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Full Papers

PROJECT-BASED LEARNING (PBL) IN PRACTISE: ACTIVE TEACHERS' VIEWS OF ITS' ADVANTAGES AND CHALLENGES

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ABSTRACT

Teachers' ability to execute project-based learning (PBL) in practice determines the effectiveness of such learning. Teachers' implementation of PBL has been shown to greatly affect students' content understanding and development of skills. (Han, Yalvac, Capraro & Capraro, 2015; Kokotsaki, Menzies & Wiggins, 2016) The purpose of this qualitative study is to understand the views of active teachers on the advantages and challenges of PBL and use these perspectives in order to better promote its' implementation in teacher education programs and in general teaching practice. Data was collected using an e-survey with some open questions in the context of teachers' reports of the PBL in an international StarT programme. The data was analysed by a data-driven content analysis (k was from 0.62 to 0.67). 99 active teachers from early childhood to secondary level participated voluntarily on this study. The teachers found PBL very useful to use in their instruction such that it promotes (i) students' or teachers' learning and motivation, (ii) collaboration and a sense of community at school level, (iii) student-centered learning, and (iv) brings versatility for their instruction. However, the most challenging aspects of PBL use in practice were: (i) project organization (e.g. time management), (ii) technical issues, (iii) resources, (iv) student-related challenges and (v) collaboration. Teachers' pedagogical content knowledge in PBL could be promoted for better implementation of PBL in practise through collaborative learning in which students, teachers and other participants are learning from each other.

Keywords: *Project-based learning, teachers, teacher education, math and science education, STEM, integrated education*

1. INTRODUCTION

Project-based learning (PBL) has a lot of potential to enhance 21st century skills and engage students in real-world tasks (e.g. Bell, 2010; Han et al., 2015). There is evidence that PBL is beneficial both by teachers and students (Thomas, 2010). Earlier research shows that teachers' understanding of the criteria for effective PBL plays an essential role in how teachers implement PBL, thereby also affecting students' content understanding and developing skills (Han et al., 2015; Kokotsaki et al., 2016). In relations to STEM education, it has been shown that when PBL is implemented and instructed properly by teachers, student

learn more, whereas teachers who ineffectively implement PBL have negative effect on students' performance (Han et al., 2015). However, little is known about the challenges experienced by teachers in developing and enacting PBL on their own (Thomas, 2010). Therefore, more research is needed in exploring the advantages and the challenges of PBL from the perspective of active teachers in order to better promote the use of PBL in practice.

According to Thomas (2010), research on PBL has not yet had a substantial influence on PBL practice. By many national curricula (e.g., NGSS, 2014; Finnish National Board of Education, 2014) teachers are now urged to implement integrated and inquiry-based approaches, such as PBL. Thus, teachers are left in a position of having to construct a unique instructional model almost completely on their own without guidance, texts, resource materials, or support (Thomas, 2010). The purpose of this study is to understand how teachers implementing PBL perceive the advantages and challenges of PBL. The teachers studied are active, motivated to develop their teaching and voluntarily taking part in an international StarT programme (https://start.luma.fi/en/) that supports implementation of PBL in their instruction.

2. THEORETICAL BACKGROUND

2.1. Definition of PBL

There are a lot of different definitions for project-based learning (PBL). According to Thomas (2010), it is a model that organises learning around projects. It is also defined as an interdisciplinary, student-centered activity with a clearly defined project outcome (Han et al., 2015). PBL is characterised by students' autonomy, constructive investigations, goal-setting, collaboration, communication and reflection within real-world practices (Kokatsaki et al., 2016).

Blumenfeld et al. (1991) describe PBL as a comprehensive approach to classroom teaching and learning that is designed to engage students in the investigation of real-world problems. There are two essential components of projects: 1) They require a driving question or problem that serves to organize the project activities 2) these activities should result in artifacts that culminate in a final product that addresses the driving question. The driving question designed by students and/or teachers should not be so constrained that the outcomes are predetermined, leaving students with little room to develop their own approaches to answering the question. Students' freedom to generate artifacts is critical, because it is through this process that students construct their knowledge. Artifacts are concrete and explicit (e.g., a model, report, videotape, or computer program) representations of the students' problem solutions that reflect emergent states of knowledge. This allows others to provide feedback and permits learners to reflect on and extend their emergent knowledge and revise their artifacts. PBL also places students in realistic, contextualised problem-solving environments. In so doing, projects can serve to build bridges between phenomena in the classroom and real-life experiences; the questions and answers that arise in their daily enterprise are given value and are shown to be open to systematic inquiry. (Blumenfeld et al., 1991)

