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Benefits and challenges of introducing a blended project-based approach in higher education: Experiences from a Kenyan university

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ABSTRACT

This article investigates a blended project-based approach that was introduced to forestry and ICT undergraduates as an extracurricular activity at the University of Eldoret, Kenya. The approach blends problem-based learning and participatory design to solve real-life forestry problems. Even though the use of the approach itself is not novel, in this article, we explore its introduction as an extracurricular activity at a university that currently follows a more traditional teaching paradigm. Using a multiple case study, the study explores the project implementation activities and student experiences in order to identify the benefits gained and challenges faced. The findings show that the used blended project-based approach results in solutions that are more contextually relevant and also equips the participating students with technical, interdisciplinary and interpersonal skills that are essential to entering the workplace which they may otherwise have not acquired from their curricula.

Keywords: *project-based; problem-based; participatory design; higher education; ICT; forestry.*

INTRODUCTION

Currently, Kenya is facing forestry-related challenges, including the need to improve the forestry and nature-based education curricula, and competencies and expertise in forestry at higher education institutions. While some western countries (e.g. Finland, Germany, Canada) have gone through reforms in forestry curricula that reinforce the competences of foresters for their work as versatile natural resource and environmental experts and managers, this progress in forestry education is not apparent in developing countries and Africa is particularly lagging behind (Duveskog et al., 2013). University of Eldoret (UoE) is the sole university in Kenya providing holistic forestry education at all three educational levels (B.Sc., M.Sc. and Ph.D.) (Arevalo et al., 2014). Strengthening the use and integration of Information and Communication Technology (ICT) within the forestry curricula has been seen by UoE and the Forestry department as one of the key activities to addressing the knowledge gap. Especially as ICTs have the potential to contribute to sustainable development (Mansell & When 1998). However, having seen that applications and technology have often been merely transferred or duplicated from a developed to a developing context with poor results (Unwin, 2009); UoE was motivated to address and develop solutions to the forestry-related problems locally, as developing locally helps ground the work in context.

Unfortunately, the current curriculum at UoE still has challenges in instilling and giving students practical skills that are beneficial for when they graduate and enter the professional world. This is in part due to inadequate funding for forestry education, with the result that most practical aspects are not adequately addressed. Hence with the desire to strengthen the forestry education, improve the capabilities and skills of graduates, and address the various related forestry

problems in the community in a sustainable way, a project-based approach was adopted at UoE's forestry and ICT departments. Central to adopting a project-based approach was to strengthen the students' abilities to think critically, to transform foundational theory into skills that are relevant in working life, and propose proactive solutions (Soundarajan 1999; Chawdurry 1999; Blumenfeld et al., 1991). As an initial effort, the project approach was introduced as an extracurricular activity among Bachelor level degree students in their 3rd and 4th years of study.

The project-based approach introduced by UoE blends problem-based learning (PBL) where the projects are organized around a driving problem (Blumenfeld et al., 1991), and participatory design (PD). PBL has been advocated as a possible approach to improving quality of education and improve student competencies (Dahms & Stentoft, 2008). In addition, it also prepares the students to better handle complex, real-life problems, and work (Coto et al., 2013). PD approaches emphasize the importance of involving target users of an artefact in the planning and design process as it helps to ensure that the resulting artefact does function appropriately (Allen et al., 2002).

Herein, we present a multiple case study in which we explore how two projects using the blended approach were introduced and implemented at UoE. The study aims to explore student experiences, the benefits gained and challenges faced.

