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Learning Physics in Blended Modalities: A Descriptive Qualitative Exploration of STEM Senior High School Students' Perceived Meanings

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Abstract — Meanings of learning Physics is unclear. I explored the sources of the meanings in learning Physics amid blended learning. I employed descriptive qualitative research design, purposive sampling, focus group discussions, and thematic analysis. My conversations with participants laid that the meanings of learning Physics are shaped by fragmented learning, emotional and social responses, cognitive complexity, hands-on experimentation, and emerging real-life understanding. Physics teachers, administrators, and policymakers may strengthen instructional coherence, enhance emotional and collaborative support, promote experiential and inquiry-based strategies, and sustain institutional and policy support for more integrated and contextually meaningful instruction. My journey does not end with this research. My study opened possibilities for multiple regression analysis, Structural Equation Modeling (SEM), and quasi-experimental designs to examine the meanings of learning Physics in blended modalities from a confirmatory viewpoint.

Keywords: learning physics in blended modalities, descriptive qualitative exploration, STEM senior high school students, perceived meanings

I. INTRODUCTION

In this chapter, I presented the problem and its scope, followed by the significance of the study, the statement of the problem, the theoretical framework, and the assumptions.

The Problem and Its Scope

Across global contexts, I am convinced that learning Physics in a blended learning environment has been increasingly described as a learning experience with unclear and inconsistent meanings among students, particularly as they shift between online and face-to-face modalities. Students often interpret Physics learning in fragmented ways, where abstract concepts, simulations, and classroom discussions are not always coherently integrated into a unified understanding of the subject. This situation reflects recent ideas of Harper et al. (2023), who point to a broader educational concern in which learners struggle to construct stable meanings of Physics concepts across multiple learning platforms.

In the United States, I learned from Forde et al. (2024) that students describe difficulty in linking online and face-to-face practical learning experiences, which may result in fragmented understanding of concepts. In South Korea, blended science instruction has been viewed as cognitively inconsistent due to differences in how content is delivered across learning platforms (Kim & Choi, 2023). In India and other developing educational contexts, I noted that students similarly report challenges in conceptual understanding and engagement because of frequent transitions between digital and classroom-based instruction (Chandola, 2023).

In my own country, STEM senior high school students also experience unclear meanings in learning Physics within blended learning environments. Physics concepts are often perceived as disconnected between online modules and face-to-face discussions, leading to varying interpretations of the subject matter. Recent studies of Novita and Jumadi (2023), I learned that students describe their learning as dependent on multiple fragmented experiences that do not always converge into a clear conceptual framework of Physics.

The persistence of unclear meanings in learning Physics within blended learning environments leads to inconsistent conceptual understanding of scientific principles. This concern is critical because Physics requires strong conceptual integration, logical reasoning, and precise interpretation of abstract ideas. When meanings remain unclear, students struggle to develop a coherent understanding of foundational concepts necessary for advanced scientific learning and real-world application (Brundage et al., 2023). These consequences push me to conduct this study.

Significance of the Study

I believe that my study contributes to the Sustainable Development Goal (SDG) 4: Quality Education, as it aims to improve understanding of how students make meanings of learning Physics in a blended learning environment. By examining students' self-reported emotions, strategies, and perceptions, my study may help enhance instructional practices and promote more meaningful and inclusive learning experiences. My study also aligns with the goals of Holy Cross of Davao College (HCDC), as it supports the institution's commitment to providing quality, innovative, and student-centered education. Through the findings of this study, I hope to provide useful insights for teachers and academic stakeholders in improving Physics instruction and strengthening blended learning strategies for better student learning outcomes.

Statement of the Problem

In this study, I explored the sources of the meanings of learning Physics amid blended learning. Specifically,∆ I seek to answer the central research question: What are the sources of the meanings of learning Physics in a blended learning environment as perceived by STEM senior high school students?

Theoretical Framework

I anchored my study on David Kolb's Experiential Learning Theory (ELT), which views learning Physics as a knowledge that emerges through concrete experience, reflective observation, abstract conceptualization, and active experimentation. In Kolb (1984), it is emphasized that meaningful learning in Physics is not a passive reception of information but an active process in which learners construct meaning by integrating experience, reflection, conceptualization, and experimentation.

