MOVING FORWARD IN STEM EDUCATION, CHALLENGES AND INNOVATIONS IN SENIOR HIGH SCHOOL IN THE PHILIPPINES: THE CASE OF NORTHERN ILOILO POLYTECHNIC STATE COLLEGE

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ABSTRACT

This qualitative research focused on school experiences of 20 females and 14 males senior high school (SHS) students majoring in science, technology, engineering and mathematics (STEM) in Northern Iloilo Polytechnic State College (NIPSC), the Philippines from Academic Year 2017-2018 and 2018-2019. This study aimed to identify both the positive and negative points on Senior High School (SHS)- Science, Technology, Engineering and Mathematics (STEM) track in terms of curriculum, instructional materials, laboratory equipment, faculty educational qualification, research output and courses to be taken in NIPSC of SHS-STEM students. Purposive sampling was used for the selection of the informants. Interview, focus group discussion, and observation were employed in the study. The students’ responses in the interview revealed teachers’ qualifications and their passion for enhancing SHS-STEM curriculum. Besides, the availability of facilities was a strong point of NIPSC as a model school in implementing STEM curriculum in the district. However, lack of time management for teachers to hold classes, limited science textbooks and classroom, and unavailability of the laboratory for hands-on activities need proper attention by concern authorities. Around 46% of SHS-STEM graduates take civil engineering at NIPSC because of the well-trained teachers, and the high rating in board examination. Also, the Commission on Higher Education (CHED) allowed non-STEM to enroll in science-related courses, and the Department of Science and Technology (DOST) allowed them to apply for the scholarship program. However, the bridging program is a waste of time, effort, and money for both teachers and students. NIPSC as a model school in SHS-STEM track has to enhance facilities as well as the guidance office to correctly assist students in future endeavors and to take courses similar to their tracks and interests.

INTRODUCTION

In 2011, after series of consultations, discussions, and debates among experts and practitioners, the Philippines government agreed to enhance primary education in the entire archipelago called K-12 basic education program by virtue of Republic Act 10157 (Cabansag, 2014). Twelve years is the standard for a basic education program in the world (Orale & Sarmiento, 2016)
and the ten-year system being the shortest in the world for primary education is a disadvantage for Filipino students as well as those wanting to continue their education outside the country; thus, the call for shifting to 12 years is very significant for all Filipinos (Tupas & Matsuura, 2011a).

Philippine researchers have identified poor achievement results in science which were documented for many years are also one of the reasons for enhancing the education curriculum in the Philippines (Estonato, 2013). For instance, in 1990 the National Elementary Achievement Test (NEAT) was 41.5%, an increase of 12.6% in 2005 but only 14.8% attained mastery of the goals of science curriculum (Bernardo, 2004). Moreover, in School Year (SY) 2011-2012, the result of NEAT for grade 6 was 40.5%. While in the secondary curriculum, the result was 39.5%, and around 1.8% of students reached the mastery learning. In Trend International Mathematics and Science Survey (TIMSS), the Philippines ranked 43rd out of 46 countries in high school (HS) II Science. (Out of 25 participating countries, fourth grade was ranked 23rd (Calderon, 2015).

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 science teachers. Moreover, the scarcity of instructional materials contributed to the low performance of Filipino science learners (Tupas & Matsuura, 2011a). Thus, Montebon (2014) exposed that science curriculum in primary education should undergo significant revisions.

Series of discussions, debates, and meeings with experts, and practitioners, the Filipino government decided to enhance the primary education curriculum by virtue of Republic Act 10157 or also known as K12 Basic Education Program. The new system composed of 1 year in kindergaten at the age of 5, 6 years in elementary school, 4 years in junior high school (JHS) between 6 to 11-year-old and two years in senior high school (SHS) between 16 to 17 years. It was pushed through to develop Filipino learners’ holistic 21st-century skills. In SHS, there are three major tracks: general academic, sports and arts, and technical vocational and livelihood educati- on. The additional two years help students master and prepare for workforce aside from traditional thinking to make them ready for college life (Cabanas, 2014). Around 1.5 million grade 11 enrolments for the implementation in the Philippines (Pat- rinos & Al-Samarrai, 2016).

