

Implementing Problem-Based Learning Through the Water Vision Program: Students' Experiences and Perceived Development in a Sabah Secondary School

Lai Kian Hua^{1*}, Nur Suhaidah Sukor¹, Mohd. Zaki Ishak¹, Christina Peter Ligadu¹

¹Faculty of Education and Sports Studies, Universiti Malaysia Sabah, Malaysia

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ABSTRACT

This study explores the implementation of Problem-Based Learning (PBL) through the Water Vision Program (WVP) in a Sabah secondary school, focusing on how this implementation was experienced by students and interpreted in relation to their cognitive, interpersonal, and intrapersonal development within the framework of 21st-century competencies. Using a qualitative case study design grounded in relativist ontology and constructivist epistemology, the research was guided by an integrated theoretical framework comprising four theories arranged in a clear hierarchy: Constructivist Learning Theory as the primary explanatory theory, Vygotsky's Sociocultural Theory and Cognitive Learning Theory as secondary supporting lenses, and Lickona's Character Education Theory as the primary interpretive lens for perceived student development. Data were collected through interviews, focus group discussions, and document review involving eight student participants and three teacher facilitators, and were analysed thematically using NVivo, supported by reflexive journaling, triangulation, and supervisory validation. Findings are presented across two themes: the implementation of PBL in the WVP, described by participants as involving authentic real-world problem-solving, student-centred learning, teacher facilitation, collaboration, technology integration, and outreach activities; and perceived student development, interpreted as reflecting growth in learning and innovation skills (communication, critical thinking, creativity, and cognitive development), life and career skills (leadership, accountability, initiative, and resilience), and literacy (environmental, scientific, and digital). Although challenges such as time management, group dynamics, and workload pressures emerged, these represented genuine constraints that varied in the degree to which they were resolved within the program's timeframe. Overall, the study offers a contextualised account of how PBL was implemented and how students interpreted its developmental significance, contributing interpretive insight into students' experiences within an environmental science learning context, rather than establishing causal effectiveness, consistent with the goals of the Malaysia Education Blueprint 2013–2025 in promoting higher-order thinking, student-centred learning, and character formation.

Keywords: Problem-Based Learning (PBL); Water Vision Program (WVP); Implementation; Students' Experiences; Perceived Student Development; Science Education

INTRODUCTION

Secondary school science education in Malaysia aims to enhance students' interest in science while developing their creativity, scientific skills, and scientific attitudes and values (Curriculum Development Division, 2019). Problem-Based Learning (PBL) has been recommended within the Standard Secondary School Curriculum (KSSM) Science as a teaching and learning approach capable of capitalising on students' curiosity, strengthening scientific understanding, and applying procedural and epistemic knowledge to real-life problem-solving and decision-making. The Water Vision Program (WVP), a recurring annual environmental initiative built around plastic pollution and water-related issues, has served as a platform through which a Sabah secondary daily school has implemented PBL for several consecutive years.

Despite policy aspirations for student-centred, higher-order learning articulated in the Malaysia Education Blueprint 2013–2025 and the KSSM Science Curriculum, conventional classroom practice in Malaysian secondary schools remains predominantly exam-oriented and teacher-centred, leaving limited space for student

autonomy, ethical engagement, or the meaningful application of knowledge. While PBL has been studied extensively for its association with academic performance, critical thinking, and problem-solving, much of this evidence derives from Western or tertiary-level contexts, particularly nursing and engineering education, leaving a gap in understanding how PBL contributes to perceived student development, especially its character-related dimensions, within Malaysian secondary science education. Existing Malaysian PBL research has likewise concentrated on tertiary and vocational settings, leaving limited empirical insight into how PBL is enacted in authentic secondary school settings such as the WVP, and how participants interpret student development arising from these processes.

This study therefore addressed the limited understanding of how PBL is implemented in an authentic school context and how student development is perceived within that implementation. The objectives were: (1) to explore the teaching and learning processes experienced by students through PBL in the WVP; and (2) to examine how participants perceive student development across cognitive, interpersonal, and intrapersonal domains in relation to these processes. Correspondingly, the study addressed two research questions: (RQ1) What are the teaching and learning processes experienced by students through PBL in the WVP? (RQ2) How do participants perceive student development across cognitive, interpersonal, and intrapersonal domains in relation to these PBL processes?

The study contributes conceptually by repositioning student development as interpretive rather than causal, a departure from literature that frames development as a direct outcome of PBL; empirically by providing an in-depth, contextually grounded account of PBL implementation within an authentic, sustained Malaysian secondary science initiative; and theoretically by integrating four theories in a clear, non-overlapping hierarchy to interpret both the enactment of PBL processes and the character-related dimensions of perceived student development.