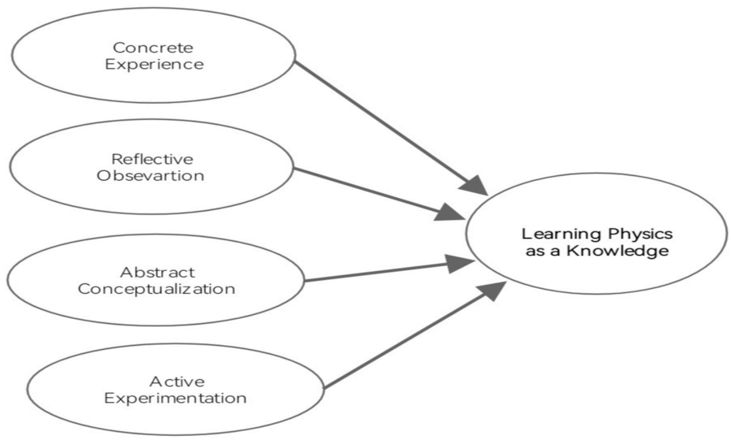

FIGURE 1
THE EXPERIENTIAL LEARNING THEORY

Assumptions

My study proceeds with several assumptions. First, I assume that the selected STEM students' perceptions meaningfully represent their experiences in blended Physics learning. Second, I assume that their self-reported emotions, learning strategies, and perceptions are reliable indicators of their engagement and understanding of the subject. Although there may be variations in instruction, resources, and learning conditions, I consider their experiences to be sufficiently comparable for analysis. Lastly, I assume that descriptive research design is appropriate and effective in capturing the shared meanings, patterns, and interpretations of students' learning experiences in Physics within a blended learning environment.

II. METHODOLOGY

To ensure the credibility of the study, I clearly discussed my research design, research locale, sample and sampling technique, data gathering and analysis technique, and trustworthiness.

Research Design

In this study, I employed descriptive qualitative research design, which focuses on providing a rich, detailed, and direct description of participants' perceptions, experiences, and meanings without attempting to test hypotheses or establish cause-and-effect relationships. I used this design because it is appropriate for understanding how individuals perceive and interpret a particular phenomenon within its natural context, especially when the topic requires in-depth exploration. In my study, this approach allowed me to capture STEM students' perceptions of learning Physics in a blended learning environment. I found this design advantageous because it is flexible and suitable for analyzing complex social phenomena, while also allowing participants' voices to be expressed in a clear and authentic manner. It further supports systematic thematic interpretation while staying close to the original data, ensuring that the findings accurately reflect students' perceptions and meanings (Hall & Liebenberg, 2024; Villamin et al., 2024).

Locale of the Study

I conducted this study in a selected private senior high school in Kabacan, North Cotabato, which offered the Science, Technology, Engineering, and Mathematics (STEM) strand under the K–12 curriculum. I chose this place as it provides an appropriate and relevant setting for examining STEM students' perceptions of learning Physics in a blended learning environment. The school's structured academic environment, along with its available learning resources and implementation of blended learning modalities, made it suitable for exploring how students perceive, navigate, and make sense of Physics concepts. This setting also allowed me to better understand the strategies that students employ to cope with learning challenges within a blended learning framework.

Sample and Sampling Technique

In this study, I engaged nine Grade 12 STEM students, consisting of four males and five females, who belonged to the same section and were enrolled in the school year 2025–2026. Among them, three were minors and six were adults, while five were performing well in Physics and four were non-performing. I used purposive sampling to intentionally select learners who had direct experience with blended Physics learning and could best express their perceptions of it. This non-probability approach allowed me to focus on information-rich participants whose views, interpretations, and experiences directly reflected how they perceived the learning process. I found this approach beneficial because it strengthened my study by capturing relevant, in-depth, and context-specific perceptions, making the data more meaningful and closely aligned with the research problem (Campbell et al., 2020).

