EVALUATION OF STE-GRADUATES' SENIOR HIGH SCHOOL SCIENCE AND MATHEMATICS PERFORMANCE

PIERRE JARED T. MORADOS
https://orcid.org/0000-0002-1226-6995
morados.etsmed@gmail.com
Science and Mathematics Education Department, University of San Carlos, Cebu City, Philippines

ABSTRACT

The Special Curricular Program in Science, Technology and Engineering is developed to cater students whose interests are in the fields of Science and Mathematics. To achieve its goals, the program enhances its basic education curriculum by offering additional science and mathematics subjects. Financial assistance is provided as well to schools implementing the program. However, the program seems to lack evaluation. There are no means of monitoring the students' performance, and no attempts were made to determine whether these students pursued Science-and-Mathematics related courses after graduation. Along this line, this study aimed to evaluate the program by comparing the performances of students who graduated in the program to those who did not. It also investigated whether these students tend to pursue career paths along the fields of science and mathematics. Earth Science and General Mathematics scores of 177 Grade 11 students from different academic strands were analyzed using Multivariate Analysis of Variance and Chi-square test. Results showed that there was a significant difference between the students' Earth Science and General Mathematics scores when grouped according to their junior-high program; that is, students who graduated from the program performed better than those who did not. On the other hand, there was no interaction found between the students' performance and gender. A significant association between the students' junior-high program and strands was also established; that is, majority of the students who graduated from the program is in the STEM strand, which prepares students for careers along the fields of science and mathematics. Despite the results, further studies may be done to include a wider range of variables that would better capture students' performance.

Keywords: Special Curricular Program in Science, Technology and Engineering (STE), STEM strand, Science and Mathematics performance, Career paths, Quantitative research

INTRODUCTION

Science education is a vital part of a country's success. This idea is ignited by the launching of the Soviet Union satellite, Sputnik 1, in the 1950's, which played an important role in science education (Wissehr, Concannon, Barrow, 2011; Schmid, 2018). In the United States, this event served as a wake up call that improvements and reforms in the curriculum must be made to produce students who are able to compete with the Soviets in what was then a new space age. This curricular change led to the emphasis on science and mathematics education, which was seen as a solution to win the science-and-technology race.

Almost seven decades later, the Sputnik-effect in science education has remained, not just in the US but all around the world (Schmid, 2018). This is evidenced by the continuous research in science education and science education programs aimed to reinforce science, technology, and engineering.

The Special Curricular Program in Science, Technology and Engineering (STE) is part of the continuing initiatives of the Philippines' Department of Education to strengthen the teaching of Science, Technology, and Engineering in the basic education. Particularly, this program is implemented to cater students in the junior high school, from Grades seven to ten; and is especially designed to nurture students who are naturally gifted in sciences and mathematics. The program enhances the K to 12 Basic Education Curriculum by offering add-on science and mathematics courses on top of its core subject requirements, geared towards the development of students along these areas (DepEd, 2004).

Incoming Grade 7 students must undergo a rigorous screening process before they may be admitted into the program (DepEd, 2017). First, they should meet the minimum average grade of 85 percent, with at least 85 percent grade in Science, Mathematics and English, and 83 percent in other subjects. The students are then subjected to an interview, together with their parents. Lastly, they should pass an admission test, and belong to the top scorers, depending on the number of students the school admits. Hence, it is safe to say that students in the STE program are relatively superior intellectually amongst other candidates. In addition, STE students are also privileged. Schools implementing the STE programs are provided with financial assistance, which may be used to support the students' school needs (DepEd, 2013). Thus, these students have access to facilities, which non-STE students may not enjoy.

Despite the governments' investments into this program, it seems to lack evaluation. Aside from the fact that students have to maintain an 85 percent average grade to stay in the program, there are no other means of monitoring these students' performances. Moreover, studies specifically dedicated to document STE students' performance are scarce. Further, there are no efforts spent to determine whether these students pursued Science-and-Mathematics related courses after they graduated.

OBJECTIVES OF THE STUDY

The current study aimed to evaluate STE-graduate students' performance in their senior high school by comparing the relative Science and Mathematics performance of students who are STE- and non-STE- graduates. The study also investigated whether STE students tended to pursue career paths along the fields of science and mathematics in their senior high school. Specifically, it sought to determine if: 1.) there is a significant relationship between the students' Earth Science (ES) and General Mathematics (GM) scores; 2.) there is a significant difference in the students' ES and GM scores when grouped according to: 2.1) gender, and 2.2 junior-high program; 3.) there is a significant association between the students' junior-high program and strands.

METHODOLOGY

This study was a non-experimental, retrospective explanatory research. By comparing STE- and non-STE- graduate students, it investigated if the performance of senior high school students can be explained by the junior-high program they graduated from. Despite the two-group comparison, there was no intervention introduced in the study. The grouping only relied on whether the students graduated from the STE or the non-STE programs, in which the researcher has no control with.

