An Experience in STEM: A case study in planting

Teoh Sian Hoon[1*], Mohd Sollehuddin bin Ab Gani[2] & Sheiladevi Sukumaran[3]
[1]Faculty of Education, Universiti Teknologi MARA, 42300 Bandar Puncak Alam, Selangor, Malaysia
[2]Merbau Kilat Resources, 1197, Lorong 7, Kampung Merbau Sempak, 47000 Sungai Buloh, Malaysia
[3]Faculty of Education, Language and Psychology, SEGI University Malaysia
[*]corresponding author: teohsian@uitm.edu.my
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Abstract
Unemployment is one of the most concerning issues facing by university graduates. Reported that graduates' inability to apply 21st-century talents such as soft skills (including communication, presentation, and leadership skills) and technical skills is one of the reasons for their unemployment. STEM field that applies all the important skills may help students in developing the skills of twenty-first century. In this study, a single-subject case study of public university undergraduate student was employed to collect the qualitative data. The case study was undertaken to see how the individual was driven to pursue a STEM job as well as to investigate the crucial of STEM skills in the career growth. The investigation involves the student's first job, which was as an entrepreneur in agriculture. The participant was interviewed, and the data was analyzed in different scope. The participant reflected that the planting skills that built naturally integrated with 21st-century skills, including collaboration skills. The integrated skills were demonstrated with more practical success regarding the utilizing of STEM knowledge with the community's assistance. This study provides insights an approach to develop a STEM workforce naturally especially during the outbreak of Covid-19 and the relation of STEM in assisting the career development.

Keywords: Soft skills, STEM activities, 21st-century skills

Introduction

STEM is critical for everyone to develop 21st-century skills, all schools are moving towards involving students in STEM activities for a more long-term aim (Zizka, McGunagle, & Clark, 2020). For this purpose, the national blueprint is highlighting the need of meeting the workforce by fostering 21st-century skills in the STEM field. Hence, students should work on STEM tasks that challenge them to use or integrate 21st-century abilities. STEM abilities are becoming increasingly important in the digital, and IR 4.0 era, as the nature of learning necessitates multi-disciplinary knowledge (Boyd & Romig, 1997). Nevertheless, the percentage of Malaysian students who are taking STEM subjects in upper secondary school is still low. A source reported that Malaysia aims to achieve a balanced distribution of students in the STEM field so that at least 40% of the students register in the STEM discipline (Warta, 2021). Thus, there are activities specifically organize organized to increase their interest such as STEM Days and the mentor-mentee program. In STEM, there is a greater emphasis on developing abilities. Despite this, recent data continues to show a high unemployment rate. It is challenging to verify the effort put in for STEM development since many complaints are about failing to get employment after graduation. Many people will continue to inquire about any errors made in the long-term promotion attempt. With the impact of the Pandemic Covid-19, this situation is becoming more serious. It was reflected in a decline in job openings across the board (Rosnah, Rabiatul, Mohammad Faris, & Nurul Syahirah, 2021). As a result, greater research into the growth of STEM occupations during the Covid-19 period is required. Hence, there is a need for more research into the development of STEM careers during the Covid-19 period.

Integrate 21st-Century Skills into STEM Activities

Many researchers are identifying ways to implement Science, Technology, Engineering, and Mathematics (STEM). They aim to meet the current needs and plan for future development. It is the current trend to promote STEM in schools and universities. Students' STEM skills may contribute to more industrial development and achieve sustainable development goals (SDG), specifically economic and educational development. Many reports display successful ways of implementing sustainable operations by developing integration approaches, such as applying the concept of sustainability within the context of food security (Berry, Demini, Burlingame, Meybeck, & Conforti, 2015) and many more (Brundtland, 1987). Hence, integration approaches become examples of efforts to integrate 21st-century skills into STEM activities. To achieve this purpose, students should equip themselves with 21st-century skills. Applying 21st-century skills among university students shows tremendous need. Among the reasons for unemployment are graduates' weaknesses in applying 21st-century skills such as soft skills (such as communication, presentation, and leadership skills) and technical skills. All the 21st-century skills can be gained through STEM activities.