Data Gathering Technique

In this study, I used Focus Group Discussion (FGD) as my qualitative data-gathering technique through guided group interviews. FGD is a structured method where I facilitated discussion among selected participants to explore their perceptions, experiences, and meanings regarding learning Physics in a blended learning environment. It allows participants to interact, respond to one another, and co-construct ideas, resulting in richer and more dynamic data than individual interviews. I applied FGD because it is effective in examining complex educational experiences and shared perceptions, particularly when the goal is to understand how students collectively interpret and make meaning of learning situations in blended learning environments (Legarde, 2025). Through this technique, I was able to gather multiple perceptions efficiently while also capturing deeper insights shaped by group interaction, including similarities and differences in viewpoints. This approach strengthened my study by producing context-rich and meaningful data that reflected students'experiences and perceptions in blended learning environments (Ropero-Padilla et al., 2023).

Data Analysis Technique

In this study, I used thematic analysis to systematically analyze the qualitative data gathered from FGD transcripts, observational notes, and written narratives. Thematic analysis is a method where I identified, organized, and interpreted patterns of meaning (themes) within the data to better understand students' perceptions and experiences in learning Physics in a blended learning environment (Braun & Clarke, 2022). I applied this technique when exploring complex and layered student experiences because it allowed me to capture how meanings were constructed across different accounts. First of all, I familiarized myself with the data by repeatedly reading the transcripts and notes. Second, I generated initial codes by identifying meaningful segments related to students' perceptions. Third, I searched for patterns among these codes and grouped them into potential themes. Fourth, I reviewed the themes to ensure they accurately reflected both the coded data and the entire dataset. Fifth, I defined and named each theme based on its meaning. Finally, I produced the overall analysis by integrating the themes into a coherent interpretation of students' experiences. One advantage of thematic analysis is its flexibility and clarity, as it systematically analyzes large amounts of qualitative data while remaining grounded in participants' actual responses, making the findings both credible and easy to understand.

Trustworthiness

In conducting this study, I strictly adhered to the ethical standards outlined in Republic Act No. 10532 and the guidelines of Holy Cross of Davao College's Society for Moral Integration and Legal Ethics (HCDC-SMILE). I secured informed consent from all study participants through proper procedures and ensured their participation remained voluntary throughout the research process. To establish trustworthiness, I applied Egon Guba's (1981) criteria, including credibility, which was achieved through member checking to ensure the accurate representation of participants' accounts; dependability, maintained through systematic documentation of research procedures; conformability, ensured through reflexive journaling and transparent records to minimize researcher bias; and transferability, addressed by providing sufficient contextual descriptions to support applicability in similar settings. Finally, I upheld fairness in this research by selecting participants inclusively and respectfully.

III. RESULTS

In this section, I narrated my conversations from my participants in the focus group discussions. I analyzed the data to explore participants' thoughts and meanings, providing insights into their perceptions in learning Physics in a blended learning environment.

Sources of Meaning in Learning Physics within a Blended Learning Environment

To explore the sources of meaning in learning Physics in a blended learning environment, I engaged in conversations with STEM senior high school students, noting that fragmented concrete experience in a blended environment is marked by difficult and disconnected moments between online and face-to-face settings. For instance, one group shared,

> *Hindi palaging nagco-complement ang online at face-to-face discussions dahil minsan hindi na-clarify sa classroom ang misunderstandings mula sa online lessons. Ang pag-shift between sa dalawa ay nagpapahirap sa pag-aaral ng Physics dahil mas mahirap mag-focus online at minsan hindi malinaw ang explanation. -FGD3_P1_L7*

> (Online and face-to-face discussions do not always complement each other because sometimes misunderstandings from online lessons are not clarified in the classroom. The shifting between the two makes learning Physics more difficult because it is harder to focus online, and sometimes the explanations are not clear.) -FGD3_P1_L7

Additionally, I noted that participants experienced difficulty adjusting to shifts between modalities. As stated,

> *Nahihirapan kami minsan mag-adjust tulad ng... ahmmm, or example sa explanation sa online. Hindi namin masyadong gusto dahil hindi madaling maintindihan ang lessons, lalo na kung kulang ang foundation namin sa basic Physics topics, lalo na kapag palipat-lipat from online to face-to-face without enough clarification. -FGD1_P1_L6*

> (We sometimes find it difficult to adjust, especially with online explanations. We don't really like it because the lessons are not easy to understand, particularly we are lack of foundation in basic Physics topics, especially when we keep shifting from online to face-to-face classes without enough clarification.) -FGD1_P1_L6

Participants also emphasized challenges in focus and comprehension as one group expressed,

