Strides in Mathematics and Science: An Introspective Look on the First SHS Graduates' Perceived Self-efficacy

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The Asian Conference on Education 2021
Official Conference Proceedings

Abstract
The K to 12 Curriculum has changed the landscape of the Philippine Education System. Several speculations and challenges emerged before and after its initial implementation. This prompted the interest of the researchers to identify the readiness of the first senior high school (SHS) graduates of the K to 12 curricula who were then admitted in the different program offerings of the College of Science of the Bulacan State University. An initial collection of data was obtained from students of differing senior high school backgrounds. Results indicated that students have average perceived self-efficacy in mathematics and science. A second part study was conducted to identify the challenges and difficulties they have encountered and the adjustments they have made while being in the Program. This was carried out using a qualitative method of data collection. Thematic analysis revealed the sources of challenges and difficulties and sources of adjustments. Using the same analysis method, students were asked to describe their perceived self-efficacy before and while completing their Program. Resulting from this are themes that generally relate to their self-efficacy as (1) Positive description, (2) Negative description, and (3) Neutral description. Moreover, recommendations from student-respondents regarding the improvement in learning mathematics and science were taken into consideration, serving as bases for the proposal and development of a program for mentoring aimed at building capacity and enhancing proficiency among students of the S&M programs for the College of Science.

Keywords: Self-efficacy, STEM, SHS

Introduction

The K to12 curriculum, initiated in 2012 under the administration of the then President Benigno C. Aquino III, initially received many criticisms and speculations. But along these are the rationalization for its implementation and allocation of funds to augment the additional costs of schooling and finance capacity-building for teachers. Since the K to 12 aims to create primary education that will produce citizens equipped with all the needed skills and competencies, it is expected that with these additional years in basic education, the students will be well prepared for higher education (DepEd, 2021) and better equipped with life skills. Also, since one of the K to 12 Education Program features is the decongestion of the curriculum by removing repeated competencies, mastery could be developed. It will ensure continuity in knowledge, skills, values, and attitudes (EFA, 2015).

The implementation of the new curriculum was deemed vital since there is always the demand for a nation to have its citizens keep up with the local demands and international standards, for which having high-quality education is an esteemed major key in their fulfillment. In support of this, former DepEd Secretary Brother Armin A. Luistro, FSC, stated in an interview, "As students go up the ladder, we want them to learn skills that are being demanded by employers while at the same time giving them the chance to appreciate and enjoy the lessons," (DepEd, 2012). However, prior and present challenges in learning, particularly science and mathematics, have gained more concern based on the following reports.

As revealed in the OECD (Organization for Economic Cooperation and Development) report for the Filipino students' performance, there were distressing results of assessments to meet the international standards, especially in science and mathematics. In the Philippines, PISA (2018) results revealed that the average performance in the science of 15-year old students is lower by about 132 points compared to the average points in OECD countries (357 points for the Philippines against 489 points average in OECD countries). Meanwhile, for mathematics, the average performance of 15-year old students is 136 points lower than the average performance in OECD countries (353 average points for the Philippines compared to 489 average points in OECD countries). These assessment results in science and mathematics are not novel since, before these results, the Philippines has not been faring well in the TIMSS (Trends in International Mathematics and Science Study). In 2019, the scores of Filipino students had even leveled down compared to the 2003 results, that is, 297 in math and 249 in science in 2019 as compared to the results 358 in math and 332 in science in 2003. It was also cited that for mathematics, only one percent of students have reached a high standard (Bernardo, 2020). The performance of Filipino students in science and mathematics has long been a concern, especially with the realization of how these two disciplines serve as tools for nation-building and sustainable development.

The K to 12 has caused major transitions and changes in the Philippine system of the education landscape. This means that the transition impact is not isolated to the Department of Education (DepEd) but also to higher education. The Commission on Higher Education (CHED, 2020) agrees that there was never a doubt on the implementation of K to 12 as based on historical antecedents in the Philippine system of education. Its adoption is inevitable, and the only question that remained was when it would be implemented, especially with the vision of empowering students and achieving complete human development more adjusted to global change. Hence, the commission itself made changes to be aligned with the new curriculum using the outcomes-based approach. Also, to avoid duplication of science and

mathematics courses already offered in the STEM track of the senior high school (SHS), some have either been removed or replaced. Consequently, general courses were trimmed down to a lesser number of units. However, one that became a foreseeable challenge is the degree of competency of the STEM track along with the competency of non-STEM SHS K to 12 graduates who decided to embark on taking STEM programs.

