



STEM STRAND IN THE PHILIPPINES: AN ANALYSIS

Joel I. Alvarez

Faculty, Nueva Ecija University of Science and Technology, Cabanatuan City, 3100, Nueva Ecija, Philippines

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ABSTRACT

One of the Department of Education's (DepEd) programs is the K-12 program. They extended it for two more years to give students more time to consider their options for the future. The Senior High School (SHS) program had four tracks: Arts and Design, Sports, Technical and Vocational, and Academic, which included the Science Technology Engineering and Mathematics (STEM) strand. STEM is understood to be an integral part of math and science courses at the school level. It also contributed to the development of 21st-century abilities for all learners. This study determined the status of STEM students in the Philippines. Through descriptive research, this study described and analyzed the trends in the enrolment of STEM students as well as the factors that explain the dropout rate of STEM students. The data under this study came from a trusted source, which is the Department of Education's reports of enrollment from 2016- 2021. The enrollment rate and completion rate of SHS-STEM students are steadily increasing year after year. Thus, different intervention activities were proposed to address the identified factors that led to students dropping out of the STEM track. In addition, the findings of this study were used to improve the STEM strand's implementation in SHS and helped future generations as well as the Department of Education in the effective implementation of STEM education across the country.

KEYWORDS: *STEM, Department of Education, SHS, Enrollment rate, Completion rate.*

INTRODUCTION

"The function of education is to teach one think intensively and to think critically. Intelligence plus character – that is the goal of true education." – Martin Luther King.

Education plays a crucial role in shaping both individual lives and society as a whole, with educational institutions providing the foundation for students to enhance their self-confidence and acquire knowledge (Estonanto, 2013).

The K to 12 program, initiated by the Department of Education (DepEd), aims to extend basic education by adding two years, known as the Senior High School Program (SHS), to help students explore future options (Estonanto, 2013). SHS offers four tracks, including Arts and Design, Sports, Technical and Vocational, and Academic, with the Science Technology Engineering and Mathematics (STEM) strand being a part of the Academic track.

STEM education encompasses math, science, engineering, and technology, fostering critical thinking, problem-solving, leadership, and other 21st-century skills (Sahin, Ayar & Adiguzel, 2014; NCR, 2012). DepEd prioritizes the expansion of Special Science schools to promote Science and Mathematics education at all levels (DECS Order No. 69, s. 1993; DepEd Order No. 51, 2. 2010; DepEd Order No. 55, s. 2010). The curriculum emphasizes Spiral Progression across subjects to ensure students master knowledge and skills, aiming to develop globally competitive learners (DepEd Orders; NCR, 2012). By making STEM education accessible to all high school students, regardless of attending science-focused schools or universities, the curriculum seeks to enhance the quantity and quality of STEM education nationwide (DepEd Orders; Bishop, 2015). Early exposure to active learning activities enhances STEM content learning and academic preparedness in science and mathematics (Bishop, 2015).

According to Blotnicky et al. 2018; Wang et al. 2013, students with stronger self-efficacy in mathematics and STEM career knowledge are more likely to choose a STEM job. Subject teachers who consider the preparation of young people for work as an intrinsic part of their professional responsibility and who have the professional abilities and confidence to act on this have better STEM careers activities (Finegold, Stagg, & Hutchinson, 2011).



Students who wish to pursue a STEM field career may be disheartened by the diminishing number of students studying the strand if they lack sufficient knowledge about STEM-based careers. This may lead to misunderstandings and a decrease in their desire to participate in activities that increase their awareness and knowledge about STEM careers. Not all SHS graduates advanced to STEM-related courses in college. Despite assistance and initiatives to achieve a match and a decrease in degree-job mismatch after college, there was a decrease in students in the STEM field track (Harackiewicz, Rozek, Hulleman, and Hyde (2012).

Hence, this investigated the status of STEM students in the Philippines. The findings of this study were used to improve the STEM track's implementation in SHS and served as a model for all academic tracks. The findings of this study helped future generations as well as the Department of Education in the effective implementation of the STEM curriculum across the country in order to grow the STEM workforce sectors.

Statement of the Problem

This study determined the status of STEM students in the Philippines.