BACKGROUND

Current teaching at the University of Eldoret

The current teaching style at UoE is the traditional chalk board face-to-face approach. In this approach there is very little free discussion between students and lecturers. Thus students hardly get to fully develop their thinking, reasoning and critiquing capabilities. Course content is most often not based on equipping students with job market competencies; a major drawback of the traditional approach. The government of Kenya has pledged increased education for all but this may come at the cost of quality and lack of relevant competencies due to challenges of poor infrastructure and resources for practical activities, fieldwork and inadequate attachment opportunities for students. There is also inadequate skills improvement for teachers. Hence teachers, more often than not will tend to use the very same teaching and pedagogical methods they themselves learnt in college many years before, notwithstanding the fact that these approaches may be outdated. In addition, like in many other higher learning Institutions in the region, there is little use of ICT.

Pedagogical underpinnings

Project work puts students at the centre of their learning process and gives them an opportunity for them to act in a proactive way (Penteado, 2009). Due to word limitations, this section will briefly review the pedagogical underpinnings of the projects introduced by UoE.

Problem-based learning in projects

Problem-based learning (PBL) is a set of principles based on the constructivist view of learning that puts forward that people actively construct knowledge rather than receive and store it (see e.g., Driver & Bell, 1986; Greening, 2000; Ben-Ari, 2001; Dahms & Stentoft, 2008). PBL projects are supported by the Inductive Learning theory, which is defined by Prince and Felder (2006) as an experience where students are given a starting point from which they gather observations that drive their further actions. Here, learning is organized around projects and these projects are

further organized around a driving "real world" problem or situation (Blumenfeld et al., 1991; Cheaney & Ingebritsen, 2005). Combining PBL in projects has been suggested by researchers such as Barron et al., (1998) as a way of providing students with a problem that acts as a framework for a project. It provides the big picture and helps students form initial knowledge which can be developed and improved within the project.

PBL has been applied in undergraduate programs and has been observed to improve the applicability of theory in practice and increase students' skills (see for instance Wiek et al., 2014; Sangestani & Khatiban, 2013). Additionally, PBL has been proposed as a possible approach to improving the quality of education and competencies of students in African universities (Dahms & Stentoft, 2008).

Participatory design in projects

Participatory design (PD) as described by Törpel (2005), is about the direct participation of those who will use or be affected by the development of a solution in the decision-making, design and/or development process. PD assumes that the users themselves are in the best position to determine how to improve their work. This is because they are the ones with the most knowledge about what they do and what they need (Schuler & Namioka, 1993).

Participation of users has also been recognized as a critical component for success of projects as it helps create sustainability and in improving the quality and appropriateness of the outcomes (Pretty, 1995; Rydhagen, 2002; Moens et al., 2008). Especially in the field of Information Systems and development (Walsham & Sahay, 2006).

Blending problem-based learning and participatory design in projects

Combining PBL and PD in projects was motivated by the strengths that each approach gives as highlighted in the previous sections. By combining the approaches, it ensures that (1) the students learn and gain skills by actively solving realistic problems, and (2) by involving users of the solutions, it not only engages the users as participants but also ensures that the solutions are usable in the community. Thus, increasing the sustainability and success of the solutions (Rydhagen, 2002; Pretty, 1995).

RESEARCH QUESTION

The study explored how projects blending PBL and PD were implemented as extracurricular activities by UoE. It looked at the organizational aspects of the approach, the solutions developed, roles involved, and the student experiences. In particular, the study aimed to answer the following research question:

RQ: What are the benefits gained and challenges faced when using the blended approach in projects introduced as extracurricular activities?

The research question is answered by analyzing sections of the data collected throughout the whole implementation of the projects.

RESEARCH METHOD

The study follows a multiple case study approach where the unity of analysis is an extracurricular project that makes use of the blended approach. It additionally adopts an interpretive research approach (Walsham, 1995). Using a case study approach allowed us to study the use of a blended approach in context, helping us to understand how context characteristics affect the implementation of the projects and the manner in which they were carried out (Runeson & Höst, 2009).

Data collection and analysis

The primary data sources used are observations of the project implementation process, participant activities, online meeting minutes and notes including email communication from the time of initiation of a project to completion, and informal interviews conducted at individual and group level. A data repository with all the primary data was maintained for each case.

