IMPLEMENTING PHENOMENON-BASED LEARNING IN THE SCIENCE CLASSROOM

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INTRODUCTION

Supporting deep student understanding can be challenging for both new and experienced teachers, especially when more complex concepts are involved. Traditional methods of teaching and learning (e.g., lectures, rote memorization, or excessive readings) often lack the elements of interaction and relevancy necessary to promote this kind of comprehension (Taylor & Parsons, 2011). The aim of this project is thus to introduce and analyze phenomenon-based learning (PhBL), a non-traditional framework driven by higher-order thinking questions (Fields & Kennedy, 2020).

INQUIRY QUESTIONS AND TPEP

TPEP CRITERION 4

Providing clear and intentional focus on subject matter content and curriculum.

This criterion states: "The teacher uses content area knowledge, learning standards, appropriate pedagogy, and resources to design and deliver curricula and instruction to impact student learning."

INQUIRY QUESTIONS

What is phenomenon-based learning and how does it affect student achievement?

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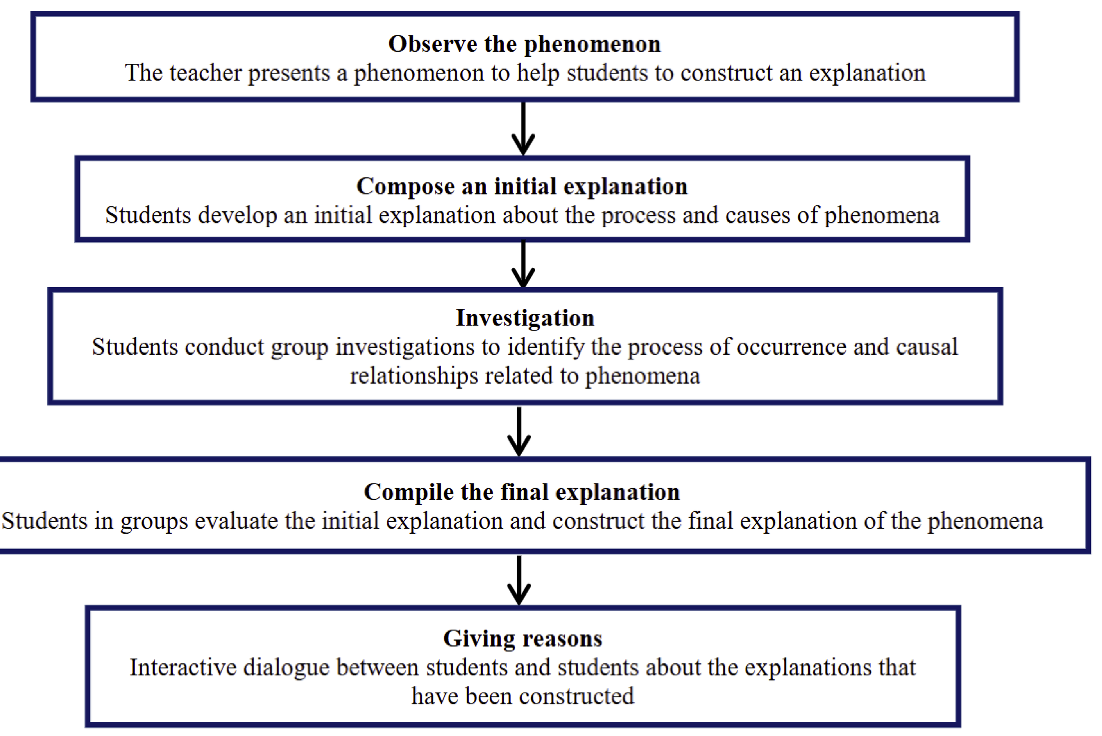
DEFINITION AND IMPLEMENTATION



Activities of phenomenon-based learning
Adapted from Islakhiyah et al. (2017)

