International Journal of Evaluation and Research in Education (IJERE)
Vol. 15, No. 6, December 2026, pp. 5572~5584
ISSN: 2252-8822, DOI: 10.11591/ijere.v15i6.39218

Understanding STEM faculty teaching effectiveness in higher education through outcomes-based education

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Article Info

Article history:

Received Feb 24, 2026
Revised Jul 26, 2026
Accepted Aug 6, 2026

Keywords:

Higher education
OBTL
Outcomes-based education
STEM
Teaching effectiveness

ABSTRACT

Evaluating teaching effectiveness in science, technology, engineering, and mathematics (STEM) higher education within outcomes-based education (OBE) frameworks remains underexplored, particularly from the perspective of faculty lived experience. This study employed a descriptive phenomenological design guided by Colaizzi's seven-step method to explore how STEM faculty and administrators conceptualize and enact teaching effectiveness in OBE and outcomes-based teaching and learning (OBTL) contexts. A total of 10 participants, including vice-presidents for academic affairs, deans, chairpersons, and faculty members from STEM programs in the Visayas region, Philippines were purposively selected; data saturation was confirmed after the ninth interview. Analysis yielded eight themes across three dimensions: i) communicating intended learning outcomes-clear articulation and alignment with standards; ii) facilitating teaching-learning activities-active-collaborative learning, hands-on application, and diversified methods; and iii) implementing assessment tasks-OBE-aligned authenticity, rubric use, and feedback mechanisms. These findings informed a three-dimensional framework: outcome clarity and alignment, pedagogical responsiveness, and authentic and feedback-rich assessment. The framework positions STEM teaching effectiveness as a dynamic, integrated practice rather than isolated competencies, offering actionable guidance for faculty development, curriculum design, and institutional teaching evaluation systems in Philippine STEM higher education.

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1. INTRODUCTION

Evaluating teaching effectiveness is critical to improving teaching-learning, particularly in science, technology, engineering, and mathematics (STEM) education. STEM disciplines are pivotal in addressing global challenges, driving technological advancement, and shaping the future workforce. The complexity of teaching STEM subjects in higher education highlights the need for a nuanced understanding of teaching effectiveness. In particular, the frameworks of outcomes-based education (OBE) and outcomes-based teaching and learning (OBTL) provide a structured approach to assessing faculty performance by aligning

teaching strategies with explicit learning outcomes and assessment tasks. OBE emphasizes learner-centered approaches that focus on achieving clearly defined outcomes. OBTL operationalizes this by linking intended learning outcomes to teaching activities and assessment methods [1]. Within this context, evaluating teaching effectiveness involves understanding how well faculty members communicate learning outcomes, facilitate engaging teaching-learning activities, and implement authentic assessments aligned with these outcomes. These dimensions are crucial for fostering meaningful learning experiences, especially in STEM disciplines where practical applications, critical thinking, and problem-solving are essential [2].

Despite growing adoption of OBE and OBTL in higher education, evaluating STEM teaching effectiveness within these frameworks presents specific challenges. Existing evaluation tools tend to be quantitative and standardized, often failing to capture the contextual, learner-centered dynamics that OBE requires [2], [3]. Moreover, previous studies have predominantly examined OBE implementation at the curricular or institutional level, leaving a critical gap in understanding how individual faculty members and administrators conceptualize and enact teaching effectiveness in practice, particularly through the lens of qualitative, phenomenological inquiry. In the Philippine higher education context, where OBE has been mandated by the Commission on Higher Education (CHED) since 2013, this gap is especially pressing: institutional compliance does not guarantee pedagogical depth, and faculty perspectives remain underrepresented in the literature [4].

This study addresses these gaps and makes three contributions. Theoretically, it extends OBE literature by proposing a grounded, three-dimensional framework of STEM teaching effectiveness derived from faculty and administrator lived experiences, a novel contribution that goes beyond descriptive catalogues of best practices. Practically, its findings can directly inform the design of faculty development programs, OBTL-aligned teaching evaluation rubrics, and STEM education policy in Philippine and comparable HEI contexts. The scientific question guiding this study is: how do STEM faculty and administrators in Philippine higher education institutions (HEIs) conceptualize and enact teaching effectiveness within OBE and OBTL frameworks?

