GRADUATE PERSPECTIVES ON THE DELIVERY OF THE SENIOR HIGH SCHOOL – SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS PROGRAM

JOHN ROBBY O. ROBIÑOS, LPT, Ph.D(c)[1], HOLDEN KENNETH G. ALCAZAREN, LPT, MAELED[2], EVANGELINE D. MARASIGAN, LPT, MA[3]
https://orcid.org/0000-0002-7051-7764[1], https://orcid.org/0000-0002-9684-6961[2],
https://orcid.org/0000-0002-2550-4593[3]
johnrobby21_0987@yahoo.com[1], holdenkenneth.alcazaren@deped.gov.ph[2]
University of Perpetual Help Molino Campus Bacoor City, Cavite, Philippines[1,3]
Gen. Pantaleon Garcia Senior High School Malagasang I-G, Imus City, Cavite, Philippines[2],

ABSTRACT

Improving the implementation of the Science, Technology, Engineering and Mathematics (STEM) program in the Senior High School (SHS), curriculum evaluation is essential. It is a planned process of change that leads to effectiveness of program delivery and student's learning experience. This qualitative descriptive research analyzed the graduate perspectives on the delivery of the STEM strand in a private university in the Philippines. Graduates (n=11) who obtained academic distinctions, and currently taking STEM-related courses in autonomous universities were purposively selected. The participants were interviewed using a validated pre-structured interview using Zoom/Google Meet platform. Recorded responses were individually transcribed and returned to participants for final edit and validation. All the participants enrolled in the STEM strand because they wanted to pursue STEM-related courses in college. The research found out that the implementation of the university STEM program has its strengths and weaknesses. It was revealed that the program provides a range of learning activities and experiences for students that hone their academic and character development. The program, however, needs to offer more opportunities to improve students' practical skills through investing in laboratory facilities and equipment. To further improve the program, the study proposes a more specialized and skill-based approach in the delivery of the STEM curriculum.

Keywords: Graduate Perspectives, Curriculum Evaluation, STEM program implementation, Philippines

INTRODUCTION

The K to 12 curriculum is one of the most well-researched educational reform measures undertaken across the globe. The Enhanced Basic Education Act or R.A 10533 is a product of decades of study that aims to accelerate the shared recognition of Filipino graduates and professionals across the world (Dizon, Calbi, Cuyos & Miranda, 2019). Implementation of K to 12 aimed at enhancing literacies and competencies needed for college preparation, and for the demands of employment (Fernando, Retumban, Tolentino, Alzona, Santos & Taguba, 2019). Thus, the K-12 curriculum, particularly in the senior high school (SHS), prepares and envisions learners to be holistically developed and ready with the basic and new literacies across the curriculum. Moreover, it ensures that SHS graduates have sufficient mastery of core skills and ready for higher education, and emotionally matured which is essential for the world of work (Perez, 2018).

Implemented in the academic year 2016-2017 in the Philippines, senior high school spans over two academic years composed of two semesters each. One of the strands from the academic track is the Science, Technology, Engineering and Mathematics (STEM) which is reported to be highly in demand locally and internationally. Students who are interested in the STEM strand has significantly increased throughout the years (Geminiano, 2018; Rafanan, De Guzman, & Rogayan, 2020). In addition, a survey initiated by Emerson Electric Company found out that about 90 percent of junior high school graduates are interested and encouraged in pursuing STEM careers because it is believed to be that technology-driven, innovation-allied, and highly-compensated careers which are associated and affiliated to STEM are projected to be constantly emergent in the next coming years (The Manila Times, 2019). STEM careers had wages above the national average. The highest compensated STEM-related jobs based from the survey are petroleum engineers, architectural and engineering managers, computer and information developers, natural sciences managers, physicists, environmental science and protection technicians, biological technicians, surveying and mapping technicians, agricultural and food science technicians, and forest and conservation technicians (Fayer, Lacey & Watson, 2017). As expected, STEM-related careers are significant contributors to improvement and productivity, and progression in most advanced economies (Deming & Noray, 2018).

