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Original Research Article

Design-Based Learning for Elementary School Classrooms

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Abstract: Vietnam's general education is in the process of transforming its educational program goals, in which creativity, collaboration and communication abilities are the core competencies that need to be developed at all levels [1]. There have been quite a few studies on innovating teaching methods in the direction of developing learner capacity. Studies show that important skills include critical thinking, creativity, collaboration and Communication... needs to be trained for children right from elementary school. Statistics of research results abroad over many decades show that design-based learning (DBL) can form and develop these (Kolodner, J, 2003). This study introduces design-based learning as a pedagogical approach to support children with learning differences. Experimental teaching is the result of collaborative research on design-based learning over a 3-week period, with more than 100 4th grade students at FPT Cau Giay Primary School Hanoi - Vietnam. Experimental results are part of this study.

Keywords: Skills; Design; Design-based teaching; Primary education.

1. INTRODUCTION

Currently, teacher training programs in Vietnam lack recognition of Design-Based Learning (DBL), and there is a shortage of resources in education universities dedicated to teacher training. These are obstacles that hinder the widespread application of the design-based teaching method. Therefore, providing teachers with flexible tools to develop their own DBL projects tailored to the needs of their classrooms is an urgent requirement. The aim of this research is to supply teachers with resources to support them in planning and creating appropriately designed lessons aligned with the curriculum and learning objectives according to the 2018 General Education Program. The research poses the following questions: How can DBL be implemented in elementary school classrooms to yield differences in students' academic achievements? What are the benefits of DBL? Is DBL compatible with the teaching and learning goals of the new General Education Program (2018)?

2. LITERATURE REVIEW

Design-Based Learning (DBL) connects students' acquired knowledge with real-world challenges and fosters continuous connections throughout the curriculum. DBL is an effective strategy to engage a wider range of learners compared to traditional teaching methods (Kolodner, J, & colleagues, 2003) [2]. Over the years, DBL has garnered attention from the educational community and researchers. Studies on DBL often focus on exploring its effectiveness in enhancing learning outcomes and developing skills for students (Hmelo-Silver, C. E., 2004).

Research in this area explores the learning outcomes of students through Problem-Based Learning (PBL), a form of DBL (Barak, M., & Doppelt, Y., 2000), investigates educational software design based on constructionist theory (Kolodner, J., & colleagues, 2003), applies DBL in teaching middle school science (Fortus, D., & colleagues), and examines the relationship between design thinking and critical thinking in developing diverse education programs (Tissenbaum, M., & Slotta, J. D., 2017).

In practical teaching scenarios, the challenging task for educators today is to teach students everything they need to learn. By integrating design thinking into their classrooms, teachers need to find ways to blend this approach into existing subjects. DBL enhances instructional flexibility, promoting innovative and personalized learning experiences for teachers, reducing the rigidity of current teaching programs, and fostering extracurricular skills, supporting lifelong learning. In DBL, students don't all learn in the same way; while traditional teaching methods limit a teacher's ability to cater to multiple students simultaneously, DBL helps teachers overcome this limitation, allowing for more

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creative freedom in the teaching process (Carroll, D., & colleagues, 2010) [3].

DBL is founded on the educational philosophy of John Dewey (1859-1952), a pioneer in experiential education. Dewey advocated situating students in real-life situations, encouraging active engagement for learning through real experiences. Renowned psychologist Jerome Bruner (1979) affirmed that DBL is a suitable method to improve 21st-century skills, which are currently in high demand in education. Recent perspectives highlight that design activities foster 21st-century skills such as collaboration, communication, critical thinking, creativity (Gordon, 2011), as well as synthesis, empathy, and imagination (Lee & Breitenburg, 2010), creating a trend of design implementation in classrooms.

However, these studies primarily focus on higher education rather than secondary education. Research and application of DBL in secondary schools have only recently begun to yield results in the United States [4].

