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A Project-Based Learning (PBL) Event in a Chinese Rural School: How Can PBL Help Teachers and Students Accomplish Deep Learning?

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Abstract

This study explores the potential of deep learning through project-based learning (PBL) and examines how it can facilitate the achievement of deep learning for both teachers and students. Fullan and Langworthy's (2018) core principles of 21st-century skills, such as creativity, critical thinking, problem-solving, communication, cooperation, and character education, are closely related to deep learning, which has been demonstrated to lead to better learning outcomes. PBL is an innovative teaching approach that has been recognized as an effective pedagogical strategy for enhancing student learning.

The study will draw on constructivism and Bloom's taxonomy to examine the three stages of deep learning in PBL classes and assess how well the author's personal PBL teaching experience promoted deep learning for their students. The study will present a literature review of PBL and deep learning, followed by a description of the PBL session, its three stages, and the shortcomings of the learning process that occurred. Finally, the study will conclude with the author's reflections on their teaching session.

Keywords: project-based learning, deep learning, constructivism, Bloom's taxonomy

1. Introduction

Fullan and Langworthy (2018) identified creativity, imagination, character education, citizenship, communication, problem-solving, cooperation and critical thinking as the core principles of 21-century skills. They related these abilities to deep learning, which is a well-established notion in the field of education. The difference between surface and deep learning is fully developed (Entwistle & Ramsden, 2015), with deep learning methods being linked to better learning results (Trigwell, Prosser & Waterhouse, 1999). In recent years, as the emphasis on teaching has shifted to students, studies on learning styles, motivation, and strategies have gotten a lot of attention (Lynch, McNamara & Seery, 2012). Consequently, a variety of innovative teaching approaches have emerged, such as project-based learning (PBL). PBL has established a strong presence in the education field and has often been regarded as an effective pedagogical strategy for improving student learning (Prince & Felder, 2006; Felder & Spurlin, 2019).

To explore the promise of deep learning using PBL, the study will draw on constructivism and Bloom's taxonomy and examine the three stages of deep learning in PBL classes (Li, Deng & Zhang, 2022). Then it will try to find out how PBL can help teachers and students accomplish deep learning. In this study, the study assesses how well the PBL teaching experience promoted deep learning, as well as how it represented a deep learning experience for the students.

Firstly, the study will present a literature review of project-based learning and deep learning. The first focus of this part is to examine the definition, benefits and shortcomings of PBL and deep learning approaches. Then the

correlation between deep learning and PBL will be explored. Different research will be examined and discussed based on constructivism and Bloom's taxonomy. Then the study will present the learning event, which is a PBL session. The session will be divided into three stages to meet the stages of the deep learning (Li, Deng & Zhang, 2022). Following that, it discusses some of the shortcomings of the learning process that occurred throughout the teaching session. Final thoughts on what the study have learnt and the reflections on the teaching session will be presented.

2. Literature Review

2.1 Deep Learning

In the 1970s, researchers first used the terms 'deep learning' and 'surface learning.' For instance, Marton and Säljö (1976) linked deep learning with the focus on comprehension and meaning placement in content and surface learning with memorization. At the same time, research on students' study methods contributed to the development of a common vocabulary for crucial phrases like 'surface,' 'depth,' and 'achieving' (Biggs, 1970, 1979, 1987; Mahat et al., 2018). Donche (2014) attempted to define the terms "surface learning" and "deep learning." He argued that deep learning is linked to students' intents to comprehend and engage appropriately in learning, concentrating on fundamental topics and concepts and using procedures that are suitable for generating such meaning. Surface learning, on the other hand, refers to pupils deliberately recalling information based on reasons or goals that are unrelated to the task's true purpose, such as avoiding failure or staying out of trouble (Donche, 2014). Frey, Fisher and Hattie, (2017) used similar terminology, referring to the consolidation and acquisition of basic information (surface learning), engagement with abilities and ideas (deep learning), and organising and expanding conceptual knowledge (transmission of the knowledge).

Students' sense of purpose, academic engagement, and real-world connections are seen to improve in deep learning 'environments' (Fullan & Langworthy, 2018). Such students have a wide perspective, think critically, connect ideas to daily experiences, connect perspectives to one another, and develop new concepts (Filius et al., 2019). They have a tendency for studying beyond the course requirements. Deeper learning is also expected to foster connections among learners, their families, communities, and instructors, as well as a greater desire to connect with others to perform well, all of which contribute to the development of abilities required to flourish in today's society (Fullan & Langworthy, 2018). But students who take a superficial approach are more driven to jump through the requisite hoops to get a good grade, mark, or certificate than they are to become interested in and understand the topic. (Filius et al., 2019).