The novelty of this study lies in the construction of a grounded, three-dimensional framework-outcome clarity and alignment, pedagogical responsiveness, and authentic and feedback-rich assessment derived from the lived experiences of STEM faculty and administrators in Philippine HEIs through descriptive phenomenological inquiry. Unlike prior OBE studies that rely on quantitative instruments or student evaluation data, this study is the first to generate a phenomenologically grounded, multi-dimensional framework for STEM teaching effectiveness within OBE/OBTL contexts in the Philippine higher education setting, simultaneously capturing outcome articulation, pedagogical practice, and assessment design as an integrated whole. This framework advances both theory and practice by providing a conceptual foundation for developing validated OBTL-aligned faculty evaluation instruments and structuring evidence-based professional development programs for STEM educators.

Despite the growing body of literature on OBE implementation, a significant gap remains in understanding how STEM faculty and administrators in Philippine HEIs subjectively experience and operationalize teaching effectiveness within these frameworks. Most existing studies rely on quantitative instruments or student evaluation data, leaving the faculty perspective qualitatively underexplored [2], [3]. Moreover, prior research has not yet produced a grounded, multi-dimensional framework for STEM teaching effectiveness derived from phenomenological inquiry, one that simultaneously accounts for outcome articulation, pedagogical practice, and assessment design as an integrated whole. This study employs phenomenological inquiry to capture the lived experiences of STEM faculty and administrators as they navigate OBE and OBTL implementation. Further, this study seeks to deepen understanding of the complex dynamics of STEM teaching effectiveness by focusing on qualitative insights and providing actionable insights to inform development of more precise evaluation tools. Specifically, this study sought to answer the following research questions:

- How do STEM faculty and administrators conceptualize teaching effectiveness in communicating intended learning outcomes within an OBE framework? (RQ1)
- What teaching-learning strategies and activities do STEM faculty employ to facilitate student achievement of intended learning outcomes? (RQ2)
- How do STEM faculty implement and perceive assessment tasks aligned with OBE objectives? (RQ3)

2. METHOD

This section presents a detailed description of the research methodology employed in this study. It covers the research design, environment, participants, instruments, the data-gathering process, data analysis, and ethical considerations that govern the conduct of the study.

2.1. Research design

This study employed a qualitative research design to explore and evaluate STEM faculty teaching effectiveness in HEIs, aiming to gain in-depth insights into how faculty and administrators understand and operationalize teaching effectiveness within OBE and OBTL contexts. More specifically, this study employed a descriptive phenomenological design, grounded in Husserl [5] philosophical tradition and operationalized through Colaizzi [6] seven-step procedural framework. Phenomenology was deemed appropriate because the study sought to uncover the lived experiences and meaning-making processes of STEM faculty and administrators as they navigate OBE and OBTL implementation, dimensions of experience that are inherently subjective and resist reduction to numerical measurement [7]. Unlike grounded theory, which aims to build substantive theory through comparative analysis, or case study, which focuses on the bounded context of a specific institution, phenomenology was most appropriate here because the research purpose was to capture the essential structure of how teaching effectiveness is subjectively experienced not to explain institutional variation or generate transferable theory across sites [7], [8].

Purposive sampling was used to select participants, focusing on administrators and faculty members actively implementing OBTL. The selection criteria ensured that participants had substantial experience and knowledge in STEM teaching and were familiar with OBE and OBTL principles. Participants were recruited through purposive and snowball sampling by contacting STEM program heads and college deans across HEIs in the Visayas region via formal recruitment letters. Inclusion criteria required that participants: i) held a teaching or administrative position in a STEM-related program at a HEIs in the Visayas region; ii) had a minimum of three years of teaching or supervisory experience in STEM; iii) demonstrated working familiarity with OBE and OBTL principles; and iv) provided informed consent.

In accordance with phenomenological rigor, the researchers engaged in reflective bracketing (epoche) prior to and throughout data collection. As faculty members with prior experience in OBE curriculum development and OBTL implementation, the researchers held pre-existing assumptions about the challenges and best practices of STEM teaching. These assumptions were acknowledged and systematically set aside through a reflective journal maintained throughout the research process, ensuring that interpretations remained grounded in participants' own accounts [7], [9]. Member-checking was conducted with three participants to verify the accuracy of the themes generated, strengthening the credibility of the findings.

2.2. Research environment

The research environment focused on HEIs in Visayas, renowned for their rich educational landscape and commitment to excellence in STEM education. These institutions offer diverse programs to foster innovation, critical thinking, and problem-solving abilities among students. Within these HEIs, STEM programs encompass various disciplines crucial for societal advancement and economic growth.