Despite the growing emphasis in advancing STEM education and the increasing number of students undertaking STEM strand, its curriculum and instruction fails to necessarily prepare graduates for college and career demands. Students showed negative interests and emotions towards the strand because of its wide range of factors including demographic characteristics, students' competence (e.g. belief in one's ability to successfully perform in STEM), institutional hurdles, subject avoidance and disinterest, misalignment of some subjects offered and lack of social interaction (Dizon et al., 2019; Mattern, Radunzel & Westrick, 2015; Sellami, El-Kassem, Al-Qassass & Al-Rakeb, 2017). STEM SHS graduates are generally not comparatively equipped in taking STEM-related programs because they lack the content knowledge expected of a university student. Alarming number of students with STEM backgrounds (i.e., with set of skills and certifications) divert away from STEM-related careers, either in the university level or later in their professions (Carnevale, Smith & Melton, 2015; Fernando et al., 2019; Rafanan, et. al, 2020). As technology progress and new STEM skills advance, this creates a greater sense of threat, misalignment and shortage among the graduates of STEM-related professionals (Deming & Noray, 2018). The educational system is also not generating skilled and proficient STEM graduates to keep up with the demands both in traditional and current STEM-related careers and other areas across the economy that mandate comparable capabilities and experiences (Carnevale et. al, 2015).

This research is timely and relevant to contribute to the efforts of research and development, and of examining the role that the school system as a whole perform. The interest in this topic emanated from the desire of not just improving and promoting STEM education, but also to make the university graduates uniformed with the international criteria. Moreover, the paper aspires to make the STEM offering of the university diverse, advance and outstanding. Despite the pronounced efforts exerted and the considerable resources allotted by the academic leaders through quality assurance and the department's frontliners in an ongoing attempt to provide quality education and services, not adequate attention has been paid to the ways and means of enhancing the K to 12 offering, specifically of the STEM strand. As the areas of content, skills, and attitude of STEM-related jobs quickly change contributing to unprepared tertiary students and graduates (Deming & Noray, 2018), there is a need for a shift in approach and additional support and initiatives to address the issues and concerns found in the implementation of the curriculum instigated by the government and counterbalance such lack of practical aptitudes required in STEM curriculum in preparation for higher education (Carnevale, et. al, 2015; and Dizon et al., 2019).

Curriculum evaluation broadly captures efforts to improve and increase the educational ideals to better engage students in a meaningful teaching-and-learning experiences. It is a process of validation of alignment and appropriateness, effectiveness and efficiency, and achievement of the execution by means of scientific research processes. Its main motivation is to check whether curriculum purposes are being or have been achieved, so that amendments and enhancement can be proposed if deemed indispensable (White, 1971; Afsahi, 2016; Anh, 2018; and Aslan & Saglam, 2017). Ideally, though curriculum evaluation purposes and questions vary, assessment can be utilized to create sound decisions, improve quality offerings and student academic achievement (Malin, 2014).

One of the ways to assess the implementation of a curriculum is through the responsive (Stake) model. Stake's assumption is greatly concern with the stakeholders, those for whom the curriculum is made, as paramount in determining the evaluation issues. It is derived from the desire to respond to the needs of the clients. Generally, responsive evaluation model considers the search for quality and the representation of quality in the program (Anh, 2018; Durdella, 2010). The study utilized Stake's responsive approach to evaluate the implementation of STEM Curriculum in a Philippine university to be able to propose an enhanced offering and implementation that will respond to the needs of calibrating and preparing graduates to university-level STEM-related programs, and be at par with the global standards. Alumni discussions and focus group were utilized to gauge the effectiveness of the curriculum delivery as assessment can be accomplished using these methods. Discussions are done after the completion of program to provide vital feedback and evaluation.

OBJECTIVES OF THE STUDY

This study aimed to suggest strategies towards better curriculum delivery that would cater to the needs of the STEM learners, make graduates highly competent and ready, lessen STEM attrition, and contribute to economic progress and educational innovation: Specifically, it sought to fulfill the following:

1. identify the strengths and achieved outcomes of the implementation of the STEM Curriculum relative to instructions, assessments, learning resources, and other support services;
2. analyze the weaknesses and issues of the implementation of the STEM Curriculum as perceived by the graduates; and
3. propose enhancements in STEM program delivery as response to university's quality policy statement of continuous improvement.

METHODOLOGY

The descriptive qualitative design was utilized in evaluating the STEM curriculum from the perspectives of the first batch of graduates. Qualitative research was used to generate value-added understanding (Aspers & Corte, 2019). The role of the researchers is to ensure the adherence on the steps provided in the responsive model: a) to gain a sense of the participants' perspectives; b) to ensure meaningful discussion towards the desired data; and c) to decide the most appropriate materials in developing a sound assessment. At the beginning, the researchers met the participants via online to explain the rationale of the study and to encourage openness of views and thoughts. Evidence for this research study were drawn from the STEM graduates' responses and perspectives on the implementation of the strand and in general, the delivery of teaching-and-learning process. Curriculum implementation involved the learners, learning resources, teachers, school environment, culture, leadership and management and assessment (Chaudhary, 2015).

