K TO 12 STUDENTS' JOURNEY IN AND OUT OF STEM: SOME EXPERIENCES TO SHARE

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ABSTRACT

Despite reforms, policies, and initiatives implemented worldwide to increase STEM students' interest, attrition is a problem that beset Science education and STEM-related workforce. In the Philippines, the first K to 12 Senior High School (SHS) entrants in 2016-2017 who enrolled in Science, Technology, Engineering, and Mathematics (STEM) and graduated in April 2018 did not all continue to STEM-related courses in college. Henceforth, this qualitative study used a phenomenological approach purported to describe and give meaning to the lived experiences of the first K to 12 STEM graduates who opted for non-STEM field courses in college. The study employed a purposive selection of the 10 K to 12 STEM graduates for an in-depth interview. A model labeled ***Follow Through model*** *describes the participants' narration of their experiences from the STEM strand to non-STEM field course. The model conceptualized under three emergent themes Going in (why the students chose STEM track/strand), Going out (coping mechanisms and reasons for leaving STEM), and Going On (students' life after leaving STEM). The study results showed that socioeconomic factors, personal goals, and interactions with people around them impact the K to 12 students' beliefs, behaviors, and experiences in choosing STEM. All-encompassing curriculum implementation policies must be clear and appropriately implemented to avoid wasting money, time, and effort.*

Keywords: K to 12 Curriculum, STEM Education, Follow through model, Phenomenology

INTRODUCTION

Today's life conveniences are undeniably owed to Science and Technology innovations and inventions by Science practitioners worldwide. Nevertheless, STEM attrition (Aryee, 2017) and image problems (Harris, 2013) compel countries to work hard to meet the demands for more innovators, creators, and problem-solvers for global competitiveness. Similarly, as a developing country, the Philippines face a STEM workforce shortage. There are only 189 research/scientists per million population as of 2013, far below the recommended ratio of 380/millions of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). In response, the government is determined to boost the STEM workforce by investing much in research and development to produce close to 19,000 new researchers and scientists for continued progress (Ambag, 2018).

In education, the Department of Education continues to establish and strengthen Special Science schools to boost Science and Mathematics education at the Elementary and Secondary level (DECS Order No. 69, s. 1993; DepEd Order No. 51, 2. 2010; DepEd Order No. 55, s. 2010). Moreover, the Republic Act 10533 or the "Enhanced Basic Education Act of 2013 legalized the conversion of the 11-years Basic Education Curriculum (BEC) to 13 years scheme called the K to 12 Curriculum. Using Spiral Progression in all subjects or disciplines to

guarantee students' mastery of knowledge and skills, the curriculum targets to produce holistically developed and globally competitive 21st-century learners from Kindergarten to Senior High School (SHS). Furthermore, the Science curriculum focused on inspiring students and raise the quantity and quality of STEM education in the country by making it accessible to all high school students even without going to Science high schools or universities. The Science curriculum exposed the first K to 12 SHS entrants to activities through inquiry and authentic learning in 2012. Bishop (2015) posits that exposure to active learning at an early stage will deepen their STEM content learning and prepare them academically in science and mathematics. Teachers' pedagogical practices will also increase students' motivation and interest while decreasing the "perception of science as a difficult subject" (Shirazi, 2017, p.1).

Furthermore, Zhang and Barnett (2015) hypothesize that students who develop low anxiety levels will generate a higher ability to handle situations of potential barriers and communications. Therefore, support to students will enhance achievement and '*non-cognitive skills*' (Aryee, 2017). Students' motivation, academic and social experiences, and self-efficacy to succeed will increase to keep pace with grade requirements of 85 in English, Science, and Mathematics if opting to STEM strand (DepEd Order No. 55, s. 2016) and STEM-related field because the coursework is "demanding" (Rickels, 2017).

DepEd Order No. 41, s. 2015 directs the conduct of career advocacies to ensure Senior High School (SHS) entrants arrive at informed career decision-making; to positively and proficiently decide (Bolat & Odacı, 2017; Jordan, Dela Cruz, & Salvador, 2013) in choosing from the four tracks that will suit their skills and interest in preparation for life: Academic; Technical-Vocational-Livelihood; Sports; and Arts geared towards employment, entrepreneurship, and education. SHS track gives students the chance to choose, particularly those who do not continue to higher education because of socioeconomic status or do not continue to enroll in "high-status degrees" and universities (Papasin, 2015; Gore et al. 2017). There are four strands in the Academic track: Accountancy and Business Management (ABM); Science, Technology, Engineering and Mathematics (STEM); Humanities and Social Sciences (HUMSS); and General Academic Strand (GAS).

