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LEARNING THROUGH PROJECTS: EXPLORING ELEMENTARY STUDENTS' EXPERIENCES IN SCIENCE EDUCATION

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Abstract

The concept of project-based learning (PBL) has become one of the most revolutionary pedagogical elements in science at the elementary level with an emphasis on inquiry and collaboration, as well as, practical application (students). In this research, the authors examine the experience of elementary students working on PBL to learn how it affects the student engagement, understanding of concepts, and attitudes to science. The qualitative research design was used where classroom observations, observations, semi structured interviews and reflective journals of Grade 4 and 5 students in three schools were adopted. It utilized thematic analysis in order to determine the patterns in the perceptions and the learning behaviors of the students. It was an assumption of the study that patients did not have much previous experience of PBL and they had to work under a conducive teaching setting. Results indicated a higher interest in science, a greater sense of confidence in solving a problem and a more endowed sense of ownership in the course of learning. Students also reported that they liked working in team and putting concepts in practice through real projects. PBL helped create more engagement and held interest as compared to the traditional one.

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INTRODUCTION

The elementary science education is very crucial in developing curiosity, critical thinking and the basics of knowledge which students develop as they progress through their studies. The conventional teaching methods which are based on memorization and using of textbooks have been denounced as not meaningful enough to capturing the interest of young learners (Santhika and Rohmani, 2025). Project-based learning (PBL) has been accelerated as a solution to this weakness, providing a student-centered and inquiry-based alternative to it. The models of PBL promote the investigation of the problems of the real world with the help of interdisciplinary projects based on scientific concepts and innovative approaches to research and practice (Untari and Sukamti, 2018). It also influences the development of PBL as a tool of more profound learning, better motivation, and higher problem-solving abilities are supported by research.

Although PBL has been gaining popularity, the majority of studies revolve around implementation and the result of learning based on a teacher or a curriculum design basis. Few studies have been done on the emotional and cognitive experience of students with PBL especially in the elementary level of schooling. There are common assumptions that PBL works across board, but very little is known of how students perceive, internalize, and traverse such environments of learning (D'Ambra, 2014). Qualitative research, which focuses on student voices, needs to be conducted in order to gain a clearer insight into the outcomes of PBL in terms of student engagement and their related sense of agency and attitude towards science.

To address my research question, the proposed study will examine lived experiences of elementary students in project-based learning science. The research gives the readers the understanding of how PBL affects the students in terms of their comprehension, motivation, and a sense of belonging within the science classroom by emphasizing their stories, thoughts, and discussions. The most prominent findings are the appeal of hands-on project to the emotions, importance of collaboration to students, and how autonomy helps to maintain their interest. The research paper will be organized in this way: literature review based on the existing theories and the previous research, the methodology section that will explain how the study will be conducted in a qualitative manner, then results, discussion and conclusion about implication and practice.

Elementary level science education provides the basis of a child to understand the natural world and builds the curiosity, inquisition, and critical thinking abilities. Nevertheless, conventional classroom teaching, where students watch textbook-oriented lectures, with straightforward examinations, have been largely criticized on failing to engage students and encouraging learners to have an in-depth understanding of knowledge (Santhika and Rohmani, 2025). To rebuttal this, teachers have been progressively adopting Project-Based Learning (PBL) as a paradigm shift of pedagogy that promotes meaningful inquiry in students by engaging in practical and team-related projects.

PBL provides students with the chance to be responsible in their learning by involving them in problems of real life, investigations, and giving project reports in creative and applied forms. In comparison to the conventional teaching approach, PBL focuses on questioning, search, and knowledge creation, which makes science approachable to learners during their young age (Haryanti et al., 2024). Regardless of the high level of interest in PBL theory and the demonstrated evidence of the learning outcomes improvement in practice, the university-level academic discussion tends to focus primarily

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on the perspectives of teachers and their students. The majority of the reviews of PBL in elementary school focus on quantifiable academic benefits or approaches to implementation conducted through the prism of a teacher or an institution (D'Ambra, 2014). The big gap in the uncovering how students experience PBL personally is still present: what students love about it, what is quite difficult to them, how they work in group, and what is the impact of this kind of work on their attitude to learning science.