Semi-structured interviews were utilized in the study. During the interviews, the researchers enabled a smooth flow of communication, recognized cues, and made sure that respondents are at ease. The protocol questionnaire was validated to ensure that all the research objectives were covered. The interview questions were validated by the external validators (a professor in the graduate school, an academic supervisor and the head of the RDC). Questions formulated were intended to prompt evaluative details in the implementation of the STEM strand curriculum. Recorded interviews were then transcribed verbatim and subjected to validation and confirmation.

The learner is the central character in the execution and practices of a curriculum (Chaudhary, 2015). Alumni-based evaluation is acknowledged to be part of the process of curriculum assessment. It offers useful feedback to curriculum implementers and designers. When measuring school "success", one important perspective is that of the graduates. They are in a better position to reflect based from their experiences, especially if they graduated at least in the past ten years (Picho et al., 2015; Cobb, Brown, Hammon & Mossop, 2015). Participants of the study comprised of eleven (11) graduates of the STEM strand selected based on these criteria: (a) graduated in the S.Y. 2018; (b) graduated with academic distinction, (b) with no disciplinary cases; (c) can understand English and Filipino; (d) currently taking bachelor degree in the field of science, technology, engineering, and mathematics; and (e) enrolled in an autonomous university in the Philippines. Purposive sampling was used to provide information-rich for an in-depth study analysis. Participants are registered conferring to preselected criteria associated to the research intentions (Etikan, Musa & Alkassim, 2016). Ensuring the anonymity of the participants, each of them were given pseudonyms.

Researchers used thematic analysis. It provides core skills for conducting qualitative analysis. A method for systematically identifying, organizing, and understanding patterns of meaning across the obtained set of data was conducted. By focusing on implications through a dataset, it permits the researcher to realize and make sense of collective and shared meanings from student-participants' answers (Vaismoradi & Snelgrove, 2019). Recognized emerged themes were validated through the conduct of focus group discussion.

RESULTS AND DISCUSSIONS

1. Strengths and Achieved Outcomes of the STEM Curriculum

1.1. Diversifies student learning experiences

In evaluating the STEM curriculum of the university, one notable result is how the graduates find their SHS learning experiences diverse, in terms of instruction and assessments. Ariana, a BS Dentistry student, stated that the university provides "*diverse range of assessments which maximized the potential of the students*." Furthermore, the range of assessments and learning activities enable the students to improve on their adaptability in managing problem-solving techniques. Mino, a BS in Biology student, explained this further: "*The assessments given differ from one to another and I think, it is one of the strengths of the university as students learn how to approach various sets of assessments, may it be an exam, performance tasks, assignments, group projects and the like.*" Aside from the student learning experiences in the classroom, the participants were able to point out how the university provided co-curricular activities that served as their academic break away from the pressures of the classroom. These activities did not only make the students' school experiences enjoyable but also provided opportunities for other skills to develop. Nikki, a BS in Physical Therapy student, pointed out how she enjoyed various extra and co-curricular activities, like dance competitions and quiz bees, of the school. She stated, "*It served as a break from all the tasks that needed to be done and it also provided us learning and experience. I really enjoyed our inter school competitions such as in folk dance competitions, quiz bees, journalism etc.*"

The varieties of learning experiences can be attributed to the people who handle the different learning activities of the students, primarily the SHS teachers. Valerie, a BS in Biochemistry student, stated how "*some of the professors were very creative enough to set up a lesson plan that can boost the student's learnings and creativity*." This is seconded by Cory, a BS in Agricultural Biotechnology student, when she shared her sentiments about her previous teachers. She mentioned that, "*The teachers are knowledgeable enough to teach their subjects and the professors I had for the core subjects of STEM were all well-equipped and have their own distinct way of teaching their subjects.*" Moreover, some participants were able to point out other departments of the university, like the guidance and counseling office and performing arts group, in helping them develop and hone other skills and potentials, aside from the skills required in the STEM program. Patty, a BS in Math and Science Teaching student, described how these available groups and organizations had been supportive and accommodating to the student body "*to unleash the potential of the students and to properly guide them with the right path.*"

High quality learning emerges when students become active during the teaching-and-learning process. Students' interest increases through instruction, assessment, and co-curricular activities that are based on real-world situations. They become more interested in learning if they see the connections of what they are learning to what they do. Learning occurs through connected experiences. It includes the integrated functioning of the whole person, a result of synergetic relations between the students and the environment (Šteh & Kalin, 2012; Passarelli & Kolb, 2012; Nguyen, Nguyen & Tran, 2020).