2.3. Research participants

In this study, data saturation was achieved with 10 participants, including vice-presidents for academic affairs, college deans, academic chairpersons, and faculty members from STEM programs in HEIs in the Visayas region. The adequacy of this sample size is consistent with phenomenological research conventions, wherein small, information-rich samples are preferred over large random samples [7]. Data saturation defined as the point at which no new themes or meaningful information emerged from subsequent interviews was continuously monitored throughout data collection [10]. Saturation was confirmed after the ninth interview, and one additional participant was recruited to verify confirmability of the emergent themes.

Participants were recruited through purposive and snowball sampling strategies. Initial contact was made through the research team's professional networks within STEM departments across HEIs in the Visayas region. Recruitment letters describing the study purpose, inclusion criteria, and ethical assurances were distributed to STEM program heads, who facilitated referrals to eligible faculty members and administrators. Saturation was operationally defined as the point at which successive interviews produced no new formulated meanings beyond those already identified [10]. Saturation was confirmed after the ninth interview; one additional participant was subsequently recruited to verify the confirmability and stability of the emergent themes.

2.4. Research instrument

In this study, the researchers served as the main instrument. Using a semi-structured interview guide, the selected administrators and faculty members were asked about their conceptions regarding implementing OBTL. An audio recorder was used to record participants' responses during the interview. The interview guide was developed around the three research questions and pilot-tested with two STEM faculty not included in the final sample. Representative guiding questions included for RQ1: “how do you communicate intended learning outcomes to your students at the start of a course, and how do you ensure

they understand what is expected?"; for RQ2: "what specific teaching-learning activities do you use to help students achieve the intended outcomes, and why do you find these effective?"; and for RQ3: "how do you design and implement assessment tasks to ensure they are aligned with OBE objectives, and how do you use feedback to improve student learning?" Probing questions were used throughout to encourage elaboration and ensure conceptual depth. The interviews were conducted based on participants' convenience and time preferences, utilizing one-on-one interviews with four participants and focus group discussions with six participants. Six interviews were conducted online via platforms such as Zoom, while four were conducted face-to-face. Each session lasted approximately 20–30 minutes.

3. DATA ANALYSIS

Following Colaizzi method [6], the qualitative data were analyzed through a structured seven-step phenomenological procedure. This approach was selected for its systematic rigor in extracting and validating the essential structure of lived experience from narrative data. The steps were applied as: i) all interview transcripts were read in their entirety to gain a holistic sense of participants' descriptions; ii) significant statements directly pertaining to STEM teaching effectiveness were extracted; iii) formulated meanings were derived from each significant statement, translating participants' language into phenomenological constructs; iv) formulated meanings were clustered into preliminary theme clusters across all transcripts; v) an exhaustive description of the phenomenon was composed, integrating all theme clusters; vi) the fundamental structure of the phenomenon was articulated; and vii) member-checking was conducted with three participants to validate interpretations and ensure trustworthiness.

To ensure the rigor of findings, the study applied Lincoln and Guba [11] four criteria of trustworthiness. Credibility was established through member-checking and peer debriefing. Transferability was enhanced through thick description of the research context. Dependability was addressed through an audit trail comprising interview guides, field notes, and a reflective journal. Confirmability was achieved by grounding all interpretations directly in participants' verbatim accounts [11]. Data from both individual interviews and focus group discussions were transcribed verbatim and treated as a unified corpus for analysis. The source of each statement was noted in analytical memos to monitor potential variation; no systematic differences in thematic content were observed across modes.

4. RESULTS AND DISCUSSION

This section presents data on the conceptions of the administrators and faculty members regarding implementing OBTL in terms of communicating intended learning outcomes, facilitating teaching-learning activities, and implementing assessment tasks. The eight themes that emerged across the three dimensions constitute a coherent, integrated picture of STEM teaching effectiveness under OBE. Each dimension informs the next: clarity in communicating outcomes shapes the design of teaching-learning activities, which in turn determines the form and focus of assessment tasks; feedback from assessment then loops back to refine outcome articulation and pedagogy.

4.1. Communication of intended learning outcomes

This is the knowledge, skills, attitudes, and values learners are expected to have achieved by the end of a course or program. Under OBE and OBTL frameworks, the effective communication of these outcomes is foundational, as it sets clear expectations for both students and instructors. The following themes illustrate how STEM faculty and administrators in Philippine HEIs conceptualize and practice the articulation and alignment of intended learning outcomes.

