



Rethinking Work and Energy: A Cross-Context Phenomenological Inquiry in Physics Classrooms

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ABSTRACT

Purpose of the study: This study aims to explore and analyze the lived experiences of students and teachers in learning the work and energy topic using a phenomenological approach across Indonesian and Malaysian contexts, in order to understand how conceptual understanding is constructed within different pedagogical and socio-cultural settings.

Methodology: This study employed a qualitative phenomenological design with purposive sampling. Data were collected using validated in-depth interview guidelines (content validity index = 0.81), classroom observations, and document analysis. Data were transcribed verbatim and analyzed through phenomenological procedures (horizontalization, coding, thematic clustering, textural-structural description, cross-case analysis) with triangulation, member checking, audit trail, and researcher reflexivity.

Main Findings: Students in both Indonesia and Malaysia predominantly experienced work-energy learning as formula-based and computational. Conceptual understanding was fragmented, with weak causal integration between work, kinetic energy, potential energy, and conservation principles. Procedural competence exceeded qualitative reasoning ability. Mathematical ability strongly influenced confidence and performance. Pedagogical practices in both contexts emphasized numerical problem-solving, reinforcing algorithmic thinking over reflective and conceptually integrated understanding.

Novelty/Originality of this study: This study introduces a cross-context phenomenological analysis of work-energy learning in Indonesia and Malaysia, moving beyond diagnostic measurement of misconceptions toward exploring students' and teachers' lived experiences. It advances existing knowledge by revealing how pedagogical structures and socio-cultural classroom dynamics systematically shape computational-dominant understanding, offering a deeper interpretive framework for conceptual reform in physics education.

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1. INTRODUCTION

Physics education in the era of globalization faces significant challenges in fostering deep conceptual understanding among students so that they are not confined to mere computational procedures. Misconceptions regarding fundamental concepts such as work and energy are frequently reported in international science education

research, which may further impair students' ability to connect theory with real-world phenomena [1]-[3]. For example, although the law of conservation of energy is a fundamental principle of physics, students at various educational levels tend to hold the idea that energy can "disappear" in systems involving friction, or they perceive energy merely as an entity that changes linearly without understanding its physical mechanisms [4]-[6]. Recent studies also indicate that such misconceptions not only hinder problem-solving abilities but also affect overall learning outcomes in classical mechanics subtopics [7]-[9].

The concepts of work and energy constitute central pillars of classical physics, forming the foundation for understanding particle dynamics, conservation laws, and various technological applications. At the theoretical level, it is essential for students to develop a solid understanding of the mathematical and physical relationships among work, kinetic energy, and potential energy [10]-[12]. This understanding, along with the principle of energy conservation, promotes their ability to interpret physical phenomena scientifically [13]-[15]. However, empirical evidence shows that students' understanding of this subtopic remains low, even after formal instruction at the secondary school level [15]-[17]. Quantitative studies report that a substantial number of students experience difficulties in analyzing work-energy relationships across various contexts, including graphical and applied interpretations, indicating systemic conceptual challenges in this topic.

In line with global challenges in physics learning, various empirical findings in Southeast Asia reveal that learning problems related to work and energy possess distinctive and complex contextual nuances. For instance, diagnostic studies in the Indonesian context indicate that students still experience significant misconceptions about work and energy, including the mistaken belief that the mere presence of a force automatically implies that work has occurred, even when no actual displacement takes place [18]. These findings are consistent with other studies identifying misconceptions in work and energy topics, reporting that the percentage of misconceptions reaches tens of percent due to strong preconceptions [19], [20]. Furthermore, other studies in Indonesia show that misconceptions in work and energy are relatively widespread in students' responses to conceptual questions and are associated with predominantly procedural teaching approaches [21]-[23]. These studies illustrate that, in addition to pedagogical factors, language, cultural learning backgrounds, and teachers' readiness to implement concept-based instructional strategies further reinforce the complexity of physics education in the region, including Indonesia and Malaysia. Thus, empirical issues in Southeast Asia suggest that conceptual and structural learning challenges are not solely cognitive in nature but are also influenced by socio-cultural contextual dynamics within classrooms and schools [24], [25].