1.2 Provides strong academic and character foundation for students

Results also elucidated how the STEM curriculum of the university provided sufficient academic background for their STEM-related university programs. Salvi, a BS in Aeronautical Engineering student, stated that the STEM program excels in terms of teaching concepts and theories, mainly strengthening students' content knowledge as preparation for their college journey. He explained, "*They [teachers] were able to impart the necessary concepts and learning objectives to the students. The lessons that were taught, especially in technical subjects like math and science, greatly helped me in my college lessons. Overall, I can say that the STEM strand prepared me for college and was able to give me the foundation that I need in understanding the concepts taught in my course*." This was seconded by Ariana when she said that, "*The STEM strand helped me build up a solid background knowledge that is essential in my current study which enabled me to somehow easily and quickly understand more complex learnings*." It should also be noted how the STEM curriculum is still restricted by the DepEd's mandated curriculum guides. Teachers are still patterning their syllabi's learning objectives and content from these curriculum guides so that there would be alignment of the student learning competencies institutionally and nationally. These types of restrictions may have hindered the exploration of some teachers to introduce additional concepts in their subject matter. Myrtle, a BS in Electrical Engineering, mentioned this dilemma when she shared, "*Like for example, when I was taking Chemistry in college, I found it easy because I have a very good prof in SHS. However, in subjects like Pre and Basic Calculus, I find it hard since what I learned in my whole SHS is only our Day 1 topic of my Calculus class in college*." The STEM curriculum of the university might not anymore be at fault in these types of problems but how college courses transition their objectives and content based from their students' background in the SHS.

Apart from all the necessary content and knowledge discussed in the curriculum, the school has also highlighted the importance of character development among their graduates. Uriel, a BS in Electronics Engineering student, shared, "*The foundations were somehow given to the students on how to properly deal with everything. Because of the basic foundations taught, for example in responding and evaluating things, children have a basic knowledge of how to be the right character when they take their course*." Another participant shared how the university also allowed values formation in all the teacher-learning activities they had. Mino shared, "*I think it's not just the book-based learnings I received but all the good values and life lessons the university taught me, which helped me as I study in college and in a bigger, more diverse university*." One value that has been pointed out by the participant is the value of socialization and social participation. It was mentioned how the institution provided students opportunities to hone their social skills in different situational activities that the graduates perceived beneficial in their life. Mickey, a BS in Information Technology student, stated that, "*One thing that I am doing a lot right now in college is socializing and interacting with different types of people. I think it's very necessary to teach these students* *socializing skills and experiences because they're going to be needing a lot of that in college and the workplace. And I think I learned that a lot during my SHS stay*." Based on the participants' insights, it was clear that the STEM program does not only hone students' content knowledge but also develop students' attitude and character towards learning in general. Through this holistic teaching-learning practice, the STEM curriculum manifests students who are not only academically capable but also characteristically mature for university life.

SHS students need to have necessary cognitive capability and attitude to better prepare them for STEM-related university programs. Modern citizens must be able to employ the STEM academic content to deal with challenges including unpredictable phenomena, political conflict and other real-life problems. This would entail connections between knowledge and character development. Quality learning experiences happen when the students are ready cognitively and emotionally. Contents, prior knowledge and values must be clearly linked to ensure meaningful learning (Šteh & Kalin, 2012; Fernando et.al., 2019; Nguyen, et. al, 2020).

2. Weaknesses and issues of the STEM curriculum

2.1. Limited opportunities on improving practical skills of students

Evaluating a curriculum does not only present its strengths and benefits but also its weaknesses and difficulties experienced by the students. Among the majority of the interviews, one of the issues with the implementation of the STEM curriculum is the lack of opportunities for practical skills developments. This was shared by Ariana when she said that, "*I think practical skills and the necessary sets of competencies were not really practiced/ imparted well due to the difficulty in doing so because of having a large class, almost 50 students per class. Due to this, the STEM strand of the university only helped me greatly in terms of content knowledge."* This insight revealed how the university STEM curriculum only helped the graduates in terms of their content knowledge, not necessarily equipping them with real-life practical skills. According to Cory, the STEM program lacked sufficient opportunities and activities that can hone students' practical skills, more specifically with their laboratory skills. She stated how her college professors were surprised by, and even mocked, their incompetence in the laboratory, expecting that the SHS curriculum already trained these STEM students on basic laboratory skills. She shared that, "*My college professors were also shock about this because many of the first batch truly lack when it comes to practical skills, and they expected that senior high already taught us all the basics and that's why they were forced to remove the basic subjects in the college curriculum only to welcome students like me who can be called, 'didn't learn that much from SHS'.*" This can be a result of the STEM curriculum not having enough learning objectives that target the development of students' practical (and laboratory) skills. If the curriculum does not aim for the development of these skills, the content of the syllabi of all the specialized subjects might not reflect the need for hands-on experiences in the laboratory for students. Salvi shared his sentiments on not having enough experiences inside the science laboratory of the university. He said, "*The school has almost complete facilities and laboratories but students were not given the experience to use it. Throughout our stay, we were not able to use any laboratory equipment or taught how to operate it which is crucial especially for students who plan to take technical courses*."

