Development of a Task-driven Mobile Teaching Tool for Enhancing Teachers' Motivation

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Abstract: Mobile technology is widely available and has a potential to support teaching and learning. However, teachers are not motivated to integrate new technology frequently. Therefore, innovative technology is missing in most teaching situations. This research put emphasis on teachers' needs and requirements since they are as important stakeholders as students. To increase motivation to use mobile technology in teaching, we propose to focus on task design and distribution. That fits well to the flexibility and personalization aspects of mobile technology. In this paper we present the results of user studies conducted in Norway and Uganda, at early development stages of a task-driven mobile teaching tool for enhancing the teachers' motivation. The study participants indicated that the use of mobile technology can help to enhance motivation to use technology in teaching. This article describes the requirements for developing an innovative task-based tool for teaching.

1 INTRODUCTION

The context we are going to discuss in this paper is teaching in higher education with a special focus on the teachers' perspective and needs towards supportive Information and Communication Technology (ICT). Our observation is that there are plenty of possibilities to introduce new technologies, especially mobile technologies, into the teaching process which could be motivating as well as beneficial for the teacher to use. Many ICT tools are already used in teaching and learning environments (Hwang et al., 2015) and the use of mobile devices in educational settings increases (Jacob and Issac, 2008). A pilot study revealed that teachers use diverse kinds of ICT tools in their teaching process (Schulz et al., 2015). The tools used the most are those classified as "tools used for presentation", "complex, but unspecific tools" like Learning Management Systems (LMS), and topic-specific tools, which are not explicitly developed for teaching but part of the topic being taught. It was found that generally many tools which could support teaching are not being used. The teaching process comprises of various components which could be supported by technology: creating student tasks, tracking student activity, supporting interactions (teacher-student, student-student, student-material) and student support at different phases of learning. We would like to augment the support of those teaching components through the use of mobile technology in the teaching situation. However, technology cannot be integrated into the teaching process without regarding the teachers' motivation to use additive ICT tools in their teaching first. The simple question is: What motivates teachers to teach in the first place and what could motivate them to support their teaching process with ICT tools? The main drives to teach, apart from external motivators such as salary and reputation, seems to be "to see the students learn", "to see them grow" and "to have personal interaction and feedback" (Schulz et al., 2015). Some of the teachers prefer face-to-face teaching over virtual teaching and in addition to that, many different teaching methods are being used. Tools which are able to support these individual teaching approaches could be perceived as beneficial from the teachers' perspective and therefore motivating to be used.

The initial research question for this project is: "What are the requirements for ICT tools to be motivating for teachers and how to design them"? It was found that mobile technology could be used in teaching and motivating to use if it can support the teaching process meaningfully. The demand, that the tool is not specialized for one course and one topic raised the question, what common elements the teaching process contains. The idea is to design a supportive and motivating tool that helps the teacher

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to design and distribute tasks for students and build new interaction possibilities between the students as well as the teacher and the students. It should be usable for teachers with different teaching approaches. This implies that it should support face-to-face teaching as well as distance, blended and virtual teaching. The focus should be on (personal) mobile devices to support the interaction between teachers and students and between students themselves. More precisely the following research questions were stated for the current stage of progress:

- What are the teachers' perceptions about a task driven tool that improves motivation to use technology in teaching?
- What are the requirements for developing a task-driven mobile teaching tool that improves motivation to use technology in teaching?

In this work we adopt the human-centred design (HCD) process to develop a supportive mobile learning system. This article presents the analysis of the context of use, user needs and first steps of user testing and evaluation to specify the requirements. Important aspects to support are the interaction between learning and teaching participants, feedback and to address the need for students to better manage their learning. Our main focus is on the teachers' viewpoint since we found that their perspective is widely missing but essential for future systems. This paper is structured as follows: related work is presented in section 2. In section 3 we describe the conceptualization of mobile teaching. Afterwards, in section 4, we focus on the user evaluation as a part of the human-centred design process. Conclusion and future directions are stated in section 5.

2 RELATED WORK

The term *mobile learning* refers to the use of mobile technology, including mobile devices, to conduct learning and teaching. This device can be used as an exclusive device for learning and teaching or as a supporting tool used for example in a face-to-face class environment. Mobile learning can occur in face-to-face courses, blended learning courses and virtual courses. The learning and teaching process becomes unbound from local restrictions which in turn creates more possibilities in terms of time scheduling. Using mobile devices enables more flexibility and spontaneity for the users (Lehmann and Söllner, 2014; Traxler and Kukulska-Hulme, 2005). Recent research speaks about ubiquitous learning rather than mobile learning to differentiate it from the concrete use of technology, in this case smart phones or other mobile devices.