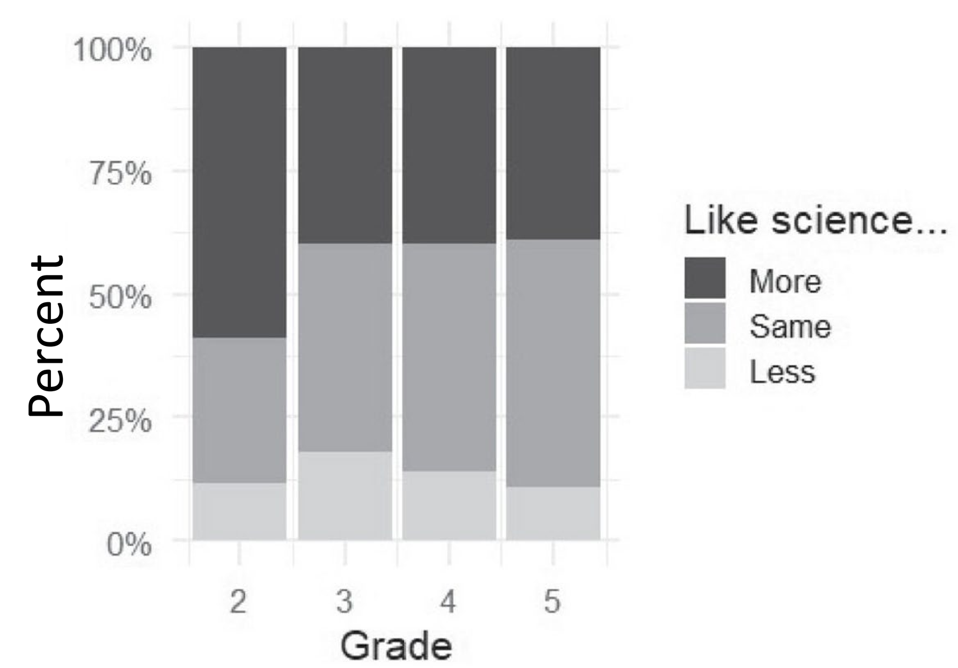
Phenomenon-based learning (PhBL) begins with the shared observation of a real-world phenomenon in the learning community. A phenomenon in this case is usually an object of observation, acting also as a framework for the concepts to be learned (Silander, 2015). Students then develop higher-order inquiry questions and create initial explanations to try and explain the phenomenon, before conducting investigations to answer their inquiries (Islakhiyah et al., 2017). Student groups use their results to then construct causal explanations of the phenomenon.

A phenomenon can be…

- An authentic object of observation
- A systemic framework for the things to be learned (systemic model)
- A metaphorical framework for the things to be learned (analogous model)
- However, sometimes also a motivating "base" for attaching the things to be learned

What is a phenomenon?
Adapted from Silander (2015)

ATTITUDE TOWARD SCIENCE



Student attitudes toward science after PhBL intervention
Adapted from Helsel et al. (2022)

