



Case Study: Students' Achievement in Chemistry, Technology, Engineering and Mathematics (CTEM) at Urban Schools

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ABSTRACT

Since Malaysia engaged to become a developed country and compete globally, Chemistry, Technology, Engineering, and Mathematics (CTEM) integrated into Malaysia education since the year 2017. This study determined students' achievement in CTEM at urban schools. The Methodology for this study was quasi-experimental with a sample of 30 students. The instrument used for data collection was test validated by two experts and reliability index of 0.79 was obtained. The findings showed that the urban students learning CTEM for chemistry topics were still in improvement stage. It was concluded that learning achievement and performance such as critical thinking, creativity, problem-solving and innovative skills get improved as the CTEM are continuously integrated into the curriculum of urban schools.

Keywords: students' achievement, chemistry, urban school, CTEM

INTRODUCTION

In the 21st century, Malaysia intends to become a developed country to compete with other countries globally. Therefore, education as a main contributor to social-economic development need to act as a key that lead to growth in the Malaysian economy [1]. Based on the targets, Malaysia Education Blueprint 2013-2015 stated that Malaysia's education is enrolled in a system called STEM (Science, Technology, Engineering, Mathematics) in education in expectations of better productivity. This is in reference to Curriculum Development Division statement that STEM aims to assist or manage students' views align with a scientific view or science literacy in the future that they are able to fulfil the job relate to STEM [2]. Through this, it could be can clearly observed that Malaysia put a lot of efforts into STEM education. STEM is an approach that departure away from typical and traditional instruction and followed by professional development under well planned and delivered to students [3][4].

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STEM as the guideline for the economic development involving production-based economy for a knowledge-based economy country [5]. This is in reference to Ministry of Education [6], that developing Malaysia education in line with Science and Technology culture would enhance individuals' competent in their science and technology subject. By implication STEM integrated into education promotes huge advances to students such as increase in their interest through a learning approach which consists of the higher-r-order thinking skill, improve teachers' competency skill and awareness of the important STEM fields in their future [7][8]. These skills can support students' creativity, expand their knowledge, assimilate their prior knowledge and new knowledge in order to pursue their goal.

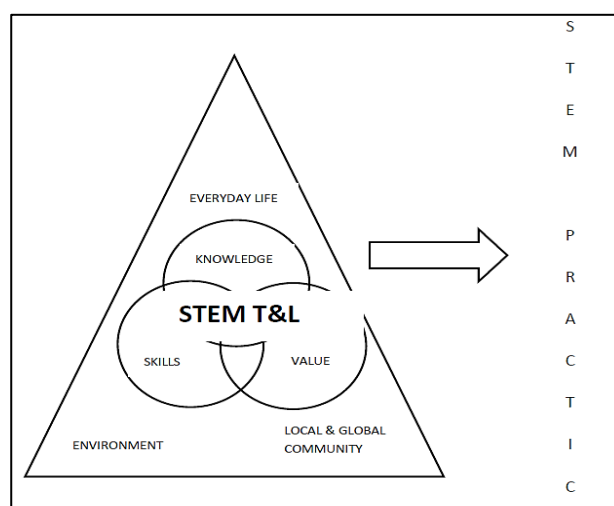


Figure 1. STEM as Teaching and Learning Approach [2]

Breiner, Harkness, Johnson, and Koehler states that United States maintains its position of competitiveness with emerging technologies through recognising STEM for students and graduate in relevant fields [9]. While based on Asghar, Ellington, Rice, Johnson, & Prime, education in the form of STEM system encourages students to learn the natural world through their survey, investigate and problem-solving experiences [10]. Chemistry subject is being learn during upper secondary school and learning chemistry is able student had intellectual and technique in science and technology [11]. As important science subject it need to create awareness in preservation and conservation for future communities Development Centre and play an important role in our daily life [12], everywhere and oracle of modern science [13], need to be taught using STEM based teaching approach most particularly in the urban schools where the population of students is mostly high which requires application of different style of teaching in order to carry every student along. Urban schools in this context refers to the school located in the city or town. By so doing students'

achievement in the subject is likely to improve. Sukor, Osman and Abdullah, stated that to improve students' achievement in chemistry, the teacher should apply the technology in their learning and teaching process and this can provide an opportunity for them to discover their own knowledge by use of technology [14]. In addition, in the Programme for International Student Assessment (PISA) 2018 stated that Malaysian students have improved in subject of mathematics and science [15]. This case study focused on determining students' achievement in CTEM integrated in urban school.

Based on McCracken and Barcinas, schools in urban areas are larger, had more teachers, administrators, and staff with more courses or activities that will be offered [16]. Urban schools are mostly the emphasis of education. The urban family also give more emphasis to their children's education and expect their children to advance beyond high school. Therefore, STEM integrated into education can assist the student to improve their thinking, problem-solving, innovative and creative skills and increase motivation in their learning. This was supported by State Department of Education Report that in STEM education students as acquire such skills like curiosity, logical reasoning, collaboration and investigation and problem solving to prepare for their post-secondary study and 21st-century workforce [17].