Mobile learning can be used to enhance the interaction between students, teachers and also their learning material. It is noted that *interaction* is one of the most important factors for designing effective e-learning environments in general (Liaw, 2004). Further on, there is a study indicating that a theory-driven approach can be used to increase the interaction in large-scale lectures using a mobile learning application (Lehmann and Söllner, 2014). That study focuses not only on increasing one type of interaction but supporting three different types (Moore, 1989): learner-content-interaction, learner-lecturer-interaction and learner-learner-interaction. These three types are important for our work because our preliminary context analysis indicates the need for better and increased interaction, with at least two of the three aspects (learner-lecturer-interaction and learner-learner-interaction) (Schulz et al., 2015).

We would also like to focus our attention on task design, distribution and evaluation as this has a potential to improve both the interaction and self-reflection of the students. Earlier research work (Laru and Järvelä, 2015) explored how self-regulated learning and the associated learning activities can be supported by multiple software tools. The authors show how learning activities can be enhanced through technological artefacts such as smart tools. That includes activities such as "refine strategies, monitor, evaluate, set goals, plan, adopt and change belief". They argue that smart phones are more than simple devices; they are smart tools which can help us to mediate activities and support the everyday thinking processes. Therefore, they offer massive opportunities for educational settings (Laru and Järvelä, 2015).

For our work it is very important to look into different approaches to solve the *motivation* problem. An earlier study (Jones et al., 2006) analysed the characteristics of mobile devices with consideration to literature about motivation. The authors came up with six factors why mobile devices may be motivating: freedom, ownership, communication, fun, context, and continuity. In general, the literature speaks more about the motivation to use ICT tools and the factors which influence teachers to use such technology. Some of the important variables (Liaw et al., 2007) include personal attitudes (perceived self-efficacy, usefulness and enjoyment) and system quality comprising of perceived satisfaction and ease of use. Additionally, factors that surround the teaching situation are influencing the teachers'

motivation to use ICT tools. These factors include: teaching resources, teaching environment, teachers' salary, policies and support for teachers (Wastiau et al., 2013; Schulz et al., 2015).

To address the need for motivation we consider the use of gamification. The adding of game like aspects to a serious context is called gamification and can be a highly motivating factor when done right (Deterding et al., 2011). However, it is neither researched very often, which aspects are motivating in which context, especially in higher education, nor is the teacher's point of view usually taken into consideration.

3 CONCEPTUALIZING MOBILE TEACHING

This includes how the HCD process is applied, has been achieved until now and in which phase of the HCD process we are.

3.1 Human-centred Design Approach

In our research we are using a human-centred design process according to ISO 9241-210 (ISO, 2010) to be able to meet the user needs and requirements for an interactive system. Figure 1 shows the HCD process. What differs most from other design approaches is that it focuses on understanding the users' needs, experiences and desires (Giacomin, 2014). It was argued that HCD can be applied to model educational user interfaces (Oviatt, 2006), because they have requirements that are tightly tied to the teaching context and identified stakeholders. What is particularly noteworthy about this approach is not only the interface part of the design, but the way people interact, the cultural challenges and the stimulation of people (Giacomin, 2014). The foundation of our prototype, we are using for the evaluation, is provided by a preliminary context analysis concerning the teachers' motivation to teach with ICT tools (Schulz et al., 2015). User needs and requirements specification from initial analysis led to an early stage prototype. Then, this prototype was used to analyse further the context of use, to validate previous findings and to specify requirements in order to improve the system.

Considering higher education as the context of use, we carried out user testing with participants from two universities: one in Norway and another one in Uganda. The intention was to give a global perspective and validation to our findings. Since most of the study participants mainly teach in face-to-face settings, we limit this work on face-to-face teaching mode. Additionally, we chose face-to-face teaching mode as our main focus because that is where teachers expressed biggest need for new and innovative tools; as the majority of currently used tools seem to be outdated. While it is very common to use presentation slides, LMS and file sharing tools; there is a very limited use of tools that directly enhance the interaction among students or between students and teachers.