Science, technology, engineering, and mathematics (STEM) strand is embedded in the general academic track. The traditional method is shifted into a more innovative approach that emphasizes critical thinking and scientific skills (Montebon, 2014). Moreover, Estonato (2017) explained that STEM is planned to encourage secondary level graduates to enroll in science-related courses in the tertiary level. Furthermore, Orale & Sarmiento (2014) discovered that SHS STEM track in the Philippines is better than that in Japan and the US. Cabanas (2014) revealed that STEM would be prepared graduates for a better occupation abroad. Also, this will genera- te competent learners of the 21st-century skills, who are essential for economic and social prog- ress of the country. However, since this is new to the educational system of the country, close monitoring and evaluation must be implemented properly. The teachers must undergo education development to eradicate misconceptions of the K-12 program.

SSHS-STEM curriculum is designed to develop learners’ skills from simple to complex problems in the country and the world as well in terms of science, technology, engineering and mathematics concepts. It also intends to prepa- re them to pursue education or work as future scientists, technologists, expert engineers, engineers, mathematicians, programmer, science educators and others (Estonato, 2017). The curriculum content is derived from SHS core curriculum to run; thus, it is defined as to run by a student for achieving specific goals specifically in education. Nowadays, the curriculum is about total experi- ences of a child in school activities and experi- ments. In the perspective of science, it refers to the acquired knowledge on science teaching gi- ven on specific time in the classroom. Thus, the science curriculum is all about learning experi- ences through various activities inside or outside school premises, either formal or informal educa- tion. The curriculum is a gist of lessons and to- pics covered in a specific period in a class (Mal- lick, 2012). Science curriculum materials include textbooks, teachers guide, and technology-based materials provide by the ministry or department, designed by teachers to help learners improve their performance.

Effective science teachers have a vast array of instructional strategies and methods to produc- e successful learners. Filipino teachers become flexible; they always have unique strategies, and techniques to make science teaching fun and ex- citing for all the Philippines (Tupas & Matsuura, 2012) to enhance the performance of science learners. Education is constantly changing; thus, professional growth is one way to stay on current knowledge and prac- tices. Professional development of teachers is re- quired to bring strong information in science and enable them to acquired new knowledge (Ejiwale, 2013).

In grade 10, junior high school students will take the National Career Assessment Examina- tion (NCACE). This assessment aims to provide information to students regarding career aware- ness. There are four domains in the NCACE evalua- tion. In terms of general scholastic aptitude, the assessment covers Science, Math, Logical Reason- ing, Reading, and Verbal. Student’s Career Opportunity and Personality Evaluator (SCO- PE) is a computerized assessment developed by System Technology Institute (STI) College. This examination is taken by senior high graduates to help them find the best career that fits their per- sonality.

In 2017, Northern Iloilo Polytechnic State (NIPSC) answered the call of the national government to help DepEd in the operation of SHS. The requirements for allowing secondary schools and higher education institution (HEI) to offer SHS are qualified faculty, facilities, and class- room. As a lone college in the district, facilities are all ready. For two years all HEI in the country will have no freshman enrollees; thus, the admi- nistrations were informed to send their faculty for graduate programs, or do extension and research works, or “on the job training”. Nevertheless, the administration still finds ways to improve the implementation of SHS-STEM track in NIPSC as a model school in Iloilo. The significant problems in the ope- ration of STEM strand are the lack of facilities and instructional materials of the school in the Department of Education (DepEd) (Estonato, 2017). DepEd cannot afford and accommodate to offer all tracks and strands in one school. The implementation of the SHS will be dependent on the availability of classrooms, teacher quali- fication, and facilities. Thus, some colleges and universities, both public and private, are allowed to offer SHS curriculum (Gubalone, 2016). Stu- dents enrolled in state universities and college, the private institutions will also be provided a voucher, a government subsidy to cover the entire school year.