Thus, the distinctive feature of project-based learning is problem orientation, that is, the idea that a problem or question serves to drive learning activities. The second feature of PBL, constructing a concrete artefact, is what distinguishes project-based learning from problem-based learning. Helle, Tynjälä and Olkinuora (2006) add three other features to PBL. The first, learner control of the learning process, which leaves scope for decisions regarding the pacing, sequencing and actual content of learning. The second, the contextualisation of learning is evident in student projects. The value of authentic or simulated learning contexts

has been argued for both cognitive reasons and by the situated learning camp. The third, characteristic of the project method is its potential for using and creating multiple forms of representation. In modern working life, most tasks require the combined use of (interdisciplinary) knowledge in different forms (e.g., abstract, concrete, pictorial, verbal, as formulae etc). (Helle et al.,2006)

2.2. Advantages and challenges of PBL in practise

Learning responsibility, goal setting, independence, and discipline are outcomes of PBL. It promotes social learning as children practice and become proficient with the twenty-first-century skills of communication, negotiation, and collaboration. The element of choice is crucial for students' success. Differentiation allows students to develop their own interests and pursue deeper learning. The active learning process of PBL takes students' various learning styles and preferences into account. When we implement PBL, we allow children to discover who they are as learners. It is important for the teacher to confer with students regularly to ensure that students are on track and developing their ideas and skills fully. These skills are critical for future success in both school and life. Research supports PBL as a tool to engage students in real-world tasks. Real-world projects deepen learning for students. (Bell, 2010)

PBL promotes links among subject matter disciplines and presents an expanded, rather than narrow, view of subject matter. Also, projects are adaptable to different types of learners and learning situations. (Blumenfeld et al., 1991)

Some studies of PBL report unintended, beneficial consequences associated with PBL experiences. Among these consequences are enhanced professionalism and collaboration on the part of teachers and increased attendance, self-reliance, and improved attitudes towards learning on the part of students (Thomas, 2010). A common goal for PBL has been to help students acquire deeper content knowledge, skills as well as feelings of commitment and ownership of their learning (Han et al., 2015). This requires active engagement of students' effort over an extended period of time (Blumenfeld et al., 1991).

Common barriers to implementing PBL effectively include teachers' resistance to student-driven learning because they often see this as giving up control of the class. According to a case study on a three year in-service teacher training on PBL by Mentzer, Czerniak, and Brooks (2017), teachers valued inquiry-based instruction used in PBL from the onset, but their teaching style preferences changed slowly to inquiry-based over the course of three years of practicing and teacher training. For example, teachers with little practice on PBL are more prone to resist the idea that students should self-determine their own the important concepts of the lesson. Other barriers with the implementation of PBL are teachers confusing inquiry-based instruction with hands-on activities, inability to motivate students to work in collaborative teams, scaffolding instructions, the development of authentic assessments and overcoming student resistance to employing critical thinking. Also time issues, granting students sufficient autonomy and understanding what this entails as well as melding required curriculum with PBL are noted as barriers in research. (Mentzer et al., 2017)

3. METHODOLOGY

3.1. Data collection

The purpose of this study was to understand the views of active teachers on the advantages and challenges of PBL in practice. Data was collected through an e-survey that was distributed to Finnish teachers from early childhood education to upper secondary school

who were participating on international StarT programme (https://start.luma.fi/en/) during the 2016-2017 school year. Teachers are defined as active teachers in this study because they participated on StarT voluntarily. All participants who applied to StarT during January to March 2017 were given some open research questions in the reporting form of StarT programme. Responding to this form was voluntary. Out of 113 Finnish StarT participating teachers, 99 answered the questions. There were teachers from four different school levels: early childhood education (13%), primary school (57%), secondary school (24%) and upper secondary school (6%).