4.1.1. Theme 1: clear and understandable articulation of the learning outcomes

OBTL, as mentioned in the interviews, requires teachers to state the intended learning outcomes in a clear manner [12]. Thus, providing students with learning objectives gives them a framework to initiate self-directed learning. The assessed skills and results are aligned with the learning objectives integrated in the syllabus and institutional learning outcomes [13]. The theme is supported by the following responses:

> "*Students under this OBE within the time that they are taking the course they have this course learning outcomes should be met not only in paper but in reality.*" (Informant A)
> "*In terms of communicating our intended learning outcomes to our students, we have to define our clear outcome; that's the first thing we have to do. And the third one is the use of friendly language.*" (Informant C)

"*At first, what we really did at the start of the semester, we gave the students the course outline ahead of time. In the course outline, of course, the topics are already visible.*" (Informant D)
"*So, in STEM education, OBE focuses on clear learning goals, practical teaching methods, and assessments that measure real understanding and skills.*" (Informant E)
"*Precision and clarity of intended learning outcomes ensure that our learners know what is expected from them and how these expectations can be achieved.*" (Informant F)
"*When* communicating *intended learning outcomes for STEM disciplines in the context of OBE, it is critical to ensure clarity and specificity.*" (Informant H)

According to key informants, clear and concise learning outcomes are critical for STEM education in the OBE spectrum. Such discoveries conform with the literature noting OBE establishes a focus on clear, prominent outcome goals at multiple levels [14], [15], which inform the curriculum, instruction, and assessment [15], [16]. Having clear learning objectives also helps with professional development and performance assessment [17], [18]. There is a strong need for precise learning outcomes arising from the requirement of competency-based education for the provision of skills [19]. Experts proposed measurable performance indicators to evaluate whether courses and programs performed at the institutional level [20] while it is expected that learning outcomes of each course are aligned with program goals. Notably, these findings extend prior quantitative studies by surfacing the communicative and relational dimensions of outcome clarity. Faculty do not merely list outcomes; they negotiate meaning with students through accessible language and tangible examples.

4.1.2. Theme 2: alignment with standards and real-world relevance

This theme guarantees that instructional programs follow recognized industry and academic standards, producing a reliable and excellent educational experience.

"*We have different educational objectives bearing the same vision and mission, and objectives of the university so we want to see to it that our students under this OBE within the time that they are taking the course they* have *this course learning outcomes should be met.*" (Informant A)
"*We have to define our clear outcome; that's the first thing we have to do. The second one is to align it with the* standards*. We have different standards aligning it to the learning outcomes, like in the national, international standards in STEM education.*" (Informant C)
"*...alignment with standards, relevance to practical applications, measurability, progression and sequencing,* inclusivity *and diversity, interdisciplinary connections, and engagement and motivation.*" (Informant H)

According to the informants, STEM education must be aligned to international and national standards to ensure consistency and real-world relevance. Goncharow *et al.* [21] demonstrate that aligning learning outcomes to curricula enhances course design and coherence. Similarly, Krajcik *et al.* [22] noted that when curriculum is aligned with science standards, it supports meaningful learning and problem-solving in real-world tasks. These findings go beyond mere compliance: informants framed alignment not as a bureaucratic exercise but as a mechanism for ensuring graduates are competitive in national and global STEM labor markets. For curriculum designers, this implies that outcome-standard alignment should be revisited regularly against evolving industry benchmarks.

4.2. Facilitating teaching-learning activities

This refers to the practical application of educational methods, strategies, and resources to facilitate learning among students. Effective facilitation within OBE contexts requires faculty to design and implement activities that are outcome-aligned, learner-centered, and responsive to diverse learning styles and needs. The following themes emerged in this dimension: integration of active learning activities, practical application and hands-on learning, and diversifying teaching methods.

4.2.1. Theme 1: integration of active and collaborative learning

Well-designed OBTL requires that teaching-learning activities be designed and facilitated so that the learning outcomes will be achieved [3]. Hence, active collaborative learning should be included in the classroom. The importance of using real-life situations in which students face real-world problems was previously reported [23].