LITERATURE REVIEW

Theoretical Framework

The study was guided by four theories arranged hierarchically. Constructivist Learning Theory served as the primary explanatory theory, interpreting how students actively constructed understanding through authentic, real-world problem engagement (Crotty, 1998; Merriam, 2009). Vygotsky's (1978) Sociocultural Theory and Cognitive Learning Theory served as secondary supporting lenses, explaining the social mediation occurring through facilitator scaffolding and peer collaboration within students' Zone of Proximal Development, and the internal cognitive mechanisms—attention, working memory, metacognition—activated during problem-solving, respectively. Lickona's Character Education Theory (Lickona & Davidson, 2005) served as the primary interpretive lens for understanding the character-related dimensions of perceived student development, distinguishing performance character (perseverance, diligence, responsibility, accountability) from moral character (respect, empathy, fairness, inclusivity) as these manifested across cognitive, interpersonal, and intrapersonal domains.

Problem-Based Learning and 21st-Century Skills

PBL is widely recognised as a student-centred pedagogical strategy anchored in constructivist and sociocultural learning theories, emphasising real-world problem-solving, collaborative inquiry, and learner agency (Hmelo-Silver, 2004; Wijnia et al., 2024). International studies link PBL to gains in communication and critical thinking (Sebatana & Dudu, 2021), systems thinking (Butwong et al., 2025), and character-related outcomes such as moral sensitivity and empathy, though these are concentrated in tertiary healthcare contexts (Zia et al., 2023; Qu et al., 2024). Within Malaysia, PBL research has similarly concentrated at the tertiary level (Jabarullah & Hussain, 2019), though a recent cross-national study found PBL engagement associated with responsibility, empathy, and cooperation among primary school learners in Indonesia and Malaysia (Hakim et al., 2025).

Across this literature, three limitations recur: research concentrates on technical subjects and short-term academic outcomes using predominantly quantitative methods; studies of character-related development occur mainly in tertiary healthcare settings that may not transfer to secondary schooling; and qualitative studies

examining how participants themselves interpret perceived student development across cognitive, interpersonal, and intrapersonal domains within Malaysian secondary PBL contexts remain scarce (Nguyen et al., 2024; Affandy et al., 2026). This study addresses that gap through an exploratory qualitative case study of the WVP as a bounded case context.

METHODOLOGY

Research Design

This study employed a qualitative single-case study design (Merriam, 2009; Stake, 1995; Yin, 2018), framed within an interpretive paradigm built on relativist ontology and constructivist epistemology. The WVP was treated as a bounded, critical case representing a sustained, authentic implementation of PBL in a Malaysian secondary science context, with the embedded units of analysis comprising the participating students' perceived development across cognitive, interpersonal, and intrapersonal domains.

Research Site and Participants

The study was conducted at a government secondary daily school in the Kota Kinabalu area of Sabah, following written approval from the Ministry of Education Malaysia, the Sabah State Education Department, and the school administration. Purposeful sampling was used to recruit the full WVP team for the study cycle: eight student participants (the complete student team for that programme year) and three teacher facilitators with varying levels of involvement, selected for their direct and sustained engagement with the program. Pseudonyms were used throughout to protect participant identities.

Table 1. Summary of Participant Profiles (adapted)

Participant	Role	Description
Kath	Teacher Facilitator	Founder of the WVP; drove school-wide PBL implementation; strong community linkage.
Piana	Teacher Facilitator	Lower-form science teacher; facilitated WVP for five years.
Lydia	Teacher Facilitator	Upper-form science teacher; joined WVP as a novice facilitator.
Sam	Student – Team Leader	Initially quiet; grew into an appointed leadership role.
Verra / Leora	Student – Emergent Vice Leaders	Supported team cohesion and accountability through emergent leadership.
Yunis, Nelly, Ronaldo, Bob, Abraham	Student – Team Members	Contributed across communication, artistic, technical, and task-execution roles.

Data Collection and Analysis

Data were collected between March and August 2023 through semi-structured interviews (seven students, three facilitators), one focus group discussion with all eight students, and document review of programme reports, testimonials, posters, presentation slides, and a student-produced video. Interviews and the focus group were conducted primarily in English, with occasional Bahasa Malaysia, audio-recorded with consent, and transcribed

verbatim. Methodological and data-source triangulation across interviews, focus group, and documents supported the credibility of the findings.

