Research on project-based learning activity design for deep learning capability

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Abstract: Deep learning in blended learning environments is an important topic of educational reform. Project-based learning is an effective way to cultivate deep learning capability in blended learning environments. This article relies on the "Superstar Learning Pass" online learning platform and combines it with traditional face-to-face classroom teaching to create a blended learning environment that integrates online and offline learning. It uses the six deep learning capability frameworks proposed by the William and Flora Hewlett Foundation as a support to design project-based learning activities for deep learning capability in blended learning environments. This article explores effective ways to promote students' deep learning capability in blended learning environments.

1. Introduction

Deepening education reform is an eternal topic in colleges and universities. However, while advocating the "learner-centered" educational philosophy, many institutions continue to use traditional teacher-centered teaching methods that require students to receive the same content and teaching methods at the same time and place, regardless of individual differences. This passive acceptance of superficial knowledge often leads to students being unable to apply their knowledge after graduation. Currently, the urgent need for deep learning capability in society has prompted the education community to begin focusing on the development of deep learning capability in school education. Based on detailed literature research and extensive expert interviews, the William and Flora Hewlett Foundation has defined deep learning in terms of cognitive, interpersonal, and Intrapersonal domains as an essential ability for students to succeed in the 21st century and to participate effectively as citizens. This includes Content Mastery, Critical Thinking and Complex Problem Solving, Collaboration, Effective Communication, Self- Directed Learning, Academic Mindset[1]. Project-based learning integrates the needs of deep learning, changes the previous teaching method based on knowledge transfer, and focuses on students' "learning". It aims to help students better improve their ability to analyze and solve problems, creatively complete learning tasks, and is an effective way to enhance students' deep learning capability. This study will design project-based learning activities for deep learning capability based on the "Superstar Learning Pass" online learning platform. Through project-based learning centered on students' "learning", it will guide and help students actively participate in learning, and further enhance students' deep learning capability.

2. Research Status of Project-Based Learning

Project-based learning is a teaching activity design strategy that supports deep learning. The key to educational reform is to reform the traditional classroom teaching structure and shift from a teacher-centered teaching structure to exploring new teaching models to promote high-quality talent development. Project-based learning is an effective and learner-centered approach that enables students to acquire in-depth knowledge and skills through active engagement. It does not just focus on learners using a pre-defined method to explore and solve problems but emphasizes the development of skills and abilities during the process of problem solving. Project-based learning typically involves the formation of small groups for collaborative learning. Learners have clear divisions of labor within the group and are required to engage in independent thinking and reasoning while also collaborating with group members to complete shared tasks. In the process of promoting educational reform in China, project-based learning has also been gradually adopted by more educators. Ren Yonggong et al. integrated the particularity of deep learning in the field of programming to structurally design a project scaffold that promotes learners to effectively complete programming[2]. Xiong Bangzhong et al. proposed a new learning scaffold based on "O2O iteration" as project-based learning, and conducted an empirical study with "Information Technology application" course of open education as an application case[3]. Hao Chunlei et al. designed a project-based college English course based on the "Comprehensive English" course of an application-oriented undergraduate college with reference to the previous design dynamic model and design scheme, and conducted application and research[4]; Guided by project-based learning theory, Cui Xiangping et al. built a deep learning process model supported by COOC, a collaborative open online course, and carried out application practice [5]. Shan Meixian et al. combined project-based learning with flipped classroom teaching, and organized an 8-week project-based peer online collaborative learning teaching activity from three aspects: pre-class content reconstruction, in-class case explanation, and after-class reflection optimization[6]. On the basis of exploring the connotation and the value of The Times, Qi Chenglong et al. took the project of "Making traffic lights in primary school science" as an example to design the course and explore the practical path to promote STEAM project-style teaching[7]. Cheng Hui et al. designed and implemented a project-based learning of integrating music into mathematics classroom from an interdisciplinary perspective combined with the 5EX design model[8]. Existing research has shown that project-based learning has accumulated rich practical experience in application and has provided effective methods and strategies for promoting students' deep learning capabilities. However, specific practices on how to promote students' deep learning capabilities through project-based learning in blended learning environments are not yet clear. Therefore, this study aims to design specific project-based learning activities focused on deep learning capabilities with the goal of cultivating students' deep learning capabilities in blended learning environments.

