

The Implementation of Science, Technology Engineering, and Mathematics (STEM) Strand: Its Strengths and Areas for Improvement

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Abstract— The mainstreaming of Science, Technology, Engineering, and Mathematics (STEM) education has garnered international interest due to its ability to improve students' critical thinking abilities, problem-solving skills, and suitability for the modern workforce requirements. This study investigates the implementation of the STEM strand, with a specific focus on its strengths and areas that need enhancement. This study thoroughly analyzes existing STEM Strand education by reviewing the literature, conducting focus group discussions, and administering a qualitative interview questionnaire. The participants in this study are the 12 Grade 11 and Grade 12 students, 8 subject teachers, and 1 school head of the STEM strand in Gallanosa National High School, School Year 2023-2024 selected through a purposive sampling technique. It aims to determine the effectiveness of this program and identify the significant factors that contribute to its success and the challenges that limit its optimal implementation. The findings demonstrate several advantages of the STEM strand, such as its capacity to facilitate interdisciplinary learning, foster intellectual curiosity and ability to solve problems, cultivate inclusivity, collaboration, and teamwork, stimulate hands-on learning opportunities, and nurture innovative thinking in students. Nevertheless, the research reveals notable aspects that require development, including improved teacher training, expanded availability of resources and technology, and the significance of promoting diversity and inclusion in STEM education. To effectively utilize the STEM strand and adequately prepare students for the needs of a technology-driven world, educational stakeholders must establish a continuous professional development program for teachers, integrate multidisciplinary innovation in the curriculum, and strengthen partnerships with potential stakeholders.

Keywords— STEM education, interdisciplinary learning, innovative thinking, diversity and inclusion in STEM education, multidisciplinary curriculum

I. INTRODUCTION

The STEM (Science, Technology, Engineering, and Mathematics) program is an educational initiative to emphasize and integrate these core disciplines into a holistic and interdisciplinary learning approach. STEM programs have gained prominence globally due to their potential to prepare students for the demands of the modern workforce and to foster innovation and scientific literacy. STEM programs play a crucial role in preparing students for the challenges and opportunities of the 21st century. They emphasize interdisciplinary learning, critical thinking, and problem-solving skills, ultimately contributing to innovation and addressing global issues.

In recent decades, an international effort has been made to prepare students for the challenges of the twenty-first century by incorporating Science, Technology, Engineering, and Mathematics (STEM) education into school curricula. STEM education fosters the development of critical thinking, problem-solving abilities, and innovation, all of which are indispensable

for tackling intricate societal challenges and propelling technological progress. In an effort for countries to maintain their competitiveness in an ever-changing international environment, integrating STEM disciplines into educational curricula has become a major concern among stakeholders, policymakers, and educators.

Science, Technology, Engineering, and Mathematics (STEM) education has become educational reform efforts worldwide in our fast-changing modern society. The STEM strand, which aims to provide students with essential skills and competencies required for success in a society driven by technology, has become increasingly important in secondary education curricula globally.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) recognizes the critical role that STEM education plays in advancing scientific knowledge, technological innovation, and sustainable development. UNESCO emphasizes the importance of STEM education in achieving the Sustainable

Development Goals (SDGs). STEM skills are essential for addressing global challenges such as climate change, healthcare, food security, and environmental conservation.

Indeed, UNESCO advocates for STEM education to achieve sustainable development, address global challenges, and promote equity and gender equality. The organization works to facilitate international cooperation, improve the quality of STEM education, and ensure that STEM fields are accessible and inclusive. UNESCO's efforts align with the broader global goals of advancing science, technology, and innovation for the betterment of humanity.

UNESCO is focused on advancing gender equality and empowering women and girls in science, technology, engineering, and mathematics (STEM). UNESCO aims to overcome systemic hurdles and misconceptions that impede women's involvement in STEM fields, to establish inclusive learning environments and equal opportunity for all learners. The goal is to guarantee that women and girls have the same opportunities as men to access STEM-related education, training, and job paths.

The incorporation of STEM education signifies a fundamental change in pedagogical principles, as it abandons the conventional practice of compartmentalizing disciplines in favor of an interdisciplinary strategy that emulates practical implementations. STEM education endeavors to cultivate comprehensive learning experiences that surpass technical and scientific limitations, scientific principles, technological advancements, engineering design methodologies, and mathematical reasoning. Utilizing practical experimentation, cooperative undertakings, and inquiry-driven education, students are motivated to investigate the interrelatedness of STEM fields, thereby fostering the ingenuity, and problem-solving proficiencies that are indispensable for achievement in the labor market of the twenty-first century.

Although the adoption of STEM strands has received considerable acclaim for its capacity to foster a proficient STEM labor force, it has obstacles. A principal issue of concern pertains to the promotion of equitable access and participation in STEM education, given that marginalized communities frequently encounter obstacles stemming from inequities in resources, gender prejudices, and cultural attitudes.

Furthermore, the efficacy of STEM education is contingent upon the competence of teachers in seamlessly incorporating STEM principles into their instructional methodologies and adjusting pedagogical approaches.

In the Philippines, the STEM (Science, Technology, Engineering, and Mathematics) program has evolved over the years, driven by the need to enhance the country's competitiveness in the global arena, particularly in science and technology. The Philippines initially focused on science education in the 1960s. The government recognized the importance of producing a skilled workforce in science and technology to drive economic development. During the 1970s, there was an emphasis on technological and vocational education in the country. This period lays the foundation for more specialized STEM education.

Article XIV, Section 10 of the 1987 Philippine Constitution recognized the importance of science and technology for national development and stated that "science and technology are essential for national development, invention, innovation, and their utilization." This is a guiding principle for the country's commitment to leveraging science and technology as drivers of progress, innovation, and national development.

In 2013, the Philippines implemented the K-12 program, which added two years to the basic education curriculum. This change allowed for the integration of more STEM subjects and the development of specialized tracks for students, including the STEM track. Under the K-12 program, the STEM strand was introduced in senior high school. This strand offers a specialized curriculum focused on science, technology, engineering, and mathematics subjects. The STEM (Science, Technology, Engineering, and Mathematics) component in the K to 12 curriculum signifies a crucial advancement in preparing students with the necessary abilities and proficiencies required for accomplishment in today's world. The K to 12 program seeks to cultivate critical thinking, problem-solving, creativity, and innovation among students by incorporating STEM education into the curriculum from a young age. This multidisciplinary approach not only equips learners with the necessary skills for future professions in STEM-related fields but also fosters an attitude of continuous learning and adaptability in response to technological breakthroughs and societal concerns.

In addition, the STEM strand in the K to 12 program focuses on providing practical learning experiences that involve students applying STEM principles to real-world situations. Engaging in inquiry-based activities, project-based learning, and collaborative problem-solving projects, students enhance their academic competency and cultivate essential soft skills such as teamwork, communication, and perseverance. The K to 12 program enhances students' understanding of the interconnections between STEM disciplines to actively contribute to defining the future of innovation and discovery through immersive and genuine STEM experiences.

Republic Act No. 10533 (Enhanced Basic Education Act of 2013): This law, also known as the K-12 Law, mandated the K-12 program. It provided the legal framework for STEM education in the country. The STEM (Science, Technology, Engineering, and Mathematics) programs in education have gained significant attention in recent years, as it is seen as a crucial avenue for preparing students to thrive in an increasingly technology-driven and interconnected world. STEM programs aim to foster critical thinking, problem-solving skills, and creativity while equipping students with the knowledge and skills necessary for careers in STEM fields. While these programs have shown numerous strengths and benefits, they also face challenges that call for continuous improvement and refinement.

This study delves into the implementation of STEM programs, aiming to explore the gaps and issues that require improvement. By conducting a comprehensive analysis of STEM initiatives in education, this research seeks to provide insights for educators, policymakers, and stakeholders to enhance the effectiveness of STEM education. In doing so, we can better prepare students for the challenges and opportunities of the 21st-century workforce and contribute to the advancement of society through scientific and technological innovation.

Progressing further, the thesis delves into a comprehensive examination of the merits of the STEM strand. This study examines the incorporation of many academic subjects to promote comprehensive learning experiences, equipping students with the necessary skills to navigate the intricacies of the contemporary labor market. Furthermore, the thesis examines the impact of practical, experiential learning activities on

increasing student involvement and strengthening conceptual comprehension in STEM fields.

By exploring the strengths and areas of improvement of STEM strand implementation, this study aims to contribute to the ongoing discourse on STEM education and provide actionable insights for stakeholders to refine and optimize these programs. Ultimately, the goal is to ensure that STEM education continues to play a pivotal role in preparing the next generation for success in a rapidly changing world. While the study may focus on a specific geographical context, its findings can have broader relevance. Lessons learned from effective STEM program implementation can be adapted and applied in other educational settings worldwide, contributing to global efforts to enhance STEM education and workforce readiness.

