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Divergence on Students' Interest in Engineering Program and Academic Performance in General and Professional Courses as Input to K-12 Engineering Education

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Abstract
Students' interest is subjective in nature as it changes overtime based on educational and personal experiences that drive them to behave accordingly. The main objective of the study is to determine the difference on students' interest towards engineering program from the first enrolment compared to their interest before graduating; and its correlation to academic performance.
Descriptive type of research was utilized in the study. Results showed that divergence on students' interest is very evident in the increase on satisfaction in terms of knowledge and skills acquired in engineering and decrease on the level of students' enjoyment in doing the skills and operations involved in engineering. In general, there is a positive change on the level of students' interest towards engineering program after five years of studying in the university. Student interest during freshmen is related to the academic performance in general education courses but not anymore true to professional courses and their interest in the engineering program after 5 years. Academic performance in General education courses is significantly related to professional courses.

Keywords: Students' Interest, Engineering Education, Philippines, General education

Introduction

College education is the preparation of every student for their future career as professionals. It can lead students to different directions but it builds character, knowledge and skills to perform whatever duties and responsibilities they would encounter as they leave the portal of the academic institutions. They often choose undergraduate degree program to pursue in college through their interest or preference to a specific discipline. It is necessary to consider the desire of the students what to take but there are factors that may affect that leads to redirecting their career preparation to other fields of study which is out of their interest and divergence comes in between first enrolment and last term in college before graduating. Ramirez and Dizon [1] noted that "interest like motivation could drive someone to pursue their degree programs as they plan it to finish in specified time of five years for engineering. Since due to low or lack of interest, students could have thought of either dropping the enrolled courses or even stop schooling". Engineering as a degree program requires the students' inclination to mathematics to survive on carrying out various challenges of solving problems more analytically and critically [2]. Hayden et al., [3] noted that "it is important for educational agencies to help develop the underrepresented population's potential to become professionals in areas that are essential to the nation's competitiveness in the global marketplace".
Students certainly have different abilities, come from different family backgrounds, have different understandings of their academic life, and desire to study for different reasons and select different courses [4]. Moving in college after Senior High School is an option for most students to pursue baccalaureate degree program to further enhance their skills in their chosen academic strand. But they are already capable to join the workforce after graduation in high school if they prefer to earn as early as 18 years old. In the third world country like the Philippines, students have the opportunity to

land any jobs suitable to their educational background because they are already equipped with technical skills during senior high school so that they could be able to adapt the work environment and they can earn a living to support the basic needs of their family.

There are many different goals of K-12 Engineering Education that include: increasing public appreciation of engineering work and research; increasing student science and math performance; and increasing the supply of future engineers [5]. K to 12 in the Philippines is just started accepting senior high school for Grades 11 and 12 for most institutions in School Year 2016-2017 which is somehow part of the internationalization process [6] of education to meet the demands of global market for ASEAN integration. Its implementation is generally nationwide with few secondary school started earlier for pilot test. This is an appropriate time for the junior high school students to internalize and assess their interest on what to pursue in college by choosing the academic strand they are interested to work at specifically exploring the possibility of taking Science, Technology, Engineering and Mathematics (STEM) strand [7].

Based on the data collected from CHED in AY 2013-14 [8], Engineering and Technology ranks 4th with the highest number of graduates of 10.86 percent out of the total number of 585,288 graduates (*include pre-baccalaureate to doctoral programs).* This signifies that engineering as undergraduate program is still popular in the Philippines where number of graduates is higher compared to other programs except for business, teacher education and information technology that have higher number of graduates than engineering. But Engineering and technology is more popular tertiary degree program in other Asian Countries. Meanwhile, Malaysia has approximately 26 percent of engineering, manufacturing and construction graduates in 2010 based on the Education Statistics of World Bank [9] while Indonesia has 16.7 percent and Thailand has approximately 15 percent in the same year. Secondary school students in Qatar show a significant interest in engineering mainly because of the strong demand for engineers in the local market [10].

Duderstadt [11] stated that "students sense the eroding status and security of engineering careers and increasingly opt for other more lucrative and secure professions such as business, law, and medicine. Today's engineers no longer hold the leadership positions in business and government that were once claimed by their predecessors in the 19th and 20th century, in part because neither the profession nor the educational system supporting it have kept pace with the changing nature of both knowledge-intensive society and the global marketplace.