Deep learning has a clear path and an open vision due to the effect of motivation. It can be separated into 3 stages: the introduction is the first stage, that emphasises learning as the primary means of acquiring academic concepts (Reichstein et al., 2019); the second one is the central core stage, where errors are analysed and knowledge is integrated, thereby promoting students' judgement and critical thinking abilities (Sun, 2019); and the evaluation stage is the third, where an active and deeper learning environment is accomplished by self-evaluation, peer-evaluation or mutual evaluation between students and teachers in classrooms (Yu, 2019). Figure 1 depicts the deep learning procedure. The subjects activate relevant information in their thoughts, debate the issue using prior knowledge, establish a link between newly learned and existing knowledge, and make new concepts logical, resulting in the creation of a new knowledge structure (Li, Deng & Zhang, 2022).

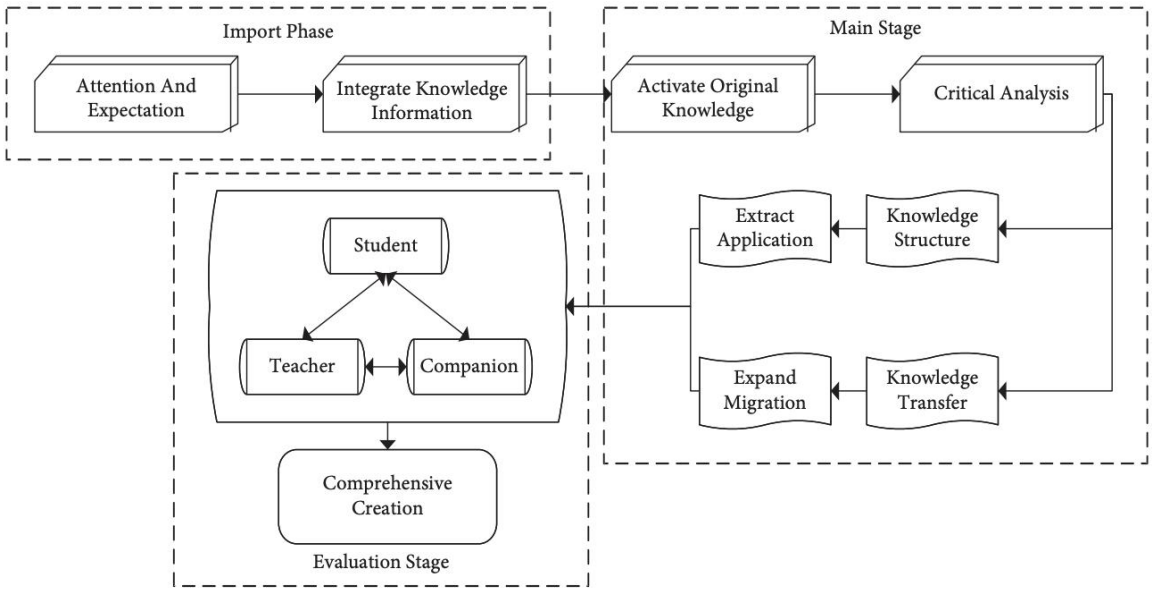

Figure 1. Progress of the deep learning (Li, Deng & Zhang, 2022, P.5).

The focus of this paper on discovering new understandings about the linkages between deep learning and project-based learning—was informed by a sensitivity to the fundamental ideas connected with the process of deep learning, Bloom's taxonomy and Constructivism.

2.2 Project-Based Learning (PBL)

Project-based learning (PBL) is a student-centred approach that encourages all instructors and students to move beyond the transmission-based teaching method by having them work on projects to attain their goals (Mohamadi, 2018). PBL, according to Bell (2010), involves learners solving real-world problems and requires them to do their own research, design their own learning, and use different methods to accomplish their work.

Learning by doing, cooperation, and teamwork are key features of PBL (Harmer, 2014). And the benefits for pupils include higher-level cognitive abilities like problem-solving skills, critical thinking, decision-making skills (Thomas, 2000), and increased motivation and self-esteem (Ocak & Uluyol, 2010). Many scholars agree that learning by doing is at the core of this strategy (Danford, 2006; Stauffacher et al., 2006). Students learn via inquiring, investigating, writing, talking, advocating, debating, analysing, and synthesising in order to answer a question (Wolpert-Gawron, 2015).