In response to this empirical complexity, a research approach is needed that can explore learning experiences from the in-depth perspectives of students and teachers, rather than relying solely on quantitative data such as scores or frequencies of misconceptions. A phenomenological approach in educational research enables researchers to examine the subjective meanings of learning experiences and the dynamics of how the concepts of work and energy are understood as experienced by participants in authentic classroom contexts. This approach is rooted in qualitative traditions that emphasize holistic and reflective understanding of learners' lived experiences (for example, examining how students "experience" physics concepts) [26]. Although still relatively limited, phenomenological studies in physics education have been used to explore teachers' experiences in implementing diagnostic assessments, thereby revealing their perceptions and practices regarding students' misconceptions in greater depth [27]-[29]. This approach is relevant for linking global findings on conceptual misconceptions with empirical realities in Southeast Asia, thus enabling a richer understanding of how students and teachers interpret, experience, and respond to the challenges of physics learning in Indonesia and Malaysia.

Based on a review of previous research, there exists a conceptual and methodological gap that reinforces the urgency of this study. Research on work and energy has predominantly focused on identifying and reducing misconceptions through diagnostic instruments or specific instructional interventions, such as the use of four-tier tests and the PDEODE*E model, which emphasize quantitative measurement of conceptual change [30]. Other studies have concentrated on analyzing students' levels of conceptual understanding through written tests and answer categorization without deeply exploring learners' subjective experiences in making sense of work and energy concepts within authentic learning contexts [12].

Similarly, research employing three-tier diagnostic tests in Indonesia tends to identify the percentage of misconceptions and their causal factors descriptively, but has not explored how socio-cultural dynamics, language, and pedagogical practices shape students' learning experiences [31]. Moreover, these studies are generally conducted within a single national context, thus lacking a comparative cross-cultural perspective between educational systems with historical and curricular similarities such as Indonesia and Malaysia. Therefore, this study offers novelty by adopting a phenomenological approach to explore in depth the lived experiences of students and teachers and analyzing them through a cross-contextual study. It is expected to provide more comprehensive theoretical and practical contributions to the development of physics learning in the topic of work and energy.

This study aims to analyze the experiences of students and teachers in learning the topic of work and energy through a phenomenological approach within the contexts of Indonesia and Malaysia. Its urgency lies in the need to understand learning problems not only from the perspective of conceptual misconceptions, but also from learning experiences influenced by pedagogical and cross-context socio-cultural factors. This study is

expected to contribute theoretically to the development of phenomenological research in physics education and practically to the formulation of more contextual and reflective instructional strategies in both countries.

2. RESEARCH METHOD

This study employed a qualitative approach with a phenomenological design to gain an in-depth understanding of students' and teachers' experiences in addressing learning problems in physics, particularly on the topic of work and energy. The study was conducted across contexts at MA Guppi Samata (an Islamic Senior High School), Indonesia, and at a Senior High School (Sekolah Menengah Atas/SMA) in Kuala Lumpur, Malaysia, in order to obtain a comparative perspective on learning dynamics within two different yet culturally related educational systems. Data were collected through in-depth interviews, classroom observations, and document analysis, and were subsequently analyzed using phenomenological procedures to uncover the meaning and essence of participants' lived experiences in understanding the concepts of work and energy.

The population of this study consisted of all students at the Senior High School level (SMA/MA), including those enrolled in Islamic Senior High Schools (Madrasah Aliyah/MA), who had studied the topic of work and energy, as well as physics teachers teaching at that level in both research sites. The sample was determined using purposive sampling, with criteria including students who had received instruction on work and energy and teachers with experience teaching the topic [32]-[34]. Participants were intentionally selected to obtain rich and in-depth information aligned with the objectives of phenomenological research, ensuring that the data represented authentic learning experiences in both contexts.

Data collection techniques in this study included in-depth interviews, classroom observations, and analysis of supporting documents such as lesson plans and evaluation sheets related to the topic of work and energy in both schools. Interviews served as the primary instrument to explore students' and teachers' subjective experiences regarding conceptual and procedural difficulties, as well as internal and external factors influencing learning. The interview framework covered seven aspects: conceptual understanding, problem comprehension, strategy planning, calculation processes, answer evaluation, internal factors (motivation and interest), and external factors (teaching methods and learning environment). Each aspect was designed to identify the forms and sources of learning difficulties.