General education subjects are being offered in preparation for better understanding of professional courses to be taken during the third year of all Engineering programs. Engineering students were called General Engineering during their 1st year and 2nd year. They have to pass the qualifying exam if they want to pursue any board programs. It is important to know by the students whether they are performing well or poorly by giving them advice through consultation hours. Low performing students during their 1st year or 2nd year should not end up their college education still as low performers. It is ideal if they could keep higher grades as their year level went up. But since professional education subjects are considered complicated than general education, the tendency of the students' grades would gradually go down to the lowest possible grade. Professional courses require technical skills on critical analysis and problem solving to address the issues related to their respective disciplines. Engineering design is part of their curriculum that is evident in their feasibility studies and design projects as final requirements in the program. This serves as the venue for the students to apply what they have learned in general education and professional courses.

Analyzing the significant correlation of General and Professional Education subjects is imperative to determine whether the students are improving their performance from first year up to their Fifth year level. This study would serve as a reference guide for the teachers, department chair and Dean of the College of Engineering in monitoring the academic performance of their students.

This study explores on the level of interest of the engineering students [1] enrolled already in college and how their interest change after five years before graduating as well as testing the correlation of their interest towards academic performance in general education and professional courses. Findings will serve as substantial input to K-12 transition on how to encourage students to pursue further studies in college. The students will be given an idea of pursuing a higher level of interest to achieve greater academic performance and develop a constant study habits.

Many students are just taking courses and activities in college for granted but they have to realize the significant contribution of all these undertakings for their future employment as they will take part in the economic development of the country and mobility in international community.

Objectives of the Study

The main objective of the study is to determine the level of interest of engineering students in taking up engineering and its correlation to academic performance. Specifically, the study aimed to determine if there are changes in the level of interest of students in engineering program when they were freshmen compared to their interest as graduating student; to determine the weighted average of the engineering graduates in terms of General Education subjects: Mathematics, Languages and Natural Sciences; and the Professional courses of Computer Engineering, Industrial Engineering, Mechanical Engineering and Electronics Engineering; to test if there is a relationship between the students' interest in taking engineering program and the academic performance; to examine if there is a significant relationship between the general education courses and the engineering professional courses.

Methods

This study used descriptive type of research method. Documentary analysis was used as data gathering procedure to obtain the grades of all engineering graduates from 2011 to 2015 from the College of Engineering office wherein total population was used in the study. The following engineering

degree programs were included in the study: BS Computer Engineering (BSCpE), BS Industrial Engineering (BSIE), BS Electronics Engineering (BSEcE) and BS Mechanical Engineering (BSME). A survey instrument was utilized in the study to collect the data on the students' interest towards engineering program. All engineering graduates were included in the study with 77% of their finals grades from different courses were retrieved from the report cards including the professional courses and general education courses which comprised of languages, natural sciences and mathematics.

Researcher-made survey instrument was used to gather the data which was pilot tested to marine engineering students who are not part of study with computed Cronbach alpha of 0.761 which is considered good in the rule of thumb.

The primary data were gathered after a week that the students were already immersed in the program during first year and a week before their final examination during fifth year. In the case of those graduates of 2011, the first set of data was gathered in the year 2006 during their first year of enrollment. Some records of the students were kept intact for almost 10 years.

Arithmetic mean was used to calculate the weighted average of the professional and general education subjects and weighted mean was used to interpret the result of students' interest towards engineering program while Pearson Correlation Coefficient was used to determine the relationship between students' interest and academic performance as well as between Professional and General education courses. Independent sample t-test was used to test the differences between the result of students' interest during their 1st year and 5th year at 0.05 level of significance.

The given scale was used to interpret the result of the data gathered: 3.50-4.00: Very High; 2.50-3.49: High; 1.50-2.49 Low; 1.00-1.49: Very Low

Results and Discussion

Table 1 presents the interest of the students towards the engineering program. When the students were asked during their first year, they strongly believed that engineering will take them for employment abroad (3.56) and it gets higher by 0.12 when they were asked after five years. They never lose hope of going abroad to work where they can establish their professional career in engineering in international companies rather than staying in the home country.

They also strongly believed that they can be successful in the future in engineering (3.52) but their interest decreases by 0.18 after five years. They already rationalize the thought of being successful needs hard work and patience. They encountered too much difficulty in finishing the program and the success rate of their future from their present failures really reduces the value after several years. But the state of mind dictates the feeling of frustration as they still conquering the fear of not having met all the requirements before graduation. The variation is very subjective as how they sense the future based on their present condition without considering its return after several years of graduation. In the result of the study of Alpay et al., [12] indicates that "while many students start an engineering degree with an aspiration to 'invent something new' and 'make a difference to the world', these diminish with time to be dominated by issues such as financial security". Misran and Sahuri [13] also found out that the duration of learning experiences does not influence the student's perception towards engineering program.