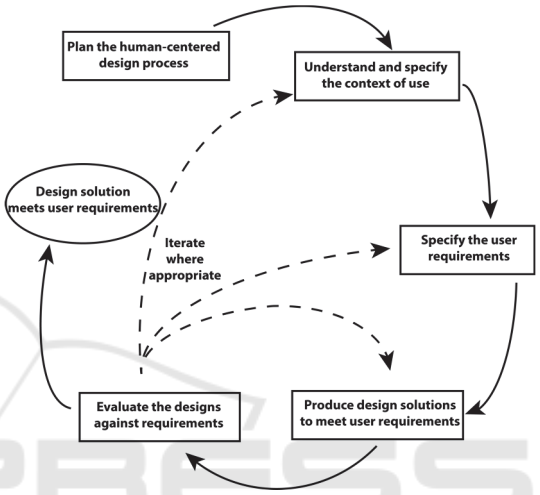

Figure 1: The Human-centred design process by ISO 9241-210:2010 (ISO, 2010).

Students are often the focus stakeholder group when it comes to studies on educational technology. However, teachers should also be considered as important stakeholders for effective use of technology in education. We argue that there is a need to focus on the teachers' needs and requirements while developing technology to support various teaching methods.

3.2 Mobile Teaching Prototype

The use of students' tasks in teaching is a common practice among teachers. They design and develop new tasks, distribute them to students and assess students' performance based on the given tasks. This can be done in the same way regardless of the teaching mode (face-to-face, virtual or blended). The challenge is that, in some cases, teachers can not sufficiently interact with students, even though such interactions are perceived to be one of the motivating factors for teaching. We suggest to enhance the interaction between teachers and students based on an everyday occurrence in teaching: the tasks.

Given the increasing use of mobile devices in everyday activities, there is a potential to use the same kind of tools for enhancing interactions in teaching and learning. A mobile technology supported solution can primarily be considered as a platform for importing pre-designed tasks into a system which encourages further interaction between the students. It is also indicated that teachers would need to monitor students' performance, in order to provide better support. Therefore, the monitoring option should also be integrated into such a system. The level of monitoring may vary from a very close observation to a rather casual and anonymous overview of individual student's progress.

Teachers expressed concerns regarding too much extra work potentially deriving from the administrative tasks when integrating new technologies into their classes. It should be possible to involve students into the task design process, so that teachers focus on teaching and monitoring students' performance. One approach to promoting students' active involvement could comprise of a system which allows students to challenge each other on a given topic. Such a design decision would imply that students are able to create new tasks for a specific topic and are also encouraged to solve tasks that have been created by their fellow students. Student's ability to design tasks can lead to deep learning of the topic, thus it is beneficial to the learning process as a whole.

The new task-driven teaching tool should have support for: creating new tasks, handling tasks and distribute tasks based on the environment and status of students. It should also support motivating aspects for the teacher to use such a system during the teaching process. To avoid too much administrative overhead, the teacher should not be expected to explicitly trigger tasks distribution. It should be possible to setup event triggers based on data measurement through the sensors embedded in mobile devices. This is one of the benefits of using mobile technology for educational purposes. These sensors can collect context information to provide a new dimension of teaching flexibility.

Prototyping allows to communicate, test and evaluate design solutions from the early stages of a development process. In this work, we developed a prototype consisting of 12 screen sketches. The prototype represents the collected ideas about task creation by students, teachers, as well as possible interactions between both groups (Figure 2). It is important that these screens have an unfinished look so that the participants would feel encouraged to criticize and discuss them openly. In order to validate the general suitability of mobile devices for such tasks, we assembled these 12 screen sketches into an interactive prototype for an Android based smartphone. The prototype was put together by designing application mock-up screens using *balsamiq* (Balsamiq, 2015). Then the screens were transferred to *marvel* (Marvel, 2015) to make them interactive. The decision to use an unfinished and rough-looking prototype helped a lot to make the participants criticise the prototype. We actually found that for some participants the screens on the mobile phone already looked like finished product. In the beginning they only expressed additional ideas, assuming the screens they can see and use are already fixed. After some time, however, all participants were able to discuss the interface elements as well as provide feedback and critique. The arrows in Figure 2 show the navigation between screens. By tapping the application's name on the top of the screen, a participant could always switch to the overview