The research is anchored on John Dewey’s Theory on Education, Experience, and Educati- on published in 1938. In this theory, students en- rolled in school not just to learn concept and ide- as but also to learn how to apply in daily lives. Learning is not just about mental development but also the growth of a person as a whole. This is a vital tool to develop the system so that the encourage students to formulate their own con-
clusions and teacher as facilitator continues to extract more ideas from the learners. This creates a learning environment following Piaget’s theory of constructivism. They challenge the student by making them effective critical thinkers. They act as not being merely a “teacher” but also a mentor, a consultant, a coach and a friend (Matthew, 2003).

This study focused on the school experience of the SHS-STEM students of NIPSC. Everyone’s life experiences always have tremendous values. Our experiences also teach us our purpose as human. It gives us a sense of directions as well as the purpose of living the best out of our negative and positive involvements. Nevertheless, the schools focus more on knowledge and information than experiences; thus, learning institutions are commonly branded as enormous mind-oriented. Learners are taught facts and abstract information that has no significant values to career and life (Hodson, 2013).

The Office of the Registrar-NIPSC Main Campus revealed that there were very few students enrolled in STEM programs. Each of this degree has only around 35 or fewer students. Learners preferred to take criminology or tourism because that pursuing those degree would make it easier for them to find a job. Thus, it is essential to strengthen STEM track in NIPSC to encourage more students to engage in science and technology fields.

Hence, this study was formulated to identify both the positives and negatives points on SHS-STEM. Both identified points were used as a basis to enhance the implementation of the STEM track in NIPSC, and become the model school in the district. The results of the study are expected to help the DepEd in the effective implementation of the STEM curriculum in the country.

The purpose of this research was to determine and account the perceptions and live experiences such as curriculum, instructional materials, laboratory equipment, faculty educational qualification, research output and courses to be taken in NIPSC of SHS-STEM students.

METHODS

This study was a case study using purposive sampling. The research started in June 2017 during grade 11 of the informants and ended in July 2019 after they enrolled in college. Furthermore, this study focused on school experiences such as curriculum, instructional materials, laboratory equipment, research outputs, and courses to be taken in NIPSC of SHS-STEM students.

There were 34 SHS-STEM students enrolled in NIPSC, Estancia, Iloilo in Academic Year (AY) 2017-2018. See Table 1. They were top 1 or excellent students in science and mathematics coming from different neighboring towns. All the responses were analyzed, triangulated, and the median for two years. All informants were given a pseudonym. Triangulation was utilized in this study because of multiple responses of the informants from different methods to ensure the accuracy of the findings.