For the analysis of the qualitative data, thematic analysis method (Braun & Clarke, 2006) was utilized. The method allowed us to identify, analyze, and report patterns within the data. Data from each case data folder was extracted and reviewed by the first author in order to first obtain an overall understanding of each case. Next, the initial codes were separately assigned to corresponding data segments from each case, following an inductive and exploratory approach. Then, the initial codes were cross-checked from each project case separately and were then evolved iteratively in a structured way.

Case context

The cases (i.e., projects) explored in this study are a result of collaboration between the forestry and the ICT departments at UoE and the University of Eastern Finland in a project titled 'Strengthening ICT supported community-engaged forestry education in Kenya'. Henceforth, referred to as *CollabProject*. The CollabProject aimed at the reformation of UoE's forestry curricula, development of relevant learning materials and resources, and strengthening the use of ICT as a medium for generating and disseminating new relevant knowledge. The CollabProject provided the problems to solve in the introduced projects that are the focus of this study. These are described in the following subsections.

Project A

Project A was initiated mid-2013 and lasted for a period of 18 months. Project A focused on addressing one of CollabProject focus areas which was to create awareness about the current problems facing Kenya's forests and to educate the community about forests and natural resource conservation. This focus thus defined the problem area of project A. The first step in starting the project was the selection of students that would be appropriate and have the motivation to participate in the projects, especially since the project was being introduced as an extracurricular activity. An announcement was made by the forestry department's Head of Department (HoD) around the forestry and ICT departments for interested students to come forth. Face-to-face interviews were conducted by an expert in ICT and the HoD. Class performance, skills, ability to handle extra work and gender were factors that were taken in consideration for the selection. In particular, for the ICT students, prior programming projects were reviewed by an ICT expert. The ICT expert and the HoD were the supervisors of the project.

A total of 10 students (six forestry and four ICT) were selected. They were in their final years of their Bachelor degrees (i.e., 3rd and 4th year) because at this stage they would have gained sufficient knowledge in their respective fields to address the project problems.

After the selection of the students, a meeting was held between the students and supervisors. In the meeting, the problem area was explained. The roles of the students were outlined, for instance, the forestry students were tasked with creating and providing most of the content and the ICT students with carrying out the technical implementation. One student was chosen to be a leader and was responsible for communicating and organizing activities among the students and supervisors. Additionally, compensation of the students was discussed, this included incentives, such as a small monetary allowance (coming from the CollabProject), mobile data packages, job reference letters and certificates.

Through ideation and brainstorming of possible solutions, a consensus between the supervisors and students was reached that a good solution would be a storytelling game that would create awareness and be a fun way to educate school going children in Kenya who might not know the important role of forests in sustaining life.

For the implementation, the students decided to expand on a previously developed game, called EntVenture which had a similar aim of creating awareness (see Duveskog et al., 2013) and was developed for Android mobile devices. Main decision behind this was that two of the ICT students had worked with EntVenture and had the capability to expand on the game. The idea of an Android mobile game was also attractive for the students as the game could be disseminated easily, i.e., on Google Play.

In the months that followed, the students developed the game, called Eucalyps. They reviewed and researched relevant information that would be good content for an awareness story. Following the PD, the game was also designed and periodically tested with the school children, at a nearby primary school, who were the target end users of the game. The storytelling part was developed as a visual and audio narrative of a character called Mwafanikio who lives in a rural village. Mwafanikio tells the story of how beautiful his village once was. Hence he decides to do something about the situation in order to improve the environment in his village. Mwafanikio's story aims to raise awareness on what is happening to Kenya's environment. The story was also narrated by all the students. Here, the students got to learn new skills such as recording in a studio, creating sound effects and manipulating video files.

