The Encouragement of 21st Century Skills Through The Integration of STEM Activities in Basic Education

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Abstract. The unprecedented growth and development in digital technology require a nation to direct its educational goals towards attaining certain developmental skills. These skills include critical thinking, problem-solving, creativity, collaboration and communication shortened as 4Cs and otherwise known as Twenty-first Century Skills. Some of the issues challenging the target include lack of hands-on activities in their teaching and learning strategies, particularly science and technology-based subjects, limited access to standard teaching and learning facilities; irrelevant subject contents; and outdated teaching strategy. However, with ongoing Science, Technology, Engineering and Mathematics (STEM) programs and activities, the young minds right from the elementary level of education are getting sharpened with the necessary learning context and experience required to engender twenty-first-century skills. Hence STEM programs and activities are currently serving as a vehicle through which 21st-century skills can be realized. Practical evidence from empirical studies proved the effectiveness of STEM activities toward inculcating the 21st-century skills right from the basic level of education. Therefore, these activities need to be integrated into the teaching and learning domain to support the young learners at their early stage of learning for the onward realization of the required skills.

1. Introduction

Digital age overtook the 21st century with unprecedented growth and development in science and technology requiring societal populace to be scientifically and technologically literates. This is necessary because a technological world is understood and managed by the technological mind. The emergence of Digital Age started is the beginning of the unprecedented record in the growth and development of technology and subsequent information explosion. Courtney [1] asserted that the nature and difficulty of today’s problems make it necessary to equip society, particularly the youth with a new set of skills and practice that guide them analyze and solve problems of life. For this reason, Science, Technology, Engineering and Mathematics are receiving serious attention from scholars around the globe which may not be unconnected with it is aims of developing learner’s thinking and creative skills. The main target is not just to prepare learners to acquire knowledge but also have a creative mind by practical implementation of the knowledge.
New technological tools for making life easier multiply daily rendering the existing tools outdated and less relevant. Technology and engineering are part of critical components of 21st-century skills. Hence there is a need to impart the skills available in technology and engineering literacy in mind of youngsters, not only in technological and vocational schools, but also to the generality of students [2]. These can be achieved only when the students are at their basic level of education where there no discrimination, yet among future science and non-science students. Hence, general education in primary and basic secondary education should be directed toward developing students’ potentials in this regard. When these skills are introduced in addition to general primary and basic secondary science and mathematics, then realizing 21st Century Learning Skills involving knowledge, skills and attitudes such as 4C (Critical Thinking & Problem Solving, Communication, Collaboration and Creativity) is feasible [3]. Hence, it will go a long way in enhancing Genovation Entrepreneurial Mindset (GEM).

Although Science, Technology, Engineering and Mathematics as individual disciplines are not new but recently, is attracting serious attention which resulted in researchers to engage in defining ways by which strong and concrete connections can be made between it is various components. This strong connection would raise the interest of student toward learning the discipline [4]. Gravemeijer, Stephan, Julie, Lin and Ohtani [5] argued that STEM education appears to be a domain that mainly fit for nurturing 21st-century skills. STEM aims at developing and fostering such skills as critical thinking, collaboration, problem-solving, and communication which are the major target for the 21st-century generation. According to Virtic and Sorgo [6] when STEM education is neglected the society should expect to recruit future engineers among present students who have never attempted to repair a toy. The encouragement of 21st-century skills through the integration of STEM activities in Basic Education is therefore expected to bring significant achievement towards realizing the necessary target.

2. Twenty-first Century Skills: Issues at Stake

Alozie, Grueber, and Dereski [7] considered 21st-century skills to encompass adaptability, communication and social skills, problem-solving and thinking skills, collaboration and self-management and control. In other words, they are shortened and represented as the 4Cs (Critical Thinking & Problem Solving, Communication, Collaboration and Creativity). In this era of digital life, for nations to prepare its citizens and compete in the global perspectives, these skills are necessary to be imparted to the young stars of learners right from their initial and basic level of education background. Mishra[8] in Figure 1. below demonstrates that learning environment of the 21st century is expected to provide students with; foundational knowledge enriched content knowledge of digital and ICT literacy cutting across various disciplines; meta-knowledge that enhances critical thinking, creativity, innovation, communication and problem solving skills; and humanistic knowledge inculcating in him the life/job skills of emotional awareness and cultural background. Sahin [9] highlighted that 21st-century skills and workforce are necessary requirements to transform the world into a knowledge-based society from industrial society. This necessitated today’s employers to look for employees who are equipped with a new set of skills and experiences that are more erudite than mere paper qualifications.
However, the conventional system of education centred toward content and cognitive goals. While imparting content knowledge and cognitive development are important, critical thinking and technical skills in the mind of learners and graduate are most crucial to survive the today’s competitive labour market [6]. Part of the competition is Industrial revolution 4.0, which aimed at designing of innovative services and products using current technologies. Future graduates need to be strengthened in this direction to join global competition toward realizing such a dream. According to Kojmane and Aboutajeddine [10] graduate is expected to acquire relevant technical skills and creative mind and design innovative products and services to be able to participate in the global competition of the 21st century. Despite this requirement, many undergraduate students of various science, technology, and engineering courses possess poor creative and problem-solving skills. Most of the recent graduates' engineers faced a lot of challenges in innovating new design and solving persistent life problem due to their low creativity and critical thinking skills [10, 11, 12].