It is grounded on these aforementioned that the researchers conducted a study to identify the students' self-knowledge of their capacity to take and finish their chosen Science and Mathematics (S&M) program being offered by the College of Science of the Bulacan State University. This study aims to describe the perceived self-efficacy in mathematics and science of the first SHS graduates of the K to 12 curriculum before entry and while in their respective S&M programs. It is noted that the students' perceived self-efficacy is based on how they look at their capabilities. Having a high level of efficacy improves human achievement and personal well-being differently, while those who doubt their abilities tend to avoid challenging tasks (Bandura, 1994). Remarkably this has an impact on learning since it is regarded that those who believed themselves as having a high level of efficacy, like in mathematics, have more advantage in solving mathematical problems as compared to those who have self-doubts and are also regarded as having higher resiliency (Bandura, 1997) mainly when their abilities to perform well are challenged. Moreover, since self-efficacy is also associated with positive emotions, it has a beneficial influence on learning, especially mathematics (Villavicencio & Bernardo, 2015).

This study was expected to achieve an illumination on the perceived self-efficacy of students before and while completing their program. This also served as a reference line study on the effectiveness and point for reflection on the K to 12 curriculum and the S&M programs of the College of Science of the Bulacan State University.

Generally, this study aimed to describe the perceived mathematics and science self-efficacy of the first batch graduates of the K to 12 curriculum upon entry and while completing their S&M program in the College of Science.

Specifically, the study sought answers to the following:

1. what is the profile of the first SHS graduates of the Grade K to 12 curriculum enrolled in the S&M programs of the College of Science;
2. how can the perceived mathematics and science self-efficacy of the first SHS graduates of the K to 12 curriculums be described;
3. what major difficulties and challenges concerning mathematics and science capabilities have the students encountered in the program they are in, and what significant adjustments have they made; and
4. how do students described their perceived self-efficacy in mathematics and science before taking the program they are in up to their present perceived self-efficacy?"

B. Apart from the abovementioned, it was also the aim of this study to come up with a proposal for intervention or program based on recommendations of the student-respondents to help out the students of the College of Science in keeping up with the demands of the S&M programs and cope with the challenges in learning mathematics and science courses.

Methods

This study used the mixed-method research design (Creswell, 2009). Firstly, for the quantitative part, this study employed a survey research method using direct administration as the mode of data collection (Frankael & Wallen, 2007). Initially, a self-made questionnaire was subjected for validation and underwent a try-out or pretest. Randomly selected first SHS graduates of the K to 12 curriculum newly enrolled (School Year: 2018-2019) in different S&M programs of the College of Science were asked to answer the constructed questionnaire. This questionnaire consisted of two parts. The first part is related to the profile of the student-respondents and the second part is about their perceived self-efficacy in mathematics and science. Each item in the questionnaire pertained to competency in a particular specialization subject in S&M. The level of perceived self-efficacy was rated using a Likert Scale by the student-respondent ranging from "Very Poorly" to "Very Well." Mean and standard deviation for each item were given verbal description and general interpretation. Overall, the data gathered and analyzed were presented in tables.

Secondly, for the qualitative part, an open-ended questionnaire was answered via an online google form. Purposive sampling involving students from the mathematics and science programs was utilized in this study section. A block section of students from each department was chosen. One section comprises 40 third-year students of the Bachelor of Science in Mathematics with specialization in the Business Applications program. The other section is composed of 31 third-year students from the program Bachelor of Science in Environmental Science. Students from both departments were student-respondents in the first part of this study. Their responses to questions 3 and 4 in this study were thematized, analyzed, and presented. They were also asked to provide recommendations for improving learning in mathematics/science, which responses were also thematized, analyzed, and presented.

In all of the foregoing, permission from the student-respondents was also secured with the dean of the College of Science. The participants of this study were considered young people (ages 15-24), and possible ethical issues such as harms and benefits, consent, and confidentiality were given close attention (Truscott et al., 2019).

