Examining Multiple Intelligences and Performance of Science, Technology, Engineering, and Mathematics (STEM) Students in the Specialized Subjects

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ABSTRACT

This study generally examined the multiple intelligences of the Senior high school (SHS) students under the Science, Technology, Engineering, and Mathematics (STEM) strand and their performance in the specialized subjects. Descriptive and comparative research designs were utilized to measure the variation among the identified study variables. It involved 193 STEM students (composed of 94 males and 99 females) who were selected using complete enumeration sampling. Secondary data on students’ performance in the specialized subjects and an adopted Multiple Intelligence Inventory survey questionnaire were employed to collect the data. The T-test for two independent samples was likewise used to examine the significant difference between the performance in the specialized subjects of students with STEM strand as their preferred choice and those who do not prefer STEM. Based on the results, interpersonal intelligence was shown to be the most dominant intelligence type among STEM students, whereas logical intelligence was determined to be the least dominant. On the specialized subjects’ performance, the students demonstrated very good to superior performance in pre-calculus, general biology, and basic calculus subjects. Meanwhile, the study indicated no significant difference in the specialized subjects’ performance between students with STEM strand as their preferred choice and those who do not prefer STEM. Career guidance orientation for students must be reinforced so that they can be advised on what career track or strand to take in senior high school. Future related studies are suggested to further substantiate the results.

Keywords: Multiple Intelligence, Senior High School Students, Specialized Subjects, STEM Strand.

I. INTRODUCTION

The Science, Technology, Engineering, and Mathematics (STEM) strand of the Senior High School (SHS) curriculum’s Academic Track is essential for a country to develop and grow. To stay competitive in the scientific and technological quest and to remain relevant in a rapidly changing global environment, several countries around the globe place a greater emphasis on STEM education (Kazu & Yalçın, 2021). This is why in the Philippine context, students are encouraged to pursue the STEM strand at the senior high level due to its appeal and employment prospects; it is regarded as one of the most significant and in-demand professions (Maksimović, 2020), especially for students who want to engage in the future scientific and technological developments. On the same note, the competence of students in the science and mathematics fields could help them overcome the hurdle of wanting to pursue STEM. The degree to which a student is interested in a STEM career will directly affect his or her motivation to pursue one in the future (Razali, 2021). However, some students may be engaged in a senior high school strand that does not correspond to their intelligence type.

For many years, intelligence has been linked to academic performance (Al Hosni & Manthari, 2021; & Aydin, 2019). According to Yavich and Rotnitsky (2020), psychologist Howard Gardner's Multiple Intelligence (MI) theory is based on the notion of intelligence being described as the capability to solve problems and generate products in a variety of ways. Gardner's MI theory is widely used in the field of education since it helps teachers choose the most effective methods for teaching that are appropriate for the various types of intelligence and enhance students' learning. Yavich and Rotnitsky (2020) further specified that students apply what they learn in class in the most efficient manner for them, taking into account their dominant intelligence. Winarti et al. (2019), on the other hand, noted that teachers’ emphasis on academic ability as the only factor in successful learning prevents learning from cultivating students’ MI, despite the fact that MI can be utilized to help students realize their full potential and sharpen their cognitive abilities.

The inclination to choose the STEM strand, along with the
dominating intelligence of students, could help enhance their learning experiences. Likewise, it is vital for STEM students to recognize their intellectual qualities in order to adapt to and thrive in their academic pursuits (Yildiz et al., 2020). It is as well essential to understand students' academic progress and to pay attention to the many forms of intelligence as well as the teaching approaches that are best suited to the students' intelligence type (Al-Saeedi et al., 2011; Al Hosni & Manthari, 2021). The complexity of the strand, as well as the specialized subjects they are taking as part of their program, provide significant challenges to STEM students. The specialized subjects are those that are specific only to the student's chosen career track or learning strand. Although they are intended to be less sophisticated than their college equivalents, these are comparable to the major disciplines taken by college students (Senior High School in the Philippines, n.d.).

Despite the fact that there have been several studies on the multiple intelligences and scholastic performance of secondary school students, most of them come from international situations, with only a handful from the Philippine context. There is also a dearth of research in the Philippine context that analyzes students' most to least dominant intelligence types, particularly those pursuing STEM. A thorough examination of the difference in specialized subjects’ performance between students who choose the STEM strand as their preferred option and those who do not, has not yet been established. Hence, this study intends to fill in the gap in the literature and provide teachers, curriculum planners, and the entire academic community with information that will help improve SHS programs, particularly the STEM strand. This present study further intends to assist not only SHS teachers but also parents to take into account their children’s dominant intelligence types so that they can be guided in making decisions that will help them realize their full potential.