II. OBJECTIVES

The study was conducted to assess the implementation of the Science, Technology, Engineering, and Mathematics (STEM) strand in Gallanosa National High School.

Specifically, it aims to identify the strengths and areas for improvement in enhancing the learning outcomes, the effectiveness of teaching methodologies in facilitating learning, the level of influence on students' interest in Science, Mathematics, and Technology, and the intervention mechanism to further boost the student learning outcomes.

III. METHODOLOGY

This study utilized the inductive qualitative research methodology to assess the implementation of the STEM strand in Gallanosa National High School, school year 2023-2024. The informants of the study were 12 Grade 11 and Grade 12 STEM students, 8 STEM teachers, and 1 school principal of Gallanosa National High School. A researcher-made open-ended questionnaire was used to investigate the strengths and areas for improvement of the STEM strand implementation.

The validation of the open-ended questionnaire was done by a Master Teacher II, and 3 Grade 11 students, and the results showed that the questionnaire measured what it set out to measure. The interview and focus group discussions followed with a subset of informants; students, teachers, and the school principal. Informants were asked to answer the open-ended questionnaires.

The responses that emerged from the interview, focus group discussion, and open-ended questionnaires underwent a five-phase qualitative data analysis. Phase 1, the data collected were organized. In phase 2, the data were sorted into relevant topical categories. Phase 3, open and initial coding of data. Phase 4, patterns, themes, and findings were identified. Phase 5, application of theory and explanation of the findings.

IV. RESULTS AND DISCUSSIONS

The following results were gathered, analyzed and interpreted by the researcher based on the objectives of the study,

1. Strengths of the STEM strand implementation in Gallanosa National High School in enhancing students' learning outcomes

The learning outcomes of students can be defined as the quantifiable competencies, aptitudes, understanding, or principles that students are capable of exhibiting at the successful completion of a curriculum. The Senior High School offers four academic strands, one of which is the STEM strand. The purpose of this strand is to optimize student learning outcomes through the implementation of a comprehensive and interdisciplinary educational strategy. STEM education is an innovative approach to teaching that combines science, technology, engineering, mathematics, and other relevant knowledge, skills, and beliefs with these specific fields. (Baran et al., 2016; Koul, Fraser, Maynard, & Tade, 2018; Thibaut et al., 2018).

Fosters Intellectual Curiosity and Ability to Solve Problems. STEM education is an educational method that involves teaching and learning knowledge within the STEM framework. This framework places significant emphasis on the application of problem-solving techniques to real-world scenarios, while also combining diverse academic fields and skills, including science, technology, mathematics, and engineering. The STEM strand has its foundation in the development of analytical reasoning and the ability to solve problems. It is the source from which all the skills originate. Students are presented with complex real-world problems that need creative problem-solving through the use of scientific concepts, computational reasoning, and engineering methodologies. By incorporating actual experimentation, mathematical modeling, and group projects, students are allowed to develop the essential analytical, synthesis, and

evaluative abilities required for success in both academic and professional spheres.

Informant no. 9 testified "Enhanced my skills in analyzation and problem-solving skills."

Informant no. 10 also testified "It assists me to learn some useful skills for solving problems in science and math."

Informant No. 14 said, "Rewarding as I guide my students through hands-on activities, encourage curiosity, and facilitate problem-solving."

Informant No. 16 also said, "STEM students are creative, critical thinkers, and problem-solving skills are evident."

The STEM strand in Gallanosa National High School is effective in developing critical thinking and problem-solving skills by exposing students to subjects like Basic Calculus, General Chemistry, and Earth Science.

Informant 3 said: "STEM strand has been enriching and challenging. Opportunity to explore various subjects like Basic Cal, Gen Chem, and Earth Science which help me develop critical thinking and problem-solving skills."

Informant No. 2 also shared, "Helps me establish my competency in my academics by being exposed to more advanced learning in the subjects offered in this strand."

Students in the STEM strand are expected to analyze complicated problems, deconstruct them into smaller, more manageable components, and spot patterns or linkages. This develops critical thinking abilities, which are necessary for resolving issues in both theory and practice. In Gallanosa National High School, the STEM strand academically exposes students to specialized subjects such as Calculus, General Chemistry, General Biology, General Physics, and Capstone Project, which fosters the development of critical thinking and problem-solving skills. This strategic curriculum design aims to create a comprehensive grasp of fundamental concepts in science, technology, engineering, and mathematics. Such exposure to these topics is of great importance in improving student performance. Numerous studies have demonstrated the efficacy of STEM education in enhancing various learning

outcomes among students, including academic achievement, student motivation, attitude, and problem-solving abilities. (Saraç, 2018; Yildirim, 2016).

In addition, the deliberate promotion of critical thinking and problem-solving skills within the STEM strand in Gallanosa National High School particularly through exposure to subjects like Basic Calculus, General Chemistry, General Biology, General Physics, and Capstone Projects, serves as a solid foundation for students' skills development. This approach aligns with established educational principles, emphasizing the importance of a strong foundation in STEM subjects for future success. The implications extend beyond subject-specific knowledge, fostering critical thinking and problem-solving skills essential for navigating the complexities of STEM disciplines (Yaki, 2022). This forward-thinking educational strategy positions students for success in both higher education and future careers in STEM-related fields.

Enhances Competency in Science, Technology, and Mathematics. The STEM (Science, Technology, Engineering, and Mathematics) strand in education acts as a transformative pathway that greatly improves proficiency in these vital disciplines. STEM education primarily cultivates a profound comprehension of scientific ideas, technological progress, and mathematical concepts. By engaging in challenging courses and practical exercises, students develop expertise in essential scientific methodologies, technological implementations, and mathematical problem-solving strategies. This thorough comprehension serves as the foundation on which more investigation and specialization in STEM fields can be constructed. STEM competencies encompass the cognitive abilities, technical proficiencies, and mindsets that students in the STEM field acquire, which empower them to generate original ideas and effectively address real-world challenges. These abilities encompass the cognitive component of comprehending facts and concepts in science, technology, engineering, and mathematics, as well as the motivational side of striving to acquire STEM competencies to apply practical STEM skills. STEM education aims to equip students with the skills necessary to adapt to evolving life circumstances, independently acquire knowledge, apply knowledge in practical settings, engage in critical and creative thinking, competently utilize information, effectively communicate, collaborate in teams, and cultivate moral values.

Informant No. 8 stated, "Boost my competency in the fields of Math and Science."

Informant no. 2 declared "Helps me establish my competency in my academics by being exposed to more advanced learning in the subjects offered in this strand."

Informant no. 18 also emphasized "Students gain a solid understanding of fundamental scientific principles, mathematical concepts, and engineering principles,"

Furthermore, the multidisciplinary nature of the STEM strand promotes comprehensive learning experiences that go beyond typical disciplinary boundaries. Through the integration of knowledge from several disciplines, students cultivate a sophisticated comprehension of the interplay and mutual enhancement between science, technology, and mathematics. This multidisciplinary approach enhances students' academic endeavors and fosters creativity and innovation. By fostering an environment that promotes interdisciplinary exploration, students develop the ability to effectively utilize their knowledge to tackle intricate, practical issues. This equips them with the necessary skills to confront the ever-evolving demands of the contemporary professional landscape.

Informant No. 14 declared "Exposure to diverse stem topics contributes to a well-rounded understanding of science and technology. STEM strand helps students make connections across different subjects creating a more educational experience."

Informant No. 13 shared, "Students in the STEM strand are provided with the learning opportunities to equip them with the necessary competency in fields of science, technology, and mathematics."

In Gallanosa National High School, through active engagement in practical activities, students not only enhance their comprehension of STEM principles but also refine their abilities in critical thinking, problem-solving, and teamwork, which are essential in today's world driven by innovation.

Informant no. 21 expressed "STEM is focused on developing critical, creative, collaborative and technologically inclined students."

Moreover, the STEM strand has a key function in promoting technology literacy, providing students with the information and abilities needed to navigate the progressively digitized world.

Informant no. 16 stated, “STEM students are more advanced in terms of technology.”

Informant no. 21 asserted “Students are proficient in using various technologies and software tools.”

The STEM strand in Gallanosa National High School enables students to utilize technology for creativity and societal progress by integrating computer science, programming, and digital literacy courses.

Cultivates Inclusivity, Collaboration, and Teamwork. The STEM (Science, Technology, Engineering, and Mathematics) strand in education not only improves proficiency in these essential disciplines but also fosters inclusivity, collaboration, and teamwork among students. The STEM method is characterized by its focus on collaborative learning experiences that promote inclusivity and diversity. In STEM classrooms, students of many backgrounds converge, each contributing their distinct perspectives, ideas, and abilities. The presence of many perspectives and backgrounds enhances the educational setting, fostering chances for students to gain knowledge from one another and cooperate on endeavors that tackle practical issues.