Authenticity is one of the major advantages of PBL. Students are expected to be involved in real-world tasks so that they may apply what they've learned in a fashion that's comparable to what they'll need outside of the classroom, which encourages them to learn more (Hanney, 2013). PBL promotes autonomy by requiring students to depend on their own knowledge and resources. A demanding subject, persistent investigation, reflection, student voice and choice, authenticity, critique, modification, and a public output are some of the important characteristics of the PBL (Larmer, Mergendoller & Boss, 2015).

Some certain pedagogical bases approaches also enable the adoption of the project-based learning (Helle, Tynjala & Olkinuora, 2006). The concept that learning activities are driven by a topic or issue, for example, is likely the most distinguishing element of this method. By gathering main information when sorting through a plethora of evidence, data or preceding instances that might be utilised to solve further problems, students' metacognitive talents are pushed (Morais, 2018). Despite such metacognitive issues, "project-based learning can be described as involving both vertical learning (i.e., the accumulation of content knowledge) and horizontal learning (i.e., basic skills such as program management)," which are both are helpful in trying to prepare pupils for life beyond the schoolroom (Helle, Tynjala & Olkinuora, 2006).

PBL has certain shortcomings, according to Cho and Brown (2013), who state that it is not for every pupil, that this may distract pupils and that it may cause work-life balance difficulties owing to excessive work. PBL also requires a change in mindset from teacher to facilitator and skills in assessing students' capacities, significant preparation and professional growth, and a positive work atmosphere (Ravitz, 2010; Cho & Brown, 2013). So another disadvantage is the difficulty of changing the relationship between teachers and students, the additional time required compared to the conventional instruction (Zadok, 2020), and abilities in getting answers from different people on the ground to investigate different thoughts (Pan, Poh-Sun & Koh, 2019).

2.3 The Linkage Between Deep Learning and Project-Based Learning

PBL, according to some researchers, is beneficial to the promotion of deeper learning. PBL, according to Howard (2002), engages students in completing meaningful activities, enables them to participate in active discovery, inspires them to generate knowledge autonomously, and helps them improve critical thinking skills. Several Chinese researchers shared similar opinions (Li Zhuqing, 2002; Gu Peiya, 2002). In the implementation of the project, the knowledge, strategies and methods used are not separate, but rather intertwined and interconnected, and the process of implementing and exploring the project is a process of in-depth processing of information for the learner, requiring the learner to develop a deeper understanding of the knowledge points (Zeng, 2018).

2.3.1 Constructivism

Project-based learning has its origins in constructivist pedagogical theory, which emphasizes that knowledge requires collaboration and communication with teachers, peers and others to construct one's cognition in a certain cultural context (Yan, 2018). Constructivists think that learners must absorb new information actively and thoroughly in order to contextualise it and facilitate the deep learning (Taber, 2006; Loyens & Gijbels, 2008). Project-based learning may give students opportunities to engage in a project they like and actively learn, argue and apply new knowledge. Learners are required to take the initiative in creating connections and processing old and new knowledge during the design, exploration and accomplishment of projects. To realise and complete projects, different learners actively explore and construct knowledge according to their own needs and project plans in order to achieve project realisation (Zeng, 2018). These advantages of PBL may help students accomplish deep learning.

One significant criticism made about constructivist approaches, particularly PBL, is that they fail to take into account learning efficacy and the human cognitive architecture (Kirschner, Sweller & Clark, 2006). Kirschner argued that while human cognitive architecture allows for the acquisition of scientific knowledge, it does so in a slow, laborious, and unnatural manner and considerable scientific knowledge, generally attained via serious investigation, took untold millennia for humanity to develop. It might be claimed that human cognitive processes do not lend humans to the inquiry-based procedures like PBL required for the discovery of new knowledge, based on this delayed growth. Then in the next part, the study will talk about Bloom's taxonomy of educational objectives for the cognitive domain and these issues are discussed in more detail in the critique section.

2.3.2 Bloom's Taxonomy

Bloom's Taxonomy (1956) defines a framework for categorising statements about what we want pupils to learn as a consequence of education. Within the cognitive domain, learning is classified into six hierarchical levels: "knowledge, comprehension, application, analysis, synthesis, and evaluation" (Bloom, 1956, P.13). The levels are presumed to be cumulative, with each succeeding level building on the success of the prior one (Seddon, 1978). It entails understanding methods and means of coping with information at the lower levels of Bloom's hierarchy. At its higher levels, it entails understanding "universals, principles, generalisations, and abstractions" (Goldman, 2005, p.7). As previously stated, surface learning encompasses Bloom's levels 1 and 2, deep learning encompasses Bloom's levels 5 and 6 and surface and deep learning may encompass Bloom's levels 3 and 4 together (Goldman, 2005). Bloom's levels are identified in a thorough and particular way via the use of domain-specific verbs. That is, the verbs represent evidence of that specific learning area, as will be discussed momentarily.

