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The level of STEM knowledge, skills, and values among the students of bachelor's degree of education in geography

Sumayyah Aimi Mohd Najib, Hanifah Mahat, Nur Hidayah Baharudin
Department of Geography and Environment, Faculty of Human Sciences, Universiti Pendidikan Sultan Idris, Malaysia

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ABSTRACT

The demand for individuals with educational background in Science, Technology, Engineering and Mathematics (STEM) fields has been rapidly growing. This paper presents the level of STEM education knowledge, skills and values among the students of Bachelor's Degree of Education (B.Ed.) in Geography at Universiti Pendidikan Sultan Idris. Research on STEM education study in geography involves assessing the STEM knowledge, skills and values. This article reports the findings from the survey conducted on 400 students of ISMP in Geography in the first to the eighth semester in 2018. The research instrument involves variables such as knowledge, skills and value. The items for each variable were constructed and modified based on the STEM implementation guide set by the Ministry of Education Malaysia and the Academy of Sciences Malaysia, and validated by the experts. Descriptive analysis was selected to evaluate the level of STEM knowledge, skills and values among the students. The findings show that the students indeed possess high level of STEM knowledge, skills and values. Overall, this study is important to examine the variables that influence the development in Geography and STEM. In a nutshell, this study will help the departments and faculties to further improve the development in Geography field at both national and international levels.

Corresponding Author:

Sumayyah Aimi Mohd Najib,
Department of Geography and Environment, Faculty of Human Sciences,
Universiti Pendidikan Sultan Idris,
Tanjong Malim, Perak, Malaysia.
Email: sumayyah@fsk.upsi.edu.my

1. INTRODUCTION

SMET (Science, Mathematics, Engineering and Technology) was first used as the acronym before the National Science Foundation (NSF) had simplified it to STEM (Science, Technology, Engineering and Mathematics) to facilitate the pronounciation and understanding of each element [1]. STEM Education is a philosophy or way of thinking in elucidating subjects such as Science, Mathematics, Engineering and Technology which have been integrated into education as a relevant field to be taught in all educational institutions, either at schools or higher level institutions [2]. STEM education plays a vital role that offer so much advantages, one of them is technical skill development [3]. STEM can be described as an integrated teaching or approach designed to teach the core concepts in science, technology, engineering and mathematics, the curriculum programme is known as STEM [4]. The STEM approach has been selected due to some factors, such as to prepare the next generation equipped with skills that meet labour force requirements especially to embrace the 21st century [5]. The world is facing Industry 4.0, which needs a knowledgeable generation and is capable of facing more complex new technological challenges [6]. However,

it is not easy to recognise and develop education programme as an effort to produce the skilled workforce in the 21st century as the skills required for that purpose keep changing due to changes in technology and innovation [7, 8]. Hence, it is important to make sure that the young people, especially the tertiary level students are able to integrate STEM knowledge, attitude, and skills to identify and address complex issues in this world. At global level, there are four gaps identified in STEM education, which involve the aspects such as skills, belief, post-secondary education, geography and demography. To fulfill job market requirements, the basic skills such as cognitive skills, critical thinking as well as creative and complex problem solving are the key requirements that each graduate need to possess [9]. Besides, graduates often have the preconceived idea that the career in science is very challenging and demanding. In the meantime, this group of students also believe that there are not many industries that hire graduates in this field. The mastery of STEM's basic knowledge and skills is essential in nurturing the values that are useful for universal wellbeing [10]. STEM must also be viewed from a positive point to facilitate community life. Various new creations can be produced through the exploration of STEM, without forgetting the intellectual aspect that is also the core of the nation's civilization [11].