Informant no. 6 declared “Inclusivity makes me feel more encouraged to showcase my skill and characteristics without being skeptical that I’d be judged and excluded.”

Also, informant no. 3 stated, “STEM enhances student learning by promoting a collaborative, innovative, and practical approach to learning.”

Informant No. 10 shared, “STEM strand helps me get better at working with others and trying things out.”

The multidisciplinary character of the STEM strand promotes collaborative work among students from other fields, thereby bridging the divide between science, technology, engineering, and mathematics. In Gallanosa National High School students get an understanding of the interdependence of several fields and the importance of working together to solve intricate challenges.

Through collaborative efforts in addressing complex problems, students cultivate a more profound comprehension of how their unique abilities and knowledge may enhance those of their classmates, nurturing an environment of mutual regard and recognition.

Informant no. 16 articulated “Collaboration is one of the skills learned and practiced in STEM, hence communication and problem-solving skills are enhanced,”

Informant 12 also suggested “Improve the collaboration with other students and can also improve critical thinking when solving problems and communicate properly,”

Informant No. 7 said, “STEM strand allows me to collaborate with my peers.”

The practical and hands-on learning method that is inherent in the STEM strand fosters collaboration and cooperation among students. To accomplish their objectives, students must collaborate efficiently, whether they are involved in laboratory research, engineering design projects, or coding difficulties.

Informant no, 14 mentioned, “Foster a supportive environment where students can explore, experiment and apply theoretical knowledge to practical situations.”

Collaborating in teams enables students to acquire crucial abilities such as effective communication, strong leadership, and efficient conflict resolution, all of which are important for achieving success in both academic and professional environments. The STEM strand provides students with both the technical abilities required for success in STEM fields and the interpersonal skills necessary for fostering inclusive, diverse, and resilient communities through collaborative learning experiences. Enabling collaboration among Science, Technology, Engineering, and Mathematics (STEM) disciplines in program development is vital for establishing an effective educational base for all learners in STEM education. (Haruna,2015)

Stimulates Hands-On Learning Opportunities. The STEM strand in education is notable for its dedication to offering practical opportunities that enable students to engage in immersive learning experiences. These hands-

on experiences are essential for enhancing comprehension, refining practical abilities, and promoting innovation in STEM fields. The STEM strand provides students with opportunities to actively participate in scientific investigations, engineering projects, and mathematical ideas, thereby improving their proficiency in these important subjects.

Informant no. 18 expressed, "STEM honed my abilities in facilitating inquiry-based activities and fostering hands-on learning opportunities whenever feasible."

Informant No. 7 stated, "STEM promotes a hands-on learning environment."

Informant No. 8 also stated, "STEM is more hands-on and practical."

Based on John Dewey's philosophy that education begins with the curiosity of the learner, inquiry in the classroom places the responsibility for learning on the students and encourages them to arrive at an understanding of concepts by themselves.

Laboratory experiments are key methods used by the STEM strand to provide hands-on opportunities. STEM students in Gallanosa National High School are allowed to engage in experimental activities that enable them to apply theoretical knowledge to practical scenarios, see scientific principles in operation, and scrutinize empirical data.

Informant no. 14 verbalized, "Rewarding as I guide my students through hands-on activities, encourage curiosity, and facilitate problem-solving. STEM fosters critical thinking, problem-solving, and analytical skills through hands-on experience."

According to Worth (2010), learning Science involves more than simply acquiring factual knowledge and comprehension of a specific subject. Learning science through hands-on experiments is a highly successful method that enables students to actively experience and discover perception or emotions. Through active engagement in experiments, students cultivate their critical thinking abilities, acquire the capacity to generate hypotheses, construct experimental designs, and analyze findings. Furthermore, laboratory experiments foster a culture of curiosity and investigation, motivating students to pose inquiries,

pursue solutions, and participate in scientific discussions.

Informant No. 16 shared, "As a teacher, I help them stimulate critical by applying experiential, hands-on, and problem-solving activities."

Indeed, the STEM curriculum provides practical experiences that enable students to actively participate in scientific, technological, engineering, and mathematics principles. By engaging in laboratory experiments, engineering design projects, and hands-on activities in technology and mathematics classes, students acquire practical skills, enhance critical thinking abilities, and cultivate problem-solving acumen that is crucial for achieving success in STEM disciplines. Practical experiences foster ingenuity, novelty, cooperation, and a more profound understanding of the interdependence of STEM fields. The STEM strand equips students with immersive learning experiences that connect theoretical knowledge with practical application. This enables them to excel in a fast-changing world that is propelled by scientific exploration, technological advancements, and mathematical logic.

Employs Effective Teaching Methodology. The STEM strand in education utilizes efficient teaching approaches to cultivate a thorough comprehension, analytical reasoning, and hands-on application of concepts in the fields of Science, Technology, Engineering, and Mathematics. These approaches are specifically created to actively involve students, encourage learning via inquiry, and develop skills that are crucial for succeeding in STEM-related industries. The STEM strand equips students with the necessary skills to address the problems of the 21st century by utilizing modern educational resources and implementing creative instructional practices.

Informant no. 8 shared "Dako po Mam an danon an teacher lalo na sa specialized subject na may background knowledge sa subject na intuitukduan niya kay nakaprove cya additional explanation na wara sa learning material", (It is a big help for the teacher in the specialized subject to having background knowledge for the subject she/he is teaching for he/she can provide an additional explanation that is not found in the learning material).

Informant no. 16 also shared, “As a teacher, I can help them stimulate critical thinking by applying experiential/hands-on/problem-solving activities.”

The STEM strand in Gallanosa National High School prioritizes project-based learning as a very effective teaching style. Project-based learning involves students working together to tackle authentic problems or obstacles by employing multidisciplinary methods (Kelchtermans, (2017). Students utilize knowledge from several STEM fields to tackle intricate challenges, whether it be devising a sustainable energy solution, developing a computer program, or constructing a model bridge. Project-based learning promotes the development of creativity, innovation, and teamwork, while also equipping students with practical experience in project management, problem-solving, and communication abilities. Furthermore, project-based learning facilitates a more profound comprehension of the interrelationships across STEM fields and their applicability to daily existence.

Informant no. 2 stated, “The methods of teaching demonstrated using advanced technology is effective to us to gain knowledge and be able to complete the task given us.”

Ultimately, the STEM strand utilizes efficient instructional approaches that promote active participation, inquiry-driven learning, project-centered learning, and the incorporation of technology. The STEM strand promotes the use of creative teaching methods and new educational resources to guarantee that students get a thorough understanding of STEM topics, develop critical thinking skills, and gain practical competencies that are crucial for success in the 21st century. The STEM strand equips students with the necessary skills to succeed in a fast-changing world that is shaped by scientific investigation, technical advancements, and mathematical thinking. This is achieved through practical exercises, group projects, and the incorporation of technology.

Motivates to Take the STEM Careers in The Future. The STEM strand in education acts as a powerful igniter for inspiring students to pursue work in STEM-related fields in the future. The STEM strand stimulates students' passion for STEM disciplines and motivates them to view STEM jobs as realistic and fulfilling paths by utilizing inventive teaching methods, interactive

learning opportunities, and exposure to practical applications.

The STEM strand encourages students to pursue STEM careers by cultivating an in-depth comprehension of the significance and pertinence of STEM fields in tackling worldwide issues and advancing society. Through active participation in practical activities such as hands-on experiments, laboratory work, and engineering design projects, students have direct experience in the application of STEM principles to address real-life challenges. Students observe the concrete influence of STEM in tackling urgent problems like climate change, healthcare, and technological progress, whether through the development of sustainable energy solutions, the design of technical advances, or the analysis of data for informed decision-making. This exposure not only ignites students' curiosity in STEM but also inspires them to delve into career prospects where they can have a significant impact on the world.

Informant no. 16 expressed “STEM students showed varied interests in the different courses related to their academic tracks.”

Informant no. 8 also said, “The learnings are advantageous for college preparation.”

In Gallanosa National High School, the STEM strand provides students with the necessary information, skills, and abilities to excel in STEM professions.

Informant No. 8 said, “The STEM strand curriculum is structured well and serves as prior study before college.”

Informant No. 9 also stated, “The learning materials are the things we will encounter in college.”

By engaging in demanding academic programs focused on science, technology, engineering, and mathematics, students acquire a solid grounding in fundamental STEM subjects. Additionally, they cultivate vital skills like critical thinking, problem-solving, and cooperation, which are crucial for achieving success in STEM-related careers. In addition, practical learning experiences and access to state-of-the-art technologies equip students with tangible skills and industry-specific information, thereby preparing them for future professions in STEM-related fields. Students in the STEM strand are prepared to explore various STEM vocations, such as

engineering, computer science, biotechnology, and data analytics, whether they choose to continue their education in STEM fields or enter the job immediately.