"*It is not only one-on-one but teamwork is encouraged because this we really see and test their knowledge and learning in group. The way I see it, teaching and learning, teamwork is needed.*" (Informant A)
"*The opportunity given to teachers in teaching OBE in STEM is to tell students that learning is fun. So, the activities, apart from paper and pencil, should be something fun—something you can assess, something they enjoy and can apply.*" (Informant B)
"*Planning instruction and designing teaching-learning activities promote mastery and active learning by engaging our students in active learning integration and scaffolding throughout the teaching process.*" (Informant F)
"*Planning instruction and devising teaching-learning activities that encourage active learning and mastery of STEM ideas and skills require an integrated approach.*" (Informant H)

Educators can adapt learning outcomes to fit various learning styles by integrating activities that facilitate engagement and assessment, without letting OBE targets slip [23]. This trend is away from didactic lecturing towards engaging, interactive methods. The present findings confirm this trajectory and extend it by showing that STEM faculty in Philippine HEIs view active and collaborative learning not merely as a pedagogical preference but as a structural necessity under OBE: when outcomes specify competencies (rather than content coverage), learning activities must inherently be performance-based and socially mediated. This has practical implications for faculty development: STEM instructors need scaffolded support in designing collaborative tasks that are outcome-aligned and feasible in large class settings.

4.2.2. Theme 2: practical application and hands-on learning

This technique improves understanding through a merger of school experiences with outside application. In hands-on learning, students are expected to explore and generate new ideas and concepts, which is an active implementation of student-centered education that promotes critical and creative thinking [24], [25]. The real-world approach allows for deeper understanding and provides students with the skills they need to be successful. Practical work encompasses a number of different tasks that require learners to participate [26].

"*Instructional kits even other equipment to support teaching-learning is very important, other than solving problems, there is innovation. We are looking for the workforce for tomorrow, competitive in the workplace.*" (Informant A)
"*The OBE paradigm shifts our students in STEM particularly—does our students will be able to land a job in relation to the course that they have taken. And at the same time, we have prepared them in the real world of work.*" (Informant C)
"*Sometimes resources are limited, like lab equipment. But OBE can make learning more relevant and engaging by connecting lessons to real-world applications. This helps students see the value in what they're learning.*" (Informant E)
"*Key issues include connecting instruction with defined, quantifiable learning outcomes and employing backward design to ensure assessments and activities complement these objectives.*" (Informant H)

STEM education does not only aim to produce STEM-literate individuals but to develop essential 21st-century skills including creativity and critical thinking [27]. Such OBE principal reinforcement comes through the emphasis on hands-on and practical learning. According to previous studies [28], [29], hands-on learning leads to improved retention, more participation, and greater intrinsic motivation. Importantly, the present findings reveal that Philippine STEM faculty navigate practical constraints, limited laboratory equipment not by abandoning hands-on learning but by creatively connecting lessons to real-world contexts with available materials (as informant E illustrates). This adaptive practice extends Tsakeni [30] discussion of STEM practical work in resource-constrained post-pandemic settings, affirming that resourcefulness itself is an instructional competency worth evaluating in OBE faculty appraisals.

4.2.3. Theme 3: diversification of teaching methods

Good teaching involves using a mix of teaching methods, including project-based learning, practical teaching, and real-world issue-solving. It accounts for different learning styles and allows students to apply their knowledge in practical scenarios. Teaching methods and strategies are the most important concern of pedagogy and the way the classroom is set up and run [31].

"*I think that is one of the considerations, should be a continuous process, that every now and then you also have to assess your methodologies.*" (Informant A)
"*In my classes it includes but not limited to project-based learning, laboratory and hands-on activities, and competency demonstrations which are deemed necessary to deliver relevant and meaningful learning.*" (Informant F)
"*...while multiple teaching methods, such as real-world applications and technological integration, should be used to accommodate different learning styles.*" (Informant H)
"*Personalizing instruction to cater to diverse learning needs and styles is also key. This can include offering different pathways for students to achieve the learning outcomes.*" (Informant J)

OBE demands familiarity with and use of successful active learning approaches to cater to various learning styles [23]. To increase student motivation, faculty members need to implement different instructional strategies and resources [32]. Educators promoting STEM education must have an understanding of good teaching [31]. The diversity of methods reported by informants spanning project-based learning, laboratory work, competency demonstrations, and technology integration suggests that effective STEM faculty in OBE contexts function as instructional designers who continuously assess and recalibrate their pedagogical approaches. This finding aligns with and extends Hadinugrahaningsih *et al.* [27] on STEAM integration, reinforcing that pedagogical diversity is not a stylistic preference but a structural demand of competency-based outcomes.