The career advocacies also included parents because students' interactions with their parents (parental motivation, interactions, expectations, support, and attitude), siblings, and friends (Bonayog, 2018; Cortez 2018; Ginevra, Nota, & Ferrari 2015; Lazarides, Harackiewicz, Canning, Pesu, & Viljaranta, 2015) influence their choice and interest in different careers. This external "locus of control" (Kırdök & Harman, 2018, p.1) make adolescents' career choice difficult because they are much dependent on parental support and career self-efficacy.

Upon full implementation in 2016, the K to 12 Curriculum ensued 21.86 percent, or 220,590 students enrolled in STEM (in public, private, and SUCs/LUCs) out of the 1,445,107 million students who enrolled in Grade 11. In 2017, only 87.32% or 192, 624 continued to Grade 12, and 95.5% or 183, 958 graduated in April 2018 (A. Barbosa, DepEd PS-EMISD. Personal Communication, August 19, 2019).

And not all these graduates advanced to STEM-related courses in college. There was a decrease of students in the STEM field track despite supports and initiatives to ensure a match and a decrease in degree-job mismatch after college. These conform that students are leaving STEM because of unpreparedness, lack of interest, equality issues, high course demands, attention diverted to other interests, and courses that do not make sense to students (NAP, 2012; Papasin, 2015)

OBJECTIVES OF THE STUDY

Students who enrolled in the STEM strand in June 2016 left the STEM field after graduating in April 2018. The limited literature along this phenomenon led to this qualitative study designed to describe and give meaning to the lived experiences from STEM strand to non-

STEM field course in college of the first batch of K to 12 graduates. Notwithstanding, the study aimed to: 1) determine why the students chose the STEM track/strand, 2) comprehend how the students overcame the challenges as STEM students and their reasons for leaving STEM, 3) describe students' life after leaving the STEM program.

The insights gathered from the participants' narrations may provide empirical evidence in improving the K to 12 Curriculum's educational policies towards accessible, quality, and relevant education. The STEM graduates' experiences can help other students continue and succeed in academics even when forced to make decisions beyond their will and still pursue what they intend to be.

METHODOLOGY

The study employed a qualitative-phenomenological approach to understand, describe, and interpret the essence of the first K to 12 graduates' lived experiences. Anchored on Social Cognitive Career Theory (SCCT) by Lent, Brown, & Hackett (2002), this study pursues to explain the participant's decisions in their chosen track/strand. The S C C T anchored on the inter-relatedness between self-efficacy beliefs, goals, and outcome expectations guided to explain what led the participants in the SHS-STEM program, their coping mechanisms, and the decision to leave STEM field in college towards a career path.

Ten (10) students enrolled in the STEM strand in June 2016 in one public high school were chosen as participants of the study through purposive sampling using the snowball technique. Four (4) students were from the Special Science Class (SSC), while six students belonged from the regular classes during their JHS. These differences in prior exposure to science may significantly contribute to the detailed description of the phenomenon under study.

The participants are enrolled in ABM and HUMSS-related courses in college after graduating in April 2018, leading to their perceived career before SHS.

The researchers prepared a semi-structured interview protocol. The protocol underwent peer evaluation for content validity and reliability. Pilot testing was also conducted with two K to 12 graduates, not part of the final interview to prevent data contamination. Part I is the robotfoto characterizing the participants' demographic profile. It includes their name, address, age, sex, family background, and status. Part ll is an aide-memoire to gather insights on the education of the participants' lived experiences as STEM students. It comprises interview questions to collect information on their experiences divided into three segments: Before SHS, During SHS, and After SHS. Both participants in the pilot testing and final study signed informed consent after orienting the purpose of the survey to guarantee the confidentiality and anonymity in the report. Participants had the option to halt the interview at any time. A one-on-one in-depth, face-to-face interview occurred at a mutually agreed location. The interview lasted at an average of 40 minutes until there is no new information gathered. All interviews were recorded upon the participant's consent using a digital recorder. The researchers noted observed attitudes, behavior patterns, and reactions.

The researchers transcribed the audio-recorded interviews verbatim, translated into English, and subjected to language expert checking. Thoroughly, the transcripts underwent manual clustering, and repeated analysis formed emerging themes essential in describing the 'essence' or meaning of the participants' experiences. Participants kept their line open for follow-up questions, information on the study's progress, and member checking of the coding and thematic analysis to guarantee the trustworthiness and accuracy of the shared narrative of the phenomenon under investigation.