Specifically, this study seemed to answer the following questions:

- 1) How may the rate of the enrolment of STEM students in the Philippines be described in the past five years compared to the enrolment rate of other academic tracks?
- 2) How may the trends on the enrolment of STEM students be compared to the trends on the number of Grade 12 Completers of STEM track?
- 3) Is there a significant difference between the enrolment rate of STEM students and the number of completers of the STEM track?
- 4) How may the identified factors that explains the dropped-out rate of STEM students be described?
- 5) What intervention plan may be proposed with the result of the study?

Hypotheses of the Study

- 1) There is no significant difference between the enrolment rate of STEM students and the number of completers of the STEM track.

Theoretical Framework

This study underpinned the Progressive Education Theory of John Dewey. Progressive education, according to Dewey, is a "result of dissatisfaction with traditional education," which imposes adult norms, subject matter, and methodology. It is also defined as a vision of education that emphasizes the necessity of learning by doing. According to the John Dewey theory, people learn best through a hands-on approach. Furthermore, he considered that traditional education was out of reach for young students. According to Flinders & Thomson (2013), Dewey believed that effective education occurred mostly through social contacts, and that the educational setting should be considered a social institution.

John Dewey's theory that children, not content, should be the focus of the educational process has made an indelible imprint on educators who share his views on education and how children learn best (Schiro, 2013).

This theory suggests that educators should teach children how to think rather than rely on rote memorization. Also, the school was conceived of as a laboratory in which the child was to take an active part – learning through doing. This theory was applied in the current study in order to view the children as passive recipients of knowledge, and they certainly couldn't indicate whether they liked to learn more about a specific subject. Lastly, this theory satisfied the aims of the current in which his view of education was focused on the policy and view of most schools.

RESEARCH METHODOLOGY

Research Design

In this study, the researchers used descriptive research design in order to determine the status of STEM students in the Philippines. A descriptive study design tries to accurately and thoroughly characterize a population, situation, or phenomenon, and it answers the questions of what, when, where, and how. Furthermore, a descriptive research design uses a range of research methods to explore one or more variables.



In this study, a descriptive research design was used in order to describe and analyze gathered data regarding the trends in the enrolment of STEM students as well as the factors that explain the dropped-out rate of STEM students.

The researchers utilized this research design as the most appropriate for the study in order to gather data and statistically analyze data in order to define and determine variables in the study.

Focus of the Study

This study focused on the data of the Philippines regarding the status of STEM students. The data needed for this study is the enrolment rate of STEM students in the Philippines in the past five years and the enrolment rate of other academic tracks. In addition, data on trends in the enrolment of STEM students and factors that explain the drop-out rate of STEM students are also required for this study.



Source: mapsfordesign
Figure 2. Map of the Philippines

Statistical Analysis of Data

To interpret the data gathered by the researchers, the following statistical treatments are being utilized:

1. Frequency is being used to describe the rate of STEM students' enrolment in the Philippines. Also, to compare the enrolment rate of STEM students and other academic tracks, the Mean and T-test are being used.
2. To determine the trends in the enrolment of STEM students and the trends in the number of STEM completers, regression and predictive analysis were used.
3. A T-test was used to determine if there was significant difference between the enrolment rate of STEM students and the number of STEM track completers.
4. Mean and frequency are being used to describe the factors that explain the dropped-out rate of STEM students.
5. Thematic analysis is being used to propose the intervention plan.