3. Design of Blended Learning Environment Focused on Deep Learning Capability

Project-based learning is a teaching model that allows students to actively explore real-world issues or problems through open-ended research activities with a focus on knowledge construction [9]. It typically consists of six steps: Selecting projects, developing plans, exploring activities, producing works, sharing outcomes, and evaluating performance[10]. The design of project-based learning activities requires a clear understanding of these steps as well as a clear integration of blended learning environments. Blended learning is both an important trend in global education reform and an inevitable requirement for improving the quality of education in China[11]. This study is supported by the six deep learning capability frameworks proposed by the William and Flora Hewlett Foundation. Through the creation of a blended learning environment that integrates traditional face-to-face

classroom teaching and online learning based on the " Superstar Learning Pass " platform, project-based learning activities for deep learning capability are designed, as shown in Table 1.

Table 1: Design of Project-Based Learning Activities for Deep Learning Capability

Project-based learning activity process	Activity content	Online learning environment	Deep learning capability cultivation
Ice-Breaking	After the teacher informs students of the basic situation of the course, they are assigned a project-based learning framework and guided to register on the " Superstar Learning Pass " online platform and join the WeChat group. Students voluntarily form learning groups and collaborate through Tencent Documents.	**Discussion module**: Asking questions, replying, group chat, private message	Effective Communication
Selecting Projects Developing Plans	Students, through group cooperation and discussion, determine their own group learning projects and develop project plans within the framework of project-based learning.	**Resource module**: Uploading and downloading information resources of different levels and categories **Homework module**: Student self-testing Learning to learn	Self- Directed Learning Academic Mindset Content Mastery
Exploring Activities Producing Works	Learn the subject knowledge taught by the teacher offline while working in groups to explore group projects	**Activity module**: Carrying out group tasks to achieve project-based learning activity exploration. Students conduct self-assessment and mutual assessment, and can view all group works.	Critical Thinking and Complex Problem Solving Collaboration Effective Communication
Sharing Outcomes Evaluating Performance	Groups share the outcomes voluntarily in class, revise and improve the works through mutual evaluation and teacher evaluation, and then upload the " Superstar Learning Pass " platform for students to conduct online group evaluation		

3.1. Students autonomously choose resources for personalized learning based on their existing knowledge level, which helps cultivate students' deep learning capability such as Self- Directed Learning, Academic Mindset

The "Resource" module allows teachers to push courseware and related micro-course resources at different levels. Based on their existing knowledge level, students can autonomously choose corresponding levels of learning resources for personalized learning. Unlike traditional face-to-face classroom teaching where all learners must learn the same content at the same time and place. On the " Superstar Learning Pass " online learning platform, learners can choose not to learn or skip learning the basic knowledge they have already mastered. For more complex advanced knowledge, learners can learn repeatedly. In addition to course resources, more related expansion auxiliary resources can also be obtained on the online learning platform. On the online learning platform, students can not

only access the resources provided by teachers, but also learn from other learners' dynamic generated resources during the learning process. Personalized learning helps students engage in autonomous learning and self-management, and cultivates their deep learning capability such as self- directed learning, academic mindset.

3.2. Students take the initiative to ask questions, respond to questions and engage in discussion topics, which helps to cultivate students' deep learning capabilities such as Effective Communication, Collaboration, Critical Thinking and Complex Problem Solving, Content Mastery

The internet has strengthened the dynamic development of knowledge, with networked knowledge keeping up with cutting-edge trends, able to spread simultaneously with production and continuously evolve through interaction[12]. The "Discussion" module provides a channel for teachers and learners, as well as learners to interact with each other. Teachers initiate topic discussions, post messages related to content knowledge after learning, and students reply through analysis, reflection, critical thinking, etc., which helps cultivate their deep learning capabilities in critical thinking and complex problem solving and mastering core academic content. When students encounter problems during the learning process, they can post questions on the platform at any time, and other students can reply to the questions or discuss different viewpoints. This interactive process not only promotes students' critical thinking and complex problem solving about their learned knowledge but also provides support for their ability to effectively communicate and work in teams. Additionally, under the guidance of teachers, students share in the "Discussion" module the high-quality resources they acquire and truly apply in the learning process, allowing other students to selectively learn according to their needs.

3.3. Project-based learning, in which students form cooperative groups according to specific requirements, is conducive to developing students' deep learning capabilities in Critical Thinking and Complex Problem Solving, Collaboration, Effective Communication

The "Activity" module creates conditions for project-based learning, allowing students to form learning groups on the platform, submit group works, engage in self-assessment and peer review, and view works by other groups. Students can form 5-person groups based on their preferences through face-to-face communication and online WeChat groups, providing an opportunity for effective communication. Group members are guided by the team leader to complete a series of tasks such as developing a project plan, exploring activities, producing works, and sharing outcomes, evaluating performance based on the "Activity" module's assigned tasks. All group members participate in internal and external evaluations. This process of completing project-based learning can cultivate deep learning capabilities in critical thinking and complex problem solving, collaboration, effective communication.