The interview guidelines were validated by two experts to ensure alignment between the indicators, research objectives, and interview questions. The content validity index reached 0.81, categorized as highly valid, indicating that the instrument was appropriate for use in data collection for this study.

Table 1. Interview Instrument Framework

No	Aspects Explored	Interview Indicators	Objectives
1	Conceptual Understanding	Ability to understand the meaning of work and energy	Identify conceptual difficulties
2	Problem Understanding	Ability to identify known and questionable information	Identify difficulties in the problem-understanding stage
3	Strategic Planning	Ability to determine a formula or solution strategy	Identify difficulties in planning solutions
4	Calculation Process	Mathematical accuracy and ability	Identify procedural difficulties
5	Answer Evaluation	Ability to review results	Identify difficulties in the evaluation stage
6	Internal Factors	Motivation and interest in learning physics	Identify internal factors
7	External Factors	Teaching methods and learning environment	Identify external factors

Data analysis was conducted using a systematic and iterative phenomenological analysis procedure to uncover the essence of students' and teachers' experiences in learning about business and energy. All interview data were transcribed verbatim, while observation and document data were organized based on country context and participant type. The analysis stages included [35]-[37]: (1) horizontalization, which identified significant statements related to the learning experience; (2) grouping meaning units through a coding process to form themes such as conceptual difficulties, procedural difficulties, internal factors, and external factors; (3) compiling textual descriptions (what participants experienced) and structural descriptions (how those experiences were shaped within pedagogical and socio-cultural contexts); and (4) synthesizing the essence of the phenomena in each context and cross-case analysis between Indonesia and Malaysia. Data validity was maintained through triangulation of sources and techniques, member checking, audit trails, and researcher reflexivity to ensure the credibility and consistency of the findings.

3. RESULTS AND DISCUSSION

3.1. General Description of the Research Context

This study was conducted at MA Guppi Samata (Indonesia) and at a public Senior High School in Kuala Lumpur (Malaysia). MA Guppi Samata is a private Islamic Senior High School located in a suburban area, with students from heterogeneous socio-economic backgrounds. The school implements the Indonesian national curriculum, in which physics is a compulsory subject for students in the Mathematics and Natural Sciences (MIPA) track. Physics learning facilities include regular classrooms, whiteboards, LCD projectors, and a science laboratory that is used on a limited basis according to the practicum schedule.

Meanwhile, the partner school in Kuala Lumpur is a public Senior High School with relatively more standardized learning facilities, including an actively utilized science laboratory and access to digital instructional materials. Physics is taught as part of the Malaysian national curriculum at the upper secondary level, following a structured syllabus with emphasis on conceptual learning outcomes and numerical applications. In general, both schools share similarities in curriculum structure, where the topic of work and energy is positioned within the mechanics unit at the upper secondary level. However, differences exist in terms of facility support, learning culture, and classroom interaction patterns, which potentially influence the dynamics of instruction.

The research participants consisted of physics teachers and Grade 11 students who had studied the topic of work and energy. At MA Guppi Samata, participants included one physics teacher with more than five years of teaching experience and several students selected purposively based on active classroom participation and varied academic ability levels (high, medium, and low). The students demonstrated diverse mathematical backgrounds and differing levels of motivation in learning physics. At the school in Kuala Lumpur, participants included one physics teacher with more than seven years of teaching experience and students whose academic abilities were relatively homogeneous due to the streaming system. These students were accustomed to numerically based problem-solving exercises and structured periodic assessments. In both contexts, the teachers held undergraduate degrees in physics education and served as key informants in describing classroom dynamics, perceptions of students' misconceptions, and the pedagogical strategies employed.

At MA Guppi Samata, instruction on work and energy was delivered through an expository approach combined with classroom discussion and problem-solving exercises. The teacher began the lesson with explanations of fundamental concepts (work as the product of force and displacement, kinetic energy, potential energy, and the law of conservation of energy), followed by contextual problem examples. Observations indicated that some students tended to focus on formula application without fully understanding the physical meaning of the concepts. Classroom interaction was two-way, although active participation was dominated by certain students. At the Senior High School in Kuala Lumpur, instruction was conducted in a more structured manner, beginning with prior knowledge activation, followed by concept explanation using mathematical and graphical representations, and tiered problem-solving exercises. The teacher emphasized the relationship between conceptual understanding and numerical application, providing immediate feedback on students' procedural errors. Classroom discussions were more systematic, with allocated time for answer reflection.

