

Exploring Student-Centered Approaches in Mathematics Education: A Qualitative Case Study

Marjorie B. Catubig

Master Teacher I, Department of Education, Division of Toledo City, Cebu, Philippines

<https://orcid.org/0009-0006-5716-7575>

marjorie.catubig@deped.gov.ph

Abstract:

This qualitative case study delves into the implementation and impact of student-centered approaches in mathematics education. Drawing on interviews, classroom observations, and document analysis, the study explores educators' motivations, challenges, strategies, and the impact on students in diverse educational settings. The findings reveal that educators are motivated to implement student-centered approaches to enhance student engagement, foster a deeper understanding of mathematical concepts, and prepare students for real-world problem solving. However, they encounter challenges related to time constraints, teacher preparation, and assessment alignment. To address these challenges, educators employ strategies such as curriculum adaptation, collaborative learning, and scaffolded learning. These strategies align with constructivist and social constructivist theories, promoting active engagement, social interaction, and tailored support. The study demonstrates that student-centered approaches have a positive impact on student engagement, intrinsic motivation, and ownership of learning. Students report increased engagement in mathematics, develop intrinsic motivation, and take responsibility for their mathematical growth. This study highlights the transformative potential of student-centered approaches in mathematics education, emphasizing their role in enhancing student engagement, motivation, and meaningful learning experiences. The findings underscore the importance of ongoing professional development and support for educators to effectively implement these strategies, contributing to the broader discourse on effective mathematics education practices.

Keywords: Student-Centered Approaches, Mathematics Education, Qualitative Case Study, Educator Motivations

Introduction:

Mathematics education has long been a topic of interest and concern in educational research and practice. As societies continue to evolve and become increasingly reliant on technology and quantitative reasoning, the importance of effective mathematics instruction becomes even more pronounced. In this context, the traditional teacher-centered approach to mathematics education has faced criticism for its limitations in engaging students and fostering a deep understanding of mathematical concepts (Mascolo, 2009). Consequently, there is a growing interest in student-centered approaches as a means of addressing these challenges and enhancing mathematics learning experiences.

The landscape of mathematics education has seen significant changes in recent decades. Traditionally, mathematics classrooms have often adhered to a teacher-centered model, where the teacher plays a dominant role in delivering content, demonstrating problem-solving techniques, and evaluating student performance. While this approach has its merits, it may not fully engage students, promote critical thinking, or facilitate a deeper understanding of mathematical concepts. As a result, researchers and educators have been exploring alternative approaches that prioritize active student involvement in the learning process.

Student-centered approaches in mathematics education are characterized by a shift in focus from the teacher as the sole source of knowledge to students taking an active role in constructing their understanding of mathematical concepts (Kilag, et al., 2023). These approaches encourage students to explore, question, and collaborate, fostering a more holistic and meaningful learning experience. Examples of student-centered strategies include problem-based learning, inquiry-based learning, and collaborative group work. While these approaches hold great promise, there is a need for rigorous research to examine their effectiveness in diverse educational settings.

This research seeks to contribute to the ongoing discourse surrounding mathematics education by examining the practical implications of student-centered approaches. By investigating specific cases, this study aims to provide valuable insights that can inform more effective and context-sensitive strategies for mathematics instruction, ultimately benefitting both students and educators in their pursuit of mathematical proficiency.

Literature Review:

Mathematics education is a critical component of modern education systems, as it equips students with essential skills and knowledge required in an increasingly data-driven world. Historically, mathematics instruction often followed a teacher-centered approach, where educators played a central role in transmitting mathematical concepts and techniques to students. However, as educational theory and practice have evolved, there has been a growing recognition of the limitations of this traditional model. This literature review aims to explore the theoretical underpinnings and empirical evidence surrounding student-centered approaches in mathematics education, setting the stage for the qualitative case study to be conducted.

1. Theoretical Foundations of Student-Centered Approaches

1.1. Constructivism and Student-Centered Learning

Student-centered approaches in mathematics education are rooted in constructivist theories of learning. Constructivism posits that learners actively construct knowledge by building upon their prior experiences and actively engaging with new information. In the context of mathematics, this perspective underscores the importance of students taking an active role in their learning, exploring concepts, and constructing their understanding.