Data of 177 Grade 11 senior high school students from a public high school in Cebu, Philippines were utilized in the study. Particularly, they represented students from the academic strand – STEM (N = 73), ABM (N = 54), HUMS (N = 50) – offered in the said school. Fifty of these students graduated from the STE program while 127 graduated as non-STE.

Students' actual school records were utilized in the study. Before they were gathered, permission from the school's principal, as well as the advisers, was sought. Records of the students were then collected from their respective advisers, who decided to cooperate in

the conduct of the study. These records included the following:

School Form 14 in the first quarter. This form reflects the students' scores in their first quarterly examination. Here, students' scores in ES and GM were extracted. These two subjects, respectively, were core Science and Mathematics subjects that the students have to take regardless of the strand they were in. The quarterly examination was a single paper-pencil test, collectively made by all subject teachers, which covered the competencies listed in the curriculum guide for the first quarter. Moreover, it constituted 25 percent of the students' quarterly grade in these two core subjects (DepEd, 2015). Hence, the quarterly examination scores in ES and GM were utilized in the study, as measures of the students' performance in Science and Mathematics.

School Form 1. This form contains the students' demographic information (e.g. sex, parents' names, address, etc.), where the students' sex and academic strands were obtained from.

Class lists of STE classes in the previous school year. Every grade level in the junior high school of the participating school had two STE sections. Class lists of the previous school year's two Grade 10 STE classes were checked to determine which of this school year's Grade 11 students graduated from the STE program. Students whose names were not in these class lists were considered to graduate from a non-STE junior-high program.

After all the necessary data were collected, statistical analyses was done to attain the objectives of this study. First, to determine whether there exists a correlation between the students' ES and GM scores, Pearson's test of Correlation was employed. Then, to verify whether there was a significant difference between the ES and GM scores of STE- and non-STE- graduates, two-way Multivariate Analysis of Variance (MANOVA) was performed. This was done using their junior-high program and gender as independent variables, and ES and GM scores as dependent variables. Lastly, to find out whether there exists a significant association between the students' junior-high program and their chosen strands, Chi-square test of independence was done.

RESULTS AND DISCUSSION

To answer the research questions of the study, several statistical analyses were conducted. In the succeeding sections, results and discussion of these analyses are presented.

1. Relationship Between ES and GM scores

Using Pearson Correlation, it was found out that there exists a significant, $p < 0.01$ correlation between the students' ES and GM scores; that is, they were positively moderately correlated $r < 0.58$. This suggests that students who performed well in Science also did in Mathematics.

This result, showing a positive relationship between the students' performance in the two subjects, was an indication of the connection between science and mathematics. Throughout the history, these two disciplines have been interdependent with each other– that is, mathematics has paved the way for scientific inventions and innovations, while scientific studies have opened up new mathematical domains; hence, attempts to find connections between them are visible in many countries (Kiray, Gok, & Bozkir, 2015).

2. Comparison of ES and GM Scores of STE- and non-STE- Graduates

With the students' junior-high program and gender as independent variables, and ES and GM scores as dependent variables, two-way MANOVA was performed.

Table 1
Means and Standard Deviations of Students' ES and GM Scores When Grouped According to Their Gender

Gender	*N*	Earth Science		General Math	
		M	***SD***	***M***	***SD***
Male	71	39.37	0.56	33.80	1.13
Female	106	38.71	0.46	34.72	0.91

Table 2
Means and Standard Deviations of Students' ES and GM Scores When Grouped According to Their Junior-High Programs

Junior-High Program	*N*	Earth Science		General Math	
		M	*SD*	*M*	*SD*
STE	50	41.42	4.52	43.08	4.48
non-STE	127	38.01	4.42	30.91	8.65

Using Pillai's Trace criterion, results suggested that there was no significant, $F(2,172) = 2.81$, $p = 0.063$, difference in the students' scores when grouped based on their gender. However, a significant, $F(2,172) = 40.61$, $p < 0.01$, difference was found when students were grouped according to their junior-high program; that is as Table 2 shows, STE graduates significantly performed better than non-STE graduates in both ES, $F(1,173) = 26.17$, $p< 0.01$, and GM, $F(1,173) = 81.31$, $p< 0.01$, scores.
These results imply that students who graduated from the STE program significantly performed better than those who were non-STEs. In addition to the relatively superior intellect of students in the STE program, this result may also be due to the increased resources provided and the addition of more science and mathematics subjects in their curriculum, which is consistent to the findings of Lavy (2012).

Moreover, the results signify that gender was not a factor that determines the students' performance in both ES and GM. Meaning, students' performance in both subjects were comparable regardless of their gender. Reviews about how gender affects students' performance in science and mathematics, however, showed inconsistent findings (Stoet & Geary, 2012; Murray, 2016). Other studies demonstrated males outperforming females (Murray, 2016), while others proved otherwise (De Silva, Khatibi & Axam, 2018).