Comparatively, both contexts demonstrated similarities in emphasizing quantitative problem-solving. However, they differed in the intensity of laboratory use, variation of instructional strategies, and pedagogical interaction patterns. These differences constitute an important foundation for understanding how students' learning experiences regarding the topic of work and energy are shaped within their respective socio-cultural and educational contexts.

3.2. Student Experience in Understanding the Concept of Work and Energy

Based on the results of in-depth interviews and classroom observations, students' experiences in understanding the concepts of work and energy revealed relatively similar patterns of difficulty in both contexts, although with varying levels of intensity. These difficulties were reflected in students' explanations, problem-solving approaches, and conceptual reasoning during classroom interactions. Table 2 below presents the textural description of students' experiences.

Table 2. Textural Description of Students' Experiences

No	Conceptual Aspects	Student Experience – Indonesia	Student Experience – Malaysia	Phenomenological Meaning (What)
1	Concept of Work	Students state that work = force \times displacement, but assume that all forces produce work without considering the direction of the force.	Students understand the necessity of displacement, but still have errors in cases of perpendicular forces or non-linear contexts	The dominant understanding is mathematically formulaic, not fully based on physical meaning.

2	Kinetic Energy	Students are able to state the formula, but have difficulty explaining the meaning of energy changes when velocity changes.	Able to calculate correctly, but conceptual explanations are still limited to formal definitions	Energy is understood as a quantitative quantity, not as a representation of the dynamics of motion.
3	Potential Energy	Students relate potential energy only to height without explaining the action of gravitational force.	Understand the factors of mass and height, but have difficulty explaining energy transformations causally	The causal relationship in energy changes is not yet deeply understood.
4	Conservation of Energy	Students assume energy "decreases" when there is friction.	Understand conservation equations, but have difficulty with multi-energy systems	The principle of conservation is understood procedurally, not as a fundamental law.
5	Conceptual Integration	Students have difficulty relating work to changes in kinetic energy.	Able to solve numerical problems, but hesitate when problems are story-based	Fragmentation of understanding between concepts.
6	Affective Experience	Students find the material difficult due to the many formulas and calculations.	Feel challenged but rely on structured practice problems	Self-confidence is influenced by mathematical ability.

Overall, students' experiences in understanding the concepts of work and energy in both contexts demonstrated a relatively consistent pattern, namely the dominance of a procedural approach over deep conceptual meaning-making. Students were generally able to state and apply formulas mathematically; however, they encountered difficulties when asked to explain the physical meaning, causal relationships, and interconnections among concepts, such as the relationship between work and changes in kinetic energy. The principle of energy conservation tended to be understood as a numerical substitution equation rather than as a fundamental law explaining energy transformation within a system. Furthermore, students' learning experiences indicated that their level of confidence was strongly influenced by their mathematical ability, such that conceptual understanding often depended on success in performing numerical calculations. These findings suggest that, phenomenologically, students tend to "experience" the learning of work and energy more as a computational activity than as an integrated process of constructing scientific meaning.

3.3. Structural Description: Factors Shaping Students' Experiences (How)

This structural description explains how students' experiences in understanding the concepts of work and energy are shaped through the interaction of internal and external factors within different pedagogical and socio-cultural contexts. Internally, students' learning experiences are strongly influenced by mathematical ability, learning motivation, and orientation toward academic evaluation. In both contexts, students with stronger mathematical skills exhibited higher confidence in solving work and energy problems. Conversely, students with lower numerical ability tended to experience hesitation and anxiety when faced with calculation-based questions.

These findings align with Singh and Rosengrant [38] who developed the Energy and Momentum Conceptual Survey (EMCS) and found that many students could solve numerical problems but struggled to qualitatively explain energy and work concepts. This indicates that computational skills do not necessarily coincide with deep conceptual understanding. Further research by Maries, Brundage, and Singh [39] also showed that even at advanced learning levels, conceptual understanding of energy remains weak when instruction emphasizes mathematical problem-solving. These findings reinforce the observation that students' learning experiences tend to develop as algorithmic activity rather than as scientific meaning-making.