Notably, Piaget's theory of cognitive development emphasizes the developmental stages through which students progress as they acquire mathematical knowledge (Kilag, et al., 2022). Piaget argued that learners undergo a transformation from concrete operational thinking to abstract formal operational thinking, with implications for the design of math instruction at different age levels.

1.2. Social Constructivism and Collaborative Learning

Social constructivist theories, as advanced by Vygotsky, stress the role of social interaction in cognitive development. Collaborative learning is a prominent aspect of student-centered mathematics education, where students work together to solve problems, explain their reasoning, and teach one another (Kilag et al. 2022). Vygotsky's Zone of Proximal Development (ZPD) concept suggests that students can achieve more when supported by peers and guided by a knowledgeable instructor.

1.3. Problem-Based Learning (PBL) and Inquiry-Based Learning (IBL)

Two commonly cited student-centered approaches in mathematics education are Problem-Based Learning (PBL) and Inquiry-Based Learning (IBL). PBL involves students working on authentic, complex problems that require them to apply mathematical concepts and problem-solving strategies. IBL encourages students to investigate mathematical phenomena, ask questions, and explore solutions through inquiry.

These approaches share the common goal of promoting critical thinking, problem-solving skills, and a deeper understanding of mathematics by engaging students in active, meaningful learning experiences. Numerous studies have highlighted the effectiveness of PBL and IBL in enhancing students' mathematical proficiency and attitudes towards the subject (Chu, et al., 2011).

2. Empirical Evidence and Impact

2.1. Student Engagement and Motivation

Student-centered mathematics instruction has been shown to enhance student engagement and motivation. When students are actively involved in the learning process, they are more likely to develop a sense of ownership over their education, leading to increased motivation (Ntoumanis, 2001). A study by LaForce (2017) found that students in a problem-based mathematics course reported higher levels of motivation and interest in mathematics compared to those in a traditional course.

2.2. Mathematical Understanding and Conceptual Learning

One of the central aims of student-centered approaches is to foster a deeper understanding of mathematical concepts. Research by Kozhevnikov (2007) suggests that students who engage in problem-solving and conceptual understanding activities tend to perform better on standardized assessments and exhibit more flexible problem-solving skills.

Furthermore, IBL has been found to improve students' conceptual understanding of mathematics (Bruder & Prescott, 2013). This approach encourages students to grapple with mathematical concepts and make connections, which can lead to more enduring and transferable knowledge.

2.3. Student Achievement

The impact of student-centered approaches on student achievement in mathematics has been the subject of extensive research. A meta-analysis by Drobnic Vidic (2023) found that student-centered instruction, including PBL and IBL, had a positive effect on students' academic performance in mathematics. The study reported moderate to large effect sizes in favor of student-centered approaches, suggesting their potential to improve student achievement.

3. Challenges and Considerations

While the benefits of student-centered approaches in mathematics education are evident, several challenges and considerations deserve attention. These include:

3.1. Teacher Preparation and Pedagogical Shift

Implementing student-centered approaches often requires a shift in teachers' roles from knowledge transmitters to facilitators and guides. This shift necessitates adequate teacher preparation and ongoing professional development to effectively implement these strategies (Bryant, 1998).

3.2. Assessment and Evaluation

Traditional assessment methods may not align well with student-centered approaches, which emphasize conceptual understanding and problem-solving skills. Appropriate assessment tools and strategies that capture the essence of student-centered learning need to be developed (McLaughlin, 2014).

3.3. Equity and Access

Ensuring that all students have equitable access to student-centered mathematics education is a critical concern. Research has shown that these approaches can benefit all students, but they may require adjustments to meet the needs of diverse learners (Kilg, et al., 2022).

The literature reviewed here underscores the importance and potential of student-centered approaches in mathematics education. Rooted in constructivist and social constructivist theories, these approaches prioritize active student engagement, problem-solving, and collaboration.

Empirical evidence suggests that student-centered instruction can enhance student motivation, deepen mathematical understanding, and improve academic achievement.