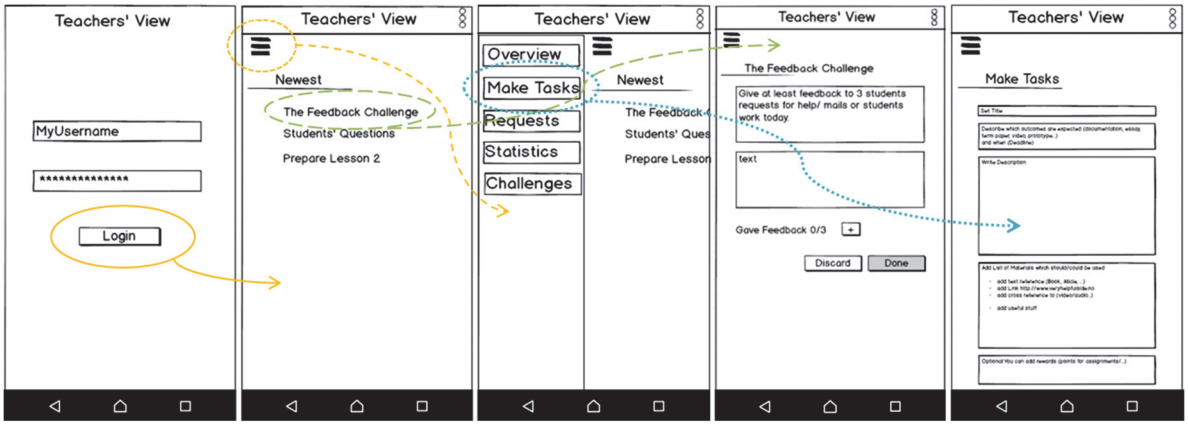

Figure 2: Screen sketches from the prototype: (1) login screen, (2) overview of recent tasks screen, (3) overview with additional side menu, (4) one sample task, (5) screen to create tasks.

screen as well. The main parts shown in the prototype include an overview of recent tasks, the section to create tasks or to register a solved task. How these artefacts could be used in teaching appropriately was part of the discussion surrounding the prototype as described in the next chapter.

4 USER TESTING AND EVALUATION

4.1 Experiment Setup

In this phase of our project we used a mixed-methods approach. The user tests consisted of qualitative and quantitative methods with multiple steps. Purposive sampling technique was used to recruit study participants from higher education institutions. This study included eight teachers from Norway and Uganda, four from each country. Their professions range from lecturer, assistant professor and associate professor, to professor. Two of the participants are women and six are men. The level of familiarity with computers differs from "I can set up my own systems" (highest score 10) to "medium familiarity" (score 5) where the lowest possible score was 1. All participants had at least a medium level of familiarity with computer systems. This is the same with regards to the familiarity with mobile devices.

First the participating teachers undertook a background survey about their teaching situation. After that they could describe their teaching in a semi-structured interview which focused on task design and distribution, the interaction with students and the challenges they have during their teaching. After that phase the participants got another survey consisting of statements which they could rate from "totally agree" to "totally disagree". These statements were the introduction to the challenges we found during the preliminary study which led to some of our prototype ideas (Schulz, Isabwe and Reichert, 2015). This section was included to confirm earlier findings, but also to see how important these are for the participants. Following this survey, the participants were asked to use the prototype and describe what they think about it (similar to the think-aloud technique). However, the emphasis was on an open discussion instead of a pure think-aloud protocol and task-based testing. All participants were at least audio recorded and most were also video recorded. The last phase was again a semi-structured interview regarding user interactions on the prototype.

4.2 Teaching Situation

We tried to focus on how the teaching situation looks like in general and how tasks for the students are designed, distributed and evaluated. Both teachers from Norway and Uganda described that they have to deal with high numbers of students in most courses, especially on Bachelor level. Teachers from Norway distinguished between lectures and laboratory (lab) work. During the lectures there are a few tasks given, most often discussions are raised or quick questions are asked to the audience. Tasks designed for learning a subject in depth (with more details) are given as lab work. The lab work is often done in small student. However, the teachers in Uganda have to deal with huge student numbers in lectures as well, but without the lab work (this could be due to the field of study for the sample teachers). Tasks are given to students as homework or in classroom discussions and quick questions to the audience. There are very limited interactions during the lectures. The teachers explained that is very challenging to appropriately address all students undertaking the given tasks. They cannot differentiate between weak and strong students due to the high number of attending students.

All teachers mentioned that they create tasks before a lecture, based on the progress within the course schedule. The teachers from Norway said that they mostly prepare tasks related to laboratory work. However, there are also project tasks and student homework which have to be prepared. The teachers from Uganda prepare the tasks as well, but they most often have no additional laboratory work. Hence, most tasks are designed as projects or homework. Tasks can be small and simple or more complex depending on the teaching situation and teaching topic. It can also happen that different students get different tasks depending on their individual performance levels. On one hand, teachers and teaching assistants are very often present to guide and help students through the tasks given in laboratory. On the other hand, students generally do project work and homework either on their own (individually) or in student groups without the teachers' presence.