A. Objectives of the Study

Generally, the multiple intelligences of Senior high school (SHS) students in the Science, Technology, Engineering, and Mathematics (STEM) strand were examined in this study, as well as how well they performed in the specialized subjects. This present study specifically sought to answer the following objectives:

- To determine the most to least dominant intelligence types of students with STEM strand as their preferred choice and those who do not prefer STEM.
- To determine the performance level in the specialized subjects of students with STEM strand as their preferred choice and those who do not prefer STEM.
- To examine the difference in the specialized subjects’ performance between students with STEM strand as their preferred choice and those who do not prefer STEM.

The study advanced the null hypothesis of no significant difference in the specialized subjects’ performance between students with STEM strand as their preferred choice and those who do not prefer STEM.

II. METHODOLOGY

The study utilized descriptive and comparative methods of research. The descriptive method was used to describe the multiple intelligences of students as well as their performance in the specialized subjects. Meanwhile, the comparative method was utilized since this study is concerned with examining whether the performance of students in the specialized subjects with STEM as their preferred choice is significantly different from the performance in the specialized subjects of students who do not prefer STEM, or otherwise.

The study was conducted in a certain Laboratory School in the Eastern Visayas region. The said laboratory school is situated in the City of Tacloban which is the capital of the Leyte province in Eastern Visayas, Philippines. Further, it is under the institution’s teacher education department and is presently offering Junior and Senior high school programs for its constituents.

Using the complete enumeration sampling, a total of 198 STEM students enrolled during the academic year 2021-2022 were targeted to participate in the study. However, in the actual gathering of data, there were 5 students who did not respond to the survey conducted. As a result, a total of 193 students (composed of 94 males and 99 females) were included in the final counting, as likewise shown in Fig. 1.

The study utilized the Multiple Intelligence Inventory survey questionnaire adopted in the study of Menevis (2011). The survey comprised of Gardner’s 9 multiple intelligences namely, existential intelligence with 13 statements, intrapersonal intelligence (7), verbal intelligence (10), naturalist intelligence (15), musical intelligence (10), interpersonal intelligence (12), logical intelligence (9), kinesthetic intelligence (9), and visual intelligence (8), with a sum of 93 statements. The statements found in the Multiple Intelligence Inventory were used to determine the most to least dominant intelligence types of students with STEM strand as their preferred choice as well as those students who do not prefer STEM.

Prior to the conduct of this study, the researcher made a request letter to ask permission from the school head with attached copies of the study’s objectives, the survey questionnaire, and the rationale specifying the purpose of the study.

Fig. 1. Distribution of STEM students according to sex.
After permission was approved, the researcher ensured that the STEM students were not forced to participate in the study based on informed consent. They were likewise provided with adequate information about the study at the beginning of the survey. The students’ participation was voluntary, and they were informed that their grades would not be affected should they choose to withdraw their participation at any time. Additionally, all relevant data gathered from the students were solely used for the purpose of this study, and their identities were treated with confidentiality.

The survey questionnaire through Google survey forms was given to the STEM students, providing them adequate time to respond. Google Forms is free online software from the Google Docs editor suite that helps users create a survey that can be accessible and answerable by the participants. The responses are recorded and seen by the user that created the form. In this study, all the data gathered from the participants were removed from the researcher’s computer after data analysis.

Moreover, when asked if STEM was their preferred strand upon entering Senior high school, nearly three-fourths of the STEM students (70.98%) replied Yes and more than one-fourth (29.02%) said No, indicating that they enrolled in the STEM strand despite not finding it to be their top choice.

The performance of STEM students in the specialized subjects, as defined by their grades in the subjects, was retrieved from the registrar’s office of the target locale. The gathered records comprised the performance of STEM students in Pre-Calculus, General Biology, and Basic Calculus.

Further, the gathered data were summarized and displayed in tabular and graphical formats. The researcher also utilized the frequency counts, percentages, and means in describing the STEM students’ profile in terms of sex and STEM strand preference, and their performance level in the specialized subjects. Meanwhile, the standard deviations and weighted means were used to determine the students’ most to least dominant intelligence types.

The T-test for two independent samples was likewise used to examine the significant difference between the performance in the specialized subjects of students with STEM strand as their preferred choice and those who do not prefer STEM. A significance alpha of 0.05 was set for the study. The processing of data was computerized using Microsoft Excel (descriptive statistics) and Statistical Package for the Social Sciences (inferential statistics).

III. RESULTS AND DISCUSSION

Tabular and graphical presentations of the results supplemented with simplified discussions to facilitate understanding were presented in this section.