### Table 1. Profile of the SHS-STEM Students

| Informant Age | Sex | Year | Grade | Home Address |
|---------------|-----|------|-------|--------------|
| 1              | M   | 17   | Batad, Iloilo |
| 2              | M   | 17   | Estancia, Iloilo |
| 3              | M   | 17   | Carles, Iloilo |
| 4              | F   | 17   | Estancia, Iloilo |
| 5              | F   | 19   | San Dominiso, Iloilo |
| 6              | F   | 17   | Carles, Iloilo |
| 7              | M   | 17   | Estancia, Iloilo |
| 8              | F   | 17   | Estancia, Iloilo |
| 9              | M   | 17   | Estancia, Iloilo |
| 10             | M   | 17   | San Dominiso, Iloilo |
| 11             | M   | 18   | Pobutan, Iloilo |
| 12             | M   | 17   | Estancia, Iloilo |
| 13             | F   | 17   | Estancia, Iloilo |
| 14             | F   | 17   | Batad, Iloilo |
| 15             | F   | 17   | Estancia, Iloilo |
| 16             | F   | 17   | Estancia, Iloilo |
| 17             | F   | 17   | Estancia, Iloilo |
| 18             | F   | 17   | Estancia, Iloilo |
| 19             | F   | 17   | San Dominiso, Iloilo |
| 20             | M   | 17   | Estancia, Iloilo |
| 21             | M   | 17   | Carles, Iloilo |
| 22             | M   | 17   | Estancia, Iloilo |
| 23             | M   | 16   | Estancia, Iloilo |
| 24             | F   | 17   | Estancia, Iloilo |
| 25             | M   | 17   | Estancia, Iloilo |
| 26             | M   | 17   | Estancia, Iloilo |
| 27             | F   | 17   | Estancia, Iloilo |
| 28             | M   | 17   | Carles, Iloilo |
| 29             | F   | 17   | Carles, Iloilo |
| 30             | M   | 17   | Batad, Iloilo |
| 31             | F   | 17   | Pobutan, Iloilo |
| 32             | F   | 17   | Pobutan, Iloilo |
| 33             | F   | 17   | Batad, Iloilo |
| 34             | F   | 17   | Estancia, Iloilo |

This study used interview, focus group discussion (FGD) and observation. The guide questions were translated to Hiligaynon for better understanding and responses among the informants. The interview was utilized to seek actual meaning on the key concepts about their experiences as SHS-STEM students in NIPSC. The semi-structured interview was used because the researchers wanted to gain rapport and trust with the informants. The researchers employed guide questionnaires composing 10 open-ended questions. These were validated by science teachers in public schools in northern Iloilo and faculty major in science education coming from different SUCs in Region VI. The interview was conducted 10 minutes after their class in Practical Research I and General Biology I. Last December 2018, the informants were asked if what courses in college they plan to take and validated in last July 2019 after they enrolled in their respected schools.

In terms of FGD, the informants were group together according to their interest and brought in the Audio Visual Room in NIPSC Main Library. They were allowed to discuss their experiences such as science subjects, time allotment, teachers’ qualification, science materials and equipment, research outputs, and courses to be taken in college. A tape recorder was used to capture all the responses of the 34 informants. In the interview, 10-15 minutes was allocated, and around 35 to 50 minutes in the FGD. This was tape-recorded and transcribed to capture the responses of the students.

The observation was carried out in this study because the researchers wanted to know each respondent. The respondents were not informed about the schedule of the observation to control the misconception. They were also instructed to act naturally during their science classes. The observation was done during their class hours in all their science subjects. The in-charged teacher was given a letter signed by the principal of NIPSC, informing them about the study.

RESULTS AND DISCUSSIONS

Tables 2 and 3 summarize the positive and negative responses of SHS-STEM students in the interview, respectively. The positive and negative points were found in subject matter, instructional materials, laboratory equipment, and research outputs.

### Table 2. Positive Responses of the SHS-STEM Students

| Topics | Number of Responses |
|--------|---------------------|
| Faculty | 27 |

“Our teachers are excellent and well-equipped with the topics.”

| Topics | Number of Responses |
|--------|---------------------|
| “They are always ready to teach the lessons.” | 20 |
Faculty in NIPSC have a good reputation among students. Teachers’ qualifications and the passion they have for teaching the SHS-STEM in NIPSC. All faculties of NIPSC are master's degree holders, and some have already finished a doctoral program in science and mathematics. Moreover, they distributed the subjects per grade levels. For instance, the Practical Research I will be placed in the 1st semester, and Practical Research II will be in the 2nd semester of grade 12. Grade 12 learners have the freedom to use any research output as a requirement for graduation. However, the limited time affects the quality of research output; thus, students have no classroom laboratories in the campus, state-of-art engineering facilities, and hatchery equipment for a fishery. However, the students have no classroom and cannot use laboratory often enough. However, Filipino teachers are innovative; they improvise science facilities to ensure quality education among students (Tupas & Matsuura, 2012). This is also one of the common problems in public high schools in the entire Philippines. Some can do hands-on activities, but not all can use science materials (Tupas & Matsuura, 2012).