2.1. Design-Based Learning (DBL)

Integrates design into the classroom as a means to support learning across various subjects, fostering inherent abilities to solve ill-defined problems in the real world (Fortus, D. & Dershimer, R. 2004) [4]. DBL in elementary school is a teaching and learning method rather than a standalone subject. Design maintains cognitive development through specific cognitive modes with symbolic significance. DBL provides opportunities to develop diverse abilities in non-verbal thinking and communication. Students learn not only from textbooks but also from the design process and project implementation. They have the chance to apply knowledge from various fields to solve real-world issues. DBL is a creative teaching method wherein students engage in creating, testing, and refining models, products, or solutions to solve specific problems. It proposes an integrated approach between education and design, encouraging students to apply the design process to tackle specific issues. DBL encourages students to develop various important skills, including creative thinking, problem-solving, collaboration, communication, feedback, and self-assessment. It offers a robust alternative to traditional teaching models by surpassing challenges where students seek answers to complex and multifaceted problems, promoting students' ability to act as change agents (Barak, M., & Doppelt, Y. 2000) [5]. DBL encourages students to think creatively and seek unique solutions to the problems they need to solve. Students apply learned knowledge to practical situations, aiding in better understanding and retention. Engaging in design and construction, students are required to use logical thinking to solve problems. DBL often necessitates collaborative work among students to complete projects, helping them develop communication and teamwork skills. Students not only learn theory but also create products or solutions that can be used within the community [2].

2.2. DBL Cycle

A research team led by Janet Kolodner published a series of Modules referred to as Learning by Design in the late 1990s and early 2000s (Kolodner, nd). Their model was designed as a method for teaching students scientific concepts while also instructing them in scientific reasoning, project work, communication, and collaboration skills. Kolodner's model places students at the center, with students effectively working as designers themselves. According to Kolodner, when we talk about design, we refer to the entire set of activities that a professional designer engages in to meet a design challenge. A designer must understand the challenge and the context within which its solution must perform well. The designer must generate ideas, explore necessary new concepts to meet the challenge (sometimes through systematic investigation), construct and test models, analyze solutions, rethink and revise ideas, and iterate until a solution is found. Furthermore, designers communicate with colleagues and other relevant parties, collaborate, make informed decisions, and adapt to changes as they occur over time. Modules designed for children at the elementary level guide students through the design process to grasp age-appropriate scientific concepts.

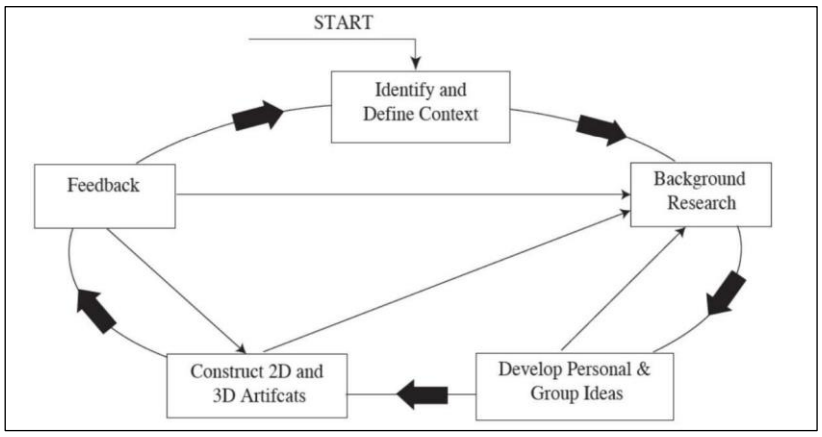

Figure 1*:* DBL's cycle of Fortus, D. & Dershimer, R. 2004

Based on referencing Kolodner's group Modules, this study employs the DBL cycle as per Fortus (2005) (Figure 1), which presents students with real-world challenges and guides them through the design process to construct practical and necessary solutions. This is crucial in developing real-world skills they can apply in future environments. "All new scientific knowledge and problem-solving skills are constructed in the context of designing artifacts as cases to solve ill-defined, real-world problems," (Fortus *et al*., 2005, p. 857) [4]. Table 1 summarizes the DBL teaching and learning activities.