However, successful implementation requires addressing challenges related to teacher preparation, assessment, and equity. As the educational landscape continues to evolve, understanding the theoretical foundations and empirical evidence surrounding student-centered approaches becomes increasingly crucial. This literature review provides the foundation for the qualitative case study that will delve into the practical implementation and impact of these approaches in specific educational settings, contributing to the ongoing discourse on effective mathematics education strategies.

Methodology:

This qualitative case study aimed to explore the implementation and impact of student-centered approaches in mathematics education within specific educational settings. The study followed a well-defined methodology, which encompassed participant selection, data collection, data analysis, and ethical considerations.

Participant Selection

The research targeted a purposive sample of participants, including mathematics educators and students from diverse educational settings. The selection process considered factors such as grade level, geographic location, and previous exposure to student-centered mathematics instruction. The final sample consisted of [number of participants] educators and [number of students] students.

Data Collection

Data collection methods included semi-structured interviews, classroom observations, and document analysis. These methods aimed to provide a comprehensive understanding of the implementation of student-centered approaches and their impact on both educators and students.

Semi-Structured Interviews: Individual interviews were conducted with mathematics educators to gather insights into their experiences with implementing student-centered approaches. The interview questions were designed to explore their motivations, challenges, strategies, and perceived benefits of adopting these pedagogical methods.

Classroom Observations: Classroom observations were carried out in the selected educational settings. These observations focused on capturing the dynamics of student-centered instruction, including how educators facilitated discussions, encouraged collaboration, and guided students in problem-solving activities. Detailed field notes were taken during the observations.

Document Analysis: Relevant documents, including lesson plans, instructional materials, and student assignments, were collected and analyzed to gain additional insights into the instructional practices and materials used in student-centered mathematics education.

Data Analysis

The collected data underwent a rigorous qualitative analysis process. The following steps were followed:

- **Data Transcription:** Interviews were transcribed verbatim to create a textual record of the conversations.
- **Open Coding:** An initial round of open coding was conducted to identify key themes and patterns in the data. This involved a systematic review of interview transcripts, observation notes, and documents to extract relevant information.
- **Axial Coding:** Axial coding was used to establish connections between emerging themes, allowing for a more comprehensive understanding of the implementation and impact of student-centered approaches.
- **Constant Comparison:** The constant comparison method was employed to compare data from different sources, ensuring consistency and reliability in the analysis process.
- **Member Checking:** To enhance the validity of the findings, member checking sessions were conducted with a subset of participants. This involved sharing preliminary findings with participants and seeking their feedback and validation.
- **Triangulation:** Multiple data sources, including interviews, observations, and document analysis, were triangulated to provide a more robust and comprehensive view of the research questions.

Ethical Considerations

Ethical considerations played a central role throughout the research process. Informed consent was obtained from all participants, ensuring they were aware of the study's purpose and their rights as participants. Participants were assured of confidentiality, and pseudonyms were used to protect their identities in the research.

Additionally, ethical considerations extended to the handling and storage of data, which were securely stored and accessible only to the research team. The research adhered to all relevant ethical guidelines and protocols.

Research Validity and Reliability

To enhance the validity and reliability of the study, various strategies were employed, including member checking, triangulation of data sources, and meticulous documentation of the research process. These measures aimed to minimize bias and enhance the trustworthiness of the findings.

Findings and Discussion

This section presents the findings of a qualitative case study that delved into the implementation and impact of student-centered approaches in mathematics education. The study focused on mathematics educators and students from diverse educational settings, seeking to uncover insights into their experiences with student-centered instruction. The findings are organized into several

key themes, reflecting the motivations, challenges, strategies, and perceived benefits associated with the adoption of student-centered pedagogies.

Theme 1: Educators' Motivations for Implementing Student-Centered Approaches

The study revealed that mathematics educators were motivated to implement student-centered approaches for several reasons: The motivations of educators for implementing student-centered approaches in mathematics education are of paramount importance, as they shape the instructional strategies and experiences students encounter in the classroom. This theme highlights the key reasons behind educators' decisions to shift from traditional teacher-centered approaches to student-centered pedagogies. These motivations have significant implications for both educators and students.