According to Moore, Johnson, Peters-Burton, and Guzey, STEM aims at the following six core objectives [18]:

1. Apply a meaningful learning content which connects content to their real life.
2. Develop students' critical and creative thinking through activities and challenge students' potential using approach engineering.
3. Students can use technology to learn a failure design solution by use of engineering with the existing design.
4. Implement teaching and learning which integrate with science and mathematics subjects.
5. Implement teaching and learning activities that are students-centered learning and this makes students become an active learner.
6. Train students to collaborate and communicate in educational activities.

From the above six core objectives of STEM, it could understand that STEM can help to develop students' critical thinking and higher-order thinking skills to solve problems through science literacy.

Those skills are very crucial to young learners and scientist. While based on the Duran, & Sendag, an individual must have skills to conduct research such as critical thinking ability, transform the information and higher order decision to survive in the competitive world [19]. Therefore, schools should train students to have this ability across the different domains of knowledge and apply STEM in their school curriculum. In this regards Capraro, Capraro, and Lewis recommended that all of the schools in the United State should apply the STEM vision in learning material and guide them in acquire STEM literacy [20]. In the study of Huffman, Lawrenz, Thomas, and Clarkson, STEM will immerse in an urban school in order to develop the capacity of the school, students and teachers

[21]. Professional learning communities assist to improve student learning with high-quality implementation and students learning in STEM among the urban students [22]. This is because relevant facilities and resources are mostly available in the urban schools than rural ones.

According to Khairani, urban school in Malaysia has better facilities and resources compared with the rural areas, thus means urban students are having better ICT facility with an internet connection and encourage them to integrate ICT in their learning [7]. This will cause students in urban areas to be more competence in STEM. In Texas, STEM known as T-STEM is to developed an innovation connect with STEM at the secondary until workforce [23], same with use of effective way to teach chemistry can improve students' critical thinking and problem-solving skills [24]. Hence, application of STEM technology-based approach is easier to be implemented in the urban schools where facilities are most available

MATERIAL AND METHODS

Methods

Quasi-experimental design was utilized where a sample of thirty (30) students that served as one group was used to investigate students' achievement in CTEM at urban school. Chemistry related STEM activities were used as the intervention.

Instrument

The instrument used for data collection was "Achievement Test" composed of into 2 parts (A and B). While part A comprises fifteen (15) multiple-choice questions, part B was made up of five (5) subjective questions. All of the items were constructed based on the bloom taxonomy. they are remembering, understanding, applying, analyzing, evaluating and creating. The instrument was validated by two experts who were lecturers in chemistry education at Universiti Teknologi Malaysia and all the questions were checked by the validators based on the criteria in item analysis of CTEM identified characteristics. The validators indicated that, the instrument is valid and could measure what is expected of it to measure. A reliability index of 0.79 was obtained using test-retest analyzed through Statistical Package for the Social Science (SPSS) version 20.0.

Procedures

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RESULTS AND DISCUSSION

After scoring and analyzing the achievement test, it was revealed that the level of students' achievement in CTEM varies with students scoring above average, average and even below average. The highest number of students were at average level (see Appendix).

From the Table 1, it was shows that 10 students are getting an excellent and brilliant result in the test, while the 13 students are at average and 7 students are below average (see also figure 2) and this result was based on the Malaysian grading system as indicated in Table 1.

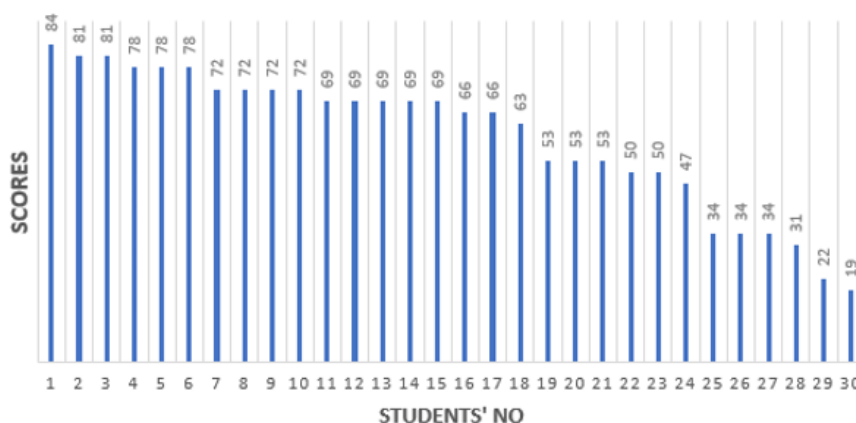


Figure 1. Students' Scores in CTEM

Table 2 indicates how grading is doing in the Malaysian system of education. A score of 80-100 marks is considered excellent, 70-79 as brilliant, 65-69 as average highest, 55-64 as honors, 50-54 as praiseworthy, 45-49 as upon graduation, 40-44 as pass and 1-39 as fail.