In STEM activities, the aim is to solve problems and produce innovative products. Nevertheless, it is challenging to achieve it. It is learned that the mentor-mentee program holds the key to boosting students' interest in STEM and hence providing guidance to gain important skills for the future workforce. As is common practice, universities conduct mentoring by pairing undergraduate students with faculty mentors. This strategy operates primarily under the traditional guiding paradigm (Stelter, Kupersmidt, & Stump, 2021). In the 21st century, everyone can easily connect to society and communicate with many people around them. Correspondingly, the development of research studies in all fields is also taking opportunities to utilize the advancement of technology. Hence, it brings a different light to universities since they can exploit the existing resources to assimilate students into STEM communities. Fortunately, many parties are taking responsibility to achieve better results by incorporating a dependable STEM model into the mentoring plan. Thus, more research is required to harness the power of communities to provide young scholars with a stimulating STEM experience for future development, thus putting in desirable outcomes for sustaining economic and educational development and hence achieving "zero hunger" among the communities. The following model presents an interesting strategy of integrating 21st-century skills into STEM with the guidance of a community. This model (Figure 2) is adapted from a study done by Stehle and Peters-Burton (2019).

Planting as a STEM Activity

In the 21st century era, many schools are creating a lot of opportunities for students to gain experience. Some institutions have integrated STEM into school lessons (Demuth, 2015). The experiences are allowing students to develop 21st-century skills. Among the activities are planting and gardening. Planting is a common daily activity in the community in two aspects (Figure 1). To someone, planting is their daily commerce activity. The plant is for the market or as their income. However, some people enjoy gardening as a hobby and to connect with the environment. Thus, planting involves some skills which may require some science knowledge to successfully produce healthy and well-growing plants as one of the food supplies. On the other hand, it is also a tool for students to integrate more knowledge into STEM since planting is closely related to the environment and the nature of living things. The integration of different dimensions of knowledge in planting has encouraged the development of STEM knowledge among the students. The following description demonstrates how STEM may make difficult subjects, such as science, more enjoyable to learn. Their adaptation allows them to be powerful enough to survive and adapt to changes in the environment (Martn-Garin et al., 2021). For example, the environment of learning has changed from physical to based on digital-based learning.

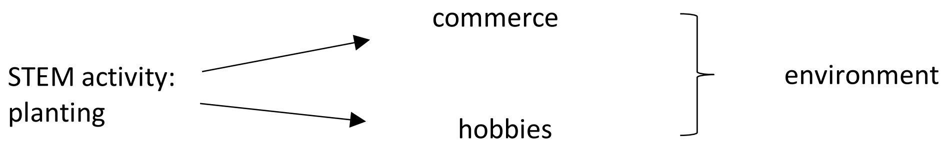

Figure 1: Planting is observed in two aspects

Working on STEM in a planting project or activity also significantly promotes a healthy life since the participants or students have the opportunity to appreciate their effort in planting. The appreciation does not only bring happiness but also promotes their habit of getting more vegetables in their food (Putnam, 2015). They may spend time wisely on their hobby of planting. Planting is a significant activity for exploring scientific knowledge. Students have opportunities to observe soil structures, types of plants, growth of plants, and the skills of planting. On the other hand, this planting may draw students' attention and encourage them to connect real-world planting and plant knowledge with what they've learned in class. Hence, planting provides a strong fundamental STEM knowledge base. It provides opportunities to expand and expose students to science and other STEM disciplines at an earlier age, which will increase the likelihood of them taking up a STEM-related field later in life.

Here are just a few of the ways to plant to support STEM-based learning in the classroom:

- **Science:** Science provides the foundation for the planting process. Students can study a wide range of science courses, including living and non-living species in varied contexts, from pre-school to tertiary level. Water and energy are two of them.

- **Technology:** Students need to understand that technology refers to everything created by people. Garden equipment and other common household objects are excellent conversation starters when it comes to how technology is employed in gardens.

- **Engineering:** Engineering knowledge is essential in a variety of professions. Critically, successful planting may need a favorable environment, such as a fertigation system and sufficient drainage, other than deciding on the amount of sunlight, water, and processes for specialized plant growth.

- **Mathematics:** Gardening is an excellent approach for pupils to learn a range of math concepts, including counting, size, shape, proportion, fractions, multiplication, and so on. Young entrepreneurs might use mathematics to project their profit from planting to generate cash.