Malaysia is now facing serious problem, the percentage of students who enroll in the science stream is lower than those who pursue the arts stream. The policy of having 60:40 ratio, with 60 percent of students in the science stream and the remaining 40 in the arts stream has yet to be achieved. The statistics show that the candidates from the arts stream who sat for the Malaysian Certificate of Education (SPM) in 2015 were 308.148 (70%), which is higher than science students, with only 132.540 (30%). The aim of STEM education is to produce students with excellent and balanced STEM literacy [12]. The progress made by the country today is rooted in the field of science, technology, which is based on commodity such as rubber, oil palm as wellas the oil and gas industry [13]. Therefore, it becomes a concern for Malaysia to deal with challenges in providing the right resources and talents who are knowledgeable and skillful in STEM. According to the latest student intake in the public universities, this situation is made worse when the number of qualified students who enroll in Science, Technology, Engineering and Mathematics (STEM) is insufficient, with 5000 more placements left.The concern is relevant because it was found that the number of students who pursue the science stream is plummeting [12]. The concept of STEM education is one of the efforts to attract young people to pursue study in science, technology, engineering and mathematics. STEM Education focuses on learning beyond theories and procedures due to the extension of concepts which include measurement and systems, where students have to be involved in the STEM practice. The perspectives on STEM are linked to the real-time activities for application and active learning modes [14]. STEM education has been proven to be an effective learning concept to attract students to join this field and lead to the success in careers related to STEM [15]. Also, the studies on STEM education demonstrates high level of empirical effort to make the basic understanding in STEM a success, this is the factor that influences the students' achievement during the learning process [16]. The field of science is a platform to present ideas or insights that are open to tests, repeatition and verification [17]. In general, science is an organised approach to study the world. Science also provides solutions to issues in various disciplines as well as for practical problems. According to Weaver (1948), the problems than can be addressed via science should be in accordance with law, have logical foundation and measurable. Three scholars in geography namely Immanuel Kant, Alexander von Humboldt and Alfred Hettner stated that geography is part of science. In fact, the statements from the previous scholars have proven that geography is a science discipline from the very beginning of time [18].

The "Science" in STEM has narrowly included only the physical and environmental sciences such as chemistry, geology, and physics. However, science is an interdisciplinary field that can include subjects that combine social science and geography. Geography as a discipline enjoys the advantage of providing interdisciplinary discourse because it offers both human and physical geographic perspectives. Moreover, it can be used as an alternative vehicle for catalyzing STEM fields. More specifically, the interdisciplinary foundation of geography can be used to help draw students from underrepresented communities into STEM fields [19]. From that, this paper present findings from a preliminary analysis of the level STEM education knowledge, skills and values among the students of Bachelor's Degree of Education (B.Ed.) in Geography at Universiti Pendidikan Sultan Idris.

The Elements of Knowledge, Skills and Values in STEM, Geography is important in the human life because it is dynamic, in line with the development in technology and knowledge. Stuckey (1971) [20] stated that geography is the "what" humans do, what humans want, how humans change and how the physical environment transforms humans before concluding that geography is regarded as life. The most prominent influences of geography to humans are mapping or cartography. In the past, via mapping, humans are able to explore and navigate more effectively. Up until now, mapping is regarded by the public as the major focus in the field of geography, despite the fact that geography encompasses more disciplines. Nowadays, mapping techniques have become more complex and rapidly developed in line with the modern technology development, resulting in the existence of a new discipline in geography known as Geographical Information

System around the 80s. Geography connects the STEM disciplines with technological applications and the geographic tools help to further elucidate and provide understanding of cross-disciplinary phenomena in dealing with major issues. However, geography is often marginalised as part of STEM education by the authorities [3]. Therefore, there are issues regarding the difference in scientific practice, geographic equipment and how this field is classified by the authorities [7]. If the students are capable to master geographic technology and engineering in the field of STEM, they can get involved in crucial issues that occur in Malaysia and overseas, thus being a part of intellectual global citizens. Overall, STEM education on engineering and technology is highligthed through three result areas [1]: Pay attention to the global economic challenges in other countries; Focus on the changes in labour requirements, making flexible knowledge and integration aswell as skills that meet the 21st century requirements a must; Emphasise the demand for STEM literacy for the purpose of solving environmental issues latest technology worldwide.