Results and Discussion

The following presents the profile of the first SHS graduates of the Grade K to 12 curriculum enrolled in the S&M programs of the College of Science. A total of 280 freshmen students of the College of Science enrolled during the School Year 2018-2019 responded to the survey questionnaire. The processed responses revealed the following.

Academic Track	No. of Students	%
STEM (Science, Technology, Engineering, and Mathematics	105	37.50
GAS (General Academic Strand)	34	12.14
HumSS (Humanities and Social Science)	4	1.43
ABM (Accountancy and Business Management)	13	4.64
Tech-Voc (Technical -Vocational)	26	9.29
No Response	98	35.00
Total	**280**	100

Table 1. Distribution of Academic Track

As indicated in Table 1, the highest number of responses is on the academic track of STEM with 105 responses for about 37.50%. Next is the GAS with 34 responses. The least number of responses is the HumSS with 4 responses for about 1.43%. There are also 98 missing responses with 35%,

School	No. of Students	%
Public	104	37.14
Private	168	60.00
No Response	8	2.86
Total	280	100.00

Table 2. The Type of School Students During SHS

Considering the additional 2 years in basic education with a consequential economic impact on families, still more students studied in private schools with 168 responses at about 60% response rate. This could be explained by the financial assistance being provided to Grade 10 completers thru the Senior High School Voucher Program (SHS-VP) (DepEd, 2020). On the other hand, 104 students studied in public schools with its response rate of about 37.14%.

First Choice	No. of Students
BS Math	51
BS Civil Engineering	66
BS Architecture	19
BS Computer Engineering	11
BS Mechanical Engineering	15
BS Accountancy	7
BS Electrical Engineering	4
BS Nursing	2
BS Information Technology	1
BS Biology	63
BS Food Science	1
Bachelor of Industrial Technology	7
BS Psychology	1
BS Environmental Science	10
BS Criminology	1
Total	259

Table 3. Distribution of Program for Students' First Choice

It can be construed in Table 3 that most of the students preferred the BS Civil Engineering course with 66 responses, followed by the BS Biology with 63 responses. The least were the BS Criminology, BS Psychology, BS Food Science, and BS Information Technology with only one response. However, for the second choice, it was revealed that the BS Math program topped the list.

The perceived mathematics and science self-efficacy of the first SHS graduates of the K to 12 curriculum was determined and described using the questionnaire below. A list of 20 skills statements for mathematics and science efficacy was used in the questionnaire.

Item	Weighted Mean	Verbal Description	Standard Deviation
1. To what extent can you explain the results of measurements and conversion of units?	3.26	Average	2.80
2. How well can you choose an appropriate formula in answering a chemistry or physics problem?	3.19	Average	2.76
3. How well can you explain mathematical and conceptual relationships?	3.06	Average	2.62
4. To what extent can you interpret data/computational results presented in charts/graphs?	3.33	Average	2.89
5. How well can you describe the relationship between biotic and abiotic factors in the environment?	3.20	Average	2.78
6. How well can you work with laboratory equipment/apparatus and chemicals?	3.30	Average	2.87

7. How well can you propose solutions to real-life problems requiring mathematical or science concepts?	3.28	Average	2.83
8. How well can you write a laboratory report, with complete data and a summary of findings?	3.12	Average	2.69
9. How well can you describe heat and electricity flow?	3.06	Average	2.64
10. How well can you handle and interpret gathered data using a statistical tool?	3.11	Average	2.69
11. How well can you describe a chemical reaction through a chemical equation?	3.08	Average	2.64
12. Are you capable of handling different live and preserved species/organisms?	3.20	Average	2.78
13. How well can you read chemical symbols and formulas?	3.12	Average	2.71
14. How well can you analyze a word problem in chemistry and physics?	3.10	Average	2.67
15. Are you capable of handling different live and preserved species/organisms?	3.04	Average	2.65
16. Are you capable of utilizing different indigenous materials for a science project?	3.14	Average	2.72
17. Can you integrate mathematical principles/theorems in coming up with a solution to a science problem?	3.11	Average	2.68
18. How well can you carry out experimental procedures with confidence?	3.24	Average	2.82
19. How well can you use calculators, charts, and tables?	3.43	Average	3.03
20. How well can you use measuring devices in the laboratory?	3.43	Average	3.00

Table 4. Description of the Students' Perceived Mathematics and Science Self-Efficacy

Based on Table 4, students, in general, have identified themselves as having average perceived mathematics and science self-efficacy. Students have rated themselves numerically using the following: (1) Very Poorly, (2) Poorly, (3) Average (4) Well, and (5) Very Well.