RESULTS AND DISCUSSION

K to 12 Students' Journey In and Out of STEM: Some Experiences to Share

Adolescence place adolescents in the crossroads of career choice. A career where they can sharpen and expose their interests, intelligence, and capabilities (Jordan et al., 2013). Hence, career guidance and career advocacies should be part of their experiences before completion in Grade 10 to expose them to the different tracks and strands' nature and benefits. The participants articulated apprehensions upon learning the additional two years of SHS because of the extra cost, time, and effort they will have to incur instead of starting college the next school year. Yet, skeptical, and anxious, the participants nonetheless willingly answered and participated actively during the interview. Before Senior High School, the participants were clear on their personal goals and aspirations/perceived career. But circumstances hindered them from taking the first step to its realization.

A model labeled as **Follow Through model** (fig.1) was conceptualized to describe the participants' experiences in the STEM program.

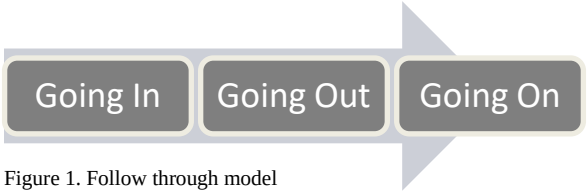

Figure 1. Follow through model

1. GOING IN *(why the students chose STEM track/strand)*

Social Influence. The participants' interaction with parents, family, friends, and school personnel strongly influenced the adolescents' decision-making to enroll in STEM. Recognition of parental support (Ginevra et al., 2015) and parents' autonomy to choose where to send their children (Cortez, 2018; Lazarides et al., 2015; OECD, 2012) led the participants to set aside their personal goals and aspirations. Accordingly, socioeconomic considerations prejudiced the participants' choice of SHS track/strand preference and school outside their locality. Despite vouchers offered to JHS completers who will study in private schools, the participants enrolled in STEM even if it was not their first choice because their parents still have to spend on the excess school fees, allowances, and fares. Hence, the participants decided based on what was offered by the school bounded by practicality, accessibility, and convenience. Moreover, the family's overprotectiveness forced the participants to enroll in STEM even if it was not their first choice. As articulated,

> *"I consulted my parents (mama) what strand I should take because they will be the ones to spend for my schooling" (P7).*

> *"None, I don't have plans to enroll in SHS because I do not know where to go, what to encounter there. I had no decision yet. My first choice was GAS because I was undecided, and no financial capability to go to the school that offers the strand daily, so my parents told me to take STEM" (P1).*

> *"I like TVL – cosmetology, but I enrolled in STEM instead because of my mother, who wouldn't allow me to enroll in far school, so I have to wait until I am in college before I can enroll in the city proper" (P10).*

Career advocacies gave way to schools to promote respective school offerings; however, there was a lack of consistent information (Kırdök et al., 2018) in implementing the K to 12 Curriculum. The misconceptions among the faculty and staff worsen the difficulty in decision making that led the participants to the wrong choice of track/strand for career preparations. The faculty and staff also influenced the students' option to enroll in STEM, "*they told us that whatever strand we take in SHS, we can enroll in whatever college course thus I enrolled in STEM" (P2)***.**

Personal motivation. On a positive note, despite negative perceptions towards STEM, participants' desire, and willingness to enhance their skills and abilities and face their fear in science and mathematics led them to major in STEM. They could persevere and focus on their academic study (Zhang & Barnett, 2015) to improve their mathematics skills while

also supporting their peers. Some responses include,

> "*STEM is considered a high strand, but since I did not learn much in Mathematics during junior high school, I enrolled in STEM to improve in math…though I like criminology*" (P4).

> "*I learned to face my fear; if you do not try, you will not know if it's hard or easy*" (P7).

The feeling of satisfaction and imagery of STEM career added to the participants' perseverance in the STEM program.

> *"I feel like I am already an engineer if I enroll in STEM, knowing it as the highest strand. It was difficult, but I told myself I could do it if I will study hard"* (P3).