3. Learning Event

This learning event took place in a rural Chinese school with a class of 24 5th grade students. There was a great gap between the top students and the low-performing students. For a variety of reasons, the teacher found this class really difficult. For starters, because of the lack of science teachers in the rural school, pupils only learnt a little about science. This meant they lacked the prerequisite knowledge required for the class. Furthermore, the range of abilities made it difficult to keep them interested. The teacher was continually afraid of pitching material too high and alienating the struggling kids, or pitching it too low and losing the attention of some of the better achievers. Third, the class's behaviour could be problematic. This was due in part to poor involvement and in part to the class's low motivation. The teacher intended to use project-based learning in my class to promote student involvement and autonomy.

The teacher decided on the theme of the project before the class: "Building a bridge." Students should design and construct a bridge that could support greater weight while using limited materials. He estimated that the project would take roughly four hours of total class time (240 minutes). This was divided into one hour of training and assessment, two hours of constructing and testing, and one hour of post-activity evaluation.

In the first stage, the teacher divided the students into groups prior to the lesson to ensure that each group had a diverse set of characteristics, with some having strong hands-on skills and others having strong leadership skills.

The teacher showed them some photographs of bridge failure from across the globe at the start of the lecture and passed the images around the room to motivate them. Their aim was to design and build a bridge with a high strength-to-weight ratio for the community where they lived.

In the second stage, the teacher gave them some background information and showed them several typical bridge types and sizes. They discovered that a substantial support framework was required. This was often in the form of a truss, a triangular latticework structure. The arch is another form that works in a similar way to the truss triangles. They talked about their design and attempted to sketch it out. The only items allowed were wooden tongue depressor sticks and white glue. He had each team have a meeting to discuss, compare, and decide on their favourite design. The best option they anticipated would be the strongest bridge with the fewest sticks, because the goal was to build a bridge that could resist the highest weight while being the lightest—having the maximum strength-to-weight ratio. They started building the bridge when they agreed on the final design as a group. After the bridges were finished, as their final prototypes might have altered over the building process, the teacher had teams measure, re-sketch, and settle down the final version of their design.

In the final stage, all the teams had to complete a self-assessment and the teacher put the bridge prototype through a weight-loading test, which included laying each bridge end on the edges of two tables situated a foot apart. They gradually increased the weight till the bridge collapsed and recorded the weight at which the bridge failed. Then he had students compute the strength-to-weight ratio of their teams, which they documented on the worksheet and discussed with the entire class. All of the design alternatives were examined, and the strength-to-weight ratios were rated in order of best performance. The teacher invited the teams who developed the top 3 bridges to give an informal presentation to the remainder of the class, detailing their design approach, and then they would get peer evaluation and criticism. They should also submit a report explaining the PBL process and outcomes after finishing the project tasks, which is essentially a self-evaluation report that requires students to evaluate and reflect on the learning process.

4. Critique of the Chosen Learning Event

The learning process throughout PBL is a complex process in which learners play critical roles in accepting and enabling learning. Understanding how deep learning happens and can be improved becomes critical for PBL to be successful. Using the stages given by the framework presented in Figure 1, the study will examine how deep learning happened throughout the PBL process.

4.1 Different Stages of Deep Learning

In stage 1 of deep learning, when it comes to projects, one of the main concerns for students is constantly satisfying the expectations of project instructors and themselves. If there is a misalignment of expectations, the project's path may need to be reconfirmed and may be redirected (Pan, Poh-Sun & Koh, 2019). As a result, students and teachers should collaborate on project objectives and benchmarks (for example, by co-creating assessment rubrics) driven by the intended results (Pan, Seow & Koh, 2019). In the case of my teaching session, THE TEACHER often participated in discussions with students to encourage cooperation, matched the course with industry expectations, and ensured that the pedagogical approach (knowledge, skills, and behaviour) achieved their goals. In this "import phase", the project problem gets attention and expectations from students and teachers will motivate the active learning (Reichstein et al., 2019).