Table I reveals that the most prevailing intelligence of students who prefer STEM was intrapersonal intelligence, with a weighted mean of 3.77, followed by naturalist intelligence and musical intelligence with weighted means of 3.69 and 3.61, respectively. It can be observed, however, that the logical intelligence type, which is predicted to predominate among the 137 students who preferred the STEM strand, was determined to be the least prevalent intelligence type. The STEM students’ visual intelligence, which is likewise anticipated to be one of the prevailing intelligence types was only ranked at the midpoint.

The result shows that although the students preferred the STEM strand, perhaps they were not provided enough details. For this reason, a career guidance orientation for students must be reinforced so that they can be advised on what career track or strand to take up in senior high school. The ability to enjoy the strand they are taking and reach their full potential may be aided by an early diagnosis of the students’ dominant intelligence types (Winarti et al., 2019; Gonzales & Montoya, 2019).

Table II indicates that the most dominant intelligence of STEM students who do not prefer their strand was likewise intrapersonal intelligence, with a weighted mean of 3.86. It was followed by the naturalist intelligence with a weighted mean of 3.71 and the musical intelligence with a weighted mean of 3.6, respectively.

| TABLE I: INTELLIGENCE TYPES OF STUDENTS WITH STEM AS THEIR PREFERRED CHOICE | WM | SD | Rank |
|---|---|---|---|
| Existential | 3.52 | 0.72 | 6 |
| Intrapersonal | 3.77 | 0.59 | 1 |
| Verbal | 3.43 | 0.55 | 8 |
| Naturalist | 3.69 | 0.55 | 2 |
| Musical | 3.61 | 0.57 | 3 |
| Interpersonal | 3.50 | 0.49 | 7 |
| Logical | 3.20 | 0.53 | 9 |
|Kinesthetic | 3.57 | 0.66 | 4 |
| Visual | 3.53 | 0.55 | 5 |

| TABLE II: INTELLIGENCE TYPES OF STUDENTS WHO DO NOT PREFER STEM | WM | SD | Rank |
|---|---|---|---|
| Existential | 3.56 | 0.70 | 6 |
| Intrapersonal | 3.86 | 0.55 | 1 |
| Verbal | 3.55 | 0.59 | 7 |
| Naturalist | 3.71 | 0.60 | 2 |
| Musical | 3.65 | 0.63 | 3 |
| Interpersonal | 3.60 | 0.54 | 5 |
| Logical | 3.40 | 0.53 | 9 |
| Kinesthetic | 3.64 | 0.64 | 4 |
| Visual | 3.55 | 0.52 | 8 |
Comparably, the first 3 dominating intelligence types of the 56 students with STEM as not their preferred choice are the same as those who are decided on the STEM strand they are currently taking. Meanwhile, the students’ logical intelligence was ranked the least prevailing intelligence type as also anticipated in this study, since it was assumed to be the reason why STEM is not their top choice. The students’ kinesthetic intelligence was also found to be at the midpoint compared to visual intelligence which is the second least prevailing type.

Despite not initially liking STEM, they may have chosen it because of possible factors like parental influence, socioeconomic background, and lack of access to alternative SHS programs. Thus, it is vital for students to pursue the career path they wish to take based on their dominant intelligence types (Neupane et al., 2018), as well as for parents to actively assist the students in achieving their aspirations. It is equally important for the teachers to take into consideration the students’ multiple intelligences during the teaching and learning process (Dawahdeh & Mai, 2021; Ahvan et al., 2016).

Fig. 3 presents the specialized subjects’ performance of students with STEM as their preferred choice. As gleaned from Fig. 3, the majority of students exhibited very good to superior performance in the specialized subjects, with more than four-fifths (87.60%) displaying very good to superior performance in pre-calculus. Correspondingly, about three-fifths (56.93%) of the students manifested superior performance in general biology, which is more than three times higher than the number of students with very good performance in this subject. In addition, slightly more than three-fifths (61.31%) of the STEM students demonstrated very good performance in basic calculus while nearly one-third (32.12%) demonstrated superior performance.
Meanwhile, it is quite remarkable that only 2 achieved a grade ranging from 75% to 80% described as having a passing score in pre-calculus and basic calculus, with no students recorded below 80% in general biology. However, out of the 137 students who prefer the STEM strand, it is somewhat disturbing that only 1 student obtained excellent performance in basic calculus which could mean that most students found the subject difficult to learn as they now have to comprehend complex concepts and procedures that are interconnected (Ghazali & Zakaria, 2011; Cabuquin & Abocejo, 2019).