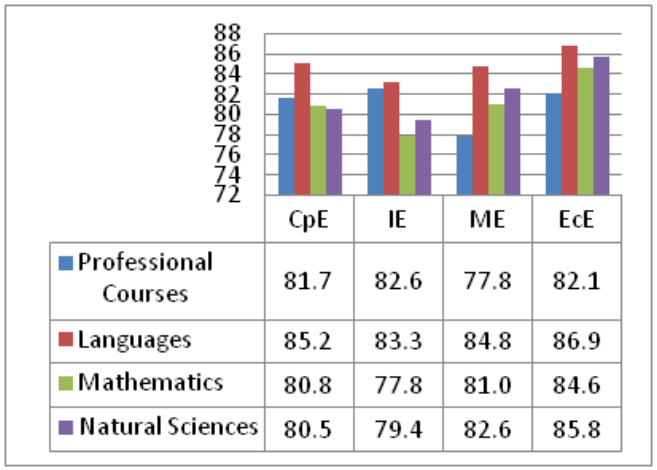
It seems that students were not enjoying anymore in doing the skills and operations involved in engineering as it has significant dropped of 0.28 from their 3.15 degree of interest in engineering program during their first year to 2.87 weighted mean score after five years. This signifies that the students experienced difficulties in complying and passing all the requirements of the program especially the major examinations, technical projects and volume of research works that made their lives almost uncomfortable.

Although they are not really enjoying in the program, they feel satisfied with the knowledge and skills they are earning in engineering with a significant increase of 0.46 from the level of interest of the students during first year (3.11). There is so much benefit they discovered in the field of engineering which are applicable and useful in daily activities. The principles and concepts of engineering are generally being used to think critically and analytically [2] that could be valuable in decision making and substantial input to strategic planning. The practical applications of the knowledge and skills acquired from the discipline will serve as guiding principle in making things better.

Table 1: Interest of the Students towards the Engineering Program

	1st Year		5th Year		
Interest	**WM**	**VI**	**WM**	**VI**	**Diff**
1. The Engineering Course is my top priority.	3.35	High	3.43	High	+0.08
2. It is the field that I think I can do better.	3.09	High	3.29	High	+0.20
3. I enjoy doing the skills & operations involved in this field.	3.15	High	2.87	High	-0.28*
4. I believe I can be successful in the future along this field of specialization.	3.52	Very High	3.34	High	-0.18
5. I have no regret in taking this course.	3.42	High	3.36	High	-0.06
6. I feel satisfied and happy with the knowledge and skills I am earning in this course.	3.11	High	3.57	Very High	+0.46*
7. If given the chance to choose among other fields of interest, I would still prefer to be in this course.	3.18	High	3.25	High	+0.07
8. I believe that this course will take me for employment abroad.	3.56	Very High	3.68	Very High	+0.12
9. I find engineering stimulating and challenging	3.42	High	3.53	Very High	+0.11
10. I appreciate the nature of duties and responsibilities being assigned to me in this course	3.05	High	3.24	High	+0.19
Composite Mean	**3.29**	**High**	**3.36**	**High**	**+0.07**

**Significant at 0.05*



	CpE	IE	ME	EcE
Professional Courses	81.7	82.6	77.8	82.1
Languages	85.2	83.3	84.8	86.9
Mathematics	80.8	77.8	81.0	84.6
Natural Sciences	80.5	79.4	82.6	85.8

Figure 1: Academic Performance of Engineering Students

Industrial Engineering graduates obtained the highest percentage in professional education subjects as manifested by the weighted mean of 2.37 or 82.6 percent followed by Electronics Engineering with 2.41 or 82.1 percent and Computer Engineering with 2.45 or 81.7 percent while Mechanical Engineering obtained the lowest weighted mean of 2.72 or 77.8 percent.

The result reveals that Mechanical Engineering is considered as one of the hardest engineering programs in LPU if the average grade of the BSME graduates will serve as the basis for its complexity. Khalid [14] noted that there are some courses, or topics within courses, that aren't especially fun or interesting for some students. But teachers can do something to make the discussions more interactive and will catch the attention of the students.