Unsurprisingly, not all students enrolled in SHS-STEM track want science-related courses in college. 75% of students planned to take STEM courses such as engineering, Bachelor of Science in Biology and Nursing, education major in science and mathematics, veterinary medicine and architecture, and 29% of them agreed to take Filippino and tourism. These non-STEM courses will help them find jobs quickly after college but that is what they think about.

Figure 1 shows the proportions of courses taken by SHS-STEM graduates of NIPSC for AY 2011-2012.
The majority of SHS-STEM for an academic year (AY) 2019-2020 enrolled in civil engineering in NIPSC as it has a good standing in terms of quality education and board passers. There were six priority STEM courses in tertiary education, such as engineering, information technology, agriculture, science, and maths. These courses performed exceptionally well in terms of science and mathematics, health, and teacher education. This was also confirmed by CHED that listed agriculture, engineering, science, and maths, information technology (IT), teacher education, and health sciences. The government also offered different science and technology scholarships to persuade students to take STEM courses with the help of various agencies. However, CHED issued a memorandum allowing students to take any courses in college regardless of their tracks or subjects in high school. Further, the Department of Science and Technology (DOSt) made a statement allowing non-STEM to be permitted to apply for government science and technology scholarships. Thus, the Philippine government should fix policy about the education system in the country.

These students who enrolled differently from their track in high school will take the bridging program or remedial class for two weeks to be qualified in the desired course. Many concluded that this is just a waste of time, effort, and money, and the effectiveness of the program. Furthermore, this will also delay students from finishing the program in college on time because the first semester will be intended to get subjects related to the courses. This is under CHED Memorandum Order No. 10 series of 2017, Category 3-a that specifies tertiary institute around the country to have options in employing bridging programs that ensure the readiness of students to enter college aside from the strand taken during SHS.

The new curriculum has a new program called career pathway that helps students from grade 10 to grade 11 and 12 to have right directions to work after SHS or to continue to college (Ontal, ND). Currently, SHS-NIPSC has no personal guidance personnel to handle the students in their journey to college. The guidance counselor must direct students on proper courses based on their interest. There were three guidance counselors in NIPSC, but they were tasked to guide college students. They cannot run their duties on the SHS-STEM because of a significant number of college students enrolled in the institution. Galliot & Graham (2015) stated that career guidance must be provided to students together with their families for awareness and guidance on how to make use of resources and opportunities available in the real world. The family has a significant factor that influences students for their future endeavors. Given the samples of mother’s profession and income which have a significant impact on the interest of students in choosing college degree (Sayayan, 2011). Other than that, siblings position, and elective grades during high school also influence students’ choices in life. Hence, cooperation with parents and guardians are also recommended. For this reason, having reliable guidance facilities will support students to be on the right track.

CONCLUSION

Teachers’ qualifications and their passion for enhancing SHS-STEM curriculum and the availability of facilities were the strong points of NIPSC as to become a model school in implementing STEM curriculum in the district. However, lack of time management for teachers to hold classes, limited science textbooks and class room, as well as unavailability of the laboratory for hands-on activities require proper attention by concerned authorities to enhance the delivery of SHS-STEM. Since almost all the courses in NIPSC are science-related, and very few secondary schools offering STEM in the district, all the positive points must remain, and negative points must be improved.

Many research advisors are equipped with various training and conferences to help their advisees to generate a quality output. The majority of the students enrolled in science-related courses around the region. Nevertheless, civil engineers had the most considerable portion, and almost all of them joined in NIPSC. Furthermore, the findings of this study are expected to be beneficial, not only NIPSC but also DepED to encourage our youth to be STEM enthusiasts and finally, the government would improve the facility and equipment.

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