Structurally, a learning orientation focused on numerical success and evaluation shapes how students perceive work and energy concepts as calculation procedures rather than as physical principles explaining natural phenomena. The teaching approach adopted by teachers also plays a significant role in shaping students' experiences. In both contexts, instruction was dominated by conceptual explanations followed by example problems and numerical exercises. While this approach effectively trains procedural skills, reflective conceptual exploration remains relatively limited.

These findings are consistent with international research showing that traditional lecture- and exercise-based instruction tends to produce procedural understanding without strong conceptual integration [38]. Moreover, the study by Sangkala et al. [12] emphasized that students in the work and energy topic often demonstrate dominance of symbolic over relational understanding, particularly when instruction focuses more on equation manipulation than on exploring physical meaning. In the Indonesian context, limited use of experiments or concrete demonstrations reinforces abstract and symbolic learning experiences. In the Malaysian context, although

instruction is more structured and systematic, the emphasis on numerical accuracy still fosters algorithmic thinking tendencies. Thus, the pedagogical structure in both contexts indirectly reinforces a mathematically-symbolic learning pattern.

Classroom environment and academic culture also shape students' experiences. In Indonesia, a culture of respecting teacher authority causes some students to be less active in openly expressing conceptual confusion, limiting the dialogical exploration of misconceptions. In Malaysia, the classroom atmosphere is more systematic with structured participation, but remains oriented toward achieving correct answers. The competitive academic culture reinforces a focus on evaluative outcomes.

These phenomena indicate that students' learning experiences are determined not only by cognitive factors but also by the instructional system and classroom culture that frame conceptual interactions. Consistent with Maries et al. [39], instructional structures emphasizing procedural accuracy can maintain the gap between computational ability and conceptual understanding.

Overall, students' experiences in understanding work and energy are shaped through the interaction of mathematical ability, evaluative orientation, numerically focused pedagogical approaches, and an academic culture emphasizing correct answers. International literature confirms that the dominance of symbolic-procedural learning contributes to weak conceptual integration [12], [38], [39]. Phenomenologically, students' learning experiences in both contexts are not merely the result of individual limitations, but rather a systemic construction of pedagogical practices and instructional structures that prioritize computation over the exploration of scientific meaning.

3.4. Cross-Context Analysis: Indonesia–Malaysia

A cross-context analysis was conducted to identify patterns of similarities and differences in students' and teachers' experiences in learning the topic of work and energy in Indonesia and Malaysia. This comparison aims to understand how pedagogical structures and academic cultures shape learning experiences differently across two culturally related educational systems that, nevertheless, differ in implementation characteristics.

Table 3. Cross-Context Analysis of Work and Energy Learning

Analysis Aspects	Indonesia	Malaysia	Cross-Context Patterns
Learning Orientation	Dominantly expository with practice questions	Structured systematic stages and tiered training	Equally oriented toward numerical solutions
Conceptual Understanding	Tends to be procedural, limited exploration of meaning	More systematic, yet algorithmic	Symbolic versus relational dominance
Business-Energy Integration	Causal relationships are poorly explored	Understood through equations, not system dynamics	Interconceptual fragmentation still occurs
Class Participation	Dominated by a few active students	More equitable yet controlled participation	Interactions are still teacher-centered
Laboratory Use	Limited to specific contexts	More integrated yet verifiable	Experiments do not encourage in-depth conceptual exploration
Academic Culture	Respects teacher authority, limited conceptual discussion	More competitive and results-oriented	Emphasis on correct answers and evaluation

Based on the table above, there are strong similarities between the two contexts, namely the dominance of learning approaches that emphasize numerical problem solving and symbolic manipulation. This creates a learning experience that tends to be procedural for students in both countries. The differences lie in the level of learning structure and the dynamics of classroom participation. Indonesia demonstrates relatively more flexible learning but less systematic conceptual exploration, while Malaysia demonstrates more structured learning with regular feedback but still maintains an algorithmic orientation. Phenomenologically, this cross-context analysis reveals that conceptual challenges in the work and energy topic stem not only from individual student characteristics but also reflect pedagogical constructs and academic cultures that generally still position computation as the center of physics learning..