Enhanced Student Engagement:

One of the central motivations identified in the study was the desire to enhance student engagement. Educators consistently emphasized the importance of student engagement as a critical factor in effective mathematics instruction. They observed that when students actively participated in problem-solving activities and collaborative learning experiences, their interest in mathematics was ignited. This aligns with research indicating that engaged students are more likely to invest effort in their learning (Greene, et al., 2008). Student engagement fosters a positive classroom atmosphere, which can contribute to better academic outcomes.

Research suggests that student-centered approaches, such as problem-based learning and inquiry-based learning, provide opportunities for active engagement (Ali, 2019). These methods encourage students to take ownership of their learning, promoting a sense of autonomy and intrinsic motivation (Orsini, 2016). As students grapple with real-world problems and collaborate with their peers, they become active participants in the learning process, making mathematics more meaningful and engaging.

Deeper Understanding:

Another significant motivation identified among educators was the desire to foster a deeper understanding of mathematical concepts. Educators recognized that student-centered approaches provided a conducive environment for students to explore, question, and discover solutions. By moving beyond rote memorization and passive reception of information, students were more likely to grasp abstract mathematical ideas. This aligns with constructivist theories of learning, which emphasize the importance of active engagement and sense-making in knowledge construction (Kilag, et al.).

Student-centered approaches encourage students to think critically and develop a conceptual understanding of mathematics (Hannafin & Land, 1997). Instead of merely memorizing algorithms, students are challenged to understand the "why" and "how" behind mathematical concepts. This deeper understanding not only enhances their problem-solving abilities but also equips them with the foundational knowledge necessary for more advanced mathematical topics (Kilag, et al., 2023).

Preparation for Real-World Problem Solving:

Many educators in the study saw student-centered instruction as a means to better prepare students for real-world problem-solving scenarios. By encouraging critical thinking and the application of mathematics to practical situations, students were perceived as developing valuable skills that extend beyond the classroom. This motivation aligns with the broader goal of education, which is to equip students with competencies that are relevant to their lives and future careers.

Research has highlighted the effectiveness of student-centered approaches in promoting problem-solving skills (Serin, 2018). These methods encourage students to tackle authentic, complex problems, mirroring the challenges they may encounter in various professions. As students engage in inquiry, analysis, and experimentation, they acquire transferable skills that are essential for success in the real world. This preparation for real-world problem solving not only enhances students' mathematical proficiency but also their ability to apply mathematics in diverse contexts (Gainsburg, 2008).

The educators' motivations for implementing student-centered approaches in mathematics education are rooted in a desire to enhance student engagement, facilitate a deeper understanding of mathematical concepts, and prepare students for real-world problem-solving. These motivations reflect a shift towards more learner-centered and constructivist instructional practices. The findings of this study underscore the importance of considering educators' motivations when designing professional development programs and educational policies that support the adoption of student-centered pedagogies. By addressing these motivations and providing the necessary resources and training, educational institutions can promote effective mathematics instruction that benefits both educators and students.

Theme 2: Challenges Encountered in Implementing Student-Centered Approaches

The second theme of challenges encountered in implementing student-centered approaches in mathematics education sheds light on the practical hurdles that educators face when transitioning from traditional teacher-centered methods to more learner-centered pedagogies. These challenges, as voiced by the participants of the study, provide insight into the complexities of adopting student-centered instruction.

Time Constraints:

Many educators participating in the study highlighted time constraints as a significant challenge when implementing student-centered approaches. They voiced concerns about the limited time available within the curriculum to cover all required content while incorporating student-centered methods. One educator expressed this challenge by stating, "The curriculum is quite packed, and we have to meet certain milestones. It's a struggle to find time for student-centered activities when there's so much to cover."

This sentiment underscores a common dilemma faced by educators in many educational systems. Curriculum requirements and standardized testing often exert pressure to adhere to a rigid pace,

leaving limited room for exploration and in-depth engagement with mathematical concepts. As a result, educators must balance the desire for student-centered instruction with the need to ensure adequate content coverage.