In stage 2, the settings of the PBL process assisted in transforming what was usually passive learning (taking notes, listening, sitting) into a more active, student-centred and hands-on experience (Kokotsaki, Menzies & Wiggins, 2016). The prior information THE TEACHER provided at the start of class helped students to reflect and prepare to participate more actively in class. Students worked in small groups to solve problems and utilised deeper learning approaches including critical thinking during class time that was focused on meaningful learning activities. Students indicated that they actively sought to transform their own learning from memorising to a higher level of thinking when they applied and related the lesson to their own projects and interests (Danker, 2015). It may be not possible for students to only rely on memorisation to complete the task – they really needed to understand the design of the bridge to be able to design their own bridge. So in a way, the design of the activity demanded deeper learning and understanding. PBL assisted these students in creatively managing their own learning. Active and engaged learning is a characteristic of project-based learning. It motivates students to acquire a greater depth of information using this technique significantly more quickly than through standard textbook-based education. Additionally, children gain confidence and self-direction as they work in teams and independently (Masalegoo, 2013).

There may be greater interaction between the teacher and the students in a PBL classroom, as well as between students. The longer time for feedback is one consequence of this interaction (Danker, 2015). This was noticed in stage 2 students who had regular feedback remarks. They either thought they gave valuable input to the instructor and their peers on their teamwork in the in-class activities, or they thought they received meaningful

feedback from the instructor and their peers. When the students completed the learning activities, the instructor was able to evaluate their level of knowledge and give immediate support (Danker, 2015). These expanded possibilities for feedback have the potential to boost student learning. An ordinary student who gets one-on-one attention is empowered by the continual feedback and a remedial procedure and may leap into "the student population in the academic accomplishment realm" (Bloom, 1956; Houston & Lin, 2012, P.1). My students took part because they enjoyed the activities, wanted to learn new things in the PBL class, and wanted to share their learning with their peers. The classroom had been converted into a learning centre.

In the stage of evaluation, students displayed the data, explained their ideas, and lastly optimised their problem-solving approaches. Finally, the instructors summarized. Deep learning cannot occur without assessment, as well as the same emphasis on critical reflection (Zeng, 2018). Deep learning assessment focuses on the learning process and outcomes, while project-based learning evaluation focuses on the process of competence development in the project implementation process, reflecting the equal relevance of process and results (Sun, 2019). The learning process and project work are evaluated in the project evaluation session. And the strategies, plans, and group collaboration are evaluated and critically reflected upon in a timely manner, which can help learners to adjust their project plans and arrangements, promote deeper processing of knowledge and develop students' critical thinking. They will be able to critically reflect on their group's issues, flaws, and strengths throughout the project, allowing them to build on their strengths and address their shortcomings in future projects and learning processes. The primary goal of process assessment is to help learners build self-critical and reflective abilities that may be used to control future learning and encourage more scientific and deep learning (Zeng, 2018).

The inclusion of feedback, self-assessment and peer-assessment in this PBL module helped to create a conducive learning atmosphere that emphasised the significance of critical thinking abilities and encouraged deeper approaches to learning. This module's structure and approach aided in the formation of an environment of equal rank learners, where each student not only had a contribution to make but was also expected to do so. 'What is required is a culture of achievement, underpinned by a sense that all learners can succeed,' as Black and Wiliam (1998, P.6) put it. As McNiff and Whitehead (2011) pointed out, students need assistance in overcoming the reliance on the teachers and in developing an awareness of themselves as having genuine knowledge in the PBL class. It's critical that THE TEACHER spent time discussing the feedback process with the students, and students should understand why they should provide and receive feedback from their peers and teachers (McGourty, Dominick & Reilly, 1998). A well-designed peer feedback method may provide important outcomes (Nicol & Macfarlane-Dick, 2006). Student instructors would see the need of fostering peer feedback and peer evaluation as a method of developing a higher-order cognition (Hopson, Simms & Knezek, 2001). Allowing students to criticise one other's work pushes them to think more deeply about their own idea and design. It also encourages them to learn from their mistakes and making mistakes becomes more acceptable in the classroom. This subject not only allowed students to experiment with other pedagogies than those typically taught at the university level, but it also fostered critical self-analysis of practice and reflection.

Deeper learning requires deeper processing of information and the acquisition of knowledge beyond understanding and application to higher levels of analysis, synthesis and evaluation (Goldman, 2005). In project-based learning, each stage is not independent and one-sided, but complex and connected, with different learning objectives from other projects, and multiple projects are interrelated and intersect with each other (Song & Yu, 2014). If the PBL stages are followed, the overall project can be successfully completed and each level of Bloom's taxonomy can be achieved because most of the time the lower levels of learning should be achieved before the higher levels (Seddon, 1978).