STEM in Workforce: a direction to 21st-century skills

STEM jobs are identified as careers involving the use of knowledge of science, technology, engineering, or math to solve related work-related problems. STEM knowledge is highly required in solving most the problems in industrial, and any other fields of job. Thus, gaining STEM knowledge is vital. This knowledge shapes their future chances in the workforce. In addition, components in STEM are related and build on each other since engineers need to apply some theories or knowledge in physic and mathematics to produce some advanced technological devices in the development of engineering aspects. Nevertheless, the success of promoting STEM skills among students or workers requires more effort in many aspects of collaboration. Some tasks may need to integrate all aspects of knowledge (science, technology, engineering, mathematics). Nevertheless, the understanding of STEM integration should involve some non-cognitive skills such as skills of collaboration. Students may need to explore more with assistance to complete heavy tasks, assist counterparts, provide training, and many other contributions. Hence, they need to possess soft skills or noncognitive skills such as communication and collaboration (responsibility, making decisions together, and working interdependently) skills. Overall, they need to prepare themselves for more comprehensive skills as stipulated in 21st-century skills. These skills are highly assessed or demanded in the STEM-based job market (Stehle & Peters-Burton, 2019). But the 21st-century skills are not gained in isolation. Stehle and Peters-Burton (2019) provide a framework (Figure 2) to foster 21st-century skills. For further and more interpretation, this framework has signified a process towards the direction. The success of the process is highly dependent on self-regulated individuals' interaction with personal skills (using communication and collaboration skills) and knowledge within the meaningful context (problem-solving). Hence, the construction of 21st-century skills involves an integrated process

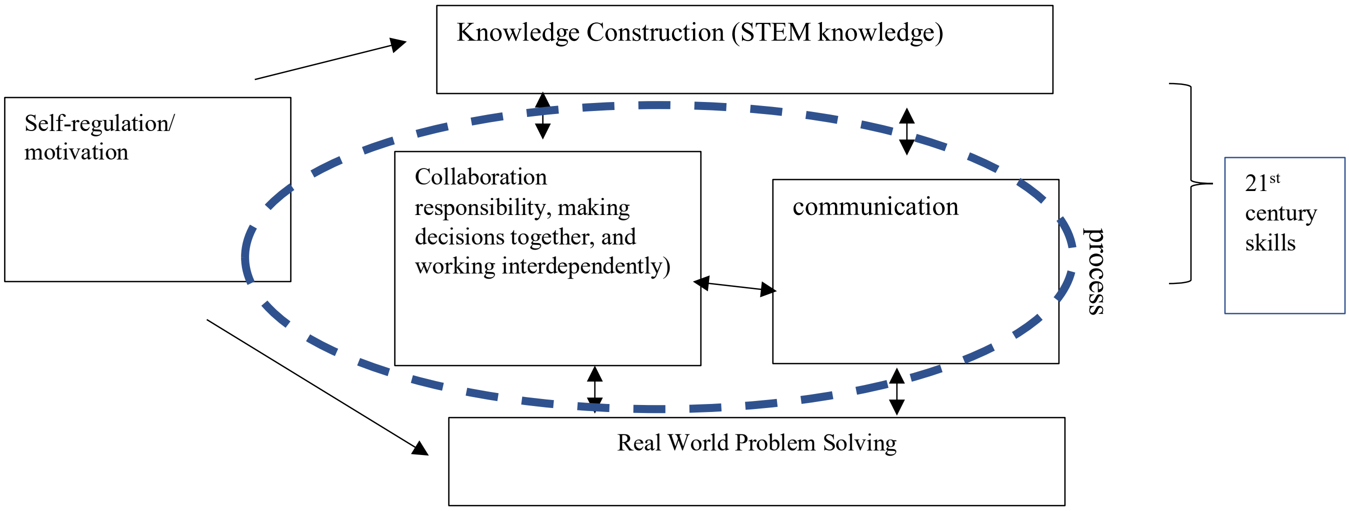

Figure 2: A modified framework on fostering 21st-century skills (Stehle & Peters-Burton, 2019)