RESULTS & DISCUSSION

Figure 4: Enrollment Rate of Academic Strands A.Y. 2016-2021

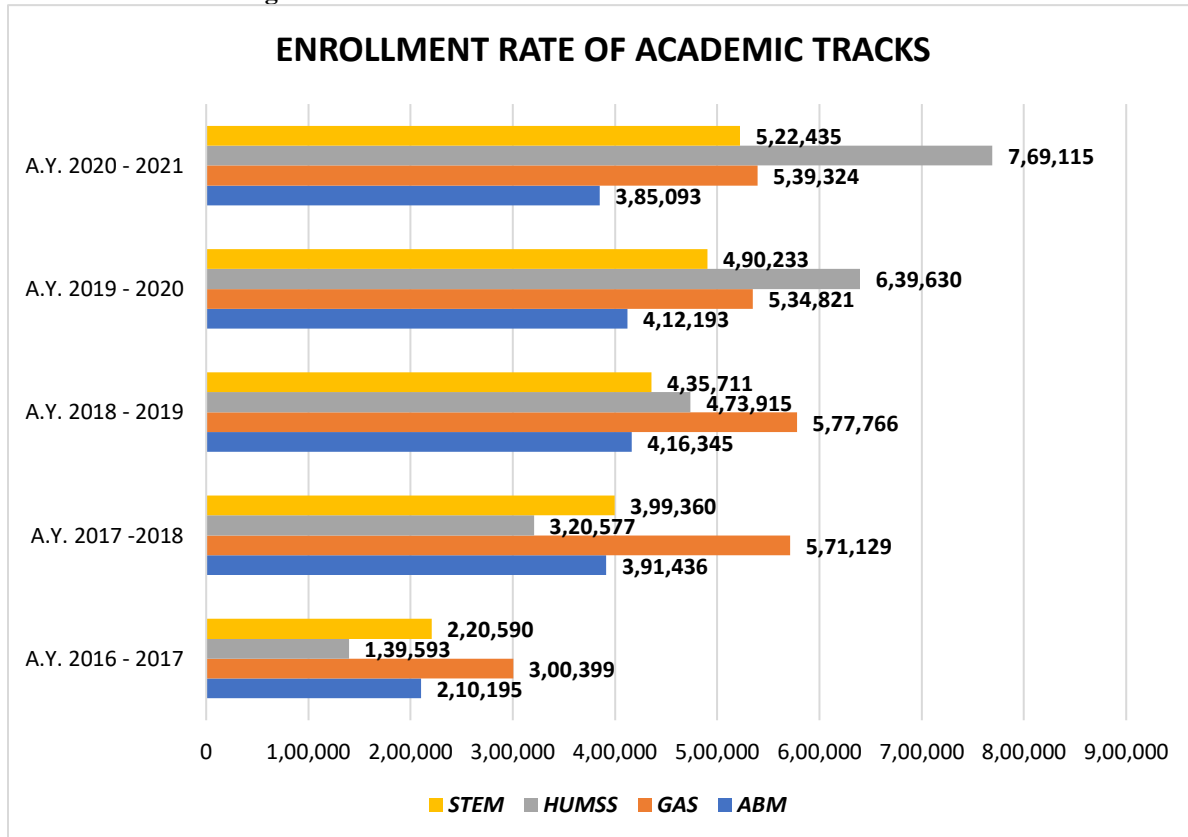


Figure 4 showed the enrollment rate of academic tracks for the past five years. In the academic year 2016-2017, the STEM strand obtained an enrollment rate of 220, 590, which had a difference of 79,809 enrollees and was less than compared to the enrollment rate of the GAS strand, which had 300,399, and STEM strand is 80,997 higher than the enrollment rate of HUMSS, with 139,593 enrollees, and 10,395 higher than ABM, with 210,195 enrollees. The STEM track obtained 399,360 enrollees, which is 171,769 fewer enrollees than GAS strand which had 571,129 enrollees in the year 2017-2018. In addition, the STEM strand is 7,924 higher compared to the enrollment rate of ABM, with 391,436 enrollees, and 78,783 higher compared to HUMSS, with 320,577 enrollees. In the academic year 2018-2019, the STEM track obtained 435,711 enrollees, which was a difference of 142,055 enrollees compared to the enrollment rate of the GAS strand, which had 577,766. It is also 38,204 lower than HUMSS, which had 473,915 total enrollees in the said academic year. Also, the STEM strand is 19,366 higher than the enrollment rate of ABM, with 416,345 enrollees. For the year 2019-2020, the STEM strand obtained 490,233 enrollees, which is 120,603 fewer enrollees compared to the enrollment rate of the HUMSS strand, which have 639,630, and the STEM strand is 78,040 higher than the enrollment rate of ABM, with 412,193 enrollees, and 122,628 lower than GAS, with 534,821 enrollees. In the academic year 2020-2021, the STEM strand obtained 522,435 enrollees, which had a difference of 246,680 enrollees compared to the enrollment rate of the HUMSS strand, which had 769, 115, and the STEM strand is 137,342 higher than the enrollment rate of ABM, with 385,093 enrollees, and 154,231 lower than GAS, with 539,324 enrollees.

Based on Figure 4, the strand with the highest enrollment rate for academic year 2016–2017 is GAS, followed by STEM, ABM, and HUMMS. In academic year 2017–2018, GAS had the highest number of enrollees, followed by STEM, ABM, and the least enrollment, HUMSS. In the year, 2018–2019, GAS is still leading among other academic strands and followed by HUMSS, STEM, and ABM. Lastly, HUMSS obtained the highest number of enrollees, followed by GAS, STEM, and ABM in the academic years 2019-2020 and 2020-2021.