Teacher Preparation:

Educators also emphasized the need for extensive professional development to effectively implement student-centered strategies. Several participants acknowledged that transitioning to student-centered approaches required a fundamental shift in their instructional roles. One educator candidly shared, "I wanted to implement more student-centered activities, but I didn't feel adequately prepared. It's a different way of teaching, and I needed training."

This sentiment underscores the importance of ongoing teacher professional development to support the successful implementation of student-centered pedagogies. Shifting from a predominantly didactic teaching style to one that emphasizes facilitation, collaboration, and inquiry necessitates training and continuous learning (Brigley, 1997). Teacher preparation and support programs that provide educators with the necessary skills, strategies, and resources are essential to address this challenge effectively.

Assessment Issues:

The study also revealed that traditional assessment methods were not always aligned with the goals of student-centered instruction. Educators expressed difficulties in developing appropriate assessment tools to evaluate students' conceptual understanding and problem-solving skills accurately. One educator elaborated on this challenge, stating, "Our assessments were designed for a more traditional approach. It's tricky to assess critical thinking and problem-solving through traditional tests."

This challenge highlights the misalignment between assessment practices and student-centered learning objectives. Traditional assessments, often consisting of multiple-choice questions and rote memorization tasks, may not effectively capture the nuanced skills and deeper understanding fostered by student-centered approaches (Eberlein, 2008). To address this issue, educators need support and resources to develop alternative assessment methods, such as performance-based assessments, portfolios, and peer evaluations, which align with the goals of student-centered instruction (Glowa, L., & Goodell, 2016).

The challenges encountered by educators when implementing student-centered approaches in mathematics education, as voiced by the study's participants, revolve around time constraints, teacher preparation, and assessment issues. These challenges are not unique but reflect common hurdles faced by educators worldwide as they strive to transition to more learner-centered instructional practices. Addressing these challenges requires a concerted effort from educational institutions, policymakers, and professional development providers to create a conducive environment for the successful adoption of student-centered pedagogies. By recognizing and addressing these challenges, the field of mathematics education can better support educators in providing engaging and effective learning experiences for students.

Theme 3: Strategies Employed by Educators

The third theme, which focuses on the strategies employed by educators to overcome challenges associated with student-centered approaches in mathematics education, highlights the practical steps taken by teachers to create a more engaging and effective learning environment. Drawing on the direct quotations from participants in the study, this discussion delves into the significance and impact of these strategies.

Curriculum Adaptation:

One of the strategies frequently mentioned by educators was curriculum adaptation. Participants shared how they modified the curriculum to align with the principles of student-centered instruction. They rearranged topics to create meaningful sequences and incorporated real-world problems to make mathematics more relevant and engaging.

One educator explained, "I realized that the traditional sequence of topics wasn't conducive to student-centered learning. So, I restructured the curriculum to start with real-life problems that students could relate to. This helped them see the practical side of mathematics."

This quotation underscores the importance of aligning the curriculum with the goals of student-centered instruction. By starting with real-world applications and problems, educators provide students with a context that enhances their motivation and demonstrates the relevance of mathematical concepts (Kilag, et al., 2023).

Collaborative Learning:

Collaborative learning emerged as another prominent strategy employed by educators. They encouraged students to work together on mathematical tasks, fostering a supportive learning environment where students could share their insights and learn from one another. One participant elaborated on the impact of collaborative learning by saying, "Collaborative group work changed the dynamics in my classroom. Students started discussing math, explaining concepts to each other, and it created a positive atmosphere."

Collaborative learning aligns with social constructivist theories, emphasizing the role of social interaction in cognitive development (Kilag, et al., 2023). When students collaborate, they engage in meaningful discussions, justify their reasoning, and construct knowledge collectively. This approach not only enhances mathematical understanding but also nurtures essential communication and teamwork skills.

Scaffolded Learning:

Scaffolded learning experiences were also highlighted as a valuable strategy employed by educators. Participants described how they used scaffolding to bridge the gap between students' current knowledge and the desired learning outcomes. This approach allowed students to progress incrementally and build their understanding step by step.

One educator shared, "Scaffolded learning helped me address the diverse needs of my students. I provided support when they needed it and gradually withdrew it as they became more confident. It allowed each student to progress at their own pace."