In the current situation, the creativity of applying STEM in schools helps the success of the workforce. Integration of STEM into real-life aims to solve many practical problems. For example, the outbreak of the pandemic Covid-19 has forced multiple applicable scientific knowledge in terms of analyzing the spread rate, modeling the recovery trend, and strategies for handling many related problems. Hence, adapting STEM knowledge is necessary among students (graduates, university, secondary, and primary students). The importance of STEM is so widely recognized among the community members that more steps and actions should be taken. STEM education is introduced to all categories of students, namely from pre-schools to university students. It involves the community too. Without the involvement of the community in STEM, students who are less exposed to society may find it difficult to get a good picture of the application of STEM (Garcia, *et al*., 2021). Hence, the community, especially teachers and parents, may need to take action to engage their children. Nevertheless, there are more alternative ways to engage them. It was shared that STEM should be enhanced from time to time along the process of learning. Even though students have gone through and are attached to STEM during school time, they need to be exposed more (Australia. Office of the Chief Scientist, 2016). Exposure, along with motivation, is a good guide to moving forward, and the bounded of inner values, namely the self-regulated factor, also plays an important role (Beier & Rittmayer, 2009).

Roles of community in STEM

The Malaysian education system is grooming students towards critical thinking, technology literacy, and problem-solving, which puts Malaysia at an improving level in the ranking among 72 countries in 2021 for global education ranking (Sirajudin & Suratno, 2021). The International Student Assessment (PISA), which measures students' acquisition of reading, mathematics, and sciences, shows many prosperous countries' top achievement in STEM. Based on educational research and data rather than tradition, countries with high achievement in assessments are leading in teaching (Shute *et al.,* 2021; Johnson-Glenberg, Bartolomea & Kalina, 2021; Reeves, Crippen,

& McCray, 2021). This achievement shows the optimal usage of new technological tools will enhance student learning. It allows the instructor to tailor their classes to suit the individual student and will also be useful for dealing with large numbers of students. All these efforts show well and are sustained through continuous development. Hence, problems and challenges associated with STEM implementation in schools need to be recognized through the evaluation of pedagogical aspects in STEM education (Asih, Wijayanti, & Langitasari, 2021; Hidayatulloh, Suyono, & Azizah, 2020).

To support the government's plan, all universities are looking into strategies to increase the number of students in the STEM field. Hence, more potential advanced and relevant elements of STEM can be applied in the existing programs, which are highly sought after by adopting and adapting the existing STEM models. For this matter, it is observed that the development of STEM is integrated with social factors. University students who have excelled or are responsible in science, technology, engineering, and mathematics (STEM) should be encouraged to help cultivate STEM in the community. Their engagement in the task force can also build up their confidence and soft skills, which complement their 21st-century skills. However, these skills are not developed overnight. More arrangements should be in the plan. By gathering all students with high regulation in a team and as a role model, the students may be encouraged and develop good experience. University students may provide more real experience to encourage their mentees (school students) to develop more STEM skills.

At the same time, all of them develop soft skills via their engagement in communication and leading the group. On the other hand, all educators are working together to build an adaptable environment using various educational approaches, which could have a significant impact (Martn-Garin *et al.,* 2021). For example, Japan’s development in STEM emphasizes the connection between students and society by implementing mobility of inbound and outbound programs (Andrews, Pritchett & Woolcock, 2017; Burgess, Gibson, Klaphake & Selzer, 2010; Hasanah & Tsutaoka, 2019; Poole, 2016), such as the Re-inventing Japan project (Morris-Suzuki, 1997), the Go Global Japan project (Iijima *et al.*, 2019), and the Top Global Universities Project (Rose & Mckinley, 2016). The fundamental ideas are supported in the process of learning, specifically, the practices of Vygotsky’s Social Development Theory, which rewards their learning. Hence, accepting good practices or models of learning as referrals may benefit all students in learning. There is no doubt that expert guides, such as any learning community, will successfully produce students’ good experience in STEM activities. Proper application of Vygotsky’s Social Development Theory, specifically the Zone of Proximal Development (ZPD), leads to students’ success by engaging in meaningful learning and hence determines the roles of STEM. The integration of STEM education in higher education and social connection into practice provides a means of confronting challenges in the real world, thereby encouraging creativity in STEM development. The real challenge context is complex to meet the requirements of "need to know" and "need to do" to integrate the process of producing a product (engineering) with content knowledge in science, technology, and mathematics as highlighted by Yata *et al.* (2020). He interpretive the relationship between engineering and other STEM elements. Nevertheless, the students require more guidance in connecting math, science, and technology knowledge to engage themselves in the process. Enhancing the community’s role, there is a need to investigate how the community plays its role in culturing STEM knowledge in a context through STEM activities.