Additionally, the assumptions that PBL is engaging and universally effective ignore the factor of diversity in learning styles of the student, social and situational aspects or variables that influence the experience. With PBL increasingly integrated into educators all over the world, there should be an increased focus on listening to the students themselves to gain a better insight into what does and does not work when building science education at the elementary level.

This paper sets out to understand the lived experiences of project-based learning in elementary science classes among elementary students. Using a qualitative methodology involving a focus on student stories, reflections and observable behavior, the research aims at comprehending how PBL does not only affect the learning outcomes, but also influences emotional involvement, group effort, self-efficacies, and science interest.

The paper is a contribution to the literature in that:

- Shining light on students perceptions and emotional reaction towards PBL.
- Determining the patterns in engagement and learning when using various project forms.
- Providing the recommendations on how educators can make PBL experiences more inclusive and engaging in practical ways.

The paper continues in the following way: literature review which contextualizes the research within the preceding studies served as an introduction and methodology which describes the qualitative research and the method used to gather the data, after which, the paper includes the results, the discussion and conclusion which charters the implications in the teaching practice and curriculum design.

LITERATURE REVIEW

Project-Based Learning (PBL) has become an influential learning approach within the student-centered instructional philosophy, which also fits the objectives of science learning in the 21 st century. The method has been most appreciated due to its focus on inquiry, teamwork, practicality and acquisition of the skill of higher order thinking. The synthesis of the existing research in this literature review is based on a thematic framework where the four areas are presented as (1) Theoretical Foundations of PBL, (2) Scientific Learning and Engaged Impacts., (3) student perspective and classroom experience and (4) Problems of implementation and Teacher roles..

Theoretical Foundations of Project-Based Learning (PBL)

Project-Based Learning (PBL) owes much to constructivist theory of learning, according to which learning is an active process that involves experience and reflection on that experience, as well as interaction with the surrounding world. The origins of PBL could be found in the writings of Jean Piaget and Lev Vygotsky, who underlined the significance of stages of development and practical exploration, and the concept of the Zone of Proximal Development (ZPD) by Vygotsky, which emphasizes the importance of social interaction and scaffolding in the further development of a learner. The focus of conversation and teamwork as well as the guidance of the more knowledgeable other by Vygotsky is fitting the collaborative elements of PBL group and the teacher facilitation technique.

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The philosophy of experiential education (as proposed by John Dewey) serves to support the theoretical concept related to PBL. Dewey argued in favor of learning, which is linked to life experience and significant enquiry. He had the view that students can learn through being given power to take part in problem-solving and decision making as opposed to just receiving information. This is consistent with PBL as it focuses on the relevance of real-world and agency as a learner that learners explore intriguing questions which are usually personally motivated or are motivated by a community problem that they study and create meaning through action.

PBL is similar to the inquiry-based learning model, which promotes questions, investigations and reasoning as a part of science education. Bransford, Brown, and Cocking (2000) theorised that learner-centered, knowledge-centered, and assessment-centered principles incorporated into a properly designed PBL frameworks should all be proclaimed to be the characteristics of effective learning environments. Besides, the group-oriented quality of PBL is facilitated by social constructivism, which underlines the fact of knowledge creation as a result of a social conversation. The students also learn together to create common perspectives, using the strengths and outlook of one another. Not only is content learning improved during this process, but communication, empathy and critical thinking also develop.

As a whole, PBL is based on a classic theoretical background consisting of constructivism, experiential learning, inquiry-based science education, and social constructivism. Those principals cement its use in the elementary classes, wherein they have the merits of learning by doing, by thinking critically, and by interacting with other people in a way that matters.