Additionally, the lack of critical thinking skills for innovating products makes today's graduate unattractive and unemployed by industries because they are deemed not suitable for the available vacancies [13]. Some of these issues resulted from a mismatch in the demand and supply of graduates for attaining 21st Century Learning Skills and industrial revolution goals. Other issues prostrating the realization of industrial revolution targets in developing countries, specifically, is the lack of hands-on activities in their teaching and learning strategies particularly science and technology-based subjects. And when students lack basic skills such as critical thinking and broad-mindedness, innovation would hardly be possible. Kamińska et al. [13] highlighted some of the issues challenging nations ability to realize the 21st-century skills and compete in the digital age among developing countries. Some of the issues highlighted are; limited access to standard teaching and learning facilities; irrelevant subject contents; outdated teaching strategy. These issues give rise to the unemployment of science and technology graduates by industries and generated a decline in interest in pursuing many science and technology courses by a number of prospective undergraduate students.
3. **Encouragement of 21st Century Skills through STEM Activities**

The young minds at an elementary level of education need to be sharpened with the necessary learning context and experience required to engender twenty-first-century skills. STEM programs and activities that serve as a vehicle through which 21st-century skills could be realized. Sahin and Vanegas [14] reported that STEM Education has a significant role in individual student’s skills and countries’ global presence. Students’ gains from STEM education include i) academic gains which increase their knowledge and interest in a STEM discipline and activities, even at a higher level of education ii) 21st-century skills comprising self-confidence, collaboration, problem-solving, critical thinking and communication skills.

![Figure 2. STEM-SOS Model’s Gains from Students’ Perspectives](image)

Sahin [9] carried out survey research on how STEM Student On the Stage (SOS) model, guide students in acquiring and developing 21st-century skills. The results revealed that STEM SOS helps students develop their oral communication and collaboration, leadership, critical thinking/problem solving, creativity and innovation skills. The students expressed their confidence, willingness and inclination to further pursuit of academic knowledge, skills and conceptual understanding. The STEM SOS model presented learning physically at their environmental exposure. STEM activities enable learners to; present authentic problems and creative approaches that involve teamwork and project-based learning style. In addition, Anne [15] supported that STEM programs and activities could be used to energize students, develop their potentials and strengthen their creative ability and critical thinking which prepare them as collaborators in the competitive world.

In addition, Smyrno-Trybulska, Morze, Kommers, Zuziak, and Gladun [16] opined that extra-curricular activities that are interdisciplinary in nature using kits and tools to build and program robots to elementary learners are a modern form presenting the interdisciplinary discipline. The rationale for such activities is that the spirit of combining different ideas and concepts for critical thinking and creativity could be inculcated in the mind of young learners before they get to a higher level of learning. A survey they conducted in Poland and Ukraine on
the use of STEM robots for young learners show that the workshops and other STEM activities played a significant role in the learners when introduced at the elementary level of education. These classes and other STEM education activities could provide successful development of twenty-first-century skills.

Furthermore, Halim, Soh, and Arsad [17] investigated the effectiveness of mentoring programs in STEM on the students’ interest. The STEM Mentoring programs are found to enhance students’ interest in furthering their studies in a STEM discipline at a higher level of education. Also, Ali, Talib, Surif, Ibrahim, and Abdullah [18] organized a program titled Young Innovators Challenge Program. The program aimed at stimulating students’ interest in STEM. The data obtained using questionnaire were analyzed based on Rasch Model guideline and the results revealed participants of the STEM program possesses a high positive interest in the STEM career discipline. From the foregoing, it can be realized that 21st-century skills among basic secondary schools can be developed and strengthen via integration of STEM activities at the Basic level of education.

4. Conclusion

Twenty-first-century skills and workforce are necessary requirements to transform the nations into a knowledge-based society where technology and engineering are the engines of development. Despite issuing bedevilling developing countries towards this direction, STEM program and activities prove to encourage learners at basic education level to realize the dream. Their interest seems to be stimulated through interdisciplinary extra-curricular activities such as STEM kits and tools to build and program robots. Therefore, necessary conditions need to be provided by developing nations to encourage STEM programs and activities for realizing 21st-century skills and industrial revolution 4.0 goals.

5. Acknowledgments

The authors would like to express their heartfelt gratitude to Universiti Teknologi Malaysia and Universitas Muhammadiyah Purwokerto. Special appreciation and thanks are dedicated to sponsor, the committee and participants of STEMEIF 2019 and all those who have helped in one way or another to make this successful study.

6. References