4.3. Implementing assessment tasks

Assessment tasks are a vital component of OBE and are very different from traditional educational exams. They evaluate students' capacity to apply what they have learned rather than their knowledge of the subject itself [14], [33] as well as through feedback mechanisms. The following themes represent how STEM faculty design and implement assessment tasks aligned with OBE principles, emphasizing authenticity, rubric-based evaluation, and continuous feedback.

4.3.1. Theme 1: alignment with OBE objectives and authenticity

The foundations of OBE assessment are authentic and designed with OBE objectives in mind. A wide range of evaluation practices, such as formative and summative assessment, are used to ensure alignment of tasks with OBE goals [34]. Here are the responses:

"*We also have the formative assessments and summative test that will be given to our students.*" (Informant C)
"*Assessments should be holistic and accurate that will truly measure the attainment of learning outcomes and achieve the desired competencies.*" (Informant F)
"*We used strategies to ensure that assessment tasks align with OBE objectives. Authentic, real-world assignments and a variety of evaluation methods accommodate diverse learning styles while also encouraging critical thinking.*" (Informant H)
"*Formative evaluations, such as quizzes and reflections, are combined with summative assessments, such as exams and projects, to provide thorough feedback and quantify overall mastery.*" (Informant H)
"*Aligning assessments with outcomes is essential. Assessments must be directly measurable.*" (Informant J)

The principles of OBE include aligning assessments with one or more learning outcomes, incorporating various types of assessments such as formative, summative, authentic, peer and self-assessments [33]. This includes formative assessments such as quizzes and online discussion that give continuous feedback [35]. Summative assessments evaluate overall learning once a course is initiated [34]. Authentic assessments measure knowledge application in real-world scenarios focusing on higher-order cognitive skills [36]. Moreover, peer and self-assessments enhance development of metacognitive skills [37], [38] and are further enhanced through technology integration [39]. Critically, these findings confirm that informants did not treat formative and summative assessments as mutually exclusive but as complementary instruments in a continuous feedback loop—formative data informing instructional adjustment, summative data validating outcome attainment. This integrated view aligns with backward design principles [1] and suggests that faculty evaluation tools should assess the coherence of how assessment types are orchestrated to serve OBE outcomes.

4.3.2. Theme 2: utilization of clear rubrics and standardized tools

Clear rubrics and standardized tools help facilitate reflection on students' performances against learning outcomes. Authentic assignments are measurable by way of assessment rubrics [4]. Students can gain more insight on how they will be graded, as transparency is found not only in the rubrics but also in the process of grading [9].

> "*...there should be uniformity, there should be a standardized assessment so that the real expected outcome can be checked.*" (Informant B)
> "*Others are also using our usual laboratory activities... and they will be rated according to the sometimes rubrics and at the same time point system or the criteria system.*" (Informant C)

Rubrics are vital to educational settings as they provide students with specific performance criteria and expectations [40]. They ensure uniformity, validity, and transparency in assessments and help articulate instructional objectives [38], [41]. Rubrics can be aligned to program outcomes, where teachers can assess student attainment of learning objectives [9]. These findings underscore that informant valued rubrics as communication tools-instruments that make tacit quality standards explicit and shared. This transparency function is particularly significant in STEM disciplines where assessment of complex competencies can otherwise appear arbitrary to students. Institutions implementing OBE should therefore invest in collaborative rubric development processes involving faculty, students, and industry stakeholders.

4.3.3. Theme 3: feedback mechanism

Feedback is critical to student growth and instructional improvement. By continuously fine-tuning instructional strategies based on the analysis of assessment data and student feedback, a responsive and dynamic learning environment is created.

> "*Providing clear and constructive feedback helps students improve, which is really, what we're aiming for. Using assessment results to refine and improve teaching methods is an ongoing process.*" (Informant E)
> "*Formative assessments such as quizzes and in-class activities continuously monitor progress and provide immediate feedback, allowing timely support.*" (Informant H)
> "*Finally, feedback and improvement are crucial. Providing timely and constructive feedback helps students understand their strengths and areas for improvement.*" (Informant J)