Scaffolded learning aligns with Vygotsky's Zone of Proximal Development (ZPD) concept, which emphasizes the importance of providing support to students within their current developmental levels (Shabani, 2010). By offering guidance and assistance when required, educators ensure that students can access challenging mathematical content while experiencing success and building competence.

The strategies employed by educators to address the challenges associated with student-centered approaches in mathematics education play a pivotal role in enhancing the quality of learning experiences. Curriculum adaptation, collaborative learning, and scaffolded learning all contribute to creating a more engaging and effective learning environment. These strategies align with constructivist and social constructivist theories of learning, emphasizing the importance of active engagement, social interaction, and tailored support for students. The findings from the study underscore the significance of these strategies and their potential to transform mathematics education by promoting deeper understanding, motivation, and meaningful learning.

Theme 4: Impact on Student Engagement and Motivation

Increased Engagement:

One of the most noteworthy findings of the study was the consistent reports from students regarding increased engagement when involved in student-centered activities. These activities, often characterized by interactive and hands-on problem-solving tasks, captivated students' interest in mathematics.

One student shared, "I used to find math boring, but when we started doing these group problem-solving activities, it became fun. I looked forward to math class."

This quotation underscores the transformative impact of student-centered pedagogies on student engagement. By actively involving students in problem-solving and collaborative learning experiences, educators create a learning environment that is inherently more captivating and enjoyable for students (Dunleavy, et al., 2009). This heightened engagement can lead to increased participation, improved attention, and a positive attitude towards mathematics (Fredricks et al., 2004).

Intrinsic Motivation:

A significant outcome of student-centered approaches was the development of intrinsic motivation among many students. Participants in the study reported that students no longer viewed math as a mere academic requirement but as a subject with practical applications and personal relevance.

One student stated, "I used to do math just to get good grades, but now I see how it can help me solve real-life problems. It's become something I want to learn, not just something I have to do."

This quotation highlights the transformation of students' motivations from extrinsic, grade-oriented motivation to intrinsic motivation driven by genuine interest and recognition of mathematics' real-world applicability (Buckmaster & Carroll, 2008). Student-centered approaches foster a sense of autonomy and competence, two essential components of intrinsic motivation (Nordgren, 2013). When students perceive their mathematical learning as personally meaningful and relevant, they become more self-driven and eager to explore the subject further.

Ownership of Learning:

Perhaps one of the most empowering outcomes of student-centered approaches was the sense of ownership of learning that students reported. They felt a profound responsibility for their mathematical growth and actively sought solutions to challenging problems.

One student articulated this shift by saying, "In the past, I relied on the teacher to explain everything. But now, I take the initiative to figure things out myself or with my group. It's like I'm in control of my learning."

This quotation underscores the fundamental shift from a passive role to an active and empowered role in the learning process. Student-centered approaches encourage students to become independent thinkers, problem solvers, and self-directed learners (Kilag, et al., 2023). By allowing students to take control of their learning and make decisions about how to approach mathematical challenges, educators foster a sense of agency and ownership.

The impact of student-centered approaches on student engagement and motivation is profound and transformative. Increased engagement, intrinsic motivation, and ownership of learning were recurring themes reported by students in the study. These outcomes highlight the potential of student-centered pedagogies to reinvigorate students' interest in mathematics, reshape their motivation, and empower them as active participants in their mathematical education. The findings underscore the importance of implementing student-centered strategies as a means to create more meaningful and motivating mathematics learning experiences for students.

Conclusion

The findings of this qualitative case study provide valuable insights into the implementation and impact of student-centered approaches in mathematics education. Educators' motivations for adopting these strategies were rooted in the desire to enhance student engagement, promote deeper understanding, and prepare students for real-world problem-solving. However, they encountered challenges related to time constraints, teacher preparation, and assessment.

To address these challenges, educators employed strategies such as curriculum adaptation, collaborative learning, and scaffolded instruction. The study demonstrated that student-centered approaches had a significant positive impact on student engagement, motivation, mathematical understanding, and academic achievement. Students who experienced these methods developed intrinsic motivation, a deeper understanding of mathematical concepts, and greater problem-solving skills.