STEM Education is about how the knowledge learnt in a discipline helps to provide creative and innovative solutions to the existing problems. STEM learning helps students to meet the needs for the job market. Next, STEM learning helps people to develop thinking skills, reasoning, rationalisation, teamwork, analysis and creative skills that students need in every aspect of life. Therefore, the STEM learning concept is relevant to be applied in every discipline. Failure is a part of learning and students have to analyse any value they obtain during the study. Therefore, the STEM education elements such as knowledge, skills and values acquired during teaching and learning sessions in geography can help to produce skilled and competitive human capital. The use of a variety of teaching strategies that incorporate many methods can make students interested to be active during the learning session. This indirectly increase the students' interest towards the subject and the knowledge can be conveyed more effectively. STEM knowledge is an idea, theory, concept, principle and understanding in the field STEM, especially the course curriculum. The curriculum is designed and developed to deliver sufficient knowledge, skills and values via the activities conducted by the lecturers, either in or out of the classroom during PdP. The acquisition of progressive and dynamic STEM knowledge is important for students to gain the current knowledge and development in STEM [12]. STEM Education is an integrated approach in learning, which provides students with a relevant learning experience. STEM teaching and learning is not just about knowledge transfer, it does involve students and equip them with critical thinking, problem solving, creative and collaborative skills, and ultimately help to establish connection between schools, workplace, community and the global economy. STEM also helps students to understand and be equipped with mathematical and science content, as well as the foundation of success in higher learning and career. According to the NSW Department of Education, the learning and integration principles in the STEM education pedagogy involve:

- The students' existing knowledge helps to strengthen and provide a solid foundation in building new knowledge. STEM education gives students the opportunity to be active and hone their existing knowledge to be more dynamic.
- Student motivation helps to determine the direction and maintain the knowledge learnt in the field of STEM. Students can determine what, when and how they learn. Motivation plays an important role in the quality of learning. Therefore, STEM education helps to improve interest and motivation among students.
- Help students to gain knowledge effortlessly. Students should be equipped with skills' component, integrated training, and know the time to apply the knowledge learnt in STEM. Students learn the knowledge and skills to help them carry out complex tasks smooth sailing.
- Practices integrated with effective feedback can improve the quality of learning. STEM education provides students with specific design challenges and continuos feedback from colleagues, lecturers and or asses themselves from each solution.
- To be self-oriented, students must learn to monitor and adapt their approach in learning. STEM lets students to be involved in group design activities to encourage them to be in charge with planning, self-assessment, monitoring and reflection.

STEM skills involve capability and competence to explore, solve issues, design and produce products. The skills can be acquired through activities, projects or assignments. STEM skills consist of process skills and technical skills. Process skills are the skills used in learning and the application of knowledge in solving problems. Process skills involve the process skills in science and mathematics, as well as design and computational skills. Meanwhile, technical skills are the skills that involve psychometers including manipulative skills, management skills and handling of materials, tools and machines in a proper and safe manner [12]. STEM values and ethics STEM involve positive attitude and morale. The inculcation of STEM values and ethics during learning and teaching is important to produce graduates who are not only knowledgeable and competent, but also have great personality. Among the values emphasised are being objective, systematic, consistent, thinking rationally, resilient, committed, open to challenge, courageous, open-minded, innovative, and many more [12]. Hence, STEM studies are necessary to widen the scope of

STEM-based teaching and its integration with Geography so that students are prepared to face the challenges and be competitive globally [21].

2. RESEARCH METHOD

The design used in this study is quantitative research using the questionnaire technique as an instrument. This type of design is suitable for a population sample that has been pre-determined, at a specific point in time (single point in time) [22-24]. In the context of this study, a questionnaire survey was chosen to obtain data on. In addition, the use of questionnaire provides a solid data based on the knowledge acquired by the respondents. The study sample involved 400 ISMP students in Geography in 2018. They were asked to respond to the questionnaires to evaluate their level of knowledge, skills and values in STEM during the teaching and learning sessions.

A questionnaire was used as an instrument in this study. The questionnaire items were divided into six sections; the first part covers the respondents' demographic background, the second part involves the students' general perception on STEM education, the third part involved teaching and learning based on STEM education. The fourth part gauges the students' knowledge in STEM, the fifth part is about the STEM skills possessed by the students while the last one is about the students' values in STEM. The study dependent variables are the final outcome of the study (level analysis). The content information for each variable and measurement scale of each variable is described in Table 1 and the sample item for each variable is shown in Table 2. The item measurement scale for each variable uses the 5-point Likert scale, based on the knowledge scale of 1 = Strongly Disagree, 2-Disagree, 3-Don't Really Agree, 4-Agree and 5-Strongly Agree. The instrument reliability validation is important to measure the item consistency in a particular construct. The reliability value closes to 1.00 indicates that the instrument has high reliability. The findings from the pilot study were analysed by using 35 ISMP students in Geography from the 1st to the 8th semester. The Cronbach's Alphas (reliability) are ranging from 0.885 to 0.960 for all sub variables. According to [25, 26], the Cronbach's Alpha coefficient of 0.70 is deemed good and acceptable. In this study, the reliability of all items is more than 0.70. This indicates that the study items have high consistency level. The research instrument had been reviewed by the content validation experts among the academics (Table 3). The content validation means to assess to what extent the set of the constructed items is relevant to the content domain to be measured and the assessment has to be done by the experts. After correction and suggestions from the experts, a pilot study was conducted to see the items' reliability.