Most research studies indicate that feedback is one of the foremost tools for improving student learning [42], [43]. Research also summarizes feedback as a vehicle students use to help them monitor and regulate their learning [43]. Constructive feedback is beneficial both to students and teachers as it gives valuable information that enhances the learning experience [42]. Hatziapostolou and Paraskakis [44] emphasize that feedback can serve in various forms to evaluate accomplishments, improve skills and knowledge, and enhance student motivation. What distinguishes the present findings from prior work is the dual directionality of feedback that informants described: feedback flows not only from teacher to student (formative guidance) but also from assessment results back to the instructor, driving iterative refinement of teaching methods. This bidirectional feedback dynamic is consistent with Biggs and Tang [14] model of reflective practice in OBTL but is rarely operationalized in institutional evaluation frameworks. Taken together, the eight themes that emerged across the three dimensions of communicating intended learning outcomes, facilitating teaching-learning activities, and implementing assessment tasks paint a coherent and mutually reinforcing picture of what STEM teaching effectiveness looks like in an OBE context, one that points toward an integrated framework of practice, as illustrated in Figure 1.

Figure 1 presents the three-dimensional framework for STEM faculty teaching effectiveness that emerged from the phenomenological analysis. The first dimension, outcome clarity and alignment, captures the foundational role of communicating intended learning outcomes with precision and connecting them to national and international STEM standards. The second dimension, pedagogical responsiveness, reflects how effective STEM faculty dynamically integrate active and collaborative learning, hands-on practical application, and diversified teaching methods. The third dimension, authentic and feedback-rich assessment, underscores the importance of assessment tasks genuinely aligned with OBE objectives, supported by transparent rubrics, and coupled with timely, constructive feedback that drives both student improvement and instructional refinement. These three dimensions are mutually reinforcing clarity in outcomes informs the design of teaching-learning activities, which shapes assessments, and feedback loops back to refine outcome communication and pedagogy.



Figure 1. A three-dimensional framework for STEM teaching effectiveness in outcomes-based higher education

5. CONCLUSION

This study addressed the question of how STEM faculty and administrators in Philippine HEIs conceptualize and enact teaching effectiveness within OBE and OBTL frameworks. Phenomenological analysis of 10 participants' lived experiences revealed eight themes organized across three dimensions, constituting a novel three-dimensional framework: i) outcome clarity and alignment, encompassing the clear articulation of intended learning outcomes in accessible language and their alignment with national and international STEM standards; ii) pedagogical responsiveness, involving the dynamic integration of active, collaborative, hands-on, and diversified teaching methods continuously assessed and adjusted; and iii) authentic and feedback-rich assessment, comprising formative and summative tasks aligned with OBE objectives, supported by clear rubrics and bidirectional constructive feedback. Collectively, these dimensions reframe STEM teaching effectiveness not as a static individual attribute but as a dynamic, integrated set of practices shaped by the demands of competency-based learning.

The contributions of this study are threefold. Empirically, it provides qualitative evidence of how STEM teaching effectiveness is experienced and constructed by faculty and administrators in Philippine HEIs, a perspective underrepresented in OBE literature dominated by quantitative analyses. Theoretically, it proposes a grounded, phenomenologically derived framework that positions teaching effectiveness as

a coherent, mutually reinforcing set of practices rather than isolated competencies. Practically, it offers STEM educators, academic administrators, and policymakers a conceptual map for designing faculty development programs, constructing OBTL-aligned teaching evaluation instruments, and informing STEM education policy in Philippine and comparable HEI contexts.

This study has several limitations that also point toward productive directions for future inquiry. The sample of 10 participants from the Visayas region, while appropriate for phenomenological research, limits transferability; future studies should expand to multi-regional or national samples and incorporate observation-based methods to triangulate self-reported data. Future research should also explore student perspectives on the same three dimensions of teaching effectiveness and develop and psychometrically validate a quantitative instrument grounded in the proposed framework through exploratory and confirmatory factor analysis.

ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to all participants who generously shared their time, expertise, and lived experiences in contributing to this study.

FUNDING INFORMATION

Authors state no funding involved.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization
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D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

ETHICAL APPROVAL

The research related to human use has been complied with all the relevant national regulations and institutional policies in accordance with the tenets of the Helsinki Declaration and has been approved by the authors' institutional review board or equivalent committee. We have obtained informed consent from all individuals included in this study.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [RJNA], upon reasonable request.

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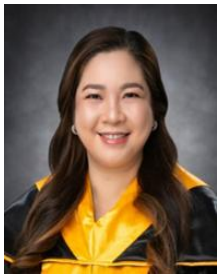
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