3.5. Synthesis of the Essence of Phenomena

This section formulates the essential meaning (essence) of student and teacher experiences in learning work and energy based on the integration of textural descriptions (what) and structural descriptions (how) as well

as the results of cross-contextual analysis across Indonesia and Malaysia. Based on the overall findings, the essence of the work and energy learning experience in both contexts can be formulated as follows:

Students experience work and energy learning primarily as a formula-based computational activity, rather than as a process of constructing integrated scientific meaning about work relationships, energy transformations, and the principle of conservation of energy in physical systems.

Phenomenologically, students "experience" the concepts of work and energy through three main characteristics:

1. Dominance of Procedurality

Concepts are understood as tools for solving numerical problems. Learning success is measured by the ability to obtain correct answers, not by the ability to explain physical mechanisms.

2. Conceptual Fragmentation

Work, kinetic energy, potential energy, and the law of conservation of energy are understood as separate components, rather than as conceptual systems interconnected through the principle of cause and effect.

3. Dependence on Instructional Structure

The way students understand concepts is heavily influenced by learning patterns that emphasize practice problems, mathematical representations, and an evaluative orientation.

Therefore, the essence of this phenomenon lies not solely in "misconceptions," but in the way learning itself is constructed and experienced, namely as a symbolic-numerical practice that is more powerful than reflective conceptual exploration. Based on the integration of findings, the conceptual model of the learning phenomenon of work and energy can be visualized as follows:

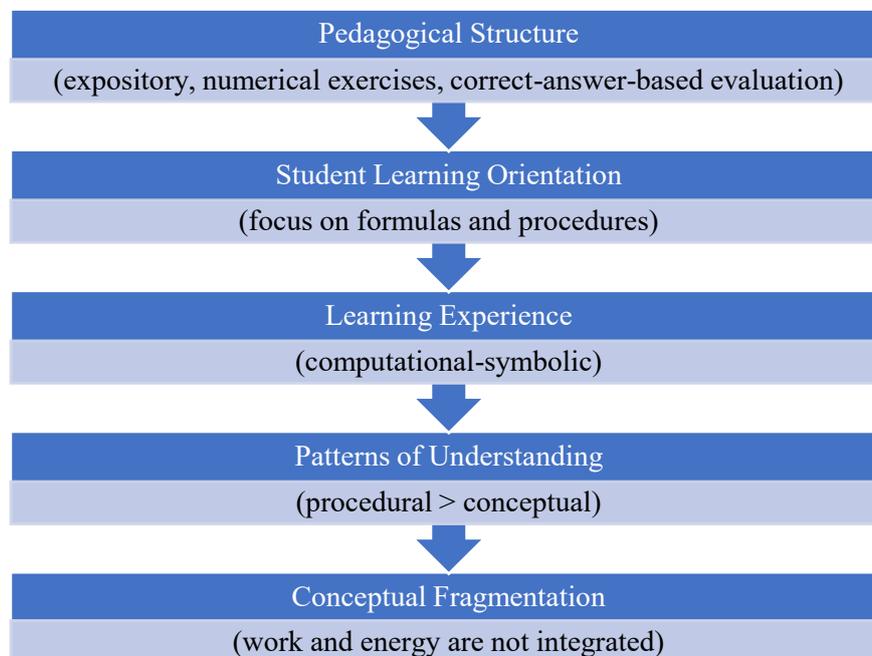


Figure 1. Phenomenological Model of Work–Energy Learning Experience Across Contexts

This model demonstrates that students' learning experiences are systematically shaped through the relationship between pedagogical approaches, learning orientations, and conceptual interpretations. Overall, this synthesis demonstrates that learning about work and energy in both contexts is not simply a matter of individual misconceptions, but rather a reflection of a learning system that implicitly shapes computational experiences as the center of learning activities. Therefore, transforming physics learning toward a more conceptual, reflective, and contextual approach is urgently needed to develop a comprehensive and meaningful understanding of energy.