Majority of the final grades of BSME students were 3.00 which falls within the range of 75% - 77% in the grading system of LPU. Most of them also received NFE remarks from their professors and when they completed and submitted the final requirement of the subject, most probably; their final grades were already the lowest passing mark which is 3.00. Mechanical Engineering has a board examination from Philippine Regulation Commission (PRC). It is definitely appropriate for the students to learn all things properly that would be included in the board examination.

Industrial Engineering is non-board program, and majority of the subjects are related to management. BSIE students were given case analysis and generally the problems solved by the students are situational. There were also various company operations being discussed and analyzed by the students and understanding the facilities planning and design of a certain work environment.

If the nature of major subjects of BSME will be compared to BSIE, BSME subjects are more on industrial design while BSIE is more on understanding the company processes.

The equivalent percentage weighted mean of Electronics Engineering is not far behind from BSIE. The 82.1% average is not bad at all for electronics engineering students and 81.7% for computer engineering. The BSECE and BSME students are those examinees who passed the qualifying examination to pursue a major with board examination. It means that they have possessed higher critical thinking compared to BSCpE and BSIE which some of them took and failed the qualifying exam while others decided right away to pursue a non-board program without taking the qualifying exam.

The low equivalent percentage weighted mean of BSME couldn't be considered for their low performance or lack of study habits. It is just happened that the nature of the program is more complicated than other engineering programs in LPU plus the strict rules, regulations and high standard of their major subject professors added up to their very challenging set-up.

Electronic Engineering graduates obtained the highest percentage in Language subjects as manifested by the weighted mean of 1.99 or 86.99 percent followed by Computer Engineering with 2.15 or 85.1 percent and Mechanical Engineering with 2.18 or 84.84 percent while Industrial Engineering obtained the lowest weighted mean of 2.31 or 83.28 percent.

The data reveals that Electronics Engineering students are good communicators compared to other engineering students as indicated by the highest equivalent percentage of 86.99%. This result only proves the intellectual capacity of BSECE students in terms of communication. Computer Engineering students also obtained high grades in English and Filipino subjects as revealed by the equivalent average percentage of 85.2% which is good enough for engineering students. The average grade of BSME students is not far behind from BSCoE while BSIE students obtained the lowest average equivalent percentage of 83.28%. The result shows that BSIE students have low communication skills.

Mathematics is relevant to the undergraduate core engineering's curriculum [15]. It is one of the major components of the qualifying examination for incoming third year who will pursue Mechanical and Electronics Engineering programs. BSECE obtained the highest equivalent average percentage of 84.6% followed by BSME with 81% which is higher with very little difference to BSCoE with 80.8% while BSIE obtained the lowest equivalent average percentage of 77.8%. The growing interest in engineering has been triggered by several factors. Among these are opportunities for embedding academic content into authentic design situations, thus generating student interest in mathematics and science [16].

The qualifying examination of the College really set apart the qualified students who will take the program with board examination. It is very important to have qualifying examination to screen the quality of students who will take BSECE and BSME programs. Therefore, the students will be pursuing a course most appropriate and suitable to their intellectual capacity where taking and passing the higher mathematics subjects are part of the preparation for the national board examination. Therefore, students should be able to maintain good study habits in order to pass the requirements of all mathematics subjects and its allied sciences as well as its applications to survive in the engineering degree program. Mathematics as the foundation field of discipline in engineering should be taken seriously by the students if they really wanted to stay alive in the program and not to suffer too much to finish it.

One of the major components of qualifying examination for incoming third year students is the Natural Sciences which include Chemistry and Physics. It is not surprising that those students who passed the qualifying examination of the engineering department are those students with high grades in Natural Science like BSECE with 85.8 % equivalent average percentage followed by the BSME students with 82.6%.
BSCoE students obtained an average equivalent percentage of 80.5% and 79.4% for BSIE. The result revealed that these two groups of students without board examination have slight difference in terms of their academic performance compared to BSME and BSECE when it comes to Natural Sciences.

Table 2: Relationship Between Academic Performance and Interest Towards Engineering Program

	r-value	**p-value**	**Remarks**
General Education Courses & Interest (1st year)	0.724	0.035	Significant
Professional Courses & Interest (5th year)	0.482	0.076	Not Significant

**Significant at 0.05*

Table 2 reveals the relationship between academic performance and interest towards engineering program.

