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Modified Hybrid Taxonomy: Effects on Academic Performance, Creativity, Problem-Solving, and Self-Regulation of Stem Students

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Abstract — Many studies have identified the development of higher-order thinking skills as a major challenge in higher education in the Philippines, particularly in Science, Technology, Engineering, and Mathematics (STEM). This study aimed to examine the effects of a Modified Hybrid Taxonomy, which integrates Bloom's Revised Taxonomy and Marzano's New Taxonomy, on the academic performance, creativity, problem-solving ability, and self-regulation of STEM students at Our Lady of Fatima University–Pampanga Campus. Anchored in Self-Regulated Learning Theory, the study employed a mixed-methods embedded design incorporating a quasi-experimental one-group pretest–posttest approach. The participants consisted of 46 STEM students selected through purposive sampling. Quantitative data were collected using standardized pretest and posttest assessments and students' final grades to measure academic performance, while survey instruments were used to assess creativity, problem-solving, and self-regulation. Qualitative data were obtained through open-ended survey responses and focus group discussions to capture students' experiences and perceptions. Quantitative data were analyzed using descriptive statistics and paired t-tests, while qualitative data were analyzed through thematic analysis. Findings revealed a significant improvement in students' academic performance, as evidenced by higher posttest scores compared to pretest results, indicating enhanced conceptual understanding. Additionally, students demonstrated high levels of creativity, problem-solving skills, and self-regulation after the implementation of the instructional model. Qualitative findings further indicated increased engagement, deeper learning, and improved independent learning behaviors among students. Although initial challenges related to workload and adjustment to blended learning were reported, these difficulties were temporary and contributed to the development of higher-order thinking and self-directed learning. Overall, the results suggest that

the Modified Hybrid Taxonomy is an effective instructional framework for enhancing multiple dimensions of learning among STEM students.

I. INTRODUCTION

Educational systems worldwide continue to seek structured instructional frameworks that develop higher-order thinking skills, creativity, and learner autonomy. In the Philippines, STEM education faces persistent challenges in improving students' conceptual understanding and analytical reasoning. Although international and ASEAN reforms advocate for learner-centered and blended pedagogies, empirical evidence on integrated taxonomy-based instructional frameworks within Philippine higher education remains limited. Bloom's Revised Taxonomy emphasizes hierarchical cognitive development from remembering to creating, while Marzano's New Taxonomy incorporates metacognitive and self-system processes. In addition, Self-Regulated Learning Theory highlights learners' capacity to plan, monitor, and evaluate their learning behaviors. Despite these strong theoretical foundations, local implementation remains fragmented and often limited to isolated instructional strategies. Thus, this study examined the effectiveness of a Modified Hybrid Taxonomy that integrates these frameworks in improving academic performance, creativity, problem-solving, and self-regulation among STEM students at Our Lady of Fatima University–Pampanga Campus.

Literature Review

Educational research has identified the importance of developing higher-order thinking, creativity, and problem-solving as part of self-regulation in STEM learners. This research has shown that traditional instruction developed around the teacher has to be modified. Instructional approaches developed around STEM learners and that incorporate critical and active learning are now being used (OECD, 2019; UNESCO, 2021).

Bloom's Revised Taxonomy (2001), developed by Lorin W. Anderson and David R. Krathwohl, has developed a hierarchy of cognitive skills from the skill of remembering to that of the skill of creating. A criticism of the Taxonomy, however, is that little is said about attention to the metacognitive and motivational processes. In contrast, is Robert J. Marzano and John S. Kendall's (2007) New Taxonomy. This Taxonomy incorporates cognitive thinking, metacognitive thinking, and self-system thinking. Instructional models for STEM education that integrate cognitive processes along with metacognitive and motivational learning processes are more effective (Guntur & Purnomo, 2024; Sui et al., 2023). Active and inquiry-based learning consistently yield better results for students. For example, Freeman et al. (2014) found that active learning led to better results in STEM classes when compared to learning via lectures. Likewise, Darling-Hammond et al. (2019) found that students create knowledge when they are engaged in real-world learning activities.