Data were analysed using Braun and Clarke's (2006) six-phase reflexive thematic analysis—familiarisation, initial coding, searching for themes, reviewing themes, defining and naming themes, and producing the report—supported by NVivo software. Coding was inductive; alignment with the study's theoretical framework occurred only at the interpretive phase, after themes had already emerged from the data. Trustworthiness was addressed through triangulation, member checking, thick description, reflexivity and positionality statements, and an audit trail of analytic memos, consistent with Lincoln and Guba's (1985) framework of credibility, dependability, confirmability, and transferability. Ethical approval and informed consent were obtained from all participants, with the right to withdraw at any stage.

RESULTS

Two major themes emerged inductively from the data: Theme 1, the implementation of PBL through the WVP (addressing RQ1), and Theme 2, participants' perceived student development (addressing RQ2).

Theme 1: Implementation of PBL through the Water Vision Program

Participants described the WVP as a technology-bounded, authentic real-world learning environment in which students collaborated within the school community and with external partners, including the Sabah Forestry Department and a recycling company (GNC), to address plastic pollution. Sam described the tangible outcome of these partnerships:

“When the plastic is collected, we store it in a room... then when the competition... almost comes to an end, we have to sell the plastic that was collected, and we got 51 ringgit... we collected like one hundred fifty-one KG of plastic.” (SFG5)

Student-centred learning was evident in how teams exercised ownership over planning, task delegation, and audience-tailored outreach, while teachers described deliberately stepping back to allow space for student decision-making. Kath, a facilitator, explained this balance:

“We will sit together with the students, and we will brainstorm together... we cannot give everything to the students. So, what we do is, we give a little bit of idea and the rest they will do on their own... because PBL is aimed mainly on student-centred learning.” (KFI2)

This scaffolding, however, was not uniform across facilitators. Lydia described a more closely supervised approach, reflecting genuine variation in how facilitation was enacted across the team: “Student is always a student. The teacher needs to guide, need to sit with them 24 hours” (LFI8). Collaboration extended beyond the immediate team to community outreach, where students adapted their communication for different audiences. Yunis recounted: “when we go to the kampung, I also learn how to tolerate with the kids... I learn how to... talk to them in a soft way, and try to get them to understand” (YII71).

Theme 2: Perceived Student Development

Participants' accounts of perceived development clustered into three sub-themes: learning and innovation skills (communication, cognitive development, critical thinking and creativity); life and career skills (character quality, initiative and self-direction, leadership and accountability); and literacy (environmental, scientific, and digital).

In the domain of leadership and accountability, students described a progression from reliance on facilitator direction toward independent decision-making and peer coordination. Ronaldo reflected on overcoming initial public-speaking anxiety: “Luckily, the teachers gave advice to me to make me less nervous and also tips on how to talk more confidently so I could emphasise on the key points in the slides” (RT7). Sam described how facilitators deliberately withheld direct answers to cultivate independent problem-solving: “The teachers didn't always tell us exactly what to do every time. They make sure to give us room to think and solve problems for ourselves...” (ST13).

Participants also described genuine constraints. Uneven participation among team members placed additional burden on more committed students and the team leader, and some participants described frustration when ideas were rejected due to time or logistical limits. These accounts are retained as authentic limitations of the collaborative structure rather than reframed as developmental gains. Environmental and ICT literacy were described as developing in tandem, as students researched plastic classification and biodegradation while using digital platforms to design and circulate outreach materials, though digital engagement varied with students' prior technology access.

Table 2. Summary of Themes and Sub-Themes (adapted)

Theme	Sub-Themes	Representative Codes
1. WVP PBL Implementation	WVP PBL Program; Student-Centred Learning; Teacher's Role	Authentic real-world issue; collaboration within school community; student commitment; facilitator scaffolding
2. Perceived Student Development	Learning & Innovation Skills; Life & Career Skills; Literacy	Communication; cognitive development; character quality; leadership; environmental and ICT literacy

DISCUSSION

Theoretical Implications

Read through Constructivist Learning Theory, participants' accounts of reorganising prior beliefs about their own capacities, and of assimilating new constraints into existing schemas while managing competing demands, are consistent with active, contextual knowledge construction (Wu et al., 2012) and with constructivism's broader characterisation of learning as a continuous, evolving process extending beyond formal instruction (Kokkotas et al., 2011). Read through Vygotsky's Sociocultural Theory, facilitator scaffolding and peer modelling appeared to support movement through students' Zone of Proximal Development, consistent with the theory's emphasis on cultural tools, institutional mediation, and social interaction in shaping cognitive development (Daneshfar & Moharami, 2018), though this scaffolding was not consistently available across all phases or facilitators, indicating that the social mediation central to this theory was activated unevenly. Read through Cognitive Learning Theory, participants' descriptions of planning, prioritisation, and metacognitive adjustment after setbacks are consistent with the development of executive functions and self-regulated learning, paralleling accounts of memory systems and information processing in Çeliköz et al. (2019) and of metacognitive regulation in problem-solving contexts in Tachie (2019).