Many of the participants felt that the university should allow more practical activities, especially providing hands-on laboratory experiences. Lucy, a BS in Information Technology student, said that the STEM curriculum should establish more practical activities and work immersions as college and career preparation of graduates. She finished by saying that, "*I think that there should be more real-life applications of the knowledge imparted to the students. The curriculum should be more specific and focus on what the students need in college*." With the lack of practical laboratory skills reflected in the STEM curriculum, it is noteworthy to mention how graduates commend the university's initiatives to improve students' practical research skills. Myrtle juxtaposed the university's lack of laboratory orientation to their extensive research exposure. She mentioned that, "*[the school] is not a technical university that's why I really don't have enough knowledge when it comes to handling basic electrical and electronic equipment. But when it comes to research, I must say that the research program of the university is quite beautiful since I am able to impart all the knowledge I have in college*."

Improving the skills and competencies of STEM students can build a strong foundation and increase their employment forecasts. Maximizing skills acquisition create an aptitude to perform at any given tasks and time with comfort and efficiency. Relevant skills are beneficial as these provide confidence to perform tasks related to the career students wanted. The development of adequate competencies and skills is an important aspect of any program in any levels of the educational system. Practical skills are about using the knowledge and values proficiently that showcase a level of competency. The acquisition of applied skills is vital because when efficient and skillful hands are engaged in any fields of human endeavors, extraordinary level of productivity and success are attained (Passarelli & Kolb, 2012; Udo, 2015; Perez, 2018).

2.2. Limited laboratory facilities and equipment

With the limited opportunities for hands-on laboratory activities, it is no surprise that the participants perceived that the university lacked laboratory facilities and equipment to suffice the number of enrolled STEM students. Cory stated that one reason why the graduates lack laboratory skills is the lack of lab instruments. She shared that in their laboratory activities, there were five to ten students who were sharing one microscope which hindered students' exploration and their development of lab skills. She continued her insight by comparing her current lab experiences by saying, "*The university fails to provide the students with engaging lab experiments that can at least help their appreciation in Science. This is a perspective from someone who is dealing now with so much lab works, especially in my thesis.*" This is also in agreement with Ariana's statements: "*Although the available learning materials are almost complete, the quantity of the materials is scarce. In a laboratory, groups that contain more or less 10 members should be formed in a class. The available microscopes, for example, are only 4 which makes it impossible or difficult for the whole class to really understand what they are doing*." Although this issue might not be a direct impact of the current STEM curriculum, this can still impair the learning of students who were training to enter rigorous university-level programs which entail basic laboratory skills for experiments and research. Furthermore, as Cory mentioned, the lack of tools can delimit learning opportunities for the majority of the students, just because they were not able to have first-hand experiences handling these instruments. This only creates inequalities of learning within the instruction and implementation of the STEM curriculum.

Problems, such as lack of learning materials, resources, and facilities, should need to be addressed. If learning is to occur, a learning space and resources are necessary. Some are a conducive physical environment, proper equipment and available of time for learning to takes place. The study presents that knowledge resides not just in student's mind but in places of practice and delivery of instruction. Laboratories extend learning beyond the teacher and the classroom. The use of laboratories and equipment during instruction-related activities and assessments help develop skills and values that can aid leaner's ability for decision-making, problem-solving, and other significant life skills. It has been reported that exposure on laboratories and appropriate resources were associated for students' improving academic performance and aligning students' choice of their university programs (Passarelli & Kolb, 2012; Perez, 2018; Pareek, 2019).

3. Perceived beneficial modifications on the curriculum

3.1. Inclusion of sub-strands for STEM

In the interviews, participants were asked to provide their insights on how to better the implementation of STEM curriculum. Majority agreed that having various sub-strands can provide a more focused teaching-learning experience for the students. Myrtle provided an extensive explanation regarding this recommendation. She said that, "*Having a focused study is something that should be prepared before going to college, so it would be nice if under S.T.E.M, students could enroll in tracks that are really related to what they will take in college. For example, those who want to take medical related courses can take STEM - Science, those who want to become engineers and architects can take STEM-Engineering*." Throughout the interviews, participants were keen to create a more specialized curriculum for the STEM that let students focus on what STEM-related degrees and programs they want. Cory provided some examples on the construction of these sub-strands, "*Consider adding microbiology and genetics, agriculture, computer and engineering as sub-strands of the STEM because in these specific subjects, most of the STEM-related degrees in college revolve.*"

STEM learning needs to be made in the context of "what is needed to know and do" for future engineers, scientists, doctors, architecture and the like. This provides advantages among graduates. Research review indicates that high school course has an impact on student's decision to enroll in college. Aligning the curriculum from the secondary schooling to the college-level should consider defining the essential skills and knowledge needed for college preparations and career orientation (Ahmed, 2016; Phelps, Camburn & Min, 2018; Sujarwanto, Madlazim, & Sanjaya, 2021).