As further demonstrated by the grand mean of 91, the result also indicates that even though the students who preferred STEM were far more likely to be interpersonally inclined than logically or visually inclined, they are still capable of doing well in the specialized subjects as expected for students pursuing STEM. This contends the finding of Pérez et al. (2014) who concluded that logical and kinesthetic intelligence types are the best predictors of students’ scholastic performance. The study’s results, however, differ from that of İkiz and Çakar (2010) who found that students with lower scholastic performance levels have lower verbal, logical, interpersonal, and intrapersonal abilities.

As reflected in Fig. 4, most students who do not prefer STEM likewise exhibited very good to superior performance in the specialized subjects, with more than nine-tenths (96.43%) showing very good to superior performance in the pre-calculus subject. Interestingly, their pre-calculus performance was 8.83% higher when compared to those who preferred the STEM strand. When taken as a group, the proportion of students who were able to obtain grades ranging from 91% to 95% could be a possible indicator affecting this variation in their pre-calculus performance.

Meanwhile, slightly more than two-thirds (67.86%) of the students demonstrated superior performance in general biology with only 7 students displaying very good performance in this subject. In addition, more than three-fifths (69.64%) of the students manifested very good performance in basic calculus which is about three times higher than the number of students in the subject with superior performance levels. Surprisingly, none of the 56 students who do not prefer STEM had grades in the range of 75% to 80% for all three of the specialized subjects as opposed to those who said they liked STEM, with 2 students obtaining a grade of 75% to 80% interval.

As likewise indicated by the grand mean of 91, the result shows that, while aptitude in mathematics and science subjects may help determine scholastic performance (Mingoa & Abocejo, 2021), particularly in specialized subjects, the STEM students who are not inclined in those disciplines may still excel, and that logical or visual intelligence types may not be the only measure (Mimid et al., 2020) of students’ success in STEM.

The mean difference in the specialized subjects’ performance of students who prefer and do not prefer the STEM strand they are taking based on the T-test is presented in Table III. As outlined in the table, the t-value is equal to 0.732 and the p-value is 0.465, indicating that there is no difference in pre-calculus performance between students who prefer and do not prefer the STEM strand. Similarly, there is no difference in general biology performance (as described by t-value = 0.921 and p-value = 0.358) between students who prefer and do not prefer STEM, and no difference in basic calculus performance between the two groups (as likewise shown by t-value = -0.263 and p-value = 0.793).

The results further imply that willingness to learn and excel in the STEM strand, complemented with the guidance and motivation provided by the parents and teachers, could result in students’ improved performance in specialized disciplines. The STEM strand preference does not necessarily influence students’ scholastic performance, as it does not matter whether the STEM students prefer the strand they are taking, or otherwise. Hence, the hypothesis of no significant difference in the specialized subjects’ performance between students with STEM strand as their preferred choice and those who do not prefer STEM is not rejected.

This study mainly focused on examining the multiple intelligences of Senior high school (SHS) students in the Science, Technology, Engineering, and Mathematics (STEM) strand, as well as how well they performed in the specialized subjects. In view of the results, interpersonal intelligence was the most dominant intelligence type among students who prefer STEM, whereas logical intelligence was found to be the least prevailing type. The students who were enrolled in the STEM strand despite not finding it to be their top choice also showed dominance in interpersonal intelligence and least in logical intelligence. Early diagnosis of students' dominant intelligence types before taking Senior high level is suggested in order to assist the students in deciding what future career path may be pursued based on their dominant intelligence type; this could help the students do extremely well and reach their full potential in their chosen field. Moreover, the students with STEM as their preferred strand exhibited very good to superior performance in the specialized subjects, the same performance level in the specialized subjects was shown by those who do not prefer STEM. The study likewise confirmed no significant difference in the specialized subjects’ performance between the two groups.

Future related research may be conducted to further substantiate the results of this study. Involving STEM students from a larger range of institutions is likewise recommended to provide a more comprehensive view of the

| Variable                  | With STEM preference | Do not prefer STEM | With STEM preference | Do not prefer STEM | t-value | p-value | t-value | p-value |
|---------------------------|----------------------|--------------------|----------------------|--------------------|---------|---------|---------|---------|
| Pre-Calculus              | 90.60                | 90.96              | 92.63                | 93.11              | 0.732*  | 0.465   | 0.921*  | 0.358   |
| General Biology           | 89.61                | 89.46              | 89.61                | 89.50              | -0.263* | 0.793   |         |         |
| Basic Calculus            | 93.11                | 92.63              | 93.11                | 92.63              | 0.921*  | 0.358   |         |         |

*Not significant at 0.05
most to least dominant intelligence types of those students taking the STEM strand. Other variables like the involvement of parents in the students’ decision-making, motivation, overall academic success, socioeconomic background, and students’ access to SHS programs may be considered using a mixed-method approach.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

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