Table 1. Grading System in Malaysian Education [25]

Marks	Grade	Remarks
90 - 100	A	Excellent
80 - 89	A	Excellent
70 - 79	A-	Brilliant
65 - 69	B	Average Highest
60 - 64	B	High Honours
55 - 59	C	Top Honours
50 - 54	C	Praiseworthy
45 - 49	D	Upon Graduation
40 - 44	E	Pass
1 - 39	G	Fail

In summary any score that ranges 70 and above is considered as above average, 50-69 is at average level and any score of less than 50 is considered as below average.

DISCUSSION

Through the result given, it could be observed that, although there are low-performance students in learning ctem at urban schools, still more than half of the students can reach ctem approach learning in chemistry subjects. Through result above one can conclude that ctem has a good impact on the urban schools and students which improves students' thinking skills based on the hots level. This is in line with the findings of Ali et al. which state that a program that employed ctem competition such as young innovator challenge can boost up students' interest in ctem and increase their curiosity toward STEM [26]. And that of Duran et al., that ctem experience supported through technology enhance urban high school students in their learning by boosting their engagement in learning through a program after school [27]. According to Mutakinati, Anwari and Kumano stated that students improve their critical thinking in ctem education through project-based learning and they can construct a realistic critique power of thought [28].

According to Parker, Abel, and Denisova, urban elementary school that focused on STEM performs well in various STEM disciplines [29]. Also, these schools in an urban area continued grow and become institutionalized by the use of the CTEM approach. Blustein et al. proven that urban students had a positive reaction towards the interaction with CTEM education and this will expand their understanding of CTEM too [30]. Duffin, Starling, Day and Cribbs stated that students improved their chemistry knowledge through intervention and authentic learning [31]. therefore, the outcome of this research and similar ones before it revealed and positive finding on students' critical thinking, creativity, problem-solving and innovative skills most particularly in the aspects of Chemistry.

CONCLUSION

It could be concluded that urban school students are still in the improvement stage through the CTEM program in their learning. Further, there have some study that also supported this case study, proven that CTEM integrated into urban schools can improve students learning achievement and performance such as critical thinking, creativity, problem-solving and innovative skills and expand their understanding of CTEM which may lead students to further their future careers in CTEM component of STEM.

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Appendix 1. Students' Result scores in CTEM

	MCQ question															Essay question											
Student	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1a	1b	2a	2b	3a	3b	4a	4b	5a	5a(i)	5a(ii)	Total
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	1	1	1	1	1	1	84
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1	1	1	81
3	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	0	0	1	1	1	1	1	1	1	81
4	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	1	1	1	78
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	1	1	1	1	1	1	78
6	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	0	1	1	0	1	1	0	1	1	78
7	1	1	0	1	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	72
8	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	0	0	1	1	1	1	0	1	72
9	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	0	0	1	1	1	1	1	0	72
10	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1	1	0	0	1	1	1	1	0	1	72
11	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	0	0	1	1	1	1	0	1	69
12	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	0	0	1	1	1	1	0	1	69
13	1	0	1	1	1	1	0	0	0	0	1	1	1	0	0	1	0	1	0	0	1	1	1	1	1	1	69
14	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	1	1	0	1	1	0	69
15	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	0	0	1	1	1	1	0	1	69
16	1	1	1	0	1	1	1	1	1	1	0	1	1	1	0	1	1	0	0	0	1	0	1	0	1	1	66
17	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	0	0	0	0	1	1	1	0	1	1	66
18	1	0	1	1	1	1	0	1	1	1	1	1	0	1	0	1	0	1	0	1	1	1	0	1	0	0	63
19	1	1	0	1	1	0	1	1	1	1	0	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	53
20	1	1	0	1	1	1	0	1	1	1	0	0	1	1	0	0	0	1	0	0	1	0	1	1	1	1	53
21	1	1	0	1	1	1	1	1	1	1	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	53
22	1	1	0	1	1	1	1	0	0	0	0	1	1	1	0	1	0	0	0	0	1	0	1	0	0	0	50
23	1	1	1	1	0	0	0	1	0	0	0	0	1	0	0	1	0	1	0	0	1	0	1	1	1	0	50
24	1	1	0	1	0	1	1	0	0	0	0	1	1	1	1	1	0	0	0	0	1	0	0	1	0	0	47
25	1	0	0	1	0	1	0	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	34
26	0	1	0	1	1	0	0	1	1	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	34
27	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	34
28	1	0	0	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	31
29	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	22
30	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	19