3. Relationship Between Students' Junior-High Programs and Strands

Table 3
Percentage of STE- and Non-STE- Graduates in the Different Academic Strands

Junior-High Program	Academic Strand			Total
	STEM	**ABM**	**HUMS**	
STE	86.00	10.00	4.00	100
non-STE	23.6	38.6	37.8	100

The Chi-square test revealed that there was a significant association, $X^2(2, N = 177) = 57.96$, $p< 0.01$, between the students' junior-high programs and strands. Table 3 shows that most students from the STE program were in the Science, Technology, Engineering, and Mathematics (STEM) strand; while students from non-STE program were distributed throughout the other academic strands.

This result evidenced that the STE program has been successful in its goal of inculcating interest in science and mathematics among its students. As shown, majority of students from the STE program decided to pursue STEM in their senior high school. In addition, most students in the STEM strand were coming from the STE program. This is an indication that the STE program produced graduates that are more prepared and qualified to be in this strand – one that requires students to be relatively better in both science and mathematics.

CONCLUSIONS

Results of this study had several findings, which ultimately answered the general objective of this study.

1. Students who performed better in Science also did in Mathematics.
2. Students who graduated from the STE program significantly performed better than those who are non-STEs.
3. There was no interaction between the students' gender and performance.

4. Most of the STE graduates chose STEM strand, which is specifically designed to prepare students who are planning to pursue careers related to Science, Mathematics, and Engineering.

These findings is an indication that students who are trained under the STE program are in fact better performing than those who are not. By using their actual records, the results reflect their real-life performances after the program. Moreover, it somehow confirms that the program has achieved its goal of developing students whose interests are along the fields of Sciences and Mathematics. Despite its limitations, these findings are a good addition to the scarce literature documenting the performance of students from the STE program.

RECOMMENDATIONS

This investigation is relatively minute compared to the goal it tries to achieve; that is evaluating the performance of students in the STE program. This study was only limited to the two variables, ES and GM first quarterly exam scores, as measures of students' performance. Hence, further research must be done along this line.

1. Studies that would include a wider range of variables that would better capture students' performance may be done. Performance of students in other subjects, as well as their scores in performance tasks and other assessments, may also be looked into.

2. Longer period of time may also be considered, such as including students' performance for the whole academic year. The current study only examined students' records during the first quarter of their first year in their senior high school.

3. Broader range of participants may also be involved in future studies to have a better overall view of how the graduates of the program do.

REFERENCES

De Silva, A. D. A., Khatibi, A., & Azam, S. F. (2018). Do the demographic differences manifest in motivation to learn science and impact on science performance? *Evidence from Sri Lanka. International Journal of Science and Mathematics Education*, 16(1), 47-67.

Department of Education (2004). DepEd Memorandum No. 41, s. 2004, Revised curriculum of the 110 S&T Oriented (ESEP) High School. http://deped.gov.ph

Department of Education (2013). DepEd Order No. 38,s 2013, Guidelines on the Utilization of Support Fund for Schools Implementing the Science, Technology, and Engineering Program. http://deped.gov.ph

Department of Education (2015). DepEd Order No. 8, s. 2015, Guidelines on Classroom Assessment for the K to 12 Basic Education Program. http://deped.gov.ph

Department of Education (2017). DepEd Regional Memorandum No. 4, s. 2017, Administration of Amission Test for the Special Science Curricular Program in Science, Technology, and Engineering (STE) to the Incoming Grade 7. http://deped.gov.ph

Kiray, S. A., Gok, B., & Bozkir, A. S. (2015). Identifying the factors affecting science and mathematics achievement using data mining methods. *Journal of Education in Science, Environment and Health*, *1*(1), 28. https://doi.org/10.21891/jeseh.41216

Lavy, V. (2012). Expanding school resources and increasing time on task: Effects of a policy experiment in Israel on student academic achievement and behavior. https://doi.org/10.3386/w18369

Murray, M. (2016). The effect of gender on perception of case studies and performance. *Journal of College Science Teaching,* 45(3), 48. https://doi.org/10.2505/4/jcst16_045_03_48

Schmid, J. (2018). Intelligence innovation: Sputnik, the Soviet threat, and innovation in the US intelligence community. *Technology and the Intelligence Community*, 39-53. https://doi.org/10.1007/978-3-319-75232-7_3

Stoet, G., & Geary, D. C. (2012). Can stereotype threat explain the gender gap in mathematics

performance and achievement? *Review of General Psychology*, *16*(1), 93-102. https://doi.org/10.1037/a0026617

Wissehr, C., Concannon, J., & Barrow, L. H. (2011). Looking back at the Sputnik era and its impact on science education. School Science and Mathematics, 111(7), 368-375.

AUTHOR'S PROFILE

Pierre Jared T. Morados is a graduate of Bachelor of Secondary Education major in Physics and Mathematics, *Magna Cum Laude,* at the University of San Carlos (USC), Cebu, Philippines in 2013. He taught for four years in a public high school before deciding to resign and focus on his graduate studies. He finished his master's degree in Science Education major in Physics in 2017, of which he presented his thesis at the 9th International Conference on Science, Mathematics, and Technology Education in Sabah, Malaysia. Currently, he is pursuing his PhD in Science Education major in Physics at USC.

COPYRIGHTS