Informant no. 7 declared “STEM strand significantly contributed to my future readiness, particularly in interest in pursuing an engineering degree.”

Moreover, the STEM strand provides students with the chance to get guidance from mentors, participate in internships, and interact with professionals in the field of STEM. These experiences serve to enhance their motivation to pursue professions in STEM. By collaborating with industry groups, universities, and research institutes, students in the STEM strand have the opportunity to experience authentic STEM settings and engage with people employed in STEM disciplines. Exposing students to real-life experiences not only gives them essential knowledge about the different career options in STEM but also motivates them by demonstrating the wide range of chances and potential within STEM fields. The STEM strand fosters confidence and inspiration in students to follow their objectives in STEM disciplines by linking them with mentors and role models who have successfully navigated STEM careers.

2. The Areas for Improvement in the STEM Strand Implementation in Addressing Current Challenges in Student Learning

The STEM (Science, Technology, Engineering, and Mathematics) strand has received considerable emphasis in recent times as a fundamental component of education, equipping learners to confront the challenges of a world that is progressively intricate and technology-oriented. Nevertheless, in light of the increasing acknowledgment of its significance, critical areas for enhancement in the implementation of STEM strands have surfaced as determining concerns for the progress of education. These domains comprise a wide range of factors, including initiatives to promote diversity and equitable access, curriculum development, and pedagogical strategies. It is critical to acknowledge and rectify these areas for enhancement to maintain the relevance, inclusivity, and efficacy of STEM education as a means of providing students with the requisite knowledge, skills, and competencies for success in modern times.

Lack of Interdisciplinary STEM Integration. The appreciation of the significance of incorporating

interdisciplinary approaches within the Science, Technology, Engineering, and Mathematics (STEM) education framework has been widely viewed as essential for cultivating comprehensive understanding and problem-solving abilities. Still, while it acknowledged its significance, the implementation of multidisciplinary integration in STEM education frequently encounters substantial obstacles.

Informant no. 15 stated, “Contents should be infused in other disciplines whenever possible.” Informant no. 18 also stated, “Integrate real-world application of STEM concepts.”

The absence of effective collaboration and communication among educators from various fields within the STEM framework is a significant concern. Each field may function independently, concentrating exclusively on its specific subject matter, which blocks the potential benefits that could result from collaboration across different disciplines.

The educational experience for students is often divided due to the placing of importance on subject-specific learning outcomes over interdisciplinary methods in institutional structures and curricular frameworks. The act of compartmentalizing not only restricts students' ability to perceive the interrelationships across several STEM subjects but also hampers their aptitude to address intricate, practical issues that require solutions from multiple professions.

Informant no. 7 raised, “Implement a physical or online domain for students, particularly on research subjects and technology-based studies like robotics.”

Informant no. 15 also raised, “Revolutionized the use of technology boosts educational paradigm shifts that give importance to student-centered and holistic learning.”

Moreover, educators may be deficient in the requisite training and assistance to proficiently incorporate interdisciplinary methodologies into their instructional methods, hence maintaining the gap between fields within the STEM framework.

The issue of insufficient multidisciplinary integration in STEM education necessitates collaborative endeavors across many levels. To cultivate a culture that places importance on interdisciplinary collaboration, educational institutions should establish mechanisms

that encourage educators to actively participate in across-discipline initiatives and avail themselves of professional development opportunities.

Informant no. 18 asserted, "Students should have opportunities to engage with external agencies or science laboratories relevant to their career aspirations not just limited to experiences within the school."

The prioritization of interdisciplinary modules and projects that emphasize the interconnection of STEM subjects and foster collaborative problem-solving abilities should be a key focus of curricular revisions. In addition, allocating resources to interdisciplinary research and fostering collaborations across educational institutions, businesses, and government can yield significant knowledge and assets to promote the progress of interdisciplinary STEM education.

Informant no. 14 suggested, "Foster partnership with industry and organization to expose students to real-world applications of STEM."

Informant No. 9 also suggested, "Increase partnership with local government."

By conquering obstacles to the integration of different academic fields, we may enhance our ability to provide students with the necessary skills to address the intricate issues of today's world and foster creativity in various areas of study.

Inadequacy of Hands-On Learning Opportunities. The inclusion of hands-on learning experiences in the STEM (Science, Technology, Engineering, and Mathematics) curriculum is crucial for fostering practical skills and establishing a strong grasp of concepts. However, the limited availability of these possibilities poses a substantial obstacle to fully harnessing the potential of STEM education. Firstly, practical experiences provide learners with concrete examples of how theoretical principles can be put into practice, thereby promoting a thorough comprehension of technical subject matter. Due to a lack of laboratory equipment, outmoded technology, and limited resources, students may encounter difficulties in applying their knowledge in practical situations. This might hinder their ability to develop fundamental abilities like critical thinking and problem-solving.

Informant no. 2 declared "Lack of laboratory equipment, inaccessible laboratory testing, outdated and lack of technology or materials for robotics."

Informant no. 18 also testified "The school needs to prioritize additional facilities and teaching equipment and ensure the provision of laboratory apparatus for hands-on activities."

Informant no. 19 further stated, "A conducive and well-ventilated laboratory room with appropriate and complete laboratory materials may be provided."

Also, informant no. 20 said "Refurbish equipment/supplies needed in their learning activities such as TV, WIFI, lab equipment, projectors among others."

Insufficient laboratory equipment poses a significant barrier to practical, hands-on learning experiences, which are fundamental to STEM education.

Informant no. 16 expressed "Employ hands-on activities through functional laboratories for science."

Informant no. 18 further expressed "Provide ample laboratory apparatus for students."

Informant No. 19 said, "Provide students with proper equipment in the laboratory."

The absence of essential tools impedes students' ability to develop practical skills and hinders the holistic understanding of complex scientific concepts.

Nevertheless, hands-on experience fosters the growth of creativity and innovation, which are fundamental attributes for achieving success in STEM disciplines. Through active participation in hands-on activities, projects, and simulations, students acquire the ability to think critically and adaptability sufficient to succeed in the ever-changing technological environment. Nonetheless, educational framework constraints, inadequate funding, and constrained access to resources frequently obstruct the integration of hands-on activities into STEM education. To rectify these deficiencies, educational institutions, administrators, and stakeholders must collaborate to give priority to spending on instructional resources, teacher development, and curriculum creation. Future generations can expect to be able to achieve success in

the increasingly elaborate domain of science and technology unless we encourage all of the possibilities of education in STEM fields and exhibit our unwavering commitment to hands-on learning employing full assistance.

Pedagogical Inadequacy in the STEM Strand. The pedagogical inadequacy poses an important challenge in ensuring the effective implementation of the Science, Technology, Engineering, and Mathematics (STEM) core in education. Inadequate competence and expertise among educators in utilizing appropriate teaching methods that promote interdisciplinary learning and problem-solving within the STEM framework is referred to as this term. Although STEM education is placing a greater emphasis on interdisciplinary approaches, many teachers may not have the required pedagogical skills and support to effectively integrate multiple subject areas.

Informant No. 5 expressed, "Teachers should use a variety of inventive teaching strategies."

Informant No. 13 said, "Some teachers need upskilling."

Also, informant No. 17 conveyed, "Screen the qualified teachers to teach in STEM."

An element of pedagogical inadequacy in STEM education arises from the conventional training of educators who primarily focus on their specific areas of expertise. Teachers frequently undergo specialized training in their areas of expertise, which may not sufficiently equip them to effectively foster interdisciplinary linkages or navigate the intricate interplay among science, technology, engineering, and mathematics. Thus, they might face difficulties in creating and executing interdisciplinary lessons that successfully include students in interconnected ideas and practical situations.

Informant no. 14 asserted "Implement inclusive teaching methods to cater to diverse learning styles and abilities."

Also, Informant No. 10 said, "Provide appropriate teaching method to easily understand the lesson, especially the Math-related subjects."

Informant no. 20 also suggested, "Implement differentiated instruction."

Inclusive education and differentiated instruction in STEM underscore the imperative of recognizing and catering to diverse learning capabilities within the realm of science, technology, engineering, and mathematics. This acknowledges that students possess varied learning styles, aptitudes, and needs, emphasizing the necessity for versatile teaching approaches. It advocates for an inclusive education model that fosters a positive and accommodating learning environment for all students.

Within the STEM context, inclusive education implies creating an environment where every student, regardless of their background, abilities, or learning styles, feels welcome and valued. Inclusivity in STEM is not only a matter of diversity but also an acknowledgment that individuals learn differently and at their own pace. Culturally immersive classes can significantly enhance the retention of students from diverse cultural backgrounds in STEM fields. (Jackson, Galvez, Landa, Buonora, & Thoman, 2016).