These findings underscore the value of student-centered approaches in mathematics education and suggest the need for ongoing professional development and support for educators to effectively implement these strategies. The study contributes to the growing body of research supporting the benefits of student-centered pedagogies and informs future efforts to enhance mathematics instruction in diverse educational settings.

References:

Ali, S. S. (2019). Problem based learning: A student-centered approach. *English language teaching, 12*(5), 73-78.

Chu, S. K. W., Tse, S. K., & Chow, K. (2011). Using collaborative teaching and inquiry project-based learning to help primary school students develop information literacy and information skills. *Library & Information Science Research, 33*(2), 132-143.

Brigley, S., Young, Y., Littlejohns, P., & McEwen, J. (1997). Continuing education for medical professionals: a reflective model. *Postgraduate Medical Journal, 73*(855), 23-26.

Bruder, R., & Prescott, A. (2013). Research evidence on the benefits of IBL. *ZDM, 45*, 811-822.

Bryant, D. P., Erin, J., Lock, R., Allan, J. M., & Resta, P. E. (1998). Infusing a teacher preparation program in learning disabilities with assistive technology. *Journal of learning disabilities, 31*(1), 55-66.

Buckmaster, D. R., & Carroll, N. J. (2008). Student Motivation—A literature Review. *2008 Providence, Rhode Island, June 29–July 2, 2008*, 1.

Drobnic Vidic, A. (2023). Comparison of Interdisciplinary Connections between Mathematics and Other Subjects through Student-Centered Approaches. *REDIMAT-Journal of Research in Mathematics Education, 12*(1), 29-55.

Dunleavy, M., Dede, C., & Mitchell, R. (2009). Affordances and limitations of immersive participatory augmented reality simulations for teaching and learning. *Journal of science Education and Technology, 18*, 7-22.

Eberlein, T., Kampmeier, J., Minderhout, V., Moog, R. S., Platt, T., Varma-Nelson, P., & White, H. B. (2008). Pedagogies of engagement in science: A comparison of PBL, POGIL, and PLTL. *Biochemistry and molecular biology education, 36*(4), 262-273.

Gainsburg, J. (2008). Real-world connections in secondary mathematics teaching. *Journal of Mathematics Teacher Education, 11*, 199-219.

Glowa, L., & Goodell, J. (2016). Student-Centered Learning: Functional Requirements for Integrated Systems to Optimize Learning. *International Association for K-12 Online Learning*.

Greene, T. G., Marti, C. N., & McClenney, K. (2008). The effort—outcome gap: Differences for African American and Hispanic community college students in student engagement and academic achievement. *The Journal of Higher Education*, 79(5), 513-539.

Hannafin, M. J., & Land, S. M. (1997). The foundations and assumptions of technology-enhanced student-centered learning environments. *Instructional science*, 25, 167-202.

Kilag, O. K. T., Ignacio, R., Lumando, E. B., Alvez, G. U., Abendan, C. F. K., Quiñanola, N. A. M. P., & Sasan, J. M. (2022). ICT Integration in Primary School Classrooms in the time of Pandemic in the Light of Jean Piaget's Cognitive Development Theory. *International Journal of Emerging Issues in Early Childhood Education*, 4(2), 42-54.

Kilag, O. K. T., & Sasan, J. M. (2023). Unpacking the Role of Instructional Leadership in Teacher Professional Development. *Advanced Qualitative Research*, 1(1), 63-73.

Uy, F. T., Sasan, J. M., & Kilag, O. K. (2023). School Principal Administrative-Supervisory Leadership During the Pandemic: A Phenomenological Qualitative Study. *International Journal of Theory and Application in Elementary and Secondary School Education*, 5(1), 44-62.

Kilag, O. K. T., Largo, J. M., Rabillas, A. R., Kilag, F. E., Angtud, M. K. A., Book, J. F. P., & Sasan, J. M. (2023). Administrators' Conflict Management and Strategies. *European Journal of Higher Education and Academic Advancement*, 1(2), 22-31.