3.2. Inclusion of electives in the curriculum

In relation to the inclusion of sub-strands, participants also felt that allowing students to select electives that will cater to their specialized STEM-related degree will further benefit their content knowledge and skills as preparation for college. Coming from an allied health background, Nikki mentioned that students should be able to select their specialized subjects to fit their need for their chosen STEM-related degree. She said that the university should, "*Provide the students a choice on what major they would choose: Calculus, Physics, Chemistry, Biology, Statistics etc., but what if I want to pursue nursing or physical therapy per se, calculus would not help me. Anatomy and Physiology choices can be added because STEM is not just about mathematics, it is also about sciences.*" Aside from a selection of allied health science courses, Mickey, with a computer programming background, highlighted the importance of having computer-related subjects in the STEM curriculum, especially that it relates to the technological aspect of the strand. He stated that, "*I think there should be more computer/programming-related subjects, or at least a sub-strand for specific fields, more focus on major subjects instead of minor subjects taking so much time of the students because in college 80% of your time would be spent on subjects that are actually related to your field, and more activities that would help students communicate/socialize with their peers because you'll be doing a lot of collaborations with different kinds of people in college*." To further provide sufficient learning experiences to STEM students, Myrtle also recommended having workshops on basic hands-on skills, especially for incoming Engineering students. She described this workshop, "*For example as an electronics engineering student, it would be nice if there was a dedicated subject for the students where they can learn and practice the basics of using multimeter, proper reading of resistor, capacitors and transistor as the fundamental skills*."

Most successful countries in STEM implementation have established strategic STEM policy. One of which is a curriculum reform and enhanced teaching standards. Enhancing curricula that links comprehensive prerequisite requirements and additional STEM subjects for university programs generate advance STEM knowledge and optimize the preparation for university. Students who earned credits in additional and special courses were more likely to enroll in STEM majors in college. A strong positive STEM identity with intensive science and math electives is a best predictor of future career choice in STEM field (Ahmed, 2016; Phelps et. al, 2018; Fernando, et. al., 2020; Rafanan, et. al, 2020).

CONCLUSIONS

Findings revealed that the curriculum allows for diversified and varied learning experiences for students, integrating classroom-based activities and co-curricular activities. It was pointed out how not only the university has helped them in establishing a strong academic background for their college courses, but also inculcated internalization of positive attitudes and character towards work and life in general. In contrast, there were different issues experienced by the participants while being under the university STEM curriculum. The time allocation and/or the hands-on experience is insufficient, resulting in missed opportunities for developing practical laboratory skills among its STEM students. Moreover, recommendations were offered to the graduates of the STEM program such as the inclusion of sub-strands and electives in the university STEM curriculum.

RECOMMENDATIONS

Here are some recommendations proposed to improve and enhance the delivery of the STEM program of the university:

1. The university should offer sub-strands under the STEM to focus on students' preferred STEM-related course and degree. Students should have options whether they will be pursuing science-focused courses (e.g. allied health and other science-related courses), technology-focused courses (e.g. information technology and computer-related courses), engineering-focused courses, and mathematics-related courses. These options allow students to have a more specialized learning experience under the curriculum. Moreover, this modification can enable teachers to align their learning objectives and learning activities to the specific sub-strand of the STEM students.
2. With the university allowing students to choose among the sub-strands of the STEM curriculum, additional electives and subject offerings can also provide explorations and sufficient academic background to students as preparation for their chosen university programs. As early as SHS, students can be introduced to subjects, like human anatomy or basic math engineering, for them to have a better understanding foundation of the STEM-related courses that they will take in the university.
3. The STEM program should prioritize the implementation of skill-based instruction as part of its pedagogical activities. Studies have shown the benefits of implementing a skill-based approach in developing essential skills for STEM students, such as mathematical learning reading comprehension and even emotional intelligence.
4. Lastly, the university should prioritize funding its laboratory facilities and equipment to cater to their expanding STEM student body. Through investing in these facilities, the university fosters a culture of evidence-based understanding and inquiry among its graduates.