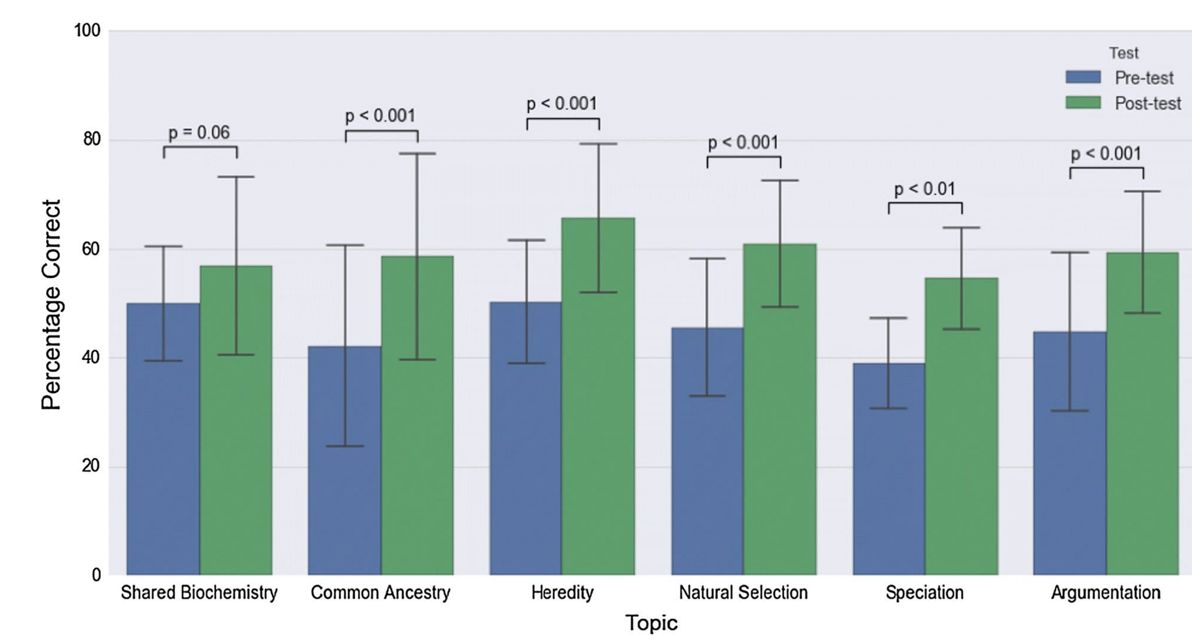
When students investigate real-world phenomena, they begin to see science as a process of discovery that they can take part in. Helsel et al. (2022) found that through the course of one phenomenon-based outreach program, students gained not only a stronger understanding of how scientific knowledge is developed, but they also developed a more positive view of science in general.

CONCEPTUAL UNDERSTANDING

Grades	Scores Percentage (PhenoBL)	Scores Percentage (Classical)
Grade 7	76%	56.54%
Grade 8	65.55%	68.25%
Grade 9	66.69%	58.68%
Average	69.41%	61.16%

ICT subject test scores with PhBL and classical instruction
Adapted from Wakil et al. (2019)

Phenomenon-based learning supports more effective content knowledge development than traditional classroom approaches, leading to higher test scores, as well as increased long-term retention (Wakil et al, 2019). Besides this, students engaging in PhBL also have an increased ability to identify and use scientific claims, evidence, and reasoning (Homburger et al., 2019; Islakhiyah et al., 2017). This ability to build explanations is a foundational practice in science education, aligning with the practices outlined in the Next Generation Science Standards (NGSS).



Student test results for content and argumentation practice
Adapted from Homburger et al. (2019)

METACOGNITION

Phenomenon-based learning also helps students develop the skills needed to think and reflect about their own learning. Esref & Cevat (2021) found that students taught in a phenomenon-based learning environment showed increased metacognitive awareness when compared with a control group. These students were more capable of applying their knowledge intentionally, choosing strategies that worked best for them, and engaging more actively in their own learning processes.

Table 4. Comparison of the experimental group's cognitive awareness scale pre-test and post-test mean scores.

Tests	N		Ss	sd	t	p	Cohen's d
Pre-test	30	40.82	4.27	29	2.64	0.02	2.06
Post-test	30	84.56	4.76				

Significant level: P<.05.

Table 5. Comparison of the control group's cognitive awareness scale pre-test and post-test mean scores.

Tests	N		Ss	sd	t	p	Cohen's d
Pre-test	30	42.02	3.72	29	1.64	0.00	0.04
Post-test	30	58.56	2.78				

Significant level: P<.05.

PhBL and traditional learning group metacognition scores
Adapted from Esref & Cevat. (2021)