In the game, following Mafinikio's story is a quiz game. The quiz aims to test a player's knowledge. The quiz questions were compiled by the forestry students based on their research of the school childrens' forestry curriculum. In addition, three mini-games were developed and included to enhance the playability of the game. Each mini-game has a specific theme that connects it to the forestry field. Below is a short description of the three mini-games included in Eucalyps:

- Forest defence: A game where player has to protect a forest from burning down;
- Picture puzzle: A game allows a player to first take or upload a picture which is then broken down;
- Cross-word puzzle: A normal crossword puzzle that has been adopted for the forestry theme.

The children stated that they found the mini-games interesting and the storytelling informative. When playing the quiz, they stated that they got to learn new things and also refresh their

memory. They however wished for a more elaborate animated storytelling part and for more mini-games to be included. Figure 1 illustrates the structure of Eucalyps.

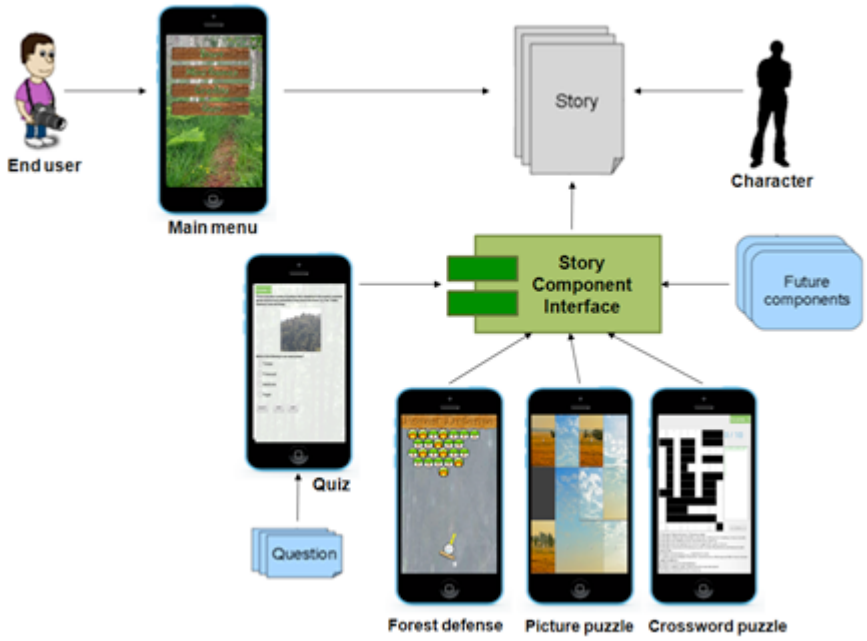

Figure 1: *Structure and flow of Eucalyps (adapted from Laine et al., 2011)*

Project B

Project B began in the beginning of 2015 and lasted for a period of nine months. In line with one of the CollabProject focus areas, Project B focused on looking at how to strengthen the integration of ICT usage in the forestry curriculum. With the problem area selected, the supervisors (same as in Project A) began the same process of selecting students as in Project A. Seven bachelor degree students (in 3rd year and 4th year) were selected, three from ICT and four from forestry.

After the selection of the students, an initial meeting was held between the students and the supervisors. The aim of the meeting was to elaborate the problem area. Similarly to Project A, the forestry students were tasked with creating the content and the ICT students with the technical implementation. One student was also chosen to be a leader. The participating students were compensated similarly as in Project A.

During the meeting, solution ideas to the problem were suggested by both the students and the supervisors. After some deliberation, a consensus on a possible solution was reached. This included developing the solution as a mobile application that could be used by the forestry students in their classroom and field work. With this in mind, the forestry students researched their curriculum to identify where a solution would be helpful, and the ICT students reviewed existing applications. After a few weeks of research, the students and the supervisors met again to discuss the findings. The forestry students had identified a set of calculations that were frequently utilized in their classroom and field work, e.g., basal area and tree height calculations. These were the calculations also identified to be problematic and cumbersome to perform

especially when in the field. Thus addressing this (i.e., creating a mobile tool to help in reducing computation time and reduce the amount of errors) became the focus of the project.