Table 1

Teacher's activities	**Student's activities**
Teachers focus on guiding, supporting, and shaping students' learning processes by applying the design process to education. They provide support and accompany students throughout their learning journey and the execution of design projects, ensuring they have enough knowledge, skills, and confidence to succeed.	Students focus on exploring, researching, and executing real design projects. They act as primary designers and researchers, taking on the role of exploring, analyzing, designing, implementing, and evaluating solutions or models based on given tasks and problems
Activity 1: Establishing Goals and Requirements: Clearly define educational objectives and skills to be developed by students. Specify specific requirements for the project or issue that students will address. Introduce the project or design challenge to students. Provide general guidance and initial resources so that students can begin their own exploration and research.	**Activity 1**: Identifying and Researching the Issue: Students commence by comprehending the issue or design task presented. Gathering information: Students search and collect relevant information related to the issue from sources such as books, articles, interviews, or even direct observations.
Activity 2: Supporting Students in Research and Design: Guide students on approaching and analyzing the issue. Provide necessary resources, tools, and supporting techniques. Monitor and assist students in the process of searching, verifying, and evaluating information	**Activity 2**: Analysis and Deduction: Problem analysis: Students analyze and evaluate the collected information, identifying crucial and necessary factors. Inference and hypothesis formulation: Based on the available information, they infer and develop hypotheses or potential solutions applicable to the issue.
Activity 3: Encouraging Collaboration and Communication: Supporting students in organizing and participating in collaborative group activities. Encouraging students to communicate, share opinions, and provide feedback to each other.	**Activity 3**: Designing and Planning: Solution Identification: Based on hypotheses and gathered information, students devise solutions or models. Implementation Planning: Students outline detailed plans on how to execute and test their solutions or models.
Activity 4: Organizing Sharing and Implementation: Organize presentations, exhibitions, or deployments for students to share and present their projects. Encourage students to further develop their projects and apply the knowledge learned into practice.	**Activity 4:** Execution and Evaluation: Implementing the solution: Students proceed with implementing the solution or constructing the model according to the outlined plan. Testing and evaluation: Students test and evaluate the effectiveness of the solution or model, comparing it against the initial criteria and requirements.
Activity 5: Assessment and Feedback: Monitor the progress and outcomes of students throughout the design process. Provide constructive and periodic feedback to assist them in improving and refining their projects.	**Activity 5**: Feedback and Adjustment: Receive feedback: Students receive feedback from teachers, peers, and the community regarding their solutions or models. Adjust and improve: Based on the feedback, they adjust and improve their solutions or models to achieve better performance.
Activity 6: Summarizing and Evaluating the Project's Results, both in terms of academic achievement and students' personal skills. Proposing improvements and feedback for the teaching and learning process in the next implementation of DBL.	**Activity 6**: Sharing and Deployment: Presenting results: Students present and share about the process and outcomes of the project with the academic community or a larger audience. Deployment of the solution (if applicable): If the solution can be implemented in reality, they proceed with the deployment and monitor its effectiveness.

(Note: Figures or tables referenced in the original text are not provided here.)

The statistics in Table 1 are based on the Design-Based Learning (DBL) cycle (Figure 1), with the six teaching and learning activities relatively interrelated. Depending on the subject matter to be taught, teachers can choose the sequence of activities that aligns with the content and objectives of the topic.

3. RESULTS AND DISCUSSION

My research methodology also included "participatory design research," involving a high level of collaboration with teachers through observation, interviews, surveys, and discussions. The initial lessons introduced students to basic design skills such as brainstorming, drawing, and crafting. These lessons emphasized that in design, there's no right or wrong answer, but rather multiple feasible solutions. Students were encouraged to experiment, share ideas, and be creative.

After the initial introductory lessons and referencing the mathematical, scientific, and artistic knowledge of fourth-grade students, the experimental teaching group selected the topic of "fashion design" for hands-on learning. The format involved small group learning, with teachers observing and participating in discussions with student groups to assess according to pre-agreed Rubrics after each session. Following these sessions, teachers collected the students' design drawings (Figure 2) to assess students' progress based on the predefined grading scale within the experimental teaching group.