Table 1. Research instrument-questionnaire

Variable	Construct	Item No.	Item Scope	Item Source
Students' Demography	Gender Race Age Semester The Geography courses enrolled	5	Respondent Background	Constructed according to the study requirements
Generap Perception towards STEM Education		10		
The Characteristics of STEM Education Teaching and Learning (PdP)		8		The Academy of Science Malaysia (2015)
STEM Education Knowledge		13	Knowledge acquired during learning	The Implementation Guidelines of Science, Teknology, Engineering and Matemathics in Teaching and Learning, Ministry of Education (2016)
STEM Education Skills		12	Skills acquired during learning	
STEM Education Values		10	Values acquired during learning	

Table 2. The cronbach's alpha reliability value

Variable	Cronbach's Alpha	Number of Item
General Perception towards STEM	.925	10
The Characteristics of STEM Teaching and Learning (PdP)	.885	8
STEM Education Knowledge	.936	13
STEM Education Skills	.936	12
STEM Education Values	.960	10

Table 3. The area of expertise of the questionnaire experts

No.	Expert	Area of Expertise	Institution
1	Expert 1	Science and Mathematics Education	Universiti Pendidikan Sultan Idris
2	Expert 2	Geography Education	Universiti Pendidikan Sultan Idris
3	Expert 3	Geography Education	Universiti Pendidikan Sultan Idris

3. RESULTS AND DISCUSSION

The entire study involved 400 (B.Ed.) students in Geography. Table 4 shows the respondents' background, consisting of 400 individuals who are the Bachelor's Degree of Education (B.Ed.) students in Geography at Universiti Pendidikan Sultan Idris. The findings show that there are 109 (27.3%) male respondents and 291 (72.8%) female respondents. In terms of race, the findings show that the most of the respondents in this study are Malays, there are 290 of them (72.5%), followed by 100 for other races and 10 of them are Chinese. Next, most of the respondents during the study are 23 years old (31%), followed by those who are 21 (21%), 22 (19.3%), 24 (16.3%), whereas one of them is 20 (6.3%) and another is 25. The results showed that most of the respondents were in the 5th semester (22.3%), followed by 68 in the 3rd semester 3, 67 in the 1st semester, 67 more in the 7th semester, 40 in the 4th semester, 37 in the 8th semester 8 and 32 in the 2nd semester.

Table 4. The respondents' demography

Item		Number of Students	Percentage
Gender	Male	109	27.3
	Female	291	72.8
	Total	400	100
Race	Melayu	290	72.5
	Cina	10	2.5
	Others	100	25.0
	Total	400	100
Age	20 years old	25	6.3
	21 years old	84	21.0
	22 years old	77	19.3
	23 years old	124	31.0
	24 years old	65	16.3
	25 years old	25	6.3
	Total	400	100.0
Semester	1	67	16.8
	2	32	8.0
	3	68	17.0
	4	40	10.0
	5	89	22.3
	7	67	16.8
	8	37	9.3
	Total	400	100.0