Creativity and problem-solving are the two most important skills for learners in the twenty-first century. Sawyer (2012) posited that the skills related to creativity are acquired through inquiry, collaboration, and experiential learning; which Jonassen (2011) argued real-world problem solving serves as the core of all elements in STEM learning. Additionally, according to Widiana et al. (2023), learning environments that are blended and integrated serve to boost creative and innovative thinking in students by presenting opportunities to think of solutions to problems that are applicable in the real world. Self-regulated learning can help predict achievement in an academic setting. Students that plan, monitor, and assess their learning as individuals tend to be more successful in their studies, according to Barry J. Zimmerman (2002). Metacognition promotes independence in learners and enhances retention in the long run, according to John Hattie and Donoghue (2016). Integrated STEM programs in the ASEAN countries have positively enhanced the thinking and performance of many students. However, the implementation was marred with limitations such as insufficient teacher training, scarcity of resources, and lack of implementation consistency (Ho et al., 2020; Salleh et al., 2017).

In the Philippines, studies evaluate the teacher-centric approach to STEM teaching (Alipio, 2020; Bernardo et al., 2018). The approach restricts teaching and learning that involves creativity, critical thinking, and self-regulation. The little research available on the multiple instructional frameworks positively correlate self-regulation, creativity, problem solving, and academic achievement. he existing research promotes a Modified Hybrid Taxonomy that fuses Bloom's Revised and Marzano's New Taxonomies. The lack applicable research that complies with this in the Philippines STEM higher education provides the context for this research. The study assesses how the Modified Hybrid Taxonomy effects problem solving, self-regulation, academic performance, and creativity for students.

II. METHODOLOGY

This study employed a mixed-methods embedded design incorporating a quasi-experimental one-group pretest–posttest approach. The participants consisted of 46 STEM students selected through purposive sampling during the Academic Year 2024–2025. Quantitative data were collected using standardized pretest and posttest assessments to measure cognitive gains, students' official final grades to determine academic performance, and a validated 5-point Likert-scale survey instrument to assess creativity, problem-solving skills, and self-regulation. The instrument demonstrated acceptable internal consistency, with reliability coefficients ranging from 0.749 to 0.813. Descriptive statistics, including mean, frequency, and percentage, were used to summarize the data, while paired t-tests were applied to determine significant differences at the 0.05 level of significance. Qualitative data from focus group discussions were analyzed using thematic analysis to provide deeper insights into students' learning experiences

III. RESULTS AND DISCUSSION

The results revealed statistically significant improvements across all measured cognitive domains following the implementation of the Modified Hybrid Taxonomy. In the data collection domain, the pretest mean score of 7.02 (Poor) increased to a posttest mean of 18.93 (Outstanding). The computed t-value of 35.31 with a p-value of .000 indicates a significant difference, leading to the rejection of the null hypothesis.

Similarly, in data analysis, the pretest mean score of 6.80 (Poor) significantly increased to 16.78 (Outstanding), with a computed t-value of 17.74 and a p-value of less than .0001. For drawing logical conclusions, the pretest mean score of 6.35 (Poor) improved to 18.64 (Outstanding), with a t-value of 28.33 and a p-value of less than .000. These findings indicate substantial gains in higher-order cognitive skills.In terms of academic performance, students obtained a mean final grade of 90.52, interpreted as Very Satisfactory. Specifically, 41.30% of students achieved Outstanding (95–100), 13.04% Very Satisfactory (90–94), 21.74% Satisfactory (85–89), and 23.91% obtained grades between 80–84.

The results further showed high levels of creativity (overall weighted mean = 4.45), problem-solving skills (4.46), and self-regulation (4.47), all interpreted as "Almost Always." Students demonstrated the ability to generate ideas, apply knowledge to real-world contexts, and regulate their learning through goal setting, time management, and reflection. Qualitative findings revealed that although students initially experienced challenges related to workload, time management, and adaptation to blended learning, these difficulties diminished over time and contributed to the development of stronger metacognitive awareness and independent learning behaviors

IV. CONCLUSION

The findings demonstrate that the Modified Hybrid Taxonomy significantly improved students' academic performance, creativity, problem-solving skills, and self-regulation. The statistically significant differences between pretest and posttest results across all cognitive domains confirm the effectiveness of the integrated instructional framework.

The substantial increase in mean scores—from 7.02 to 18.93 in data collection, 6.80 to 16.78 in data analysis, and 6.35 to 18.64 in logical reasoning—indicates meaningful cognitive development. Additionally, the high weighted means in creativity (4.45), problem-solving (4.46), and self-regulation (4.47) reflect holistic learner growth.

It is recommended that higher education institutions adopt structured taxonomy-based hybrid instructional models and provide scaffolded support during implementation. Future studies may incorporate comparison groups to strengthen causal inference and conduct longitudinal investigations to assess long-term effects. Furthermore, the dissemination of findings through scholarly publication is encouraged to contribute to the advancement of STEM education at the national and global levels.

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