***2. GOING OUT** (how the students overcome the challenges as STEM students and their reasons for leaving STEM)*

Self-efficacy. It refers to the participants' belief in themselves that helped them surpass the obstacles as STEM students. The participants' self-efficacy (vital to Albert Bandura's (1994) social cognitive theory) – belief in their capabilities to perform and succeed in the tasks, achieve their goals, and survive the challenges for future career goals. Partnered with exposure in an authentic learning setting that deepens STEM content, learning strengthens the interest of students in STEM (Brown, 2016; Lent et al., 2002; Matelski, 2016).

> "*I realize it is not only intelligence, but dedication, perseverance, and passion that are needed to overcome the difficulties in the subjects focus and excel in your waterloo*" (P8).

> *"We need to persevere in learning the lessons and meeting the demands of the subjects. Be diligent, so I passed though I thought of surrendering since I'm already there, I said go, stay since the government provides it for free" (P5).*

> *"When I passed Grade 11 then Grade 12, I felt fulfilled, it's overwhelming I was able to pass STEM, which they say is the highest strand. During SHS, I am thankful because I learned a lot like dealing with people, cooperation, leadership, and how to be an inspiration to others. I learned to stand on my own, not rely on other people, since they are always not there. So, always be on your own because now in college, it is different; there are selfish classmates, and different personalities" (P2).*

Responding to situations was also one ability the participants could take advantage while in the STEM program,

> *"I realized it is not about the subject alone but the knowledge that you learned from the subjects. I learned how to handle situations and overcome challenges. I realized I could. The two years helped me a lot to gain confidence. I became more prepared for college life. Always think that God is bigger than our problems" (P8).*

External motivation. The requirements and fear of getting low grades led most participants to think of shifting from STEM to another strand. The experiences were challenging, but support from people around (parents, family, friends, faculty, and peers) helped them face the program's challenges with a silver lining as STEM students. The supportive environment assured the participants that they belong, can surpass the trials and challenges, and can succeed academically with the group (Brown, 2016; Matelski, 2016). Their perception of themselves increased. They did not solely rely on other's help to succeed and graduate in the STEM program.

> "*The motivation of our parents and classmates that everybody should be able to graduate. We should be diligent and study hard to graduate. We pushed each other, like one of our classmates whom we pushed to be in the honor roll but unable to do it yet is thankful to us that he learned and graduated even if he is not one of the honors" (P3).*

> "*I was dismayed. There was a time I thought of shifting to another strand because of difficulty in*

the subjects, especially mathematics, where I got low grades, which means I only learned a little because I don't like STEM. With my teachers' encouragement to continue, I am thankful I did not transfer to another strand. If I did, I have not yet graduated until this time" (P5).

The participants' mother, who sacrificed leaving the family to support their schooling, inspired him to strive hard. As he shared, "w*hen I entered Grade 11, my mother left to work abroad for the first time. She said I should face the challenges and finish SHS. So, to make her proud, I faced and surpassed all the challenges. To not to disappoint her, I did all my best"* (P2).

Self-reflection. The participants developed self-efficacy to survive the challenges as STEM students for two years. Most of them learned to love STEM. They did not regret the experiences as STEM students. However, most of them were not satisfied with their performance. Aryee (2017) posits that low to moderate self-efficacy, as revealed by the satisfaction on their performance and pressure from high outcome expectations, led all the participants to shift into non-STEM field course. Most of the participants mentioned about not being ready when they started with STEM. Associated with this unpreparedness were negative emotions like nervousness, fright, and skepticism starting as STEM students because of unfamiliar teachers and subjects, especially mathematics and science. Consequently, following one's interest, happiness, enjoyment, career goals, and aspirations are why they moved out of STEM. As verbalized,

"if I will rate my performance, only seven because I do not like STEM, but at least I experienced how to be a STEM student. I would not regret it even if it were hard. I faced the challenges and survived without worrying about the grades I will get. It is not my interest. I just did my best to pass" (P2).

"Our police coordinator during the Work Immersion, made me think twice. And because I like to be a policewoman even if I am on STEM track, I followed what I like. I am not into engineering. My parents told me to get what I like in college, so I do not have to change course when the time comes. No waste in time, money, and effort" (P4).

3. GOING ON (students' life after leaving the STEM program)

Adjustments. The participants expressed remorse for not taking the ABM or HUMSS strand aligned to their present course. They had to adjust and face difficulty keeping pace with course subjects not taken in STEM like accounting subjects. As participants explained,

"It was a big adjustment at the start. I can use the practical skills and learnings from minor subjects I learned in SHS, but I need to do advanced reading and research to keep pace with the lessons when it comes to management subjects. When we do not know the topic, even the faculty members faced difficulty teaching the lessons. So, incoming SHS students should take the right strand aligned to their planned course in college if they do not want to face difficulty" (P5).