Differentiated instruction is a key component in the implementation of STEM education, focusing on tailoring teaching methods to meet individual students' needs. In STEM education, where abstract concepts and problem-solving skills are central, employing varied instructional strategies becomes vital (Tomlinson, 2017). Differentiation allows educators to adapt their teaching to address diverse learning styles, ensuring that students can grasp complex STEM concepts effectively.

A positive learning environment is fundamental for the success of inclusive education and differentiated instruction. This involves fostering a culture of respect, understanding, and support among students and educators. Furthermore, a wide-ranging meta-analysis examining culturally relevant education across all fields of study revealed compelling evidence supporting the effectiveness of subjects related to STEM (Aronson & Laughter, 2016).

The implications of inclusivity and differentiated instruction in STEM education are profound, extending beyond academic achievement. Recognizing diverse learning capabilities contributes to increased student motivation and self-efficacy fostering a positive attitude toward learning in general (Tomlinson, 2017).

The rapid advancement of technology and the ongoing refinement of pedagogical approaches both contribute to the decline of pedagogical adequacy in STEM education.

Informant No. 11 articulated “Shedding light on the pivotal role of technology in the realm of education, this advocate for the seamless integration of technology to enhance engagement and accessibility of learning. It further promotes a culture of innovation by urging educators to explore novel teaching methods, revamp curriculum designs, and leverage technology for transformative shifts in the educational paradigm.”

The integration of technology in the classroom allows educators to leverage multimedia resources, simulations, and interactive platforms, making learning more dynamic and participatory for students (Dede, 2008). This shift toward technology-enabled learning aligns with contemporary educational trends, acknowledging the evolving needs and preferences of digital-native students.

Innovative teaching methods are encouraged, prompting educators to explore creative approaches that leverage technology. This could involve incorporating virtual reality, gamification, or online collaborative tools into lessons, providing students with diverse and immersive learning experiences. Research suggests that innovative teaching methods not only enhance student engagement but also contribute to improved learning outcomes (Johnson et al., 2014).

Curriculum design is another essential aspect to be addressed. With the rapid advancement in technology, curricula need to be adaptable and aligned with the demands of a digitally-driven society. The integration of technology allows for the inclusion of real-world applications, problem-solving scenarios, and interdisciplinary approaches, preparing students for the complexities of the modern workforce (Partnership for 21st Century Skills, 2007).

Paradigm shifts in education are advocated for through the strategic use of technology. This involves moving away from traditional, teacher-centric models towards student-centered and holistic learning experiences. The literature supports the idea that paradigm shifts in education are important for preparing students for the challenges of the 21st century, emphasizing critical

thinking, creativity, collaboration, and communication skills (Trilling & Fadel, 2009).

Effective technology integration not only enhances the quality of education but also contributes to narrowing educational gaps and promoting accessibility for diverse learners. However, it requires a strategic approach, ongoing professional development for educators, and an institutional commitment to invest in necessary infrastructure (Ertmer, et al., 2012).

Inadequacy of Support for Student Engagement and Involvement in STEM Education. Emphasizing student engagement suggests the involvement of students in decision processes, considering their concerns, and creating opportunities for peer tutoring and collaboration. It highlights the importance of a student-centered approach to education.

Informant No. 11 said, “Putting a spotlight on student engagement, recommends actively engaging students in decision-making processes, considering their concerns, and fostering opportunities for peer tutoring and collaboration. It underscores the significance of adopting a student-centered approach to education.”

The student-centered approach holds significant value in the field of education due to its acknowledgment of the diverse demands, preferences, and capabilities of every learner, thereby cultivating a more individualized and captivating educational environment. By strategically involving students in the educational process, this methodology fosters profound comprehension, critical analysis, and active engagement, ultimately culminating in learning outcomes that are more significant and enduring. Additionally, student-centered classrooms foster the development of critical competencies including communication, collaboration, and independent study, thereby equipping pupils with the necessary tools to succeed in an ever more intricate and heterogeneous global society that demands adaptability and problem-solving prowess. In essence, the student-centered approach enables learners to assume responsibility for their education, thereby cultivating an enduring enthusiasm for knowledge acquisition and providing them with the necessary skills to confront forthcoming obstacles.

Informant No. 18 vocalized, “The school can solicit feedback from STEM students to better understand their needs and address them accordingly.”

Informant No. 17 also suggested: "Conduct focus group discussion, identify the problem, and solve it according to the existing problems and issues."

Such participatory involvement aligns with the principles of democratic education and has been shown to positively impact student motivation and commitment to learning (Freire, 2020)

Considering student concerns is a fundamental aspect of support, acknowledging that students possess valuable insights into their own learning experiences. By actively listening to their concerns, educators can address potential obstacles to engagement and tailor teaching methods to better suit students' needs and preferences. This approach aligns with the student voice movement, emphasizing the importance of empowering students as active participants in their education (Cook-Sather, 2016)

Informant No.2 declared, "Educators should consider that students have different learning capabilities, different approaches of teaching must be considered and be more open to versatile learning."

Informant No. 21 also suggested, "The school should provide professional development opportunities to the teachers, support structure such as peer mentoring, academic counseling and the like."

Furthermore, lack of support for student engagement is frequently the result of systemic shortcomings in academic organizations, such as inadequate professional development for teachers, limited resources, and large class sizes. Teachers who are overworked and exhausted may discover it difficult to offer personalized attention and assistance to every student, which could result in students experiencing feelings of detachment and isolation.

Informant No. 21 asserted, "A teacher should focus on adaptive and holistic approaches by integrating differentiated instructions that cater learning activities for varying skills and learning styles."

Also, the issue is further complicated by inequalities in academic support services, technology access, and participation in extracurricular activities, which disproportionately impact disadvantaged and vulnerable student populations.

Informant No. 4 stated "Best for teachers to teach by prescribing illustrations, examples using laboratory equipment, mathematical animations, simple physics machine,"

Informant No. 2 also stated, "School officials do sometimes ask the students in STEM regarding their concerns and needs but oftentimes it takes a long time for this action to be taken."

To effectively tackle this important matter, it is necessary that educational stakeholders give priority to the implementation of student-centered methodologies, cultivate inclusive learning environments, and efficiently allocate resources to accommodate the varied needs and interests of every learner. It can enable students to exceed their academic, social, and personal expectations by allocating resources towards endeavors that foster active participation, cooperative understanding, and equitable availability of educational opportunities.

3. How Effective is the Teaching Methodology Used by Teachers in the STEM Strand in Facilitating Student Engagement and Learning

The pedagogical approach utilized by teachers in the STEM (Science, Technology, Engineering, and Mathematics) field plays an important role in promoting student involvement and enabling significant learning encounters. Teachers can create a dynamic learning environment that promotes curiosity and critical thinking in students by including inquiry-based learning, hands-on experiments, and real-world applications in their teaching methods. In addition, the integration of cooperative initiatives and activities focused on resolving problems not only stimulates active engagement but also improves collaboration and communication abilities which are of great importance for achieving success in STEM disciplines. By utilizing customized teaching methods that cater to various learning preferences and incorporating technology as a valuable educational resource, STEM teachers successfully empower students to investigate, evaluate, and create, thus fostering a strong passion for STEM subjects and equipping them for future academic and career pursuits.

Exposing Learners to Varied Learning Methodology. Introducing STEM learners to a wide range of learning methods is of the utmost importance for the efficacy of teaching methodology in the STEM field. Adopting a

multi-faceted approach to education not only caters to the various learning styles and interests of students but also fosters a thorough comprehension of STEM ideas.

Informant no.18 shared “Use a game-based approach to instruction. It increases student participation and engagement. Offer positive reinforcement to the winners.”

Also, Informant No. 3 shared, “Through games and giving prizes to make the students more productive, active, and cooperative.”

Informant no. 5 likewise testified, “Teachers give a game that can be played in groups or individuals.”

Informant no. 7 also testified, “Teachers incorporate interactive games during lessons.”

By incorporating traditional lectures with interactive demonstrations, practical experiments, and multimedia presentations, teachers may accommodate various learning styles and encourage more profound involvement among learners.

Informant No. 2 stated, “A teacher prepares a PPT for her lesson and illustrates the visuals of the lesson by drawing it on the board while explaining it. It is very effective for students with diverse learning styles.”

Furthermore, the inclusion of project-based learning opportunities enables students to utilize theoretical knowledge in practical situations, thus promoting the development of critical thinking, problem-solving abilities, and creativity.

Informant no. 21 said, “In a capstone subject I let them develop Arduino-based (robot) projects which heightened their engagement and enthusiasm.”

Informant no. 14 also stated, “I design and use project-based learning experiences where students tackle real-world problems. It encourages creativity, critical thinking, and collaboration making learning more engaging and relevant.”