StarT is an international programme organised annually by LUMA Centre Finland and for the first time in the school year 2016-2017. The aim of StarT is to support collaborative, STEM related and interdisciplinary PBL from early childhood education to upper secondary school. Students' own ideas for the projects can range from everyday phenomena to complex issues in the society - or even out of this world in space. Students and teachers participate in StarT as a team. The projects allow science, mathematics, and/or technology to be incorporated with art, sports, languages, history, social studies, home economics, and many other subjects in a meaningful way. The students learn together and from each other through collaborative team working and carrying out projects related to their own interests and ideas. The projects can be shorter inquiries or long-term explorations, entire school courses or even stretch out through the entire school year. Each learning community shares the StarT projects of the teams and their school with everybody. They all report a short video and a learning diary. The products are published in the website of StarT. The primary purpose of StarT is to allow for participants to learn from others around the world.

3.2. Data Analysis

The analysis was done by data-driven qualitative content analysis (Cohen, Manion, & Morrison, 2013) with phrases and sentences as coding units. The data consist of written answers to following three open-ended questions:

1. What is the experience of the learning community as a participant in StarT?
2. What has been the most useful in StarT project working from your view?
3. What has been the most challenging in StarT project working from your view?

The data was organised for the analysis as a whole set of each teacher answers because the teachers described often experiences included notions of both advantages and challenges of PBL. Then, the data was reduced by coding. There were altogether 96 codes for the advantages and 22 codes for the challenges observed. Two examples of the naming of subcategories:

"We learned a lot more than we originally thought" (the code named "learning in general")

"*Both adults and children have learned a lot about space, planets and stars"* and *"biology concepts breathing, photosynthesis etc were learned on the fly"* (the code named "learning content knowledge")

The final categorization of the codes was tested by two researchers outside of the study. Cohen's kappa was good, ensuring the reliaibility of the findings: it was k=0.62 for the codes of advantages and k= 0.67 for the codes of challenges.

4. RESULTS AND DISCUSSION

4.1. The advantages of PBL in practise

The teachers found a lot of advantages of using project-based learning in their teaching, as shown in Table 1. Mostly teachers valued PBL for its possibilities for learning. This could

be in general learning or related to students' skills (e.g. group working, social interaction and problem solving skills as well as learning how to use equipment or programs; often related to making video) or content knowledge. Mostly learning was defined by student learning alone, but in some instances learning included everyone involved, students and teachers alike.

Table 1. Advantages of PBL

	n=99
Learning of students or teachers	63
Collaboration and a sense of community	57
Motivation	55
Student-centred learning	44
Versatility for education	35

Many teachers valued collaboration and a sense of community generated by PBL. Collaboration between teachers were found useful in practice:

"*Teachers work together planning and teaching, sharing their pedagogical expertise and professional development*" (Teacher 111)

"*Belonging to a bigger entity has given structure to our project. The educators has had an opportunity to get peer support and ideas to own group project*" (Teacher 103)

"Projects unified the whole school and added communality and we-atmosphere" (Teacher 2)

"*Most beneficial has been social action, researching together and learning as a group"* (Teacher 105)

"For the first time we tried co-teaching with four teachers. The subjects integrated were biology, chemistry and physics" (Teacher 17)

In addition, collaboration between classes and with other interest groups were found useful:

"*Schoolwork and learning were made visible to parents (in StarT-day)*" (Teacher 109)

"*Collaboration between classes of different age students was enjoyable and important*" (Teacher 24)

The motivation category includes all answers related to positive attitude change, building self-esteem, relevance, enthusiasm and getting excited or engaged in project working. Most of the cases were related to enthusiasm.

"The enthusiasm for project-based work was very infectious and initiated an actual snowball effect as the idea to pick Aronia berries for juice developed into a diverse market day!" (Teacher 11)

In the student-centered learning category most of the cases were about students being active learners, but also comments related to working in groups and taking different learners or students interests into account.

"*The student have been planning, executing, documenting and doing self-, group- and peer-evaluation"* (Teacher 21)

"Especially to gifted students StarT gave necessary challenges" (Teacher 21)

"They (students) liked the fact that they could choose the form and execution" (Teacher 78)

Versatility in education is a more heterogenic category compared to the others. Here are included all cases with possibilities for implementing curricula, teachers' professional development, and using versatile teaching methods and learning spaces.