There is a significant relationship between the academic performances of students in general education courses and the level of their interest towards engineering program as denoted by the computed p-value of 0.035 which is less than the 0.05 level of significance. This implies that those students with high level of interest towards the program are also those students with high academic performance which has also similar relationship to those students with low academic performance are also those with low level of interest. But this relationship is not anymore true between the academic performance in professional courses and level of interest after five years as indicated by the computed p-value of 0.076 which is greater than 0,05 level of significance.
It is a given fact that no matter how high the interest of the students towards the program but it seems they are already out of control in the outcomes of their examinations. No matter how hard they tried to study the lessons, they still received low or even failing grades in professional courses due to its complexity in nature. They have already exerted too much effort on learning how to solve certain problem but sometimes very simple error committed during the process would make everything crush and finally get the failing mark. Therefore, interest towards the program has nothing to do with the level of academic performance among the engineering students.
Table 3 reveals the significant relationship between engineering professional courses and the general education courses. All computed p-values are less than 0.01 level of significance, therefore there is very high correlation between the weighted average of general education courses and the engineering professional courses of the graduates. This implies that the academic performance of the engineering students when they are taking the general education courses has the same level of their performance when taking the engineering professional courses during their senior year. This signifies that those students with low academic performance during 1st year and 2nd year in college are also those students with low performance during 3rd year to 5th year while those students who perform high in junior years are also those perform high during senior years.

Table 3: Significant Relationship between Engineering Professional Courses and the General Education Courses

		Professional Courses			
General Education		CoE	IE	ME	ECE
Languages	r-value	.751(**)	.735(**)	.702(**)	.503(**)
	p-value	.000	.000	.000	.000
Mathematics	r-value	.779(**)	.568(**)	.707(**)	.669(**)
	p-value	.000	.000	.000	.000
Natural Sciences	p-value	.677(**)	.718(**)	.641(**)	.672(**)
	r-value	.000	.000	.000	.000

*** Correlation is significant at the 0.01 level (2-tailed).*

Implication to K-12 Engineering Education

Students' interest toward engineering program serves as a platform for this study to explore the needs for K-12 Engineering Education. It is in this context that putting interest of the customers in primary consideration for learning science, technology, engineering and mathematics would prepare the educational institutions of Senior High School for Grades 11 and 12 to sustain enrollment in business perspective of private HEIs during the K-12 Transition period which would give a huge impact to decrease enrolment in tertiary educational institutions. Giving emphasis on interest towards the engineering program will also serve as a springboard in providing quality education suitable to the needs and aspirations of the students.
Many organizations around the world are making their best efforts on addressing the needs of the community to sustain the interest of the public in engineering and technology. In order to intensify the country's competitiveness in global market, it is indeed necessary to strengthen the workforce in science and technology that will address breakthrough innovations in engineering and building larger networks and communication facilities. This can be done through investing in human capital.
In 2006 the National Academy of Engineering (NAE) and National Research Council Center for Education established the Committee on K–12 Engineering Education that provides a vision of what K–12 engineering might look like, the committee set forth three general principles: Principle 1. K–12 engineering education should emphasize engineering design; Principle 2. K–12 engineering education should incorporate important and developmentally appropriate mathematics, science, and technology knowledge and skills and Principle 3. K–12 engineering education should promote engineering "habits of mind." which are aligned with what many believe are essential skills for citizens in the 21st century that include
(1) systems thinking,
(2) creativity,
(3) optimism,
(4) collaboration,
(5) communication, and
(6) ethical considerations [17].

Curriculum developers must give emphasis on engineering design to stimulate critical and analytical thinking as well as creativity of the students to apply their acquired knowledge and skills to all activities and student outputs towards the achievement of student outcomes through valid assessments. Program educational objectives should also be considered in designing curriculum based on international standards specifically to cater the needs of ASEAN Economic Community.

Training and development of teachers in K-12 Engineering Education is an important aspect of transition in the Philippines. Engineering Faculty members from tertiary education may be employed in Senior High School to fill in the gap on skills of education teachers with little preparation in engineering and system design. It is always necessary to address the needs of the curriculum to deliver quality instruction to the students in order to satisfy the requirements of the customer and boost their interest towards science, technology, engineering and mathematics [14]. Teachers as facilitators of science learning would have a bigger share on the success of the teaching and learning process as they serve as the catalyst to transfer the knowledge and skills to the next generation of innovators. In the study of Nathan et al., [18] shows that the high school STEM teachers report their instruction was influenced by students' interests, family background, and prior academic achievement. Professor needs to get students to realize that the professor cares deeply about each and every one of them and wants them to learn and succeed in the course [14].