The use of technology as an educational tool stimulates innovation and discovery in the STEM curriculum. By incorporating technology into teaching methods, such as virtual simulations, online resources, interactive educational platforms, and coding applications, the

accessibility, interactivity, and adaptability of the learning experience for students is enhanced. In addition, collaborative learning endeavors, such as group assignments, peer instruction, and STEM clubs, not only promote collaboration and communication but also cultivate a feeling of community and assistance among learners, thus strengthening their motivation and dedication to STEM education.

Informant no. 10 shared, “Offering a variety of activities like PowerPoint presentations and sometimes hands-on observations like giving permission to use a microscope and giving teaching methods about robotics.”

Informant no. 19 also shared, “Excitement to manipulate, collaboration, and hard work in accomplishing the task.”

Eventually, it is imperative to introduce STEM learners to many instructional approaches within the teaching technique of the STEM strand to foster effective education in these disciplines. By adopting a comprehensive strategy that includes a wide range of teaching methods, incorporating technology, and promoting collaborative learning, educators may stimulate students' curiosity, foster their creativity, and instill a lifetime enthusiasm for STEM subjects. By employing this method, we can optimize the potential for nurturing the upcoming cohort of creative intellectuals, analytical troubleshooters, and influential figures in the fields of Science, Technology, Engineering, and Mathematics (STEM), thereby making a significant contribution to the progress of society as a whole.

Teachers' Perceived Effectiveness on the Employed Teaching Methodology. The assessment of teachers' teaching methods used in the STEM (Science, Technology, Engineering, and Mathematics) field is an important topic in education. It has an impact on both student learning outcomes and the acquisition of necessary skills for future employment. Teachers have an important function in molding students' comprehension and involvement in STEM courses, making their teaching methods essential for creating a favorable learning environment. The effectiveness of teaching approaches in STEM education mostly depends on their capacity to provoke inquiry, foster critical thinking, and cultivate problem-solving skills,

while simultaneously cultivating a fervor for exploration and ingenuity.

Informant no. 14 shared, "I design and use project-based learning experiences where students tackle real-world problems. It encourages creativity, critical thinking, and collaboration making learning more engaging and relevant."

Also, Informant No. 17 shared, "Use of research community engagement. This experiential learning helps the students to achieve their output at any cost."

Project-based learning (PBL) has been widely recognized for its efficacy in preparing students for practical applications. According to Thomas and Mergendoller (2011), PBL engages students in sustained, hands-on projects that mirror real-world challenges. This methodology not only enhances critical thinking and problem-solving skills but also fosters a sense of ownership and relevance as students grapple with authentic, complex issues. By immersing students in these projects, educators provide an opportunity for them to develop skills that are directly transferable to professional settings.

Relating lessons to real-life scenarios goes beyond the project-based approach, emphasizing the integration of practical examples and applications into everyday teaching. Connecting theoretical concepts to real-world situations has been shown to deepen students' comprehension and retention. Dewey's educational philosophy (1938) advocates for experiential learning, suggesting that meaningful experiences in real-life situations enhance understanding and long-term retention. Thus, incorporating real-life scenarios into lessons not only makes the content more relatable but also reinforces the applicability of academic knowledge in various contexts.

The perceived success of teaching approaches is significantly influenced by their alignment with the principles of active learning and hands-on exploration. Teachers who employ inquiry-based techniques in STEM topics, where theoretical principles meet real-world applications, are often regarded as more effective. These techniques promote a better understanding and memory of knowledge by enabling students to investigate topics through experimentation, collaboration, and real-world problem-solving. In addition, proficient educators in the STEM field

frequently incorporate technology and multimedia resources to enrich learning encounters, utilizing tools such as simulations, virtual laboratories, and interactive visualizations to animate intricate concepts.

Informant No. 21 shared, "In a capstone subject I let them develop Arduino-based (robot) projects which heightened their engagement and enthusiasm."

Further, the successful outcome of teaching strategies in the STEM field is closely linked to teachers' capacity to modify their approaches to accommodate various learning styles and individual requirements. Effective STEM instructors utilize differentiated instruction, individualized feedback, and scaffolding techniques as necessary strategies to guarantee that every student can access and actively participate in the curriculum. Likewise, cultivating a nurturing and all-encompassing classroom environment in which students are encouraged to venture into unknown territories, inquire about uncertainties, and derive knowledge from setbacks proves essential in advancing favorable educational achievements. To effectively address the ever-changing demands of STEM education and adequately prepare students for success in a rapidly advancing and complex world driven by technology, it is essential for teachers to consistently engage in self-reflection and make improvements to their teaching methods based on student feedback and the latest educational research.

Students' Perceived Effectiveness on the Employed Teaching Methodology. Evaluating the influence of teaching strategies in the STEM strand requires an understanding of students' perspectives of their effectiveness. This is important for assessing how different pedagogical approaches affect learning results and student engagement. The experiences that students have in STEM classrooms have a significant impact on their motivation to pursue jobs in related subjects and their mastery of fundamental ideas. Thus, assessing their viewpoints on the used instructional approaches offers vital observations regarding the advantages and locations for enhancement in STEM education.

Within the domain of STEM education, students express a strong need for ongoing enhancements in teaching methods.

Informant no. 3 voiced out, "Some teachers' teaching methodologies are not effective since most students have

different learning preferences and their teaching styles cannot cater to every student.”

Informant no. 9 also shared, “Lacks in the learning performance because some of them already practice us for self—reviewing (basically they give you the topic and you’re on your own to understand it.)”

STEM courses require dynamic and innovative instructional methods due to their ongoing evolution and close connection to real-world applications. Students frequently articulate a preference for experiential learning opportunities that enable them to put theoretical principles into practice. They are looking for instructional approaches that promote inquisitiveness, hands-on exploration, and the ability to solve problems, acknowledging that these qualities are necessary for achieving success in STEM-oriented professions.

Informant 16 said, “Problem solving and small group discussion. Inquiry-based learning to enhance communication skills. Give them activities congruent to the objectives of the lesson, allow them to discuss orally the output, and then connect the concept to a mathematical equation.”

An essential element in improving teaching methodology in STEM education is the use of inquiry-based learning. The inquiry-based teaching style is grounded in research on the learning process, as documented by Bransford, Brown, and Cocking (2000). Within inquiry-based scientific education, students actively participate in many activities and cognitive processes that scientists employ to generate novel insights. Science educators advocate for the replacement of traditional teacher-centered instructional practices, such as relying heavily on textbooks, lectures, and scientific facts. Instead, they promote inquiry-oriented approaches that involve (a) capturing student interest in science, (b) providing opportunities for students to utilize appropriate laboratory techniques to gather evidence, (c) requiring students to solve problems using logic and evidence, (d) encouraging students to conduct further research to develop more detailed explanations, and (e) emphasizing the significance of writing scientific explanations based on evidence (Secker, 2002). Students flourish when have the chance to investigate scientific facts, carry out experiments, and formulate their findings. By transitioning from mechanical memorizing and adopting a more investigative approach, educators can enable students to

actively engage in their educational process. This not only fosters a more profound comprehension of STEM principles but also imbues a feeling of possession and enthusiasm for the subject matter.

Informant No. 21 shared, “The teacher should implement different instructional approaches such as multi-modal instructions, flexible groupings, and classroom technology to create an inclusive teaching environment.”

Moreover, students strongly support the integration of interdisciplinary links in STEM education. They acknowledge that the divisions between scientific disciplines are frequently indistinct in reality, and they appreciate educational opportunities that demonstrate this interconnection. Through the incorporation of technology, engineering, and mathematics components into science courses, educators may offer students a comprehensive comprehension of the interconnections and interconnections across these disciplines. Informant By doing this, they not only enhance the learning experience but also enhance students' readiness for the multidisciplinary aspects of contemporary STEM professions.

Informant No. 8 said, “There isn’t much innovation in approaches teachers do.”

Students frequently regard teaching approaches as effective when they actively participate in the learning process and can discern the significance of the subject to their life and future goals. Students in the STEM strand often appreciate hands-on learning experiences, interactive demonstrations, and project-based assignments because they offer possibilities for practical application and experimentation. Moreover, instructional approaches that promote cooperation, analytical reasoning, and the ability to solve problems are more likely to connect with students, as they acknowledge the significance of these abilities in addressing practical obstacles and pursuing jobs in STEM fields.

The Need for Active Learning Strategies. Active learning practices are essential in the STEM (Science, Technology, Engineering, and Mathematics) field because of the detailed and ever-changing nature of these subjects. Active learning involves directly engaging students in the learning process, which leads to a greater level of comprehension, the development of

critical thinking abilities, and the acquisition of problem-solving skills, as opposed to typical passive learning approaches. Active learning methodologies in STEM topics facilitate the exploration, experimentation, and collaboration of students, effectively bridging the gap between theoretical concepts and practical applications.

Informant 8 said, "There isn't much innovation to approaches teachers do. Most of the approaches are still traditional, introducing something innovative could boost students' morale".