REFERENCES

Afsahi, A.E. (2016). *The role of evaluation in curriculum design.* Iran: Islamic Azad University. https://www.researchgate.net/publication/309556210_The_Role_of_Evaluation_in_Curriculum_Design

Ahmed, H. O. K. (2016). Strategic future directions for developing STEM education in higher education in Egypt as a driver of innovation economy. *Journal of Education and Practice*, *7*(8), 127-145. https://files.eric.ed.gov/fulltext/EJ1095333.pdf

Anh, V. T. K. (2018). Evaluation models in educational program: Strengths and weaknesses. *VNU Journal of Foreign Studies, 34*(2), 140-150. https://doi.org/10.25073/2525-2445/vnufs.4252

Aslan, M., & Saglam, M. (2017). Methodological investigation of the curriculum evaluation theses completed between the years 2006-2015 in Turkey. *Universal Journal of Educational Research*, *5*(9), 1468-1478. https://eric.ed.gov/?id=EJ1151851

Aspers, P., & Corte, U. (2019). What is qualitative in qualitative research. *Qualitative Sociology*, *42*(2), 139-160. https://doi.org/10.1007/s11133-019-9413-7

Carnevale, A.P., Smith, N. & Melton, M. (2015). *STEM: Science, technology, engineering and mathematics.* Washington D.C.: Georgetown University Center on Education and the Workforce. https://cew.georgetown.edu/wp-content/uploads/2014/11/stem-complete.pdf

Chaudhary, G. K. (2015). Factors affecting curriculum implementation for students*. International Journal of Applied Research, 1*(12), 984-986. https://www.allresearchjournal.com/archives/2015/vol1issue12/PartN/2-5-158-343.pdf

Cobb, K. A., Brown, G. A., Hammond, R. H. & Mossop, L. H. (2015). Alumni-based evaluation of a novel veterinary curriculum: are Nottingham graduates prepared for clinical practice?. *Veterinary Record Open*, *2*(2), 1-9. https://doi.org/10.1136/vetreco-2015-000116

Deming, D. J. & Noray, K. (2018). *STEM careers and technological change*. Cambridge, MA: National bureau of economic research. http://www.nber.org/papers/w25065

Dizon, R., Calbi, J., Cuyos, J., & Miranda, M. (2019). Perspectives on the implementation of the K to 12 program in the Philippines: A Research Review. *International Journal of Innovation and Research in Educational Science*, *6*, 757-765. https://ijires.org/administrator/components/com_jresearch/files/publications/IJIRES_1638_FINAL.pdf

Durdella, N. R. (2010). Evaluations that respond: Prescription, application, and implications of responsive evaluation theory for community college instructional support programs. *Journal of Applied Research in the Community College*, *17*(2), 9-19. https://eric.ed.gov/?id=EJ897827

Etikan, I., Musa, S. A. & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, *5*(1), 1-4. https://doi.org/10.11648/j.ajtas.20160501.11

Fayer, S., Lacey, A. & Watson, A. (2017). *STEM occupations: Past, present, and future.* U.S. Bureau of Labor Statistics Spotlight on Statistics. https://www.bls.gov/spotlight/2017/science-technology-engineering-and-mathematics-stem-occupations-past-present-and-future/pdf/science-technology-engineering-and-mathematics-stem-occupations-past-present-and-future.pdf

Fernando, A. R., Retumban, J., Tolentino, R., Alzona, A., Santos, F., & Taguba, M. (2019, December). Level of preparedness of STEM senior high school graduates in taking up engineering program: a Philippine setting. In *2019 IEEE International Conference on Engineering, Technology and Education (TALE)* 1-6. https://doi.org/10.1109/TALE48000.2019.9225858

Geminiano, P. M. (2018, October 24). More students now prefer science and technology courses. *The Philippine News Agency*. https://www.pna.gov.ph/articles/1051947

Malin, J. R. (2014). Curriculum evaluation for the improvement of STEM programs of study. *Champaign: Office of Community College Research and Leadership, University of Illinois at Urbana-Champaign*. https://occrl.illinois.edu/docs/librariesprovider2/prc/curriculum-evaluation.pdf?sfvrsn=e1a0bc89_4

Mattern, K., Radunzel, J., & Westrick, P. (2015). Development of STEM readiness benchmarks to assist educational and career decision making. ACT Research Report Series, 2015 (3). *ACT, Inc.* https://eric.ed.gov/?id=ED558031

Nguyen, T. P. L., Nguyen, T. H., & Tran, T. K. (2020). STEM education in secondary schools: Teachers' perspective towards sustainable development. *Sustainability*, *12*(21), 8865. https://doi.org/10.3390/su12218865

Pareek, R. B. (2019). An assessment of availability and utilization of laboratory facilities for teaching science at secondary level. *Science Education International*, *30*(1). https://files.eric.ed.gov/fulltext/EJ1209309.pdf

Passarelli, A. M., & Kolb, D. A. (2011). The learning way: Learning from experience as the path to lifelong learning and development. In M. London (Ed), *The Oxford handbook of lifelong learning* (70-90). Oxford: Oxford University Press.