Impacts on Science Learning and Engagement

The beneficial impact of Project-Based Learning (PBL) in academic achievement and student interest in science education especially among the elementary level students has been displayed as the protagonist as it is deemed important to cultivate curiosity and base skills. The studies prove that PBL does not only improve the knowledge of the students concerning the subject of science, but also promotes more active engagement, persistence, and conceptual learning.

Cognitively, PBL is an activity that facilitates scientific concepts. Since students work on real problems and use their science knowledge in actual situations, they are more likely to internalize and transfer their education in the real world. To illustrate, research conducted through Santhika and Rohmani (2025) established that PBL enhanced their better understanding of the complex science subjects by motivating them to gain practical skills through theory and application (Santhika and Rohmani, 2025).

The problem-solving abilities and critical thinking are also encouraged in PBL as the key elements of scientific inquiry. Students working on science projects are required to recognize questions, hypothesize, test ideas, and change their approaches depending on the consequences, which are the reflection of real-world scientific practices. PBL enhances personal ownership, independence, and pleasure of learning in terms of emotional and behavioral participation. When children perceive that their work is relevant, creative and collaborative, they are more likely to be motivated. The article by Harryanti et al. (2024) subsequently noted that students who were instructed on science through the project-based methods demonstrated the same view that science is easy and fun, with several students noting that they enjoyed creating models, performing experiments, or presenting their findings to others (Haryanti et al., 2024).

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Moreover, PBL has been identified with greater science literacy, which means the capacity to reason scientifically, interpret data and perform evidence-based reasoning. In a study by Ali (2023), it was shown that PBL improved the capacity of students to pose questions, provide data-driven conclusions, and share the findings with the information that are important indicators of literacy in science significantly (Ali, 2023).

Notably, the given benefits seem to cover a variety of contexts and groups of learners. Khuwayrah (2018) also discovered that the elementary students in the international environments also thought that PBL was extremely involving and helpful in building not only their content knowledge but interpersonal skills as well (Khuwayrah, 2018). In a summary, PBL affects the processes of learning science both positively and negatively as it reinforces the cognitive achievement by making scientific ideas more accessible and easier to apply, but also affects the affective experience in a positive way, making the process of learning more fun, student-oriented, and socially-focused.

Student View and Classroom Experience

Although much of the research on the topic of Project-Based Learning (PBL) is concentrated on student and school outcomes, as well as the structure of classroom-based learning, there is an emerging group of studies that underline the significance of student voices when it comes to comprehending how PBL is practiced at the school level. The way in which elementary students view PBL demonstrates that it has not only the ability to change the way science is taught but also experienced, comprehended, and appreciated by young students as well.

Research has discovered that PBL is perceived as more entertaining, applicable, and empowering compared to traditional instruction by students. The elementary students stated that they enjoyed PBL because they considered it fun, and they were creative and excited, particularly when it involved projects to construct, investigate or find a solution to a problem in real life (Khuwayrah, 2018). Skill in formulating decisions regarding project subjects, project materials or presentation format was always linked with a higher degree of ownership and drive.

This is also indicated to be a result of group projects where students claim they work more collectively and learn together. To most people, collaboration with peers is a source of exchanging thoughts, socialization, and acquisition of communication and leadership abilities. According to Haryanti et al. (2024), students valued the opportunity to share learning with other students and to approach the process of problem solution together, that increased their feelings of belonging and confidence in the science learning settings (Haryanti et al., 2024). Nevertheless, difficulties and intricacies can also be found in student feedback. There are students who are defeated by the open-endedness of projects especially where there are no expectations or when group relations are tensed. As Roosyanti and Suryarani (2024) discovered, younger students occasionally had certain problems with the management of duties in group work or conflict management, which indicated that their facilitation and scaffolding were of higher quality (Roosyanti and Suryarini, 2024). Others also complained that they could not express their creative thoughts because of time, resources or inflexible rubrics.