Most research in physics education indicates that students frequently experience misconceptions about the concepts of work and energy, particularly regarding the work-energy relationship, the law of conservation of energy, and the application of force vectors. For example, Rahmadhani et al.[40] [12] found that about 50% of students had misconceptions regarding the law of conservation of energy, which was influenced by textbooks and individual reasoning. In addition, Mufti & Sunarti [18] reported that 43% of students had misconceptions about the concept of work and energy based on a multi-level diagnostic instrument. Recent systematic research by Guerra-Reyes et al. [22] showed that misconceptions in science are generally triggered by students' everyday experiences, traditional instructional approaches, and texts that overemphasize mathematical aspects rather than conceptual meaning, in line with the findings of procedural dominance in the understanding of work and energy in this study. Meanwhile, the study by Brundage et al.[39] This study demonstrates that conceptual difficulties in

work and energy occur not only at the secondary school level but also at the tertiary level after traditional instruction, highlighting the need for learning approaches that strengthen conceptual understanding.

The findings of this study have significant theoretical and practical implications for the development of physics learning, particularly in the area of work and energy. Theoretically, the results of this study broaden the understanding of misconceptions by demonstrating that conceptual problems are not solely rooted in individual cognitive structures but are also formed systemically through pedagogical constructs that place computation at the center of learning activities. Thus, this study emphasizes the importance of a paradigm shift from a reductionist approach based on identifying misconceptions to a more holistic approach, one that views the learning experience as a phenomenon influenced by the interaction between mathematical ability, evaluative orientation, classroom culture, and instructional practices.

Practically, the results of this study imply the need to transform physics learning strategies in Indonesia and Malaysia toward a more conceptual, reflective, and contextual approach. Teachers need to integrate causal discussions, exploration of phenomena based on multiple representations (verbal, graphic, mathematical, and experimental), and reflective activities that encourage students to explain the physical meaning behind equations. Furthermore, learning assessments should assess not only numerical accuracy but also the quality of conceptual reasoning. At the policy level, curriculum and teacher training need to emphasize a balance between computational competency and relational understanding so that learning about work and energy truly builds comprehensive scientific literacy.

The main novelty of this research lies in the use of a phenomenological approach to examine learning about work and energy across the Indonesian-Malaysian context, which has previously been primarily researched through quantitative diagnostic instruments such as three-tier tests, four-tier tests, or conceptual surveys. Unlike previous studies that focused on the percentage of misconceptions, this research explores the lived experiences of students and teachers, thus revealing the essence of the learning phenomenon as a systemically structured computational experience.

Furthermore, this research offers a conceptual contribution in the form of a phenomenological model of the work and energy learning experience that explains the relationship between pedagogical approaches, learning orientations, academic culture, and forms of conceptual meaning. The cross-context analysis also provides a comparative perspective, demonstrating that procedural dominance is not merely a local phenomenon, but a relatively consistent pedagogical pattern across two related educational systems with differing implementation characteristics. Thus, the novelty of this study lies not only in its methodology and cross-contextual design, but also in the shift in the focus of analysis from “what students misunderstand” to “how the learning experience is constructed and experienced systemically.” As a limitation, this study involved a relatively limited number of participants in two schools so that the findings obtained are contextual and cannot be generalized widely to the entire student population in Indonesia and Malaysia.

4. CONCLUSION

This study concludes that the learning experience of work and energy at MA Guppi Samata (Indonesia) and a public high school in Kuala Lumpur (Malaysia) is phenomenologically dominated by formula-based computational activities and symbolic manipulation, rather than by the construction of integrated conceptual meaning. Students in both contexts are generally able to solve numerical problems procedurally, but experience difficulties in explaining the physical meaning, cause-and-effect relationships, and the interrelationships between work, kinetic energy, potential energy, and the principle of conservation of energy as a unified conceptual system. This experience is shaped by the interaction of mathematical ability, evaluative orientation, a pedagogical approach that emphasizes problem practice, and an academic culture that focuses on answer accuracy. Therefore, the essence of the problem lies not only in individual misconceptions, but in the construction of a learning system that implicitly focuses physics learning on calculation rather than reflective and contextual conceptual exploration. Future research is recommended to design and implement conceptual and context-based instructional interventions that explicitly integrate qualitative reasoning, multiple representations, and reflective dialogue to foster a deeper understanding of work–energy principles across diverse educational settings.

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