The ensuing results of the thematic analysis were obtained as guided by the question: "What major difficulties and challenges concerning mathematics and science capabilities have you encountered in the program you are in? What major adjustments have you made?" Upon analysis, sources of challenges and difficulties were identified. These could originate from students' classmates or colleagues, the program they are in, the nature of mathematics/science, and their selves.

Sources of Challenges and Difficulties	Frequency	Excerpt Examples
Colleagues/Classmates	1	"The one who gives me major difficulties is my colleagues."
Program	3	"I thought the program was just about science since it's only there where I know a bit, I was surprised that what I entered is with mostly mathematics."
		"The major difficulties and challenges that I encountered with math and science are those new topics that were introduced to us, and also the expectations of teachers regarding our capabilities in the given topics"
Nature of Mathematics/Science	8	"Both subjects are hard"
		*"*I find it difficult to understand the different lessons especially in mathematics"
Self	21	*"* Since I'm not that good in math since high school"
		" I think, one of my major difficulties in both science and mathematics is having short-term memory about the certain topic"
		*"*As long as there are computation-related, I am finding it hard"

Table 5. Summary of Thematic Analysis on the Sources of Challenges and Difficulties of Student-Respondents in A Science Program

Sources of Challenges and Difficulties	Frequency	Excerpt Examples
Program	12	"But when I began college days, it gave me a shock because I didn't expect it to be that hard"
		"Since I did not take STEM, it was very difficult for me because I was not familiar with most of the lessons and topics in this program"
Nature of Mathematics	12	"In mathematics, I find it difficult to calculate numbers to be converted into a fraction."
		*"*Math subjects that were much different during high school"
Self	17	"Difficulties… is sometimes I'm not focused on the lesson or I'm busy on other things. That's why I didn't learn."

		"There are times when I can't analyze problem sets that are described in so many words" "I am not ready yet, ready in terms of mastering the Mathematics specialization"

Table 6. Summary of Thematic Analysis on The Sources of Challenges and Difficulties of Student-Respondents from a Mathematics Program

Based on the above results, there was only one response for the challenge with Colleagues/ classmates. The theme Program that stands for all that pertains to expectations, nature, and requisites of the program, the Nature of mathematics and the Self have varying frequencies. For the nature of mathematics/science, the students have preconceived ideas how they will fare in these areas. Their perceived self-efficacy can be associated with how their perceived performance will be in mathematics/science. Specifically, when it comes to mathematics and science courses like chemistry and physics, students who have lower perceived self-efficacy in doing computations will have less perceived performance in these areas. Last among these themes is the Self. Students who came from different backgrounds (e.g. senior high school track and school) are understood to have different levels of preparations and expectations upon entry to their chosen program in the college (Cuy & Salinas, 2019).Though the students from the STEM track have understood the advantages in taking an S&M program, this turned out to be not a major hurdle for some students. One respondent from the B.S. Environmental Science program and was a graduate of the Tech-Voc track stated:

"I was into Science since then but there are topics that I don't know much about so I need to study it harder than other subjects that I have."

Another non-STEM respondent from the same program stated:

"Math is my weakness but I do exert extra efforts so that I can pass the subject."

However, some are convinced that they will not fare well especially in mathematics as indicated in a statement by one respondent:

"I've always struggled with math."

The challenges and difficulties encountered and how the students looked at their self-efficacy, encouraged them to decide and made adjustments for the program they are in. In the same manner, using thematic analysis, sources for adjustments of the students were identified. The ensuing results revealed the sources as the Self, Classmates and other individuals, and Learning tools.