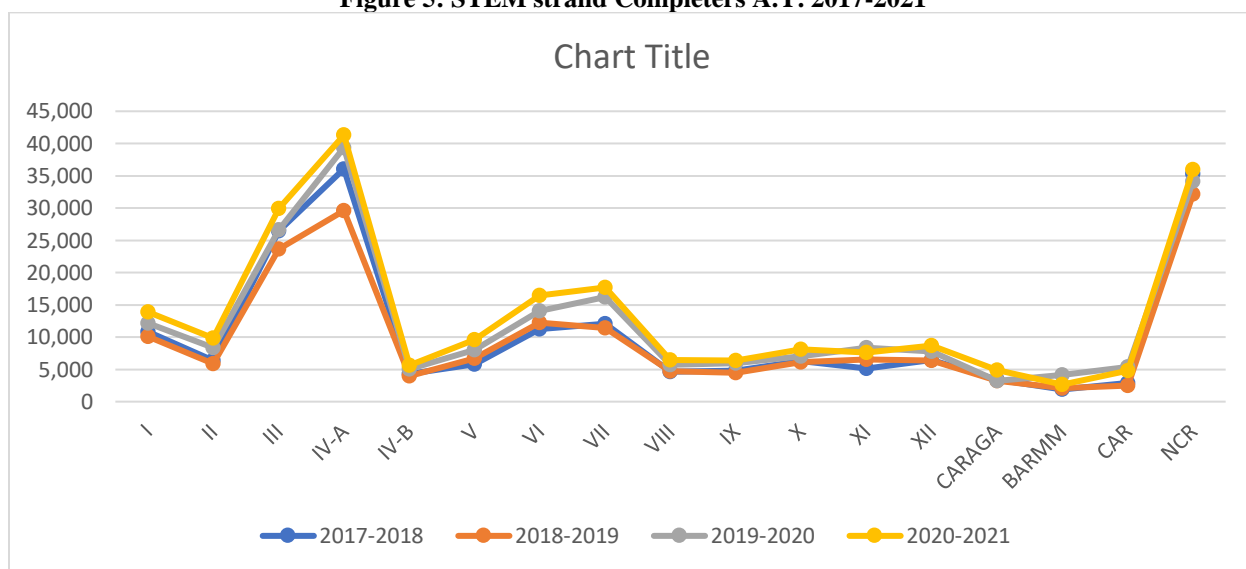
In June 2016, the Department of Education (DepEd) introduced senior high school (SHS) across the country, a new level of basic education that includes grades 11 and 12. In the first three (3) academic year since SHS launched, GAS obtain the highest enrollment



rate among other academic tracks. According to Cruz (2016), students who choose GAS are those students who are unsure and undecided about the path they want to take. Edukasyon.ph says that the General Academic Strand is ideal for students who are indecisive about their academic path. This program allows you to select electives from a variety of academic strands. Cueva (2019) says that if you're unsure or undecided about the road you want to choose, GAS is the strand offered in this track. What makes this great is that the courses given here are all-encompassing; that is, they cover every subject. The things that one can learn in this can help your uncertain mind explore your possible college options. To put it another way, this strand applies to all college courses.

A.Y. 2019 – 2020 and A.Y. 2020 – 2021, HUMSS got the highest number of enrollees among other strands in academic track. According to Klent (2020), HUMSS is one of the demand strands nowadays because they are the future servant in our country. HUMSS related job opportunities in the Philippines, from the biggest social enterprises to tech companies, people are finally realizing that in order to tackles today's social and technological problems, we need to think about these challenges in the human aspect De Guia (2018).

Figure 5: STEM strand Completers A.Y. 2017-2021



The figure showed the total number of SHS-STEM completers in the years 2017-2021. Based on the graph, the top 3 regions with the highest STEM completion rates in AY 2017-2018 are Region IV-A, accounting for 36,078, followed by NCR with 35,325 completers, and Region III with 26,486 completers. NCR leads 32,127 total number of completer, followed by Region IV-A with 29,622, and Region III with 23,627 in AY 2018-2019. In 2019-2020, the top 3 regions with the highest total of STEM completers came from Region IV-A with 39,362, followed by NCR with 34,135, and Region III with 26,602. Lastly, in AY 2020-2021, the highest total of STEM completers is from Region IV-A with 41,304, followed by NCR with 35,955 and from Region III with 29,946.