> *Most online Physics activities ay challenging para sa amin dahil minsan confusing ang tasks at hindi clear ang instructions kaya nawawalan kami ng focus or pababayaan nalang namin. Sa face-to-face classes naman, engaging ang klase lalo na sa experiments at laboratory activities tulad ng collision simulations, pero ang challenging part usually ay ang calculations at pag-apply ng concepts. -FGD2_P1_L5*

> (Most online Physics activities are challenging for us because the tasks are sometimes confusing and the instructions are not clear, which causes us to lose focus or just neglect them. In face-to-face classes, however, the lessons are engaging, especially during experiments and laboratory activities like collision simulations. The challenging part is usually the calculations and applying the concepts.) –FGD2_P1_L5

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As our conversation continued, one of the groups emphasized the importance of reflective observation, noting that emotions play a significant role, an idea reflected in their emotional and social responses, which are influenced by peer interaction and shared feelings of confusion, frustration, and stress:

> *Ang pinaka-frustrating na moment ay kapag self-taught ang module at nahihirapan kaming hanapin ang tamang formulas at equations. Nahihiya kami kapag hindi namin gets ang lesson pero naiintindihan ng iba. Minsan mas lalo kaming nalilito kapag iba-iba ang explanation ng classmates. –FGD1_P1_L4*

> (The most frustrating moment is when the module is self-taught, and we struggle to find the correct formulas and equations. We feel embarrassed when we do not understand the lesson, but others do. Sometimes we become even more confused when classmates give different explanations.) –FGD1_P1_L4

Building from this, it was also expressed that similar emotional difficulty in understanding Physics concepts:

> *Ahay, naremember ko ang pinaka-frustrating moment na nangyari, kung saan ito yong time na kapag hindi namin maintindihan ang isang formula kahit ilang beses na naming i-review ang study guide. Nakaka-stress ito at nagiging unsure kami kung tama ba ang solution namin, pero natutunan namin na tulungan ang isa't isa bilang classmates para mas maintindihan ang topics.) –FGD3_P2_L15*

(Ahay, I remember the most frustrating moment that happened, which was when we could not understand a formula even after reviewing the study guide several times. It is stressful, and we become unsure if our solution is correct, but we learned to help each other as classmates to better understand the topics.) –FGD3_P2_L15

Despite these challenges, another group emphasized that peer interaction helps ease emotional pressure and supports understanding:

Kapag mahirap ang lesson, nakakaramdam kami ng stress at nagiging unsure sa answers. Pero kapag nag-uusap kaming magclassmates, na-realize namin na pare-pareho pala kaming nahihirapan, kaya somehow nakakabawas ng pressure. –FGD2_P2_L14

(When the lesson is difficult, we feel stressed and become unsure of our answers. But when we talk with our classmates, we realize that we are all struggling, so somehow it reduces the pressure.) –FGD2_P2_L14

As our conversation went deeper, one of the members of the group emphasized the importance of abstract conceptualization and described learning physics as a complex cognitive and formula-based learning, where students struggle to form an abstract understanding due to reliance on formulas and lack of conceptual discussions:

Nahihirapan kaming i-visualize ang abstract concepts, lalo na ang thermodynamics calculations at projectile motion problems dahil hindi namin masyadong dinidiscuss nang deep ang complex ideas at walang clear explanation. Kadalasan, minememorize lang namin ang mga formula

> *kaysa intindihin. Sa group chat naman, konti lang ang sumasagot kapag may nagtatanong tungkol sa formula. –FGD2_P2_L16*
>
> (We find it difficult to visualize abstract concepts, especially thermodynamics calculations and projectile motion problems, because complex ideas are not discussed in depth, and there are no clear explanations. Most of the time, we just memorize the formulas instead of understanding them. In group chats, only a few respond when someone asks about formulas.) –FGD2_P2_L16

I noted that this reflects a shift from conceptual learning toward rote memorization as a response to difficulty in grasping abstract content. Similarly, another participant shared:

> *Kapag nasa gitna kami ng Physics class, binabasa muna namin ang problem at hinahanap ang given values. Pero minsan nalilito kami kung saan magsisimula dahil complicated ang formulas at concepts. Minsan sinusubukan lang naming sundan ang steps pero nauuwi sa paggamit ng phone. Kaya minsan minememorize na lang namin ang formulas para mas madali pero unsure kami kung tama or mali ang sagot namin. Sa group chat naman, maraming tanong at messages dahil karamihan sa amin ay confused sa topic, sineseen lang namin dahil di din kami sure. – FGD3_P2_L17*
>
> (When we are in the middle of Physics class, we first read the problem and look for the given values. However, sometimes we get confused about where to start because the formulas and concepts are complicated. At times, we just try to follow the steps but end up using our phones instead. Because of this, we sometimes just memorize the formulas to make things easier,

> but we are unsure whether our answers are correct or not. In our group chat, there are many questions and messages because most of us are confused about the topic, so we just leave them unseen since we are also not sure.) – FGD3_P2_L17

Building from this, I noted that memorization becomes a coping mechanism when conceptual understanding is not fully achieved. One group also shared challenges in applying formulas, focus, and problem-solving:

> *Madalas kaming nalilito sa lessons o formulas na mahirap intindihin. Nahihirapan din kaming magsolve ng difficult problems at nahihirapan kaming mag-focus lalo na kapag walang clear explanation. If marami sa amin ang nahihirapan sa pag-intindi at pag-remember ng iba't ibang Physics concepts and principles. Minsan naghahanap kami ng answers online o nagmo-move on na lang kapag hindi na talaga maintindihan. – FGD1_P1_L6*

> (We are often confused with lessons or formulas that are difficult to understand. We also have difficulty solving the challenging problems and find it hard to focus, especially when there is no clear explanation. Many of us struggle to understand and remember different Physics concepts and principles. Sometimes, we look for answers online or just move on when we can no longer understand them. –FGD1_P1_L6

Additionally, as the discussion progressed, one group highlighted the significance of active experimentation and hands-on application, where students engage in hands-on activities such as laboratory work, simulations, and problem-solving tasks in a blended learning environment:

> *Sa face-to-face, engaging ang laboratory experiments dahil meron kaming magagamit na mga tools or mga gamit para sa laboratory example about electricity and magnetism, may magagamit at mahihiram kami at hindi na need magbili, pero ang challenging part ay ang group problem-solving activities dahil dito natetest namin ang theories at nakikita kung paano naaapektuhan ng iba't ibang variables ang results. Pero sa online, nahihirapan kami gumawa example sa topic ng electromagnetic force, wala kaming magagamit sa bahay namin at need pang bumili. – FGD3_P2_L10*

> (In face-to-face, laboratory experiments are engaging because we have access to tools and equipment for the laboratory, for example, in topics like electricity and magnetism, where we can directly use or borrow materials without needing to buy them. However, the challenging part is the group problem-solving activities because this is where we test theories and observe how different variables affect the results. But in online classes, we struggle with doing tasks, for example, in the topic of electromagnetic force, because we don't have the necessary materials at home and we would still need to buy them.) -FGD3_P2_L10

Similarly, I noted that there is a difference in their participation between face-to-face laboratories and virtual simulations:

> *Nakakatulong ang laboratory activities dahil nakikita at nasusukat namin ang actual results. Kung sa face-to-face, masaya itong gawin dahil meron kaming kasamahan at may mga gamit na available lang. Nakakatulong din naman ang virtual simulations dahil makikita kung paano nagbabago ang outcome kapag nagpalit ng variables pero mahirap*

dahil kailangan pa namin magpractice at hindi engaging kasi pacellphone-cellphone lang, minsan hinahayaan nalang. –FGD1_P2_L11

(Laboratory activities are helpful because we can see and measure the actual results. In face-to-face, it is more enjoyable because we have groupmates and the equipment is readily available. Virtual simulations are also helpful because we can see how the outcomes change when variables are adjusted, but it is difficult because we still need to practice and it is not engaging since we are mostly just using phones; sometimes we just end up letting it be.) –FGD1_P2_L11

Additionally, I noted that although online simulations are available, they are still less engaging than face-to-face laboratory experiences. As one member of the group expressed:

Mahalaga ang hands-on laboratory sa Physics, dahil mas pinapadali nito maexplain ang mga concepts at theories. Halimbawa, sa laboratory activities namin, ginagamit namin ang concepts ng force, motion, at acceleration sa pamamagitan ng pag-measure ng objects at pag-calculate ng results at kung anong theories or principles ang ina-apply dito. Sa projects naman, ginagamit namin ang Physics principles sa paggawa ng simple experiments. Meron din sa online simulations pero limited lang ang mga activities. –FGD2_P2_L12