Sources of Adjustments	Frequency	Excerpt Examples
Self	35	"But there are topics that I don't know much about so I need to study it" "I don't waste time and take the subject seriously."
Classmates and other individuals	14	"I also seek help from my other classmates" "Then sometimes I ask some of my classmates or friends to explain or clarify "

		*"*To study if cannot understand, I ask for a tutorial from my friend"
Learning tools	15	"For the adjustment that I have made, first I watch tutorial computation videos"
		"I find solutions or examples from social platforms "
		"Adjusted by reading books and watching tutorial videos online"
		*"*There are also available online resources, there are free video tutorials"

Table 7. Summary of Thematic Analysis on the Sources of Adjustments of Student-Respondents from the Mathematics and Science Programs

The presented results revealed the adjustments made by students. Frequency revealed that Self is the major source of adjustment. The Self as a source of adjustment can be described as making a change in behavior, habits, or mindset to adjust. An example is deciding on studying harder and putting more effort into learning. As stated by one respondent:

"As of now, I have made so much adjustment to learn and to be knowledgeable about math. I am poor in math but I study more and more to be efficient and good in math."

Another adjustment made by the student-respondents is their tendency to seek out help when in need. The mastery or learning of a particular lesson like in mathematics can be associated with the students' use of their help-seeking behavior (Federici et al., 2015). An example where the Classmates and other individuals as a source of adjustment can be gleaned is in the following declarations of two different student-respondents:

"I always reach help from my classmates, so that I can control my challenges."

"That is why with the help of my classmates, it is only then that it becomes clear to me the embarrassing question to my Prof, eh I just forward it to my classmate"

Lastly, for the source of adjustment, the students have resorted to the available means by which they could be helped in learning challenging mathematics or science lessons. Admittedly, the use of online resources has helped them make adjustments. As revealed by one respondent:

"For the adjustment that I have made, first I watch tutorial computation videos"

In another statement:

"What I did is that, I tried to find alternative learning materials related to them like videos on Youtube and examples in Google."

Also, it was revealed from the responses that among the online resources, commonly the student-respondents resort to watching video tutorials having Youtube as the main platform.

For the research question: How would you describe your perceived self-efficacy in mathematics or science before taking the program you are in up to your present perceived self-efficacy?" combined general answers were presented in Table 8. For both programs in the College of Science, the results of the thematic analysis were summarized as follows.

Description	Frequency	Excerpt Examples
Positive Description	77	"I can do it like if its chemistry I can do it and I can understand"
		"Nowadays I think I put more effort and dedication in understanding the lesson and given materials since Science and Mathematics subjects get harder along the way"
		"Because of many subjects that related to mathematics subjects I learned many techniques and methods on how I can solve the problem well"
Negative Description	25	"A bit poor in math, I even had a grade of 76 (a lower grade) in pre-calculus"
		"I know to myself that before I entered the college of science under the BS Mathematics program, that I'm not that good in mathematics"
Neutral Description	10	"Just like in the past (perceived self-efficacy)"
		"I'm in the average level. I can understand some ideas but there are still some learnings that give me confusion"

Table 8. Summary of Thematic Analysis on the Description of the Perceived Self-Efficacy of Student-Respondents Before and While Taking their Mathematics and Science Program

To describe the perceived self-efficacy before and while taking the program the student is in is to identify if there has been a change in several aspects of his or her learning of mathematics/science. A positive description is interpreted as having improvements like in performance, study habits, and or perspectives. A negative description is interpreted by a declaration of negative feelings and attitudes toward mathematics/science, doubts in capabilities, and acceptance of poor performance. Lastly, the neutral description is interpreted as being on the average or accepting to be not good or bad in performance and are open for more things to learn. The students based the measure if they are performing well or fairly in mathematics or science as based on other factors like exam or class participation and not based on self-perception.

Lastly, the results of the thematic analysis of the responses for the question: "What recommendations can you give to improve the learning of mathematics/ science?" is presented in Table 9. It was revealed that areas for improvement based on the student-respondents views and experiences are as follows: Self Adjustment, Pedagogical support and learning tools, and Program and faculty.