Full support of the management is always necessary to assist the implementation of K-12 Education especially in engineering to help students develop the technical skills necessary to contribute in the economic development of the country. Indentifying students' motivation and engagement is a form of monitoring their development and progress towards the end of their degree program so that they will be properly guided on how to achieve future success.

Several studies are conducted on how to improve the interest and engagement [19], [14], attitude and behavior [20] of the students towards learning [21], [22] and success of STEM [23], [24] that may serve as reference for the implementation of K-12 Engineering Education in the Philippines.

Conclusion

There is a positive change on the level of students' interest towards engineering program after five years of studying in the university. Engineering students in general have higher level of interest toward engineering program during freshmen and before graduating with increasing and decreasing levels of interest in the indicators that makes the behavior of the students towards the program very subjective. It changes overtime based on past experiences where they learn to adapt in certain condition and environment; understand better the nature of engineering and how they can cope up with the future challenges ahead of them.

Industrial Engineering graduates obtained the highest percentage in professional courses followed by Electronics Engineering and Computer Engineering while Mechanical Engineering obtained the lowest weighted mean. Electronics Engineering students obtained the highest scores in language courses followed by Computer Engineering while BSIE students obtained the lowest average score. Students enrolled in board programs obtained higher score in Natural Sciences compared to those students in non-board programs. Academic performance of students in general education courses is significantly related to engineering professional courses.

There is a significant relationship between the academic performances of students in general education courses and the level of their interest towards engineering program. However, there is no significant relationship in the academic performance of professional courses.

Engineering design serves as an important aspect of senior high school curriculum under STEM to make the teaching and learning process more challenging and interesting to come up with meaningful outcomes.

Recommendation

Constant encouragement and motivation for the students is always necessary to be provided by the engineering department during student orientation and general assembly. Let them be aware of the latest trends and updates on engineering and technology that will guide them to attain more opportunities to learn from the environment. Assist them properly towards the realization of their goals and always have the time to listen to their concerns to make them feel important part of the institution. Give them extra-curricular assignments like preparing some projects to be used in the exhibit and provide them necessary reward and recognition of what they have done remarkable for the academic community.

Low performing students during 1st year and 2nd year must continue to strive hard to obtain better grades in professional courses [27] though addressing the different levels of motivation of the students, different attitudes about teaching and learning, and different responses to specific classroom environments and instructional practices [25]. Provide students with more meaningful first-year experience by allowing them to discover and explore important connections among the humanities, physical and social sciences and engineering subjects they studied with the end result of deeper appreciations of the subjects and interrelatedness in their professional engineering work and their lives [26]. An engineering class can be made interesting and enjoyable by engaging students in activities beyond those required in a typical class [14].

Curricular materials should portray engineering in ways that seem likely to excite the interest of students from a variety of ethnic and cultural backgrounds [17], [4]. Individual differences should also be considered by the teachers in order to address different needs of the students in terms of learning style and attitudes towards the STEM. Making them feel happy and satisfy with various teaching strategies employed in delivering instruction would somehow increase the interest of the students in engineering and technology.

It is also suggested to take Teacher Certificate Program those faculty members in engineering so that they could have formal background on various teaching pedagogies that would help them deliver the instruction more effectively. Technical skills and mastery of the subject are the qualities necessary to

posses by the teachers but the characteristics of having enough teaching skills is another factor to the success of learning science and technology in the classroom.

The Philippines still needs to produce more engineers and scientists that will stay in the country and work for the benefit of its people. Based on the findings of the study that engineering students were highly interested in taking up engineering because that will bring them to employment abroad. The government must do something to provide good employment opportunities, compensation and benefits to engineers to let them stay in the country.

More collaborative researches in STEM discipline may be conducted by teachers and students to harmonize the ideas of the mentors and the mentees. Encourage the students to take part on research activities to increase their chances and potential to become scientists in the future. Giving them enough time and resources from the academic institutions and government funding would lessen the gap on research productivity of the universities. Outputs of the researches should contribute to the attainment of the research agenda of the funding institution and would provide assistance to the national economic development of the country.

Another study may be conducted to assess the level of interest of Senior High School students in taking up STEM discipline would further provide insights for the school administration on how to address the needs of the students for proper guidance. Study on how students' interest change, sustain and enhance may also be conducted to support the findings of this investigation.

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