(Hands-on laboratory work in Physics is important because it makes concepts and theories easier to explain. For example, in our laboratory activities, we use the concepts of force, motion, and acceleration by measuring objects and calculating results, as well as identifying which theories or principles are applied. In projects, we also apply Physics principles in conducting simple experiments. There are also online simulations, but the activities there are limited.) –FGD2_P2_L12

Furthermore, one of the members of the group emphasized the importance of the real-life application of learning in Physics, which is emerging everyday understanding, where students begin to recognize Physics in real-life situations, although not consistently:

Napapansin namin ang Physics kapag may static electricity, tulad ng kapag nagkakaroon ng maliit na shock pagkatapos mag-rub sa synthetic fabric. Naranasan namin ito sa pang-araw-araw na buhay lalo na kapag gumagamit ng damit na synthetic. Doon namin na-realize na may electron transfer at static charge na nangyayari sa paligid namin. -FGD3_P2_L17

(We notice Physics when there is static electricity, such as when we experience a small shock after rubbing against synthetic fabric. We have experienced this in daily life, especially when using synthetic clothing. That is when we realized that electron transfer and static charge are happening around us.) -FGD3_P2_L17

Similarly, another member of the group described Physics as being observable in various everyday activities, particularly in motion, energy, and electricity, although often only becoming clearer when directly experienced:

Nakikita namin ang Physics sa everyday life tulad ng pagbisikleta, paggamit ng kuryente sa bahay, at pag-observe kung paano gumagalaw o nahuhulog ang mga objects. Madalas naming naoobserbahan ang mga konsepto ng motion at energy sa mga ganitong gawain. Nagiging mas

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malinaw sa amin ang Physics kapag nakikita namin ito sa aktwal na sitwasyon. -FGD2_P2_L18

(We see Physics in everyday life, such as in biking, using electricity at home, and observing how objects move or fall. We often observe concepts of motion and energy in these activities. Physics becomes clearer to us when we see it in actual situations.) -FGD2_P2_L18

Additionally, another group expressed that Physics concepts are sometimes present in daily life but are not always immediately recognized or connected to formal learning:

Minsan hindi namin napapansin ang Physics concepts sa real-life situations. Kadalasan, hindi namin agad ito naiuugnay sa mga pang-araw-araw na gawain. Kahit nandiyan lang ito sa paligid, hindi ito agad namamalayan bilang bahagi ng Physics. -FGD1_P2_L16

(Sometimes we do not notice Physics concepts in real-life situations. Most of the time, we do not immediately relate them to daily activities. Even though it is just around us, we do not always recognize it as part of Physics.) -FGD1_P2_L16

Based on the discussions, I consistently heard participants describe learning Physics in a blended environment as confusing and disconnected, where online and face-to-face lessons often fail to align, leading to misunderstandings and difficulty in grasping concepts and formulas. They also emphasized that learning becomes even more difficult without proper guidance. I saw these struggles reflected in their expressions, such as furrowed brows while sharing, others nodding and giving thumbs up to show agreement, some laughing, and a few covering their faces out of embarrassment. From these observations, I made the meaning that learning Physics in this context

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is a complex and fragmented experience shaped by cognitive challenges, limited conceptual understanding, and the need for hands-on and collaborative learning to better grasp abstract ideas. I also felt the emotional weight of their experiences, particularly their frustration, stress, and embarrassment when they could not understand the lessons while others could, alongside a shared sense of struggle that fostered peer support and helped reduce pressure among them.

Summary of the Findings

In this study, I found that the sources of meanings in learning Physics within a blended learning environment, as perceived by STEM senior high school students, are shaped by multiple dimensions including fragmented learning experiences, which students describe as difficult and disconnected moments between online and face-to-face settings; emotional and social challenging, shaped by peer interaction and shared feelings of confusion, frustration, and stress; complex cognitive and formula-based learning, where abstract ideas are formed through principles, equations, and theories; active experimentation and hands-on application, where students engage in laboratory work, simulations, and problem-solving tasks; and emerging everyday understanding, where Physics is gradually recognized and applied in real-life situations and daily experiences.