4.2 Constructivism

Traditional teaching is a one-way process in which instructors educate and pupils learn by rote, with the teacher providing the majority of the knowledge (Overholt, 2017). Modern constructivist theories of learning see learning as an active process in which students develop their own knowledge via the interaction of prior information and present circumstances (Jones & Brader-Araje, 2002). PBL shows constructionism via the establishment of a student-centred learning environment and the focus on artefact production as a component of the learning result based on realistic and real-world experiences with different viewpoints (Han & Bhattacharya, 2001).

In terms of the PBL classes, my students were at the centre of the curriculum which means they had the chance to argue their opinions and decide which way to go by themselves. Teachers were not at the centre but were instead facilitators. PBL has the potential to significantly contribute to the development of a student-centred classroom environment and to a paradigm change in global education practices (Kokotsaki, Menzies & Wiggins, 2016). The process of project implementation and exploration is a process of deep learning of information for learners, requiring them to link old and newly learned knowledge on the basis of the understanding of

knowledge points and to can analyse, synthesise and apply the project and related knowledge. For instance, my students newly learned what the strength-to-weight ratios meant. But they had learned how to calculate and compare ratios. So after understanding what this ratio is, they initially tried to figure it out and make it as great as possible. In the process of application and practice, students can discover, explore and solve dynamically generated problems in a timely manner. In the process of continuous discovery and problem-solving, the information is processed at a deeper level and can be understood and grasped from all angles, and can be used in a variety of ways, transferred and created. For example, in the learning event, the students were able to find out that shaping the bridge as an arch may not be helpful if the arch is not smooth enough. They learned this when they tried to build their bridges into some kind of strange arches without carefully thinking. Creation is the synthesis of multidisciplinary knowledge and the integrated use of multiple skills (Zeng, 2018).

4.3 Shortcomings of the Teaching Session

Beginner learners' inability to discriminate between what information is relevant and what information may be examined later or discarded is limited by their lack of expertise and experience (Vogel-Walcutt et al., 2011). As a result, some false information will be gathered, and valuable knowledge may be lost. For example, at the beginning of the design process, many students showed a struggle with which design to choose and which way to go. Teachers may need to support their students and guide students to make the right decision by asking questions to get them thinking in the right way.

Some students were worried about making the transition from passive to active learning (Ertmer, 2005). Frank, Lavy and Elata (2003) found that educating students in teamwork before the start of a project increases their comfort level and increases the project's chances of success. Some students are hesitant to change because they have perceived success in conventional learning. It is seen as a success since the student may have received excellent marks, but this does not imply that actual learning has occurred. For example, some of the top students were hesitant at the beginning. They told me they were used to working with traditional problems and were afraid of doing a project because they might not find the best way to solve the project's work. Evidence shows that secondary school kids do not always react to high-level activities by increasing their use of learning techniques and that pupils, in general, reject high-level cognitive processing tasks (Blumenfeld et al., 1991). When working with primary and secondary school pupils, some researchers have questioned the learner's maturity to employ the skills needed to complete the project-based learning assignments (Kirschner, Sweller & Clark, 2006; Wirkala & Kuhn, 2011). Some students might not good at group work and they cannot find their position in the group. So in the first several classes, THE TEACHER had to spend a lot of time discussing with them in different groups to make sure they could be adapted to group learning.

5. Conclusion

The purpose of the current paper is to determine to what extent and how project-based learning may enhance deep learning. According to the findings of this reflection, the process of PBL events may entail all three phases of deep learning and may result in a shift from surface learning to deep learning at various points. When instructors' expectations and self-expectations are met, students might become more motivated in PBL lessons and begin to participate more actively in the process during the initial stage of the session (Reichstein et al., 2019). The previous knowledge, students' interests, and cooperation may all contribute to more active and engaged learning in the next stage. The contact between students and professors, as well as between students, is critical in transforming the classroom into a learning club (Danker, 2015). Self- and peer-assessment and feedback are essential in the last stage of deep learning in order to achieve greater levels of achievement (Zeng, 2018). Another significant discovery is that project-based learning is a constructivist approach that promotes deep motivation and learning (Han & Bhattacharya, 2001; Jones & Brader-Araje, 2002). Despite its shortcomings, project-based learning has the potential to increase students' deep learning abilities while also motivating and engaging them actively in the classroom.

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