Based on the graph, Region IV-A had the highest number of STEM completers in the academic years 2017-2018, 2019-2020, and 2020-2021, while NCR had the highest number of STEM completers in the academic year 2018-2019. As we can see, the completion rates of SHS-STEM students have been continuously increasing from the year of the first completers of SHS up to academic year 2021. In addition, year-by-year, the completion rates of SHS-STEM students from the 17 regions of the country are also continuously increasing.

Students who entered in the STEM strand in June 2016 and graduated in the current year have left the STEM field. According to Barbosa (2019), only 87.32 percent of 1.4 million students who registered in Grade 11 STEM Strand continued to Grade 12, while 95.9 percent graduated. It means that as time passes, not all of the enrollees will have progressed to the same strand. Despite the assistance and activities, there was a drop in the number of students pursuing STEM careers (Papasin, 2015).



Table 1: t-Test Result: Paired Two Sample for Means

	<i>STEM Enrollment Rate</i>		<i>Grade 12 STEM Completers</i>
Mean	461934.75		199240.5
Observations	4		4
T Stat		15.6191002	
P(T<=t) two-tail		0.000570336	
t Critical two-tail		3.182446305	

Since the obtained p-value of 0.000570336 is less than the p-critical and significance level of 0.05, therefore, there is enough evidence to reject the null hypothesis “There is no significant difference between the enrolment rate of STEM students and the number of STEM completers. This means that there is a significant difference between the enrolment rate of STEM students and the number of STEM completers.

Several researches revealed that STEM majors were academically prepared especially in mathematics and science test scores, were successful when it comes to Grade Point Average (GPA), and persistent in earning a STEM degree (Chen, 2013; Chen & Ho, 2012; Mattern, Radunzel, & Westrick, 2015). Furthermore, Orale & Sarmiento (2016) discovered that SHS-STEM strand in the Philippines is better than that in Japan and the United States (US).

However, in the Philippines, STEM graduates are insufficient; hence, the country does not have sufficient scientists (Anito, Morales & Palisoc, 2019). The Philippines only has 189 scientists per million which is very low compared to the UNESCO recommendation which is 380 per million (Anito et al., 2019). The low number of scientists in the country is greatly attributed to the low graduates of STEM-related careers. The Commission on Higher Education (CHED) report revealed that the completion rate across STEM areas based on the average five-year data until 2016-2017 is only 21.10%. This scenario is further validated by EduTECH (2016) that the Philippines is experiencing shortages in the workforce in the field of STEM.

Rask (2010) states that the STEM program is very costly in terms of one’s motivation and future career potential as well. STEM education is one of the most in-demand strands in DepEd’s senior high school. With the K to 12 curriculum, more students became more competitive, especially in the field of science and technology, as well as in engineering and mathematics using advanced concepts and topics. As a result, the Philippine education system is continuously improving, and it also helps the students to be more globally competitive. But due to lack of scholarship opportunities, lack of parental support, and some other factors, many STEM students fail to finish their chosen careers.