Purpose is the other important theme in student reflections. When work was considered a project, students said that they felt their work had a meaning where this was not the case with worksheet-based learning. Be it when they were showing parents, constructing a model ecosystem, or exploring a local environmental issue, the students were visible to have seen their learning as making a difference towards something genuine

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and worthwhile. Not only was this authenticity instrumental in enhancing engagement but it also enabled students to relate science to their lives.

Overall, PBL is multidimensional and provides students with an emotional experience, makes them socially interactive, and make them think. Although the experience has a positive nature, it is also a complex task, and a teacher must facilitate it by designing the experience and making sure that it will support all learners. These perspectives should be considered to better qualify PBL models that are sensitive to needs and strengths of learners.

Implementation Challenges and Teacher Roles

As much as Project-Based Learning (PBL) has a great prospect of revolutionizing the learning of the science subject in an elementary school setting, their effectiveness usually depends on the teacher and institutional support edifice. Studies point out that, although PBL may have several advantages, there is a tendency to question its application due to practical issues, pedagogical ambiguity and system restrictions. Teacher preparedness is also one of the most quoted obstacles. In contrast to conventional teaching models which consist of lesson plans, standardized tests, PBL experience forces educators assume a facilitator, coach and co-learner role, which is a major change to most teachers. The teachers are required to come up with interdisciplinary projects, facilitate inquiry without prescribing results, handling the needs of learners with various learning needs and the process and product based learning. Unless they are trained sufficiently, teachers usually bring complaints about not being prepared or overwhelmed by the demands (D'Ambra, 2014).

The challenge of time is another significant challenge. PBL projects also need greater instruction time compared to normal lessons particularly in planning and implementation. Educators have to strike a balance between the depth and openness of the projects and the necessity to meet the necessary curriculum content requirements and train students according to the standardized testing requirements. This puts a strain between genuine learning and academic responsibility in systems of education that are rigorous or task-oriented.

In addition, strong PBL requires the flexibility of classroom management and adjustment to various student needs. The teachers have to be able to react dynamically to the unexpected questions of students, group misdemeanors, and the variation in results. This especially becomes challenging in large or under resourced classrooms where engagement and differentiation is a challenge already. Another limitation of assessment is evaluation procedures. The multidimensional character of PBL through collaboration, creativity, critical thinking and communication is usually hard to be manifested in traditional grading systems. Teachers might be confused on how to make individual and group contributions assessments, or how to record formative progress in the lifecycle of the project (Thomas, 2000).

Finally, school culture and institutional support are essential facilitators or deterrents of PBL. When schools are optimally designed (investing time in collaborative planning, investigating technology, offering resources, such as lab equipment, technology, flexible scheduling, etc.) the option to use project based approaches thrives. On the other hand, PBL is inconsistently implemented or not implemented at all in schools with strict curricula, low autonomy or professional development.

In short, though teachers are the key to PBL success, they need to be supported, trained and be flexible in their structure and organization to achieve the success. These obstacles

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need to be overcome to make PBL not only a motivating concept but a long-term and a viable and sustainable practice in elementary science classrooms.

METHODOLOGY

Methodological Approach

The research aimed to identify the way elementary students orientate the project-based learning (PBL) in the science classroom and analyze their perceptions related to engagement, cooperation, and understanding of concepts. The research design used was a qualitative research design considering that the study was an exploratory and interpretive research. It used primary data, which were gathered by the researcher through direct interaction with the students, a descriptive case study design to obtain the rich natural field classroom experience. This enabled the holistic approach to both personal and group-level dynamics in PBL settings.

Data Collection Methods

The methods used to gather data were various qualitative approaches that guarantee both triangulation and deep understanding:

- The semi-structured interviews were done with 24 Grades 4 and 5 students who were purposely found in order to provide a variety in terms of their background, academic ability, and level of group participation.
- The observations in the classroom were conducted in a period of six weeks, when students were conducting their science projects, by observing their interaction, behavior, and patterns of engagement. Field notes were taken in some detail.
- Reflections in the student journals and the project were evaluated to record self-reported cognitions and emotions regarding the PBL process.
- Informed consent was taken, and all of the names of students were anonymized.