A further contribution of this study lies in integrating Lickona's Character Education Theory with the three foundational learning theories, an integration seldom emphasised in existing PBL literature. Findings indicate that performance character (perseverance, diligence, responsibility, accountability) and moral character (respect, empathy, fairness, inclusivity) developed in tandem with, rather than separately from, the cognitive and social processes described by the foundational theories, consistent with Lickona and Davidson's (2005) contention that performance character is cultivated through authentic, sustained challenge rather than abstract instruction, and with Berkowitz and Bier's (2005) characterisation of moral character as rooted in social interaction and prosocial responsibility—for instance, empathy was described not only as a moral disposition but as enhancing the effectiveness of audience-centred outreach messaging. This problematises learning theories that risk treating knowledge construction, cultural mediation, and cognitive processing as ethically neutral, and contextualises an extension in which character development is treated as inseparable from the teaching and learning process within real-world, situated PBL.

Practical Implications

At the curriculum level, the WVP illustrates one contextually situated means of operationalising the KSSM Science Curriculum's emphasis on inquiry-based, real-world scientific application, particularly through students' described engagement with plastic classification, material properties, and ecological reasoning, topics that connect directly to KSSM Science content on ecosystems, biodiversity, and human stewardship of the natural environment, consistent with Suwastini et al. (2021) and Tanna et al. (2022), who similarly report that PBL situates academic concepts within real-world problem-solving contexts to support higher-order thinking and self-directed learning. At the training level, the variation observed between facilitators in how scaffolding and oversight were balanced suggests that pre-service and in-service teacher development could usefully address strategies for managing group dynamics, delegating ownership, and sustaining reflective, iterative feedback, in line with evidence that structured facilitator development strengthens scaffolding practice and confidence in managing group learning (Salinitri et al., 2015; Yang & Yang, 2013; Almulhem & Almulhem, 2022). At the policy level, the contextual conditions that enabled this case, including external community partnerships, facilitative leadership, and sustained multi-year programme continuity, may inform considerations for scaling similar PBL initiatives, consistent with Bara and Xhomara (2020) and Ali (2019), who similarly link student-centred PBL conditions to gains in autonomy and collaborative engagement, though such conditions cannot be assumed to transfer automatically to schools where these enabling factors are absent.

It is important to distinguish the study's most direct contribution to science education, namely its account of students' engagement with scientific knowledge, inquiry, and evidence-informed environmental decision-making, from its broader contribution to civic and character-related development, which accompanied rather than constituted the science learning examined in this study.

CONCLUSION

This study provided a contextually situated account of how PBL, implemented through the Water Vision Program, appeared to support participants' described engagement with 21st-century skills across cognitive, interpersonal, and intrapersonal domains within a Malaysian secondary science setting. The findings indicate that the WVP's real-world problem-solving, student-centred structure, facilitator scaffolding, and collaborative outreach activities were described by participants as contextualising growth in communication, critical thinking, leadership, accountability, and environmental, scientific, and digital literacy. These outcomes, however, were neither uniform nor complete: leadership and self-direction developed unevenly across team members, facilitator scaffolding varied in consistency, and constraints such as time pressure, uneven participation, and connectivity barriers shaped what was and was not achievable within the programme's timeframe.

As a single bounded qualitative case study involving eleven participants from one school, the findings are not intended to be statistically generalisable; rather, they offer analytically significant, contextually grounded interpretations that may transfer conceptually to similar PBL settings. The retrospective nature of participant accounts, and the researcher's own interpretive role in constructing themes, represent further boundaries on the claims that can be made. Future research could examine PBL implementation across more diverse Malaysian school contexts, including rural and residential schools; pursue longitudinal designs to track the durability of perceived developmental gains beyond the programme itself; and investigate the role of facilitator professional development in sustaining consistent scaffolding across PBL teams. Overall, the study contributes a grounded, contextually specific account of how problem-based, real-world environmental learning may support the interpretive development of 21st-century skills and character within Malaysian secondary science education.

Ethical Approval

This study received written approval from the Education Policy Planning and Research Division of the Ministry of Education Malaysia, the Sabah State Education Department, and the participating school's administration. Informed consent was obtained from all participants prior to data collection, with assurance of confidentiality, the use of pseudonyms, and the right to withdraw at any stage without penalty.

Conflict of Interest

The author declares no conflict of interest in relation to this study.

Data Availability Statement

The qualitative data generated and analysed in this study, including interview transcripts and focus group recordings, are not publicly available due to participant confidentiality and ethical restrictions agreed upon during consent procurement. Anonymised data extracts may be made available by the corresponding author upon reasonable request.

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