Through the analysis of descriptions of how the teachers design and use the tasks, we found that tasks can comprise of:

- Concrete reading
- Problem solving and creating of content
- Exploration of a given topic
- Repetition of concrete content
- Evaluation and reflection of own work
- Peer-review of other students' work

- Making definitions or glossaries
- Complex project where students have to plan their own sub-tasks

The tasks are provided during lectures and lab work via a LMS or other communication channels. The teachers from Uganda said that, in some cases, they give out tasks or homework via short messaging services (SMS). Complex tasks are written down, with descriptions either on a sheet of paper or within an LMS, together with links to additional details and/or hints on how to solve the tasks.

In this work, it was found that there are several variations regarding the evaluation of tasks. For instance, homework tasks are not necessarily evaluated because of the high number of students. That is why some teachers introduce the practice of peer-to-peer reviews allowing students to review each other's work. Homework tasks are primarily given out as self-studies whereas lab work is usually evaluated in the lab.

In addition to the use of tasks in teaching, teachers' motivation to teach was also of interest to this study. Therefore, participants were asked to give their opinions with reference to a list of statements about their motivation and the use of ICT tools in teaching:

- [s1] "I like to see the students learn."
- [s2] "Feedback from the students is very important to me."
- [s3] "I like it when students ask questions."
- [s4] "When students challenge me on a topic based level, I feel that the students are engaged."
- [s5] "I frequently prepare tasks and assignments/ homework for my students."
- [s6] "I like to challenge my students."
- [s7] "It motivates me to compete with my students on an academic level."
- [s8] "I can imagine using mobile devices in my teaching."

The statements were to be rated on a Likert scale, from *strongly disagree* to *strongly agree*. The main purpose was to evaluate if the ideas for a supportive ICT tool, described in the chapter "Mobile Teaching Prototype", are accepted by the teachers. The most critical statements are [s5] and [s7] where some teachers disagreed strongly to moderately. In case of [s5] teachers said that they would prefer to use existing tasks from books or previous lectures. Otherwise, they would introduce group projects instead of single tasks for the students.

In total the teachers tended to agree strongly (4-5 on the Likert scale) to all statements. Some teachers gave comments to their selections in the interview part. Some pointed out that it is not correct to say "see the students learn", since it is not possible to see the learning, but the message behind the statement was clear. The statement [s7] was discussed critically because most teachers pointed out that teaching is not about competing with students. This raised the question of finding out about the acceptance of a system where teachers and students could earn reward points for participating in a challenge about an academic topic. Teachers competing with students seem to be inacceptable to teachers, but they suggested instead that it would be motivating to see students compete with each other.

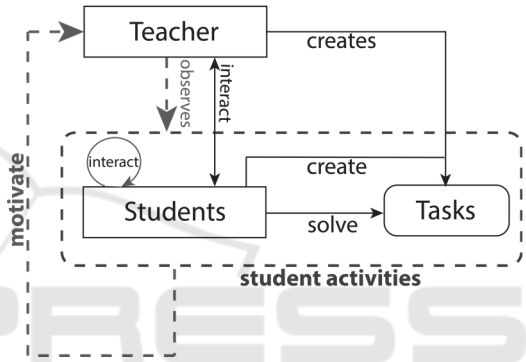

Figure 3: Motivating activities for teachers.

4.3 Results of the Interviews and Open Discussions

Most teachers mentioned that they would like students to use the system. They would love to see the outcome and statistics about students' task solving. However, teachers would rather not be involved in extra work such as creating more tasks or spending much time on solving tasks created by students. This also relates to the fact that some teachers disagree with [s7] (compete with the students). They mentioned that it could be very difficult to find a balance between tasks created by the teacher and tasks created by a large number of students. Overall, the teachers agreed that they normally create tasks and that it is not that much effort to refer to those tasks in an app. It should not be a problem to quickly put those tasks into an app system where students could find them. A lot of teachers were very excited to see the statistics corner of the app (which was not yet implemented in the prototype). They thought it sounded very promising and motivating to see statistics about students solving their tasks even if it

could be anonymised. Additionally, it was mentioned that feedback from students is generally very low and perhaps such an app could provide the right platform for students to give the teacher (anonymous) feedback about the task, teaching content and the lecture in general.