In the weeks that followed, all the students gathered requirements for the application (called mTiCalc - mti means tree in Swahili, calc is short for calculator) and explored technology possibilities and the resources that would be needed. Paper prototypes were consequently drafted. Each student was encouraged to at least submit a prototype idea of how they visioned the app working and looking like. Allowing for this idea exchange helped the students gain confidence in speaking out and sharing ideas regardless of what others might say. After several exchanges of prototype ideas, a prototype was selected for development. In addition, during these idea exchanges, it was identified that having the ability to save and retrieve saved data was an important feature for the forestry students, which meant having to integrate a database with the application. This was a new aspect for the ICT students as they had to learn to integrate components together such as database and graphical user interfaces, which they had not done during their curricula studies.

Figure 2 presents the structure of mTiCalc. The mTiCalc app assumes that a user has a plantation and on that plantation there are plots, and within each plot there are a number of trees, each with height and diameter properties. For each tree, mTiCalc produces the basal area and tree height calculation results which are also then saved.

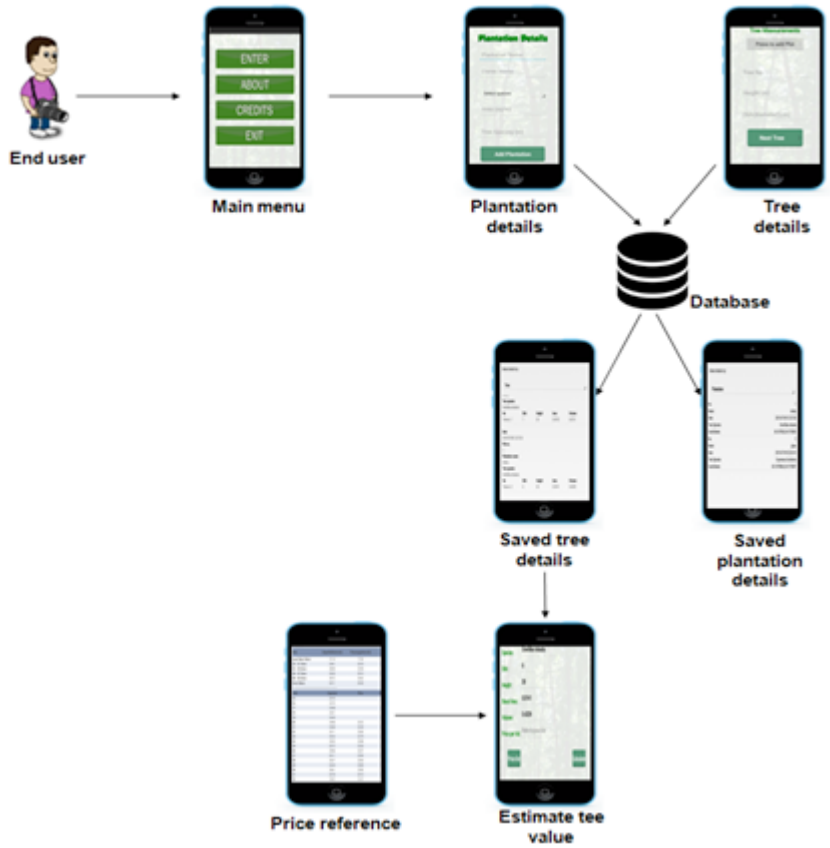

***Figure 2**: Structured and flow of mTi Calc*

Based on the tree details, the app also allows the user to assess the monetary value of trees. This ability made mTiCalc beneficial for the farmer community as well. The app has now been tested with farmers in the community and has also received positive coverage in the news (Daily Nation, 2016).

FINDINGS

By performing a cross-case analysis of Project A and B, findings based on the analysed data and the results from the introduction of the two projects using the blended approach are presented. The common evidence from both cases was analysed and coded into themes. Under each theme, the common evidence was summarized with citations of primary evidence where relevant. The findings gave answers to the research question.