At the conclusion of the experimental teaching, the design research group surveyed teachers' opinions as an evaluation of students' DBL skills. The goal of this assessment was to help us understand each student's skills and determine whether any measurable improvement could be identified in these skills through the design lessons. The statistical compilation of the assessment opinions from FPT school teachers is as follows:

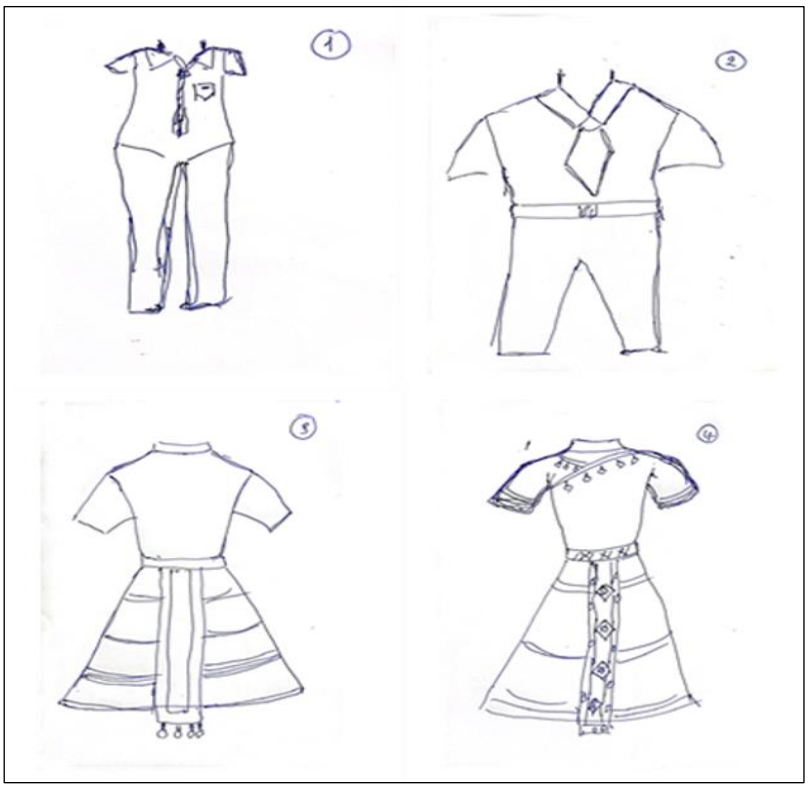

Figure 2: Students' products

"Design has provided the children with a way to apply the skills they've learned in social studies or science to real-world problems, while presenting new ways of thinking."

"Perhaps the most outstanding feature of using design activities in schools is the ability to integrate knowledge beyond the boundaries of traditional subjects at school."

"Most (95%) young students enjoyed design-related lessons; they were engaged in learning and debating."

"DBL significantly boosts self-confidence and is truly beneficial for students when they realize their success doesn't rely on their proficiency in something. It's about how they can explore an issue."

Teacher evaluations through observation (during classes) indicate: Students have taken control of their own learning, identified personal issues they need to address, devised their solutions to these problems, analyzed information to determine what to use and what to discard, identified which solutions they want to explore further, and set their own individual and group goals. DBL creates a learning environment that forces students to think for themselves, make decisions about

their own learning, and thus achieves what traditional learning environments cannot. From the student experience of self-assessment and evaluating others, students progress in communication skills as they prepare to present information to others and evaluate the information presented by other groups.

Limitations of DBL (students' biased thinking): Faced with a problem that requires resolution, students often present various viewpoints and different solutions, and they struggle to reconcile conflicting opinions when receiving criticism of their ideas. They present biased arguments to defend their own opinions. Sometimes, each group presents a different perspective on their solution.

4. CONCLUSION

The initial findings of this study suggest that applying DBL in elementary education is feasible and meets the objectives of the 2018 General Education Program in Vietnam. However, this research needs to expand its scope and subject to evaluate the quantitative development of students' critical thinking, creative capacity, communication, and collaboration during and after design-based learning.

The methodology of DBL has been around since the 1960s and is built on constructive, experiential learning theory [6]. Hence, it is understandable why DBL has garnered considerable academic attention and is becoming a prevalent subject in education systems in countries with developed education (OECD). DBL is increasingly being widely recognized and considered a mandatory subject in the education systems of many countries worldwide. Currently, DBL has not been incorporated into the education curriculum in Vietnam, and there are few scientific publications about DBL. Therefore, we believe that DBL deserves research attention and should be introduced into the education curriculum in Vietnam at an early stage.

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