Methodology

This study employed a single-subject case study to interview an undergraduate student's success in STEM. This student has provided input on how he managed to apply 21st-century skills in developing a planting project during the pandemic Covid-19.

The research questions are:

1. How does an individual get motivated to be involved in STEM for a career?
2. To what extent do STEM skills play an important role in career development?

Results and discussion

This study aims to seek reasons for a successful individual in a STEM career. The data collected are shared to explore factors that made the application of STEM possible.

Finding 1: Motivation to be Involved in a STEM Career
Community as a Transformative Agent in Integrating STEM
The participant talked about his planting experience. He stated that the purpose of his effort was to launch a career. Covid-19, the pandemic, has transitioned from a dependent individual to an autonomous worker. The success output of a planting operation that follows exemplifies his job by utilizing STEM talents. During the Covid-19 movement control order (MCO), the student described his efforts to plant 'egg-plants' to earn some money. He was first motivated and supported by the community namely family members and friends. When he was interviewed, he described that he has some knowledge about planting, but the community around him especially his friends guided him on the right technique in planting. With his high efficacy to achieve this career path, in addition to his family member's support, he managed to apply all knowledge to set up a bigger aim in the planting. He expressed the sharing as below:

> "*Saya mendapat ilham daripada persekitaran masyarat yang mengamalkan pertanian sebagai salah satu sumber pendapatan tambahan*. "
>
> "I received inspiration from the society around, they are involved in planting as part of their incomes"

He has been given guidelines in gaining opportunities to take the challenge as below. He is moved by the community of passionate people. He wouldn't be able t fulfill his wish otherwise.

> "*Rancangan bertanam saya bermula apabila saya cuba mencari perkerjaan yang sesuai dengan komitmen harian saya, yang mana konsep pertanian saya ini tidak* menggangu *saya untuk meneruskan pengajian*, .."

> "My early plan for the planting started when I tried to find an appropriate job, where this concept of planting did not deter me from continuing my studies."

Building Self-Efficacy to Start a STEM Career

This student has proved that it is about management (knowledge) on planting while pursuing his undergraduate study. He started with planting for his aim to start a career before he graduated from a university. more earning with his strong efficacy to meet the career market. He described that planting could start anytime. He also described that successful comedic does not come overnight. He has some challenges. His high self-efficacy makes his move. He shared his experience in the below WhatsApp.

> “ *Saya mula bertanam pada bulan 6 tahun 2020. Persediaan awal ilmu, maklumat dan pengalaman***.** *Cabarannya banyak, salah satunya, mengenal keperibadian masyarakat petani yang mana sebelum saya menceburi bidang ini gambaran yang saya dapt tidak sama*. Cabarannya, harga pasaran, serangga perosak dan mentaliti masyarakat. Untuk lebih berjaya, berdaya saing dan seiring peredaran zaman.

> “I started planting in June 2020 with the initial preparation of knowledge information, and experience. The challenges that I faced were various. One of them, was getting to know the personality of the farming community before I ventured into this field. The challenges, market prices, pests, and community mentality. To be more successful, competitive, and keep pace with the times.”

Inner and outer motivation contributed to his success. He was highly motivated among his family members. He described as below:

> *“Faktor utama adalah ibu saya, selain itu, ia juga menyesuaikan keadaan ekonomi saya sebagai seorang pelajar, mengukuhkan lagi motivasi saya untuk menjayakan projek ini….”*

> "The main factor is my mother, besides, adjusting my financial status as a student, further strengthening my motivation to succeed in this project…."