Areas for Improvement	Frequency	Excerpt Examples
Self-Adjustment	43	"Let yourself enjoy while studying the math"
		" Be determined to do your best to achieve your goal, so at the end, you won't regret"
		"Make yourself excited about science"
		"You've got to love the process"
		"Going further into mathematics, it'll start to become complex, but the concepts of the basics are still there. Memory is good, but improve your analytic thinking skills more."
Pedagogical support and learning tools	24	"To have a tutorial class for those students that are having difficulties in learning science."
		"Group tutorials are really of a big help"
		"Use the power of the internet. Learn something through the internet. There is a wide knowledge with regards to math that you can see in the net."
		"It helps me a lot. I am one of the Youtube users who is looking for some explanations to understand our lesson."
Program and faculty	35	"Give more examples"
		"Explain it broadly and through the easiest way even though it is hard for it to process."
		"Maybe if the Prof elaborates the topics well and not assumed that we already know those things, I think it might help those students that are facing difficulties"
		"Conduct study on techniques students can use to easily learn math lessons"

Table 9. Recommendations of student-respondents from the Mathematics Department and Science Department for Improvement in the Learning of Mathematics/ Science

The theme Self-adjustment was identified based on the recommendations made by the student-respondents relating to how one can make improvements in the learning of mathematics/science. Self-motivation techniques, the development of positive attitudes, and the achievement of traits for self-enhancement can be gleaned from the responses. As one respondent related:

> *"I can also recommend my adjustment to improve my learning for this semester which I start doing Journaling again wherein for every day I set a task or goals that I need to*

do and at the end, I write what I achieved for the day or if I fulfilled my set goals for that day and personally, it helped me to boost myself especially in my learning because I keep on track my learning progress"

For the pedagogical support and learning tools, the student-respondents' recommendations based on their experiences revealed their behavior of seeking help for tutorial either from other individuals or by watching videos from the internet. They also cited the importance of the available resources like books and learning materials that could also be from the internet. As related by one respondent:

"If you don't understand something, you can read trusted sources from the internet"

The last area in the recommendation is the Program and faculty. The student-respondents identified points for improvement for the program and methods or approach of the program faculty. One respondent in the science program recommended:

"I think more detailed lecture-discussion together also with a more detailed application on laboratory."

As for the faculty, one recommended:

"Approachable instructors that are open with their class will always suffice because it opens an opportunity for us to ask more questions and learn more"

Based on the foregoing, the researchers identified a key area that can be focused on as for the intended intervention program. This program is targeted at building capacity and enhancing proficiency among students of the S&M programs of the College of Science by setting up an official tutorial or mentoring activity specific to address difficulties in certain areas of mathematics and science. Thus, an output for this study is a proposed plan and guidelines for the implementation of the said program.

Conclusion

Based on the quantitative data gathered, it can be identified that the students who enrolled in the College of Science S&M programs have varied backgrounds in terms of the track taken in senior high school, the type of school they graduated from, and the program they first intended to apply and enroll. However, results also show that their perceived self-efficacy in mathematics and science can generally be described as average.

For the qualitative part, the data presented resulted from the thematic analysis of the responses to an open-ended questionnaire given by selected third-year students from mathematics and science programs of the college who were also part of the pool of respondents in the first part of this study. Results showed the general increase in the students' perceived self-efficacy in mathematics/science as revealed by responses themed as Positive Description. It was also identified their sources of challenges and difficulties as themed as (1) Program, (2) Nature of mathematics/science, and (3) Self. Consequently, students were able to adjust based on different sources. Sources of adjustments were identified as (1) Self-adjustment, (2) Classmates and other individuals, and (3) Learning tools. Furthermore, recommendations for improvement in learning mathematics and science from the student-respondents were thematized and analyzed.

In cognizance of the students' determination to learn mathematics and science, the researchers came up with the proposal and development of a mentoring program that will be

a formal program of the College of Science intended to promote capacity-building and enhancement of proficiency in mathematics and science of students in its different S&M program offerings.

Also, it is recommended that further study be conducted as a follow-up to determine perceived self-efficacy of succeeding SHS batches of the K to 12 curriculum. This is to enlighten and make necessary actions by the different stakeholders in improving the curriculum, especially in mathematics and science.

Acknowledgement

College of Science, Bulacan State University

Research and Innovation Office, Bulacan State University

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