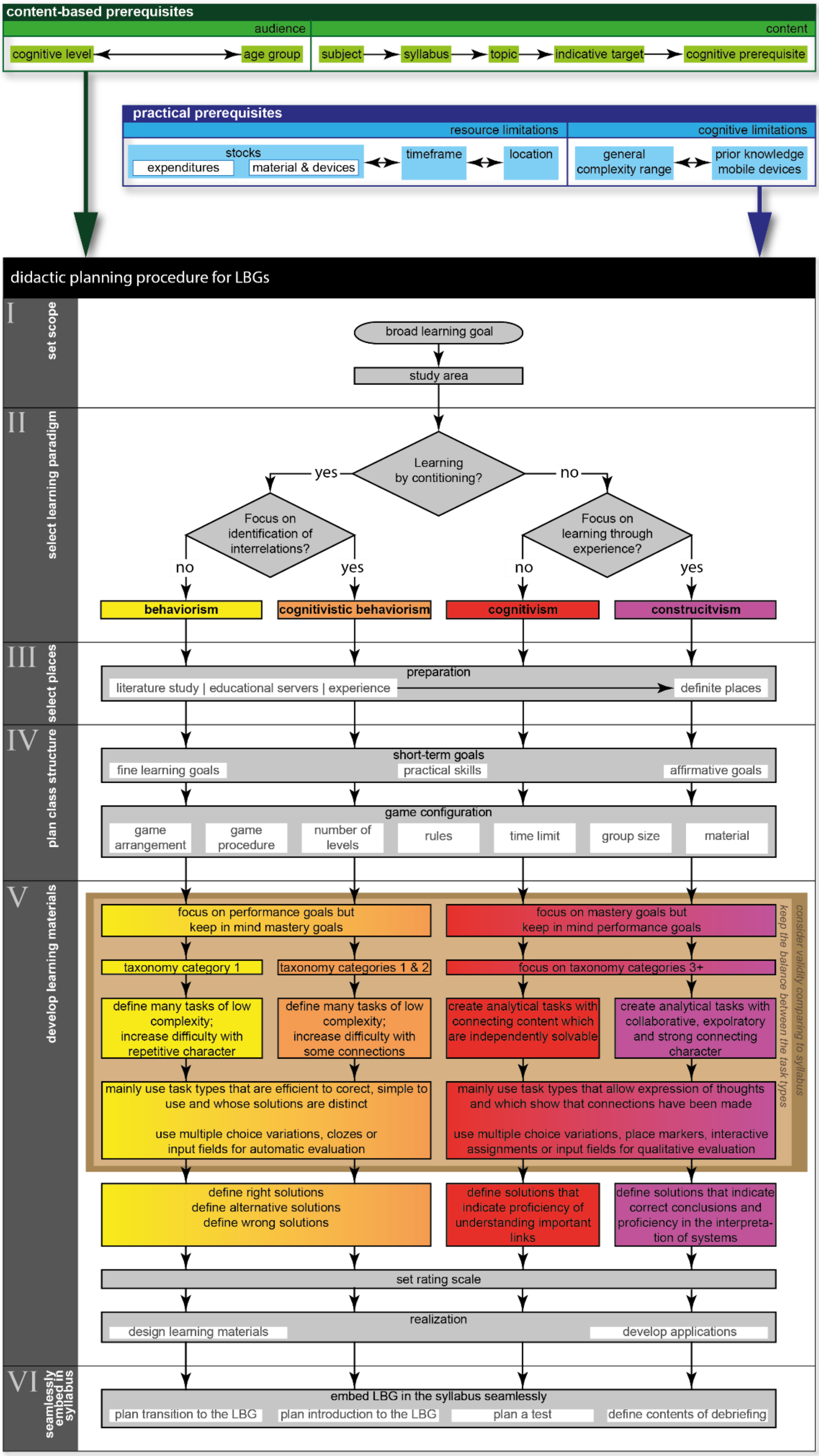

Fig. 1: Didactic planning procedure for LBGs in 6 steps.