Figure 6: Dropped-Out Rate of STEM Students A.Y. 2017-2021

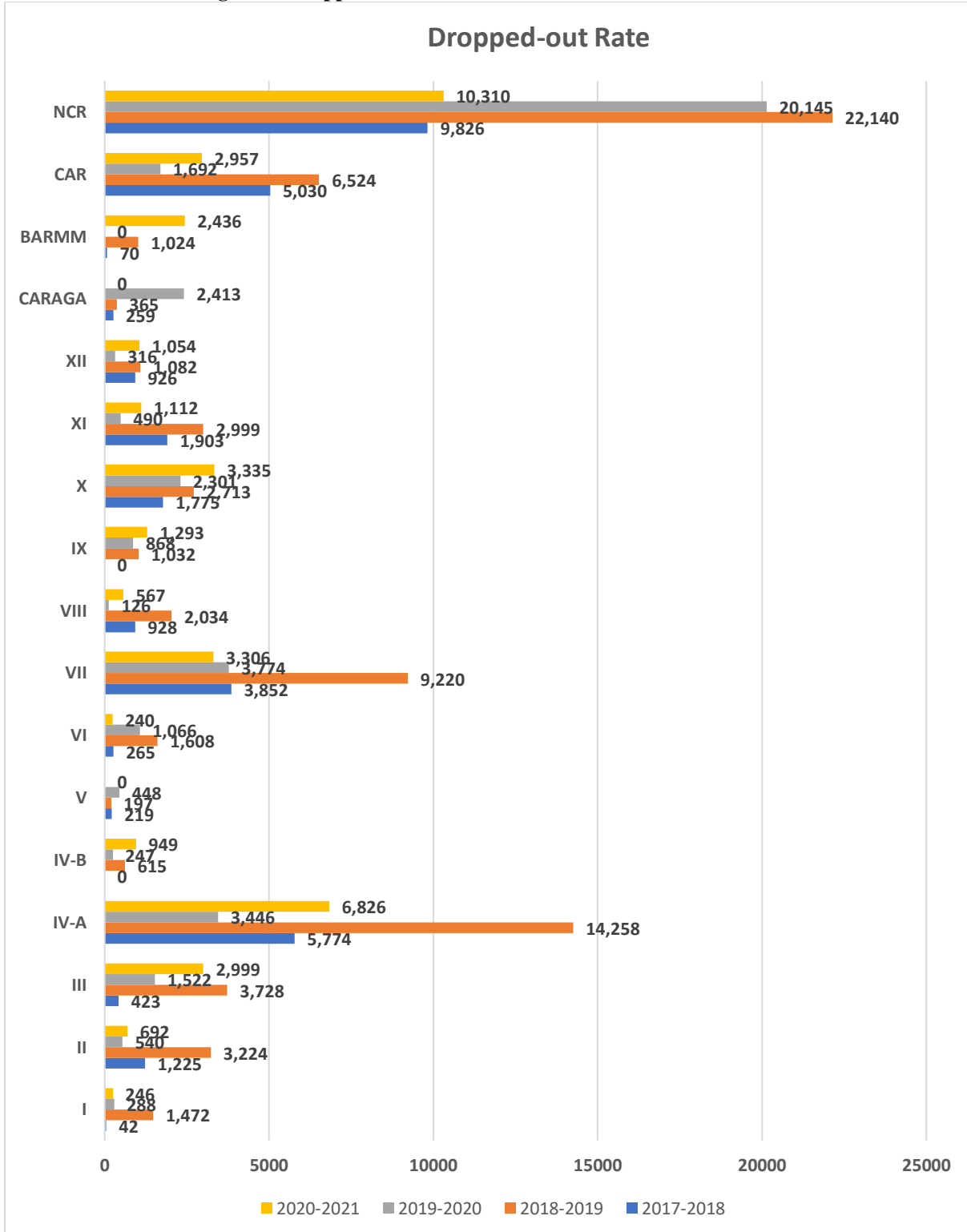




Figure 6 represents the dropped-out rate of STEM students in the different regions of the Philippines from Academic Year 2017-2021. It showed that National Capital Region (NCR) has the highest count of dropped-out STEM students from AY 2017-2021 accounting for 62,421 students.

Region IV-B and IX are the two regions with the lowest count of dropped-out students for AY 2017-2018, with a 0% drop-out rate. In AY 2018-2019, Region V has the lowest number of dropped-out students, accounting for 197. Lastly, BARMM, and Region V and CARAGA, AY 2019-2020, and 2020-2021, respectively, have a 0% dropped-out rate.

Formal education is regarded the route to a better life in developing countries, and the Philippines is on the list of perennials, persistent developing nations. Despite the fact that public education is free from primary to secondary school, the Philippines has the highest dropout rate of any ASEAN country (Borgen, 2019).

Based on the 2020 Census of Population and Housing (2020 CPH), the population of the Philippines as of May 2020 is 109,035,343, representing the total number of persons living in the 17 administrative regions of the country. With these 17 administrative regions, Region IV-A (CALABARZON) had the biggest population in 2020 with 16.20 million, followed by NCR with 13.48 million, and Region III (Central Luzon) with 12.42 million. Also included in the top five most populous regions were Region VII (Central Visayas) with 8.08 million, and Region VI (Western Visayas) with 7.95 million. That is why according to Bostwick (2019), because of the growing nation, there are shortages and dropout rate that are the norm throughout the country and are harming the countries well-being. In addition, funding for education in the Philippines as of 2018 is 672.41 billion, this funding is among the lowest budgeted among the ASEAN countries, that is why there is also a shortage of supplies in the classroom. Classrooms will sometimes have two or even three students sharing a single textbook. These are one of the reasons for the high dropout rate of STEM students in the Philippines.