Improved technical skills

A beneficial aspect to incorporating PBL in the case projects was the significant improvement of students' technical and scientific skills. The ICT students in particular were able to expand their programming knowledge and abilities beyond what they would have been able to obtain from their curriculum. They learned how to create digital stories, mini-games, integrate databases with user interfaces and make the applications available on different mobile devices. As one student stated *"it* [project] *enhanced my programming skills in android"*. A similar sentiment was also echoed by other students, for instance another student expressed that the projects "*also form a platform in which I can build my programming skills,"* and another stated that their *"programming skills improved tremendously".* Testing an application with real end users was another concept the ICT students got to learn within the scope of the projects as it was not practiced in their curriculum. As one student put it *"I have learnt to consider the final recipient of products and how it will benefit them."* It was also interesting to observe that the forestry students got to learn how to write a little bit of code, that towards the end of both projects some of the forestry students were inspired to pursue a career in forestry technology.

Improved interdisciplinary skills

Incorporating PD in the projects proved to support interdisciplinary learning as the ICT students learned more about forestry and the foresters learned more about programming and new technologies. As one forestry student stated,

> *"I have had an increased interests in technology and this has raised my research skills and am motivated to do masters in technology related field."*

And an ICT student stated,

> *"I also had to learn some of the forestry terminologies and beginning to enjoy referring to some trees with scientific names."*

This is a good outcome as Duch et al. (2001) advises, that in today's world graduates will be expected to solve problems that will cross disciplines.

Improved interpersonal skills

In both projects, the students indicated that working in project and team environments improved their interpersonal skills. They learned to listen to team members, voice out ideas not matter how small or insignificant they might have been, a finding also observed by Wang et al. (2016) of PD approaches. Working in a team also helped the students be exposed to criticism from the supervisors and were able to improve from that.

Maintaining motivation

Student motivation was one of the fundamental aspects for the success of the projects. All the selected students were motivated to join the projects for a number of reasons including improving their skill set, being exposed to new problem areas and finding opportunities for future work. Another motivating factor for the students was to create solutions that made a positive impact for their learning and community, as one student said excitedly,

> *"Building cutting edge apps requires a lot of dedication and interest. And this was just the perfect motivation for that."*

Need for resources

Another finding from both projects was that there was limited availability of resources such as Internet access, dedicated working space, and access to efficient laptops. Internet access and lack of a regular working space particularly affected routine communication and meetings. This resulted in some delays as meetings are important for the continued development of these types of projects that incorporate PD. Access to Internet was further required by the ICT students as they needed to access programming help sites for code discussions and advice. *"The issue of internet access at times was the main challenge",* stated one ICT student. In addition, some of the ICT students felt that the laptops they possessed were not adequate. As one ICT student explained,

> *"Most of us had below average laptops, and some of the software development kits require a lot of resources to run."*

Factors affecting project schedule

During both projects, the students came up with brilliant innovative ideas to address the problem areas that were introduced in the projects. However, some of the ideas were too ambitious to be fulfilled by the ICT students' programming skill set and within the planned project schedule. Additionally, we observed that in both projects, the students' schedules caused delays, especially since the projects were introduced as extracurricular activities. One student mentioned that,

> *"Getting adequate time to concentrate more on the app development. Being a final year student, I had to budget my time very well."*

Another explained that *"juggling between lectures and final year projects was another challenge."* Unfortunately, there were also circumstances that affected the projects' schedules that were outside the control of the project members, such as teacher and or students strikes.