Figure 3 shows a summary of our findings on what teachers describe as motivating for their teaching (Schulz, Isabwe and Reichert, 2015). It is indicated that a teacher is motivated to use ICT tools in the teaching process if the tool can help to make the student activities visible or observable for the teacher. Tasks can be created by a teacher or students themselves. To see the students interacting with the tasks, with each other as well as seeing them solve the tasks is also considered as an important motivation factor for teachers.

4.4 Analysed Requirements

We propose that the main areas of focus should be:

- Task design, distribution and analysis
- Enabling quick interaction between teachers and students as well as students with each other
- Possibility for enhanced motivation through the use of gamified elements (in the task design and distribution)

It is noted that the above areas should be considered primarily from a teacher's point of view.

Based on our analysis, it is suggested that the main parts of tasks or "what is needed" to create tasks are the following (organisational requirements):

- Task title
- Short description and link to the topic
- Possibility for a long description
- Resources (links, books, pages, papers…)
- Affiliated people (if necessary)
- Location (if necessary)
- Rewards for completion (optional: if agreed on)

The task title is needed but could also be represented by a number as a unique reference. The short description should contain the task itself. If a longer version or more explanations besides other resources are needed, the possibility for a longer version should be given. *Resources* describe the material needed to fulfil the task. These resources can constitute virtual (directly linked) resources or the requirement outline for physical resources. Affiliated people can be for example the teacher, teaching assistants, other professors interested in cross-course work, administrative people for submissions or team members. Designating a location can be necessary if the task for example comprises laboratory work, field work or if certain rooms are booked for the students. The reward section could include for example, the number of credits earned for certain tasks, or the percentage a given task contributes to the final grade. This can help students to know what they get out of undertaking the task. However, the rewards part can be left out in case that would be inappropriate.

The section for statistics/analysis can include data related to (functional requirements):

- Activity of participation (in-lecture/ out-lecture)
- Engagements with the tasks/ repetition of tasks
- Open tasks vs. completed tasks
- Fail/ Pass attributes of the tasks
- Improvement/ worsening of students
- Areas in which the students feel challenged
- Questions/ Feedback
- Fulfilment of goals/ actions/ deadlines
- Time and location of task fulfilment

The teacher can use this information to improve the teaching and tailor it to the students' needs.

5 CONCLUSION AND FUTURE DIRECTIONS

This research work aims at bringing innovative and motivating technology into educational environments. The focus is on the teachers' needs to make future tools feasible and usable for teachers alongside the students. Our study comprised of international surveys, interviews and prototyping to find out the needs and requirements of new tool for teachers. This part of the research is an early step towards development of a usable and supportive mobile learning system for higher education. It points out how important it is to understand the context of use and the factors that influence motivation in the environment of the users. It is suggested that the use of mobile devices such as smart phones can support teaching in higher education. These devices offer a wide range of possibilities which are not yet explored, even though the technology is already deeply rooted in many different aspects of everyday life. In this work, the emphasis is on enhancing the interaction among students as well as between students and teachers through task design and distribution. Additionally, usage data can be generated from task-based interactions. That data could serve as feedback for the teacher and students. One of our goals is to

encourage students to play a more active role in the learning and teaching process. This active role by using mobile devices creates personalised and individual feedback data. The teachers have expressed a need for more technology supported feedback and interaction with their students. But they also said that it is important to keep the face-to-face interactions. Therefore, the new system should be designed as an additional supportive tool instead of a "tool designed to contain the whole content of the course". That also ensures that those participants without mobile devices are still able to participate in the course.

We would like to continue with conceptualizing a motivating ICT tool for courses in higher education to support the teachers without forcing them to change much about their teaching approaches. One critical factor for motivating teachers to use new ICT tools is an increase in the motivation of their students. Teachers stated that they would gladly use those tools, if those tools could improve the level of students' activity. Therefore, we decided to pick out the needs about feedback and interaction between students and teachers to conceptualize a motivating ICT tool following a human-centred design process. This implies that teachers will remain part of the design process the whole time to clarify needs and requirements during the development.

As a means to designing a motivating tool we will analyse further the usefulness of gamification in a higher education context. The intention is to integrate aspects of gamification which fit that kind of teaching environment. The workings of gamification aspects are still unclear and dependent on the situation in which they are used. Therefore, the new ideas will be discussed and tested with the users during the process until they can be integrated into the teaching tool.

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