The sample involved students of three elementary schools (public) that had established PBL programs. The choice of various school settings was meant to create a variation in instruction, resource availability as well as experience among teachers.

Data Analysis Methods

The thematic analysis was used in analyzing the data where Braun and Clarke (2006) recommend a six-step method. Data in the form of interview transcripts, notes on observations, and notes in the journal were coded manually, and common patterns and emerging themes were identified because of the emotional engagement, science understanding, collaboration, and autonomy. Theme refinement and cross-validation across data sources were used to perform initial coding. The peer review by a second qualitative researcher was to guarantee coding reliability. No statistical ones were resorted to, because the research focused on narrative patterns and qualitative meaning, but not the numeric generalizability.

Assessment and Justification

The qualitative approach was selected to provide the student experience voice, which is usually neglected during PBL assessments. The beauty of this model is in its ability to create rich and subjective information that would mirror the subtle face of classroom learning. Nevertheless it also presents some restrictions, namely, the findings cannot be generalized to other scenarios than those that were tested, and the presence of the researcher at the time of observation could have affected the behaviour (Hawthorne effect). These constraints were mitigated by lengthy work in the area, and triangulating information and keeping a reflexive journal during the research.

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RESULTS

The results of this study are presented in the form of four primary themes that are based on the results of the data: (1) More Engagement and Pleasure in Science, (2) Growth of Teamwork and Interpersonal Communication, (3) Enhancement of the Knowledge in Practice, and (4) Problems in the execution of the Project and Team Decisions. The results are represented in all instances based on the research question that guides them: How do elementary students experience project-based learning in the science classes?

Of Greater Interest and Pleasure in Science

Most of the students testified that they felt more excited and enjoyed solving the real-life questions as part of PBL activities in comparison to taking normal science lessons. A good proportion of projects was characterized as fun, creative and not being boring. An example was one Grade 5 student who told, I enjoy science when we are constructing things or making experiments. I am having a sense like I am doing something important.

In the project sessions, observation observation has confirmed that students were more participatory and focused unlike when they were being taught through lectures. Students were often observed on negotiations of roles, assistance, and noticeable excitement especially in the process of designing and presentation.

Training of Teamwork and Communication Skills

All the students noted the importance of collaborating with peers. The majority of found group work enjoyable with the mention of teamwork, sharing of ideas, and assigning roles to individuals being remembered in their projects. One of the Grade 4 students commented in one of the reflections that she has learned that listening is significant. When we all had a say in our group, we worked better.

Yet, everything did not go well. According to some students, inequitable participation or any disagreement led to frustrations. Such dynamic was prevalent, particularly where group members were not present, took decisions on their own, and had not defined roles.

Increased Intensity of Knowing as a Result of Practical Implementation

A good number of the students showed a better conceptual knowledge as they used science knowledge in real life circumstances. As an example, during a unit on ecosystems, students who built terrarium models in the course of the unit exhibited a higher capacity to describe food chains and the environmental balance than those in non-PBL classes (observed during informal assessment by the instructor). One of the students remarked: It was more understandable when we did the project since we could see how the plants require light and water. It was not just depressing to read it in the book. This is in line with behavioral observations; more exploratory questions were posed by students and science vocabulary was more common during projects than during non-project classes.

Execution Projects and Group Dynamics Difficulties

Although students positively rated PBL, some of them complained that it was hard to cope with time, materials, and interpersonal conflict. Students were found to be stressed by time constraints or when they had little or no resources (e.g., poster paper, glue, devices). It was observed that ambiguity in instructions by the teachers caused confusion at early stages of project planning.