Informant 10 also said, "Using a projector and using technology advancement. Offering a variety of activities like PowerPoint presentations and sometimes hands-on observations like being permitted to use a microscope and give teaching methods about robotics"

Informant 9 also shared, "The use of whiteboard instead of blackboards for an easier and cleaner environment. Incorporating a projector for each classroom instead of a TV. Use technology to help students be more focused. Do team collaboration for engagement. Do reporting to increase their confidence in class. Lacks in the learning performance because some of them already practice us for self-reviewing (basically they give you the topic and you're on your own to understand it.)"

An important reason to use active learning methodologies in the STEM field is their capacity to cultivate inquiry and interest in students. By promoting exploration and experimentation, these approaches enable learners to inquire, pursue solutions, and establish links between theoretical concepts and actual situations. Active learning engages students in the process of discovery, fostering enthusiasm and a sense of responsibility for their learning journey, whether through hands-on experiments, group discussions, or problem-based projects.

Contextualizing the Teaching Process. It is important to contextualize the teaching process within the STEM (Science, Technology, Engineering, and Mathematics) field to promote significant learning experiences and equip students with the ability to apply their knowledge in real-world situations. Contextualized teaching in STEM education involves integrating relevant and authentic contexts into training, which helps students grasp the practical consequences and societal

significance of what they are studying, as opposed to teaching concepts in isolation. By establishing connections between abstract ideas and tangible instances and common occurrences, instructors can stimulate students' inquisitiveness and drive while enhancing their comprehension of difficult subjects.

Informant 2 testified, "The STEM organization "ISER" implemented a weekly activity where students engage in interactive learning. A teacher prepares a PPT for her lesson and illustrates the visuals of the lesson by drawing it on the board while explaining it. It is very effective for students with diverse learning styles."

Informant 6 said "Teachers apply an aligned teaching strategy. Constantly asking of the teaching pace to adjust to the preference and compatibility of the students"

Informant 7 said "Teachers incorporate interactive games during lessons. Teachers divide the class into groups and assign different tasks such as acting, illustration, or creating a song. Their methodologies often result in enthusiastic participation however passivity among students may occur, highlighting the need for varied approaches."

An essential element of contextualizing the educational process in the STEM strand involves basing courses on practical problems and challenges that exist in the real world. By incorporating real-life situations into the curriculum, students are given the chance to utilize their knowledge and abilities purposefully, whether it be in the realm of environmental sustainability, technology advancements, or data analysis. This technique not only improves students' understanding of STEM subjects but also fosters critical thinking and problem-solving skills that are important in tackling the urgent challenges confronting society in the present time.

4. The Influence of STEM Strand Implementation on the Students' Interest in Performance in Science and Mathematics

The incorporation of the STEM (Science, Technology, Engineering, and Mathematics) strand has had a substantial impact on students' engagement and achievement in the fields of science and mathematics. STEM education provides students with a thorough understanding of the interconnections and practical relevance of these areas by integrating them into an integrated structure. By actively participating in

experiential learning, students are actively involved in the investigation of scientific phenomena, the solution of mathematical problems, and the application of engineering principles to tackle real-world situations. This method not only promotes inquisitiveness and innovation but also nurtures analytical reasoning and problem-solving abilities that are important in achieving success in the fields of science and mathematics. Plus, being exposed to career options in STEM fields and role models serves as a source of inspiration for students, motivating them to seek advanced studies and careers in STEM-related sectors. This, in turn, results in heightened motivation and academic success in the subjects of science and mathematics.

Enhanced Motivation, Interest, and Commitment to STEM Education. STEM education has greatly bolstered students' commitment, interest, and commitment. The use of an interdisciplinary approach to education facilitates a more profound comprehension of practical issues and motivates students to actively participate in their academic pursuits. Through the integration of these fundamental courses, students can perceive the interrelationships among other fields, so igniting their desire to learn and propelling their aspiration to acquire further knowledge. Consequently, their motivation to achieve academic excellence and pursue professions in STEM-related fields is heightened. Several respondents shared their insights on this.

Informant No. 10 expressed, "There is a positive shift in students' attitudes towards science and mathematics, it increases interest, enthusiasm, and appreciation for the major subjects."

Informant No. 2 stated, "Students are more motivated to learn the areas of mathematics and science. I do not enjoy solving mathematics problems, but because the teacher explains the topics effectively, it excites me to solve the problem because I understand the process of solving it, the same goes with science."

Informant 2 also testified, "I hate Science but when I entered the STEM strand, I realized how this strand changed my weaknesses to strength. It boosts students' interest in science and math".

Informant 3 said "Made me contemplate that there are more options to consider on what path to pursue in the

future. I became more active and participated in the lessons"

The increased motivation and interest in STEM education reflects the transformative impact the STEM strand has on students' attitudes towards traditionally challenging subjects like science and mathematics. The perception of STEM as a catalyst for heightened motivation is rooted in the effective teaching methods employed within the strand. Research by Hidi and Renninger (2006) underscores the significance of situational interest in learning, emphasizing that when students find activities intrinsically interesting, their motivation to engage and persist in those activities increases. In the context of STEM education, this suggests that the hands-on, problem-solving nature of STEM activities may serve as powerful stimuli, igniting students' interest and motivation.

Informant No. 4 voiced, "Integrating technology, engineering, and practical problem-solving challenges in STEM enhanced the grit of students in learning."

Also, informant No. 3 said, "I hate science but when I entered the STEM strand, I realized how this strand changed my weaknesses to strength."

Informant No. 14 voiced, "Some students show increased interest in science and mathematics when taught in the context of STEM."

The hands-on element of STEM education is identified as an essential component that contributes to elevated motivation. Students are provided with the chance to employ theoretical principles in real-world scenarios employing conducting experiments, carrying out projects, and engaging in problem-solving endeavors. The use of an active learning strategy not only enhances the enjoyment of the learning process but also facilitates the cultivation of critical thinking and problem-solving abilities among students, both of which are of the utmost importance in STEM fields. As students perceive the practical applicability of their learning to actual-life situations, their inclination towards STEM courses inherently intensifies, hence fostering elevated motivation to achieve success.

Informant no. 17 testified, "A lot of the STEM students like scientific and mathematical research which shows their interest in science and math."

Informant no. 7 also testified, “STEM strand can ignite newfound interests in science and technology among students.”

The motivation and interest in STEM education highlight the distinctive commitment and active involvement of STEM students, specifically in research and competitions. The analysis suggests that the STEM approach fosters a unique culture of dedication to academic excellence and students within the framework exhibit heightened commitment in both their coursework and extracurricular pursuits. This aligns with the broader educational literature emphasizing positive engagement and academic success (Fredricks, Blumenfeld, & Paris, 2004).

STEM students' dedication is a testament to the effectiveness of the STEM approach in cultivating a passion for learning and a strong work ethic. The immersive, hands-on nature of STEM activities provides students with meaningful and challenging experiences, tapping into intrinsic motivation (Ryan & Deci, 2000). This intrinsic motivation is a key driver of dedication, leading students to invest time and effort in their academic endeavors, particularly in research projects and competitions. The literature on motivation and engagement underscores the importance of fostering a sense of autonomy, competence, and relatedness, all of which contribute to sustained dedication and engagement (Ryan & Deci, 2000; Skinner & Belmont, 1993).

Informant No. 18 shared, “Students exhibit heightened engagement in conducting high-quality research with some even participating as contestants in the division, regional and national competitions.”

The cooperative nature of STEM education fosters collaboration and trust among students. Collaborative engagement in group projects or experiments fosters the exchange of ideas, enhances effective communication skills, and promotes mutual support among students. This cooperative setting cultivates a feeling of inclusion and motivates students to assume responsibility for their education. Individuals exhibit higher dedication toward their academic pursuits and demonstrate a willingness to allocate the necessary time and exertion to achieve success in STEM domains. In short, the incorporation of the STEM strand in education has not only enhanced academic achievements but has also motivated a fresh breed of entrepreneurs and troubleshooters who are

deeply committed to effecting positive change in the world.

Developed Innovative, Creative, and Problem-Solving Skills through STEM Education. The STEM strand in education has received much attention in recent years due to its focus on developing essential skills for the global workforce. The STEM strand is designed to cultivate imaginative, creative, and problem-solving skills in students, in response to the demand for persons with competence in disciplines that drive technological breakthroughs. This theme explores how the STEM pathway cultivates these critical skills, therefore equipping students for the demands of the 21st century.

Informant No. 1 stated, “STEM strand accompanies the eagerness of future innovators, multipotential students that aspire convenience and solution for prevalent problems.”