Finding 2: STEM Skills

Specifically, he shared on STEM knowledge he applied as below. He was confident when he managed to construct a fertigation system (Figure 3). The system presents technology and **engineering knowledge.**

Figure 3: A fertigation system

Other than applying engineering knowledge, he managed to design the composition of fertilization as described below. For this purpose, he includes **science knowledge**.

> *"Peranannya STEM sebagai contoh, saya dpt mengaplikasikan stem dalam menghasilkan formula baja dan racun yang sesuai dengan tanaman saya, tambahan lagi, saya dapat menghitung dengan lebih baik dan tepat setiap aspek berkenaaan tanaman fertigasi, sebagai contoh, dengan keluasan tanah saya dapat menghitung detail setiap kos yang saya perlukan dan anggaran untung rugi hasil projek ini. Saya rasa lebih yakin untuk berinteraksi dan bersosial dengan masyarakat diluar hasil dari pengukuhan jati diri yang UITM terapkan pada setiap mahasiswanya. Kedua, secara keseluruhnya, saya dpt mengaplikasikan semua ilmu hasil dari pembelajaran di uitm dlm projek ini."*
>
> The role of STEM, for example, I can apply stem in producing fertilizer and pesticide formulas that suit my crops. In addition, I can accurately calculate every aspect of fertigation crops, for example, with the land area I can calculate the details of each cost which I need and estimate the profit and loss of the outcome of this project. I feel more confident to interact and socialize with the community outside because it strengthens the identity that UITM applies to each of its students. Secondly, I was able to apply all the knowledge gained at UITM in this project.

His success in growing the plants is shown in Figure 4.

Figure 4: Applying science knowledge in planting

On the other hand, he was aware that he applied mathematics knowledge in making a profit.

> *Yang terakhirnya saya merumuskan hasil dari pengajian di uitm dapat mengembangkan lagi potensi diri, berfikir dengan lebih positif dan seterusnya dpt digunakan bagi memajukan kehidupan saya dan org sekeliling saya.*
>
> Lastly, I summarize the results of my studies at UITM to further develop my potential. I must think more positively to improve my life and the people around me.

In this study, the participant showed his desire to engage in possible career development. underlying his prior experience and community support. The data demonstrated that the success of a STEM project (in this study, a planting project) was largely down to community support. Friends and others who had prior expertise aided the individual. There was also some help from family members. The assistance is crucial because, based on his personal experience, he has only witnessed a few environmental acts. This finding is aligned with the sharing in a previous study, showing that motivation is a factor in STEM education success (Beier & Rittmayer, 2009). Motivation is commonly defined as a factor in academic performance. Nevertheless, many researchers relate motivation to other success factors, such as the process of career development. Since the process of completing a task consumes a long time, it may influence perceptions of effort and hence affect motivation (Shipman & Shipman, 1985). In this study, it was observed that the participant perceived the benefits of spending some time planting while he was still studying. He appreciated the environment and all its limited utilities, such as community guides. Hence, this finding indicates that motivation is a factor in executing a challenging task such as a STEM-related career. Consequently, community engagement brings some additional sustainability knowledge. This is especially relevant now that the community has been highlighted as a transformative agent in integrating STEM in higher education institutions with social-economic growth (Zizka, McGunagle, & Clark, 2020). Because university students have greater opportunities to participate in social activities organized by their institutions, the connection between university students and the community should be maintained. They have more opportunities to interact with the community as well because some university courses require students to communicate physically outside of campus. The activities are critical because socially sustainable activities contribute to university STEM development (Josa & Aguado, 2021). Hence, students at universities have a lot of promise as STEM leaders. In addition, everyone is aiming for the growth of leaders by making the community-student link a priority.

Students that demonstrate adaptability are commended. They become an example of transdisciplinary learning in action. Because students are surrounded by specialists, they have the opportunity for multidisciplinary learning. Experts in higher education, on the other hand, must devise successful technology solutions to develop quality STEM professionals. (Chiang, 2021). Consequently, community and university specialists are key contributors to STEM development in these areas.

Conclusion

STEM is all over the place. Everyone must be aware of applying the STEM with relevant content for them to pursue a STEM career. However, putting the abilities into real-world situations (planting) may necessitate community assistance. Their guidance is an agent and driver. The data showed that community support was crucial to the success of a STEM endeavour (in this case, a planting project).

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