Some students said they would rather have a regular lesson and felt that group tension got in the way of learning in cases where some projects seemed to be too long. Such remarks indicate the necessity of facilitation and scaffolding, which should be organized, in particular, among younger students.

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DISCUSSION

This paper has studied the experience of elementary students on project-based learning (PBL) in science education. The results from the key findings include the realization that the students were more engaged and emotionally involved when they had to work on a practical collaborative science project. They appreciated team work, practicability and innovativeness. Nevertheless, group interaction, time and structure were some of the obstacles that impeded learning experiences among some students.

Results support the assumption that PBL creates a more advanced and significant relationship between learning material and students. The students levels of enthusiasm, as well as vocabulary used during projects to communicated concepts of science, are indicators of increased conceptual knowledge particularly when students were able to physically handle materials or to simulate a real life situation. These results are in line with constructivist and experiential learning theories, which give importance to the learning as doing. The information further indicates that group study is one of the major advantages of PBL. Communication, conflict resolution and decision making skills were some of the results that students acquired which were useful beyond the content mastery. Nevertheless, such ranges of variability in the group experiences indicate that further specific instructions in the group formation, role allocation, and structure of accountability are necessary These results are correlated with the research indicating that PBL enhances science engagement and literacy (Ali, 2023) and that students learn science better when it is more inquiry-based and hands-on (Haryanti et al., 2024). This work contributes to this group of work by providing a qualitative, student-centered approach, which takes into account emotional and social aspects of learning process that are typically omitted in an outcome-based examination. The studying sample was restricted to three schools and was not sufficient to reflect the experiences of students on a regional and socio-economic level. Their answers might have been biased by the observer effect (students might have responded better with the researcher present), and possibly younger subjects were not skilled enough to convey their more profound thoughts in words. Also, the research has an attractive focus on the experiences like the relatively short PBL cycle; all effects are still not known because of longitudinal variability. The teachers should be given resources and training on how to organize group work, classroom instruction, and task differentiation in order to better implement PBL in elementary science teaching and support the learning needs of diverse learners. The students can also gain both scientific as well as interpersonal lessons of the projects through scaffolded reflection activities.

Learners and curriculum developers need to note that the PBL value goes past content delivery that leads to the development of curiosity, resilience, and collaboration. PBL is also capable of promoting social-emotional growth, along with academic growth, with its proper support.

The initial question How do students experience project-based learning in science classrooms? is addressed by demonstrating that students tend to consider PBL as interesting and educationally worthwhile, though its successful application requires the transparent organization, facilitation of teachers, and the favorable conditions.

CONCLUSION

In this study, the project-based learning (PBL) concept was observed among elementary learners in the science classes, which uncovered the strengths, and the challenges of this pedagogical strategy as viewed by the learner. The results confirm that PBL is more exciting, cooperative and meaningful among the students than the conventional methods of

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teaching, particularly, the students are in a position to investigate real life problems, become creative and operate as a group.

The study question How do students experience PBL in science teacher-learning suited the qualitative perspective that focused on the emotional response, behaviour of learning and reflections of the students. The main results were that the motivations were higher, the understanding of science better and the communicational skills were reinforced. Nonetheless, students have also mentioned the problem of group conflict, vague instructions, and time limitations, which means that even the learner-centered approach, such as PBL, cannot be scaffolded and facilitated by the teacher.

The mentioned findings indicate the need to organize PBL environments in a student-centered and a structurally supportive manner. The PBL applied well can not only enhance the level of science literacy but also teach the critical thinking and collaboration skills that are imperative in 21 st century education. Future studies are recommended to examine longitudinal effects of PBL and its influence on different students, methods of facilitating group dynamics and inclusivity within a project environment.

So what? With its focus on student voices, this research study makes the paper a more comprehensive portrait of how the process of educational innovation is felt on the ground. Curriculum designers, policymakers, and teachers should pay attention to such views in order to make science lessons not only effective but also happy, pertinent, and empowering.

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