Choosing a communication medium

When working with several team members, finding an efficient communication medium was very important. More so, when working with students that have varying IT usage skills and levels of comfort. The communication channels used in the projects included email, Google Hangout and Documents, Skype, and Whatsapp. In both projects, Whatsapp turned out to be the most efficient and preferred communication medium because it was easily accessible, faster and cheaper compared to the other communication channels. As one student stated *"Whatsapp was most convenient as we could communicate any time of the day."* Whatsapp allowed for the quick sharing of status updates, images and ideas with almost immediate response from other team members. The disadvantages of Whatsapp as reported by the students are that if there are many voices, it's more difficult to arrive at a decision. Moreover, since Whatsapp requires the availability of an internet connection, there were times when some students were unable to respond in time.

DISCUSSION

In this section we discuss the research question and compare the findings with our expectations and findings from related works.

Benefits

By incorporating PBL in the projects, especially around realistic and relevant problems, it was observed that students were able to make authentic connections to the solutions (Eucalyps and mTiCalc). A benefit of PBL that was also observed by Barrows (1996). This connection also created a sense of responsibility and ownership of the solutions among the students, as they are not just another product from the "outside" but developed within the context itself. Moreover, developing the solutions locally while incorporating a PD approach, resulted in solutions that met user's needs, were more contextually relevant and have very strong roots in the local community. For instance Eucalyps is currently being used in primary schools and mTiCalc has been used by local farmers. As stated by one farmer in the Daily Nation (2016),

> *"Now when the middlemen come, I will be able to tell them my price and negotiate based on my calculation."*

The students also gained a plethora of relevant skills, in line with the expected results of PBL (Cheaney & Ingebritsen, 2005; McNair & Borrego, 2010). For instance, a student reported that their problem solving skills were improved and another stated that their *"research ability has been improved"*. Working in a collaborative environment further stimulated the positive aspects of group work and promoted individual learning. For the students, collaboration took place between two departments (forestry and ICT). ICT and forestry students worked together and learnt to 'team play' to achieve desired project objectives. This was a unique output as traditionally students and departments at UoE were generally averse to what others were doing. To make the collaboration a success, effective coordination and communication was important among the students. This required the ability to disclose information and listen to concerns raised by other students, supervisors and community members.

An advantage of implementing the projects around real problems in the community has been that the solutions have been able to bring in positive publicity for the university, which can lead to new partnerships. For instance, during the development of mTiCalc, the Kenya Forestry Research Institute (KEFRI) took a vested interested in the app and its continued development. Such partnerships will further afford the participating students opportunities to grow professionally. The increase in job opportunities through PBL projects was also identified in Wiek et al. (2014).

Challenges

Despite the benefits experienced, there were also challenges encountered. Many of the challenges came through the introduction of the projects as extracurricular activities and not as a result of the blended approach per-se. Both of the projects faced delays due to the limited time in student schedules and also due to that the normal studies took priority as the project could not count directly to their studies. In addition, as the projects were participatory in nature, finding common times for meeting and testing the solutions was challenging. Future plans include discussing with UoE administration to consider awarding study points for participation in these type of projects which would allow students to drop some courses for the projects.

Moreover, as an extracurricular activity and not part of the curriculum, it is hard for the university to set aside resources. Meeting rooms, internet access, adequate laptops were some of the resources that the students needed but were short of. As one student put it,

"There should be a specific room assigned for such projects so that we don't have to be up and down from one space to the other during the project. Also there should be fast and reliable internet to enable communication and research work carried out smoothly."

CONCLUSION

This article has explored the benefits and challenges of introducing PBL and PD in projects at a higher education institution. The study revealed many benefits of the blended approach, for instance, students are able to make authentic connections to the created solutions which also creates a sense of responsibility and ownership of the solutions. In particular, the solutions are contextually relevant and have very strong roots in the local community. Most importantly, the technical, research, interdisciplinary and interpersonal skills of the students are greatly improved. The projects however did face some challenges which were mostly due to them being introduced as extracurricular activities. However, these were overcome to ensure successful completion of the projects. As future work, the approach is planned to be introduced within other departments at UoE. Based on these, we will be able to explore whether similar results are obtainable.

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