"This first semester is tough. I cannot understand some of the subjects. I ask myself, what are these all about especially accounting subjects? I am still probing the topics, but my classmates from ABM knows already" (P8).

Steadfast. This sub-theme describes how abilities, struggles, pressures, expectations, and self-expression directed the participants to enroll in a non-STEM field course. Most of the participants expressed no interest in retaking STEM if given a chance recalling how they coped with the requirements and the subjects. Recognizing their abilities, they were unwavering in their decision to leave STEM and committed to finishing their present course with their family's support. As expressed,

"*my father told me to follow what I like in college so that I will not waste time, money, and efforts in the end*" (P4).

> *"I did not continue in the STEM field because I already experienced how hard the subjects were. I do not like STEM though I learned a lot. I have no plans to continue in the STEM program, so I enrolled in the HUMSS aligned course. I followed what I like to express myself more*" (P6).

Another participant contemplated, "*STEM is considered the highest strand, people think you are bright when you are in STEM. Our teachers had high expectations, which pressured me. What if I do not meet their standards? I felt it in SHS, what more in college? I am afraid that is why I did not pursue a STEM field course"* (P7).

The participants secured themselves by moving out of STEM. A student tried to challenge herself with engineering but after a week, shifted to a non-STEM course as she explained,

> *"I learned to like STEM, so I intend to continue in the STEM program. When I qualified in engineering, I thought I could do it, so I enrolled and entered the class, but after several days I transferred to tourism even if I'm shy because I can't do it. I do not like to take the risk in engineering. If I fail, it would be a waste of money. Now, it is easy for me. I am enjoying it and determined to finish my course*" (P5)

Based on the participants' accounts, they did their best to pass, graduate, and enhance their self-confidence yet were not very happy and contented. Hence, they left STEM because of happiness and self-expression. Some participants were holding back and could not show their abilities and even real self (gender). But, following their heart's desire, they found their right place.

> *"I am not satisfied because I was controlling myself. I was always conscious of what others will say about me, so I could not do what I like and show my abilities. But, because my classmates know I was a STEM student, they believe in me. They always make me the leader. Some say I should transfer to the other section where most of my former classmates are. I said I would not because I will be dependent again"* (P1).

> *"I couldn't show the true me when I was in STEM, I was hesitant. Now in my criminology course, I am more vocal with myself...I'm happy*" (P6).

Overall, the participants were positive in continuing with their non-STEM field course, motivated, confident, and strengthened by their parents' strong support when they explicitly communicated their career plans (Zhang & Barnett 2015; Jordan et al., 2013). Furthermore, Lent et al. (2002) posit that self-efficacy and self-determination theory (Paixão & Gamboa, 2017) led the students to choose a career based on how they perceived their ability, failure to fail and to follow what their hearts desire.

CONCLUSION

This phenomenological study described the lived experiences of the first batch of SHS students forced to enroll in the STEM strand but could graduate despite the obstacles and challenges.

1. The model labeled Follow through model describes the empirical basis of students' lived experiences in persisting as STEM students, coping up with the challenges, graduating under the STEM strand, and moving forward with their current courses.
2. The socioeconomic factors, psycho-social and cultural interactions (parents, family, siblings, teachers, and friends), self-efficacy, abilities, and personal goals impact students' beliefs, behaviors, and experiences towards STEM.
3. The participants had a clear perception of their future. They are determined to succeed, ready to adjust, organized, and guided in their behavior to achieve positive results over challenges of subject courses not taught in STEM to earn the degree they are pursuing.
4. Accounts of the participants' experiences were consistent with the literature factors that contributed to students leaving STEM.

Thus, to become an informed decision-maker, students should be given proper support. If students are to be encouraged to pursue STEM and become relevant in the industry and country, they must be precisely informed to optimize their STEM coursework success.

RECOMMENDATIONS

The result of this study is not generalizable to all STEM students however, the focus on future considerations can be able to:

1. Give students full freedom to choose track/strand for career preparations to avoid wasting money, time, and effort.
2. Upgrade and update continuously the parents, faculty, personnel, and administrators' career explorations for better and sound decisions.
3. Implement clear policies to adequately implement on the alignment of the track/strand towards higher education.
4. Focus future research on addressing the factors that limit High school students from continuing STEM field careers if increasing students' interest and boosting STEM education and workforce in the country.

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