4. Implementation Process for Project-Based Learning Activities

4.1. Selecting Projects

In the project-based learning process geared towards deep learning capabilities, the selection of project topic content directly relates to students' ability to successfully complete projects and truly cultivate their deep learning capabilities. Teachers first determine the overall project goals and tasks, provide a framework for students to choose from, and offer corresponding guidance as needed. However, the final decision on the selection of projects rests with the student group community. In

the process of selecting projects, students collaborate and discuss with other group members to activate their existing knowledge related to the project, establish connections between old and new knowledge, help facilitate knowledge transfer, and cultivate their deep learning capabilities in content mastery, effective communication, and collaboration.

4.2. Developing Plans

After selecting a project, ensuring its smooth implementation and timely completion requires developing a plan. The project plan is developed under teacher guidance and based on the specific tasks assigned by the project and the actual situation of each student group. Its purpose is to help students prepare for activities such as exploration and work making, including specific responsibilities for group members at different stages of the project, necessary preparations for completing the project, and the final form of work presentation. The plan should be developed through group discussion and presented in writing to ensure that each group member has a clear understanding of the group's overall plan and their individual responsibilities. After developing their plans, student groups upload them to the online learning platform where other groups can discuss and exchange ideas. This process can cultivate deep learning capabilities in effective communication, collaboration, self- directed learning and academic mindset.

4.3. Exploring activities

Conducting activity exploration is the core component of project-based learning where students primarily construct knowledge significance, acquire skills, and develop affective dispositions during this phase of the project. The task during this phase is to propose hypothesis based on activity content and use certain research methods and technical tools to obtain, distinguish between, screen out, and process relevant information to provide solutions for work production in the next phase. Conducting activity exploration requires students to construct personal meaning based on learned knowledge while also engaging in in-depth discussions with group members which can cultivate deep learning capabilities in content mastery, critical thinking and complex problem solving, effective communication, collaboration and self- directed learning.

4.4. Producing works

Producing works is a typical feature of project-based learning that distinguishes it from ordinary activity teaching. Sometimes, producing works and conducting activity exploration are done simultaneously. Students can apply knowledge in the process of producing works, reflecting their mastery of knowledge and skills throughout the entire process, and demonstrating their innovation abilities. Through group cooperation, students can complete the creation of a piece of work together. Different learning groups can flexibly choose different forms of presentation for their works, and different members of the same group can also have different styles while maintaining consistency. In this process, individual characteristics should be highlighted while taking the group's consistency into account. Through cooperation in completing a piece of work, students can cultivate deep learning capabilities such as effective communication, collaboration, and content mastery.

4.5. Sharing Outcomes

Showcasing and sharing the outcomes of project-based learning not only satisfies students' psychological needs and provides a sense of accomplishment, but also allows them to reflect based on feedback from other students and teachers, identifying and improving any shortcomings in their

work. After completing their piece of work, students can present their work through online and offline methods and evaluate and exchange ideas on their work. Firstly, in face-to-face classes, several groups can be randomly or voluntarily selected for classroom reporting, while other students engage in classroom discussion. Teachers can also provide summary feedback on common issues. After the classroom evaluation ends, each group can modify and improve their work, then upload it to the online learning platform for other groups to analyze and evaluate. This online and offline sharing of achievements cultivates deep learning capabilities such as effective communication, academic mindset, critical thinking and complex problem solving.

4.6. Evaluating Performance

Compared with traditional teaching evaluation methods, the evaluation methods for project-based learning are diverse. In terms of the evaluation content, it includes both summative evaluation of the final product and process-based evaluation of student motivation, strategies, and engagement; in terms of the evaluation subject, it involves teacher evaluation, self-assessment by students, peer assessment within groups, and peer assessment across groups; in terms of the nature and form of evaluation, it includes both quantitative evaluation methods such as questionnaire surveys, performance testing, and platform statistical data analysis, as well as qualitative evaluation methods such as analyzing works, classroom observations, and student reflections. Student participation in activity evaluation cultivates deep learning capabilities such as critical thinking and academic mindset.

5. Conclusion

The learning patterns in blended learning environments are gradually becoming the new normal in information-based teaching. The research perspectives on deep learning related to blended learning environments are also gradually diversifying. Practical exploration in real classroom teaching scenarios has become an essential path for deep learning to develop further. Educators can design or redesign schools' teaching to develop students' deep learning capabilities, one of the most effective ways being project-based learning. This study has designed project-based learning activities targeted towards deep learning capabilities within blended learning environments, and is currently in the midst of implementing them with the intention of providing a viable path towards enabling deep learning in such environments.

Acknowledgement

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