Modified Paradigm

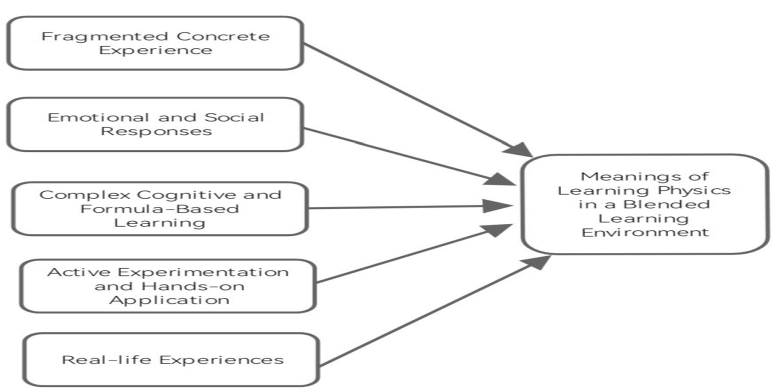

FIGURE 2
MODIFIED PARADIGM OF KOLB'S EXPERIENTIAL LEARNING THEORY

IV. DISCUSSIONS

My finding of this study is discussed in this chapter. I also highlighted the implication for practice and future direction of my study.

Multidimensional and Interconnected Sources Shaping Students' Meanings of Learning Physics in a Blended Modalities

Based on my finding, I learned that the sources of meanings in learning Physics in a blended learning environment among STEM senior high school students are often fragmented yet multifaceted—cognitively demanding, emotionally challenging, socially influenced, experientially grounded, and gradually meaningful in real-life contexts. My finding is consistent with Simpal et al. (2025), who reported that students in blended science environments tend to experience Physics learning as cognitively complex and disjointed due to frequent transitions between online modules and face-to-face instruction. Their study emphasizes that students struggle to maintain conceptual continuity when abstract Physics concepts are delivered across multiple modalities, resulting in fragmented understanding similar to what I observed in this study.

Second, my finding aligns with Saucer and Lim et al. (2024) highlighting that the emotional and social dimensions of blended Physics learning. They found that STEM students often experience confusion, frustration, and reliance on peers as coping mechanisms during shifts between asynchronous and synchronous learning. This supports my observation that peer interaction and shared struggles play a central role in how students construct meaning in learning Physics within blended environments.

In contrast, I contradict the idea of Candido et al. (2023) explaining that blended learning is well-structured, it can lead to seamless integration of Physics concepts, where digital simulations and face-to-face experiments complement each other and enhance conceptual coherence rather than create fragmentation. Similarly, my findings do not fully support Samson (2023) in stating that strong instructional alignment allows STEM students to perceive blended Physics learning as a unified and continuous experience, with online and face-to-face components reinforcing rather than disconnecting understanding.

Implication for Practice

Based on the findings, I see possibilities for Physics teachers to enhance students' meaning-making in a blended learning environment by strengthening instructional coherence to address fragmented, disconnected learning experiences. They may support students' emotional and social needs through collaborative and reflective practices, simplify complex and formula-based concepts using scaffolding and inquiry-based strategies, promote active experimentation through laboratory work, simulations, and problem-solving, and foster real-life understanding by contextualizing Physics concepts in everyday situations. Meanwhile, school administrators may support these efforts through seminars, Learning Action Cells (LAC), and the provision of relevant instructional resources. Finally, policymakers may develop and sustain frameworks, guidelines, and continuous professional development programs to ensure coherent, meaningful, and contextually relevant Physics learning outcomes.

Future Direction of my Study

Based on the results, four quantitative research directions are proposed. First, multiple regression analysis may be conducted to determine how key learning dimensions such fragmented learning experiences, emotional and social responses, complex cognitive and formula-based learning, active experimentation, and real-life experiences, predict students' overall meanings of learning Physics. By gathering data from a larger sample of STEM senior high school students using validated survey instruments, the study may identify the relative contribution of each dimension and provide empirical support for the present qualitative findings. Second, Structural Equation Modeling (SEM) may be conducted to examine the relationships among emotional and social responses, including affective factors, social interaction, and learning outcomes. Lastly, a quasi-experimental design may be conducted to investigate hands-on learning by comparing the effectiveness of different instructional approaches, such as virtual and physical laboratory activities.

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