According to Harackiewicz, Rozek, Hulleman, and Hyde (2012), without the proper knowledge about STEM-based careers, students who prefer to take a STEM field career might be discouraged with the decreasing number of students pursuing the strand. This may result in misconception and diminish their desire to participate in activities that may open awareness and knowledge about the STEM career. According to a new Pew Research Center Survey, more students don't pursue a degree in STEM because they are more likely to point the difficulty of these subjects. About half of adults say the main reason young people don't pursue STEM degrees is they think these subjects are too hard.

The alarming poor achievement results in science which were documented for many years are also one of the reasons for enhancing STEM education in the Philippines (Magulod, 2017). This poor performance in the primary science curriculum in the Philippines according to Bernardo (2004) is due to the inadequate science curriculum and poor preparation of STEM teachers. Moreover, the scarcity of instructional materials has also contributed to the dropout rate of STEM students (Tupas & Matsuura, 2011).

Rask (2010) states that the STEM program is very costly in terms of one's motivation and future career potential as well. STEM education is one of the most in-demand strands in DepEd's senior high school. With the K to 12 curriculum, more students became more competitive, especially in the field of science and technology, as well as in engineering and mathematics using advanced concepts and topics. As a result, the Philippine education system is continuously improving, and it also helps the students to be more globally competitive. But due to lack of scholarship opportunities, lack of parental support, and some other factors, many STEM students fail to finish their chosen careers. According to Andrada and David (2020), external motivation is one of the reasons why students leave STEM. The requirements and fear of getting low grades led most participants to think of dropping from STEM.

Lastly, according to Dang (2015), the lack of money is one of the major problems of the students to pursue STEM career. It is sad to think that some students do not achieve their dreams because of this problem. Some of them stop studying and just working.



Proposed Intervention Plan

Identified Factors	Intervention Activity	Length of Activity
1. Lack of budget due to growing populations. There are shortages of supplies in the classroom.	Supplemental Instruction Program (peer-led review sessions).	Two times per semester of academic quarter
2. Without proper knowledge about STEM-based careers that leads to misconception about STEM.	School-based orientation about STEM.	Four months per year (per semester or per academic quarter)
3. Poor preparation of STEM teachers.	Professional and Education Development Program.	Four months per year (per semester or per academic quarter)
4. Lack of external motivation (parental support)	Personal development programs and family mentoring sessions.	Four months per year (per semester or per academic quarter)
5. Lack of financial support.	Financial Aid Program for Students	Twice a month

CONCLUSIONS

As the result of the study, the researchers therefore concluded that:

1. The strands with the highest number of enrollees for the five consecutive years are GAS (2016-2017 to 2018-2019) and HUMSS (2019-2020 to 2020-2021).
2. Because of the highest number of enrollees in Region IV-A and NCR, they are the two regions with the highest number of STEM completers in the following years since the implementation of the K to 12 Program.
3. The numbers of STEM enrollees and completers are significantly different since the p-value is less than the p-critical and significance levels. The number of STEM enrollees is higher compared to the number of completers.
4. The NCR had the highest dropped-out rate of STEM students since it is the second region in the country to have the highest population, which is one of the main factors in STEM students' dropping-out.

RECOMMENDATIONS

To address the STEM students' enrollment and identified factors of the drop-out rate in the Philippines, programs and activities are recommended.

Since GAS and HUMSS got the highest number of enrollees for the past five years of the implementation of the K to 12 Program and STEM ranked second or third, the researchers recommended that SHS may design various activities during the career week wherein, these activities may include possible career paths in STEM courses, students' careers, and motivation. In addition, the school administration may also conduct an orientation about STEM so that students will understand the concepts of the STEM strand in SHS.

Moreover, to address the shortages of facilities and supplies in the classroom, there is a need to ensure that STEM education budgets are efficiently allocated to its respective areas. Also, STEM teachers must undergo education development to eradicate misconceptions about the program. Professional development of teachers is required to bring strong information in science and enable them to acquire new knowledge. Lastly, since external motivation is one of the factors of STEM drop-out, it is recommended that personal development programs and family mentoring sessions be conducted to guide students in their careers and motivate them to pursue STEM careers.

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