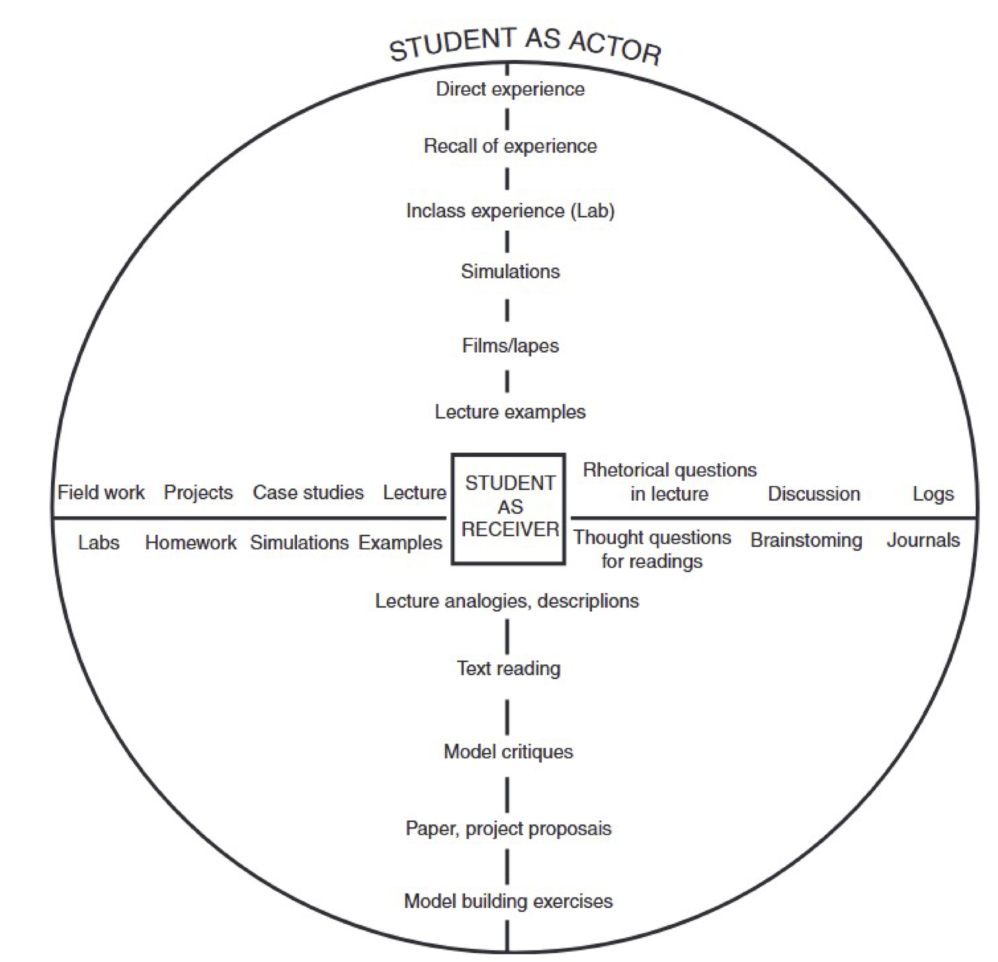
THEORY

SOCIOCULTURAL THEORY OF COGNITIVE DEVELOPMENT

Vygotsky's theory of cognitive development places heavy emphasis on the role of social interaction, culture, and language for knowledge development (Powell & Kalina, 2009). PhBL is strongly rooted in this theory, as the main environment for inquiry and investigation is in small groups. In social settings is where almost all learning happens for PhBL, as "information is seen as being formed in a social context" (Silander, 2015).

EXPERIENTIAL LEARNING THEORY

Kolb's theory of experiential learning emphasizes the necessity of student experiences in learning, as they "are the basis for observations and reflections" (Kolb & Kolb, 2009). This theory is particularly relevant for PhBL, as new information is presented to students by way of their own investigations. They make observations, which they then discuss and reflect upon before making changes to their understandings (Chen et al., 2024).



Degree of student involvement in various teaching methods
Adapted from Kolb & Kolb. (2009)

ACTION

Science teaching can be tremendously difficult, especially with the cumulative nature of the content. This is why use of high-quality, evidence-based instruction is so important. Though supported in both theory and in practice, there remain a few key considerations for use of PhBL. Educators who implement PhBL should pay particular attention to the way they are facilitating student learning. Though PhBL is largely student-driven, classroom teachers should still provide guidance and scaffolding when needed, to avoid giving students too great a cognitive load. Educators choosing to implement PhBL should also ensure that the content remains rigorous. Though many science courses focus on memorization and recall, the emphasis of PhBL should be on building causal, evidence-based explanations.