The STEM field is centered around creativity and innovation. The STEM strand promotes a culture of inquisitiveness and investigation, motivating students to think creatively and imagine innovative solutions to current challenges. Students are allowed to exercise their creativity by engaging in activities such as designing prototypes, coding innovative software, and formulating scientific theories. Furthermore, the interdisciplinary character of STEM education enables students to establish correlations among seemingly disparate topics, thus cultivating inventive cognition and expanding the boundaries of understanding.

Informant No. 19 testified, “Exposing STEM students to research work, worded problems and experiments develop their ability to think critically, reason out scientifically, and solve problems.”

Informant No. 14 also testified, “Students see the relevance of the subject in solving practical problems, making them more interested in understanding and applying scientific principles.”

The STEM strand places significant importance on experiential learning opportunities. STEM education promotes active student engagement with the topic through experimentation and application, in contrast to traditional rote-based learning approaches. The STEM strand offers students the chance to apply theoretical knowledge in practical contexts, such as constructing robots, performing fieldwork in biology, or creating

software applications. By engaging in practical activities, students not only strengthen their comprehension of concepts but also develop their ability to solve problems by learning from their errors and making continuous modifications to their designs.

The exposure to technology within the STEM strand becomes a key driver for enhancing students' technological skills. Hands-on experience with tools, software, and equipment relevant to science, technology, engineering, and mathematics contribute to the development of practical and technical proficiencies. This aligns with literature emphasizing the importance of technology integration in education for skill development and preparing students for the demands of the modern workforce (Banks & Barles, 2014).

Enhanced Confidence and Technological Competitiveness through STEM Education. STEM education has become a fundamental aspect of modern educational frameworks, influencing the abilities and proficiencies of individuals in diverse fields. The impact of STEM education is significant as it can reinforce learners' confidence and enhance their technical competitiveness. By actively participating in STEM disciplines, individuals are introduced to problem-solving approaches, critical thinking frameworks, and practical experimentation, which contribute to the development of a sense of competence and confidence in their capacity to address complex issues.

Informant No. 9 said, "STEM strand gave me a chance to enhance my technological skills and learn to love science and math even more by exposing me to these techniques."

The recently acquired self-assurance extends beyond the boundaries of education, affecting professional fields and societal settings, therefore enhancing technical competitiveness at both the individual and collaborative levels.

The core of STEM education is around fostering a growth mindset, which entails inculcating in students the conviction that intelligence and abilities are not fixed characteristics but rather may be enhanced through commitment and exertion. This shift in thinking has implications for developing confidence, as individuals adopt a positive attitude towards challenges and perceive failures as chances for learning and personal

development, rather than obstacles. While participating in STEM activities, such as laboratory experiments or computer science projects, students face challenges that require them to be persistent and resilient. Conquering these obstacles promotes a feeling of achievement and strengthens their confidence in their ability to face future difficulties, therefore cultivating a strong sense of self-confidence.

Informant No. 17 stated, "A lot of them like scientific and mathematical research which shows their interest in science and math. The use of advanced technologies such as websites helps STEM to be actively engaged in Research."

The association of the STEM strand with the advancements in technology implies an integration of cutting-edge tools, resources, and methodologies into the learning environment. Literature on STEM education underscores the importance of incorporating current and advanced technologies to prepare students for the demands of the 21st century workforce (Moore, et al., 2014). The exposure to advanced technology not only enhances students' technological literacy but also provides them with a glimpse into the real-world applications of emerging technologies.

In brief, STEM education plays an instrumental part in cultivating increased self-assurance and technological aptitude among students. STEM education equips learners with the necessary tools and mindset to succeed in a technology-centric setting through the cultivation of a growth mindset, facilitation of technical proficiency, and fostering of collaborative efforts. As individuals leverage their recently acquired self-assurance and skills, they not only position themselves for achievement in their respective domains but also make valuable contributions to the overall improvement of society, fostering innovation and facilitating progress.

Broadened Career Perspective through STEM Education. The introduction and integration of STEM (Science, Technology, Engineering, and Mathematics) education have resulted in a significant transformation in students' professional outlooks, providing a wider range of prospects and routes within the domains of science, technology, engineering, and mathematics. STEM education surpasses conventional barriers by incorporating these fields into educational courses, fostering students' exploration of interconnectedness and application of knowledge in inventive manners. An

important impact of implementing the STEM strand is the expanded outlook it provides on possible vocations, enabling students to imagine themselves as professionals in various fields that utilize STEM skills.

Informant No. 7 narrated, "Our empowerment technologies subject ignited my interest in coding, at one time I was determined to pursue a career in computer science. Since the implementation of the STEM strand, I've observed a significant rise in students choosing careers in fields like medicine and engineering."

Informant No. 13 testified, "Most of the graduates of STEM strand pursue related to Math and Science as well as technology."

Informant no. 18 also testified, "STEM strand exposes students to a wide range of STEM-related courses and opportunities, helping them understand the diverse pathways available in science and technology fields."

STEM education is often regarded as a platform that exposes students to a diverse array of opportunities, fostering a deeper understanding of careers in science, technology, engineering, and mathematics. This aligns with the literature on STEM education's capacity to provide students with a broader view of the professional landscape (Bybee, 2013).

Observations indicating an increased interest in careers such as medicine and engineering underscore the tangible impact of the STEM strand on shaping students' career aspirations. Studies, such as the one conducted by Maltese and Tai (2011), have highlighted the critical role of STEM education in influencing students' career choices. Exposure to STEM activities and projects can catalyze students to envision themselves in professions traditionally associated with science and technology. This not only opens up new possibilities but also addresses the issue of underrepresentation in STEM fields by encouraging diverse groups of students to consider STEM careers (National Academy of Sciences, 2011).

The interdisciplinary character of STEM education promotes the exploration of connections across many fields and disciplines, thereby cultivating a comprehensive comprehension of intricate phenomena. Through engaging in multi-disciplinary tasks and collaborative endeavors, students cultivate an advanced viewpoint that surpasses conventional disciplinary

limitations. The adoption of an interdisciplinary perspective not only enhances individuals' educational experiences but also provides access to many employment prospects that necessitate the integration of knowledge from multiple fields. The incorporation of STEM subjects, such as biology, renewable energy, and urban planning, allows students to imagine occupations that encompass various domains, providing a comprehensive and dynamic approach to problem-solving and creativity. Several insights from the respondents have proven this point.

Informant No. 12 stated, "By using the microscope, a lot of students are amazed at using it. It influenced them to take biology courses in college."

Informant No. 15 also stated, "It continuously reiterates the importance of producing quality professionals in the fields of Science, technology, engineering, and mathematics to support national and sustainable targets,"

Informant No. 8 also shared, "It helps me boost my confidence in taking a STEM-related course in college that they thought would be paying high rates."

The implications of broadening career perspectives through the STEM strand are significant. Firstly, it contributes to breaking down stereotypes and misconceptions about STEM professions, making these fields more accessible and appealing to a wider range of students (President's Council of Advisors on Science and Technology, 2010). Secondly, by fostering interest in careers such as medicine and engineering, STEM education plays an essential role in addressing the growing demand for skilled professionals in these sectors, contributing to the national workforce development. Lastly, exposure to diverse STEM-related careers creates a more informed and empowered student body, equipping them with the knowledge needed to make informed decisions about their educational and career paths.

V. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of the study, the researcher concludes that the implementation of the STEM strand in Gallanosa National High School represents a comprehensive approach to education that enhances students' learning outcomes and equips them with the skills and confidence needed for future success. The areas for improvement in the STEM strand

implementation in Gallanosa National High School are the inadequacy of interdisciplinary STEM integration, hands-on learning opportunities, pedagogical strategies, and support for student engagement and involvement in STEM activities. The varied teaching methodologies employed by teachers foster an engaging and impactful learning environment that prepares students for the challenges and opportunities in STEM fields and beyond. A well-designed STEM education program enhances academic performance and shapes students' attitudes, aspirations, and capabilities, setting the stage for a future generation of scientifically and mathematically literate individuals prepared to excel in diverse fields

In the light of the foregoing conclusions, the following recommendations were offered: (1) Preparing students for the evolving demands of the STEM field, advanced technologies be integrated into the curriculum to foster competitiveness and innovation. (2) Allocating and ensuring that laboratories and learning spaces are well-equipped to support hands-on learning through additional resources for infrastructure development. (3) Building partnerships with stakeholders for potential sponsorships and technical assistance of research and innovations be strengthened. (4) Exploring diverse teaching styles and methods that accommodate various learning preferences through ongoing professional development for teachers. (5) Establishing and ensuring a continuous professional development program for teachers that will promote advanced learning methodologies and competency-building to keep them abreast of the latest educational trends and content. (6) Initiating a sustainable model for ongoing teacher skill development to ensure that the projects' benefits have a lasting impact on the overall quality of STEM education at Gallanosa National High School. (7) Conducting further similar studies to the present undertaking to highlight the impact of STEM programs on students' achievement.

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