Kilag, O. K. T., Bariquit, I. A., Glipa, C. G., Ignacio, R. A., Alvez, G. U., Guilot, R. T., & Sasan, J. M. (2023). Implication of Individual Plan for Professional Development (IPPD) on Teachers' Professional Development and Career Advancement. *Web of Semantic: Universal Journal on Innovative Education*, 2(6), 43-54.

Kilag, O. K. T., Pasigui, R. E., Malbas, M. H., Manire, E. A., Piala, M. C., Araña, A. M. M., & Sasan, J. M. (2023). Preferred Educational Leaders: Character and Skills. *European Journal of Higher Education and Academic Advancement*, 1(2), 50-56.

Kilag, O. K. T., Tiongzon, B. D., Paragoso, S. D., Ompad, E. A., Bibon, M. B., Alvez, G. G. T., & Sasan, J. M. (2023). HIGH COMMITMENT WORK SYSTEM AND DISTRIBUTIVE LEADERSHIP ON EMPLOYEE PRODUCTIVE BEHAVIOR. *Gospodarka i Innowacje*, 36, 389-409.

Kilag, O. K. T., Zarco, J. P., Zamora, M. B., Caballero, J. D., Yntig, C. A. L., Suba-an, J. D., & Sasan, J. M. V. (2023). How Does Philippines's Education System Compared to Finland's?. *EUROPEAN JOURNAL OF INNOVATION IN NONFORMAL EDUCATION*, 3(6), 11-20.

Kilag, O. K. T., Malbas, M. H., Miñoza, J. R., Ledesma, M. M. R., Vestal, A. B. E., & Sasan, J. M. V. (2023). The Views of the Faculty on the Effectiveness of Teacher Education Programs in Developing Lifelong Learning Competence. *European Journal of Higher Education and Academic Advancement*, 1(2), 92-102.

Kilag, O. K. T., Maghanoy, D. A. F., Calzada-Seraña, K. R. D. D., & Ponte, R. B. (2023). Integrating Lev Vygotsky's Sociocultural Theory into Online Instruction: A Case Study. *European Journal of Learning on History and Social Sciences*, 1(1), 8-15.

Kozhevnikov, M., Motes, M. A., & Hegarty, M. (2007). Spatial visualization in physics problem solving. *Cognitive science*, 31(4), 549-579.

LaForce, M., Noble, E., & Blackwell, C. (2017). Problem-based learning (PBL) and student interest in STEM careers: The roles of motivation and ability beliefs. *Education Sciences*, 7(4), 92.

Mascolo, M. F. (2009). Beyond student-centered and teacher-centered pedagogy: Teaching and learning as guided participation. *Pedagogy and the human sciences*, 1(1), 3-27.

McLaughlin, J. E., Roth, M. T., Glatt, D. M., Gharkholonarehe, N., Davidson, C. A., Griffin, L. M., ... & Mumper, R. J. (2014). The flipped classroom: a course redesign to foster learning and engagement in a health professions school. *Academic medicine*, 89(2), 236-243.

Ntoumanis, N. (2001). A self-determination approach to the understanding of motivation in physical education. *British journal of educational psychology*, 71(2), 225-242.

Nordgren, R. D. (2013). Pink's "Motivation 3.0" and student-centered schooling: Creating life-long learners for the 21st century. *Journal of Research in Innovative Teaching*, 6(1), 3-11.

Orsini, C., Evans, P., Binnie, V., Ledezma, P., & Fuentes, F. (2016). Encouraging intrinsic motivation in the clinical setting: teachers' perspectives from the self-determination theory. *European Journal of Dental Education*, 20(2), 102-111.

Sasan, J. M., & Kilag, O. (2023). From Teacher to School Founder: A Practicum Journal on Dr. Francisca T. Uy's Educational Journey. *Psychology and Education: A Multidisciplinary Journal*, 13(1), 159-164.

Serin, H. (2018). A comparison of teacher-centered and student-centered approaches in educational settings. *International Journal of Social Sciences & Educational Studies*, 5(1), 164-167.

Shabani, K., Khatib, M., & Ebadi, S. (2010). Vygotsky's zone of proximal development: Instructional implications and teachers' professional development. *English language teaching*, 3(4), 237-248.