"The teacher was doing this kind of project for the first time and therefore development of instruction giving occurred during the process" (Teacher 41)

"Inspired by the new curricula, we wanted to develop teaching towards inquiry- and genuinely phenomenon-based learning" (Teacher 17)

"StarT brought joy and was truly in accordance with the new curricula as a transversal and phenomenon-based learning model" (Teacher 21)

4.2. Challenges of the PBL in practise

Teachers' views on the challenges (Table 2) of implementing PBL were more coherent than view on the advantages of it.

Table 2. Challenges

	n = 99
Facilitating PBL • time management • project organization • teachers' skills	62
Technical issues	35
Resources	26
Student-related learning	23
Collaboration	20

Facilitating PBL was a challenge documented in most teacher responses. This includes all notions of teachers' implementation skills, managing time for PBL and organizing project. These all relate to teachers' pedagogical skills and their ability to facilitate PBL. The examples of the subcategories:

- Time management: *"fitting time schedule (of StarT) to school working"*
- Project organization "*executing a project in small school requires a lot of effort and planning"*, and *"most challenging was finding ideas and creativity in planning"*
- Teachers skills "*I would do many things differently, if I now started again*", and "*Doing (projects) raises feelings of insecurity on whether this is away from something important and are the content knowledge of curricula fulfilled*"

Technical issues include challenges with ICT and documentation for StarT. *"StarT reporting. Difficult and time consuming,"* and *"making video with non-existent ICT-skills"*.

Although the lack of ICT equipment was not listed here, these cases were included in the resources category.

Lack of resources, mainly space, equipment and time, where reported. Cases in this category are things a teacher has less influence on.

Student-related challenges were motivational: “getting different learners engaged into working”, difficulties in guiding students: “student guidance in balanced proportions, so that you don’t restrict too much but give opportunities and offer tools” and students skills and knowledge: “The most challenging was to find suitable action that suited the students skills” “working in pre-set groups is not easy for everybody”.

The possibility to collaborate was often limited by time, as teachers experienced difficulty in finding a common time for planning.

5. CONCLUSION

To promote the use of PBL in instruction, it is useful to understand the advantages and the challenges teachers found its implementation in practice in order to design the different forms of support for teachers.

The teachers’ views recorded in this study are quite consistent with earlier research mentioned, such as Thomas (2010). PBL was found very useful in practise (see Table 1). The challenges (see Table 2) faced were mostly things a teacher can influence and take into account, such as facilitating PBL and ensuring learning. Often teachers reported lack of time being a major challenge (Mentzer et al., 2017), time referred to planning time with colleagues or the time consuming nature of project work in general. The latter is an issue a teacher can facilitate as are many of the challenges teachers reported. According to Bell (2010), thorough and careful planning is essential to the flow of the project and the success of the student. Unfortunately, teachers are reporting that they do not have sufficient time for this level of planning.

According to Blumenfeld et al. (1991), without adequate attention to ways of supporting teachers and students, these innovative educational approaches will not be widely adopted. The newer cognitively-based approaches that contemporary projects represent also require substantial changes in teachers' thinking about and dispositions toward classroom structures, activities, and tasks. PBL is not likely to work unless projects are designed in such a way that, with teacher support, they marshal, generate, and sustain student motivation and thoughtfulness.

The results found could be taken carefully account in preparing in-service training for teachers. Clearly, teachers need more training for supporting their pedagogical content knowledge (PCK) in PBL. Some teachers in StarT found collaborative learning and being a part of a community reaching beyond the limits of their school useful. The StarT programme in itself could be seen as a novel model for continuous teacher training in which 1) teachers pedagogical development occurs while facilitating PBL and working together with the students, other teachers at their school or other collaborators, 2) teachers have access to tested models for PBL and good teaching practices from other teachers as well as online instructions and training 3) participating teachers and schools are a part of StarT community, where learning is shared through workshops, science fairs and online voting for best projects as well as best teaching practices.

Because it takes time to learn to use PBL in practise, even two to three years for teachers to shift their understanding and teaching practices in teacher training (Mentzet et al.,

2017), there is a need for developing long-term or even continuous and collaborative models for teacher training. This should also include pre-service teacher training. If we want to engage more teachers in the use of PBL in future, more research is needed also to understand novice teachers' use of PBL in practice.

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