Perez, R. B. (2018). Becoming successful K to 12 implementers: operational preparedness of senior high schools in Hagonoy, Bulacan, Philippines. *Online Submission*. https://files.eric.ed.gov/fulltext/ED594773.pdf

Phelps, L. A., Camburn, E. M., & Min, S. (2018). Choosing STEM college majors: Exploring the role of pre-college engineering courses. *Journal of Pre-College Engineering Education Research (J-PEER)*, *8*(1), Article 1. https://doi.org/10.7771/2157-9288.1146

Picho, K., Gilliland, W. R., Artino Jr, A. R., DeZee, K. J., Dong, T., McManigle, J. E., ... & Durning, S. J. (2015). Assessing curriculum effectiveness: A survey of uniformed services university medical school graduates. *Military Medicine*, *180*(4), 113-128. https://doi.org/10.7205/MILMED-D-14-00570

Rafanan, R., De Guzman, C. & Rogayan, D. (2020). Pursuing STEM careers: Perspectives of senior high school students. *Participatory Educational Research*, *7*(3), 38-58. https://doi.org/10.17275/per.20.34.7.3

Šteh, B., & Kalin, J. (2012, Jun 12-15). *Students' views on important learning experiences--challenges related to ensuring quality of studies.* [Paper presentation] Bulgarian Comparative Education Society: Kyustendil, Bulgaria. https://files.eric.ed.gov/fulltext/ED567100.pdf

Sellami, A., El-Kassem, R.C., Al-Qassass, H.B., & Al-Rakeb, N.A. (2017). A path analysis of student interest in stem, with specific reference to Qatari students. *EURASIA Journal of Mathematics Science and Technology Education, 13*(9), 6045-6067. https://doi.org/10.12973/eurasia.2017.00999a

Sujarwanto, E., & Sanjaya, I. G. M. (2021). A conceptual framework of STEM education based on the Indonesian Curriculum. *Journal of Physics: Conference Series,* 1760(1), 1-8*.* https://doi.org/10.1088/1742-6596/1760/1/012022

The Manila Times (2019, August 29). STEM track prepares HS students for work. https://www.manilatimes.net/2019/08/29/campus-press/stem-track-prepares-hs-students-for-work/607355/

Udo, M. P. (2015). Techniques for improving practical skill acquisition in vocational business education (VBE) for sustainable development in Nigeria. *European Journal of Research and Reflection in Educational Sciences*, *3*(1). 27-34. http://www.idpublications.org/

Vaismoradi, M., & Snelgrove, S. (2019). Theme in qualitative content analysis and thematic analysis. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, *20*(3). https://doi.org/10.17169/fqs-20.3.3376

AUTHORS' PROFILES

John Robby O. Robiños, LPT, Ph.D.(c) has been a researcher, journal writer, statistician, teacher, and lifelong learner. Presently, he is the Senior High School Assistant Principal and part-time faculty of the College of Arts and Sciences and Education of the University of Perpetual Help Molino Campus, and of the Polytechnic University of the Philippines-Biñan Campus. He is a member of the International Organization of Educators and Researchers (IOER-2020) and the International Association of Scholarly Publishers, Editors, and Reviewers (IASPER- 2017). He has presented and published researches on Math is Love, Learning and Sharing, Higher LEAP and Math for MATH. Curiosity, love of wisdom, and growth mindset are his key reasons for engaging himself in writing collaborative researches. He believes that research experience varied greatly and allows us to hone our flairs and outlook towards life.

Holden Kenneth G. Alcazaren, LPT, MAELED, is currently taking up Phd in Education major in Language Education at the University of the Philippines-Diliman. He is a public-school teacher at Gen. Pantaleon Garcia Senior High School, teaching English Language and Research courses. His research interests are in researcher and teacher identities, multilingualism, qualitative research methodologies and gender studies.

Evangeline D. Marasigan, LPT, MA, is currently the chairperson for the Natural Sciences and Mathematics department of the College of Arts and Sciences/ Education of the University of Perpetual Help, Molino campus. She is an Assistant Professor 4 teaching science courses in the university. She is a graduate of BS in Chemical Engineering and MA in Teaching Chemistry.

COPYRIGHTS