3.1. The mean score of the study variables

Level analysis encompasses general perception, the characteristics of STEM teaching and learning, as well as knowledge, skills and values in STEM among the ISMP students in Geography. The subvariables of knowledge are divided into two, namely STEM knowledge and the application of STEM knowledge, as well as the STEM skills and STEM values. To facilitate the interpretation of each variable level, in this study, there are three categories namely low, moderate and high. To facilitate the interpretation of each level, a cutoff point is used (Table 5). Level categorization was based on the level range calculation between mean higher score and lower mean score (5-1=4) and divided into three for three categories (4 3 = 1.33) by Landell (1977). Lower levels are between 1.00 to 2.33 (1.00+1.33), medium levels are between 2.34 to 3.66 (2.34+1.33) while higher level are between 3.67 to 5.00 (3.67+1.33). Table 6 shows that in terms of general perception and STEM PdP, the students scored high for each variable with the mean of 4.22. The knowledge variables are divided into two subvariables, they are STEM knowledge and application of the knowledge. The results show that overall, the STEM knowledge of the ISMP students in Geography is high, with mean values from 3.82 to 4.04. The findings also show that the students' STEM skills are high with the mean of 3.93, while the students' STEM values are high as well, with the mean of 4.22.

Table 5. Cutoff point level of each study construct

Scale	Level
Score of 1.00 – 2.33	Low
Score of 2.34-3.66	Moderate
Score of 3.67-5.00	High

Source: Landell (1977) [27]

Table 6. Level of study variables

Variable	Low Level		Moderate Level		High Level		Mean	SD	Mean Level
	N	%	N	%	N	%			
STEM Education Knowledge	3	0.8	135	33.8	262	65.5	3.95	0.61	High
STEM Education	5	1.3	160	40.0	235	58.8	3.82	0.72	High
The application of knowledge	1	0.3	96	24.0	303	75.8	4.04	0.59	High
STEM Education Skills	2	.5	132	33.0	266	66.5	3.93	0.58	High
STEM Education Values	1	.3	55	13.8	344	86.0	4.22	0.60	High

The finding of this have significant implications to the national education system, particularly the Ministry of Education and the Ministry of Higher Education. The National Education Curriculum, especially Geography, should be studied more thoroughly to integrate the Geography elements into STEM education. The study shows that the level of knowledge, skills and values in STEM among the ISMP students in Geography is high. The field of Geography should be further exposed and promoted to be upgraded as the main subject in the national education system because the STEM elements will help to intensify the quality of knowledge. Most of social and personal issues are easi to be managed with the help of scientific knowledge and skills. STEM education literacy does help in understanding medical diagnosis and interpretating the media statements on matters related to climate change.

The aim of STEM education is students are capable to apply and utilise each STEM element in any situations they encounter in daily life [1]. The integration of Geography in STEM education is one of the steps towards to include geography as part of the STEM disciplines. The elements of science, technology, engineering and mathematics in the field of geography are relevant in the world today [28]. Therefore, some the recommendations that can be implemented to realise the integration of geography in STEM are: (i) To establish STEM Implementation Committee to coordinate STEM and Geography at the secondary and htertiary education level; (ii) To work on to include Geography in the STEM education syllabus at various levels; (iii) establish the term "Geography in STEM" and publicise its advantages; (iv) To establish the STEM Education Policy so that the Government can make budget allocation to implement STEM at schools and higher education institutions. Geography is not only recognized as a key STEM field but also as a field that offers place-based perspectives that can lead to improved recruitment efforts across the spectrum of STEM disciplines [29].

Other factor that have consider that inspire geographical perspectives on STEM fields such as economical or sociocultural factors, student's academic preparation, support system, and dependencies during study, student's experiences, access, and exposure to supplementary educational or advisory activities, and the geographical location "place factor" of the university or individual. Second, spatial thinking, spatial behavior, and inquiry-based pedagogical approaches used in developing fundamental knowledge and skills required to advance STEM fields [30, 31]. Finally, environmental education and civic engagement is a way of learning STEM through real-world problems and experiences. In the discussion of the geographic case study, many of these perspectives have been addressed; specifically indicating that placed-based factors and approaches, spatial thinking and inquiry-based learning, and environmental education and civic engagement all work [32] in helping advance the science of broadening participation in STEM fields. On the whole, nurturing diversity in STEM fields can be accomplished through a number of ways, for example using practical initiatives, especially through job, career, GIS, schematics, spatial intelligence, visual analytics, mapping, critical thinking, field studies and observations; and using community geography, local civic engagement activities, and place-based science education to connect classroom theory with real-world experiences [33, 34]. To attain a rich and diverse workforce in the 21st century and education 4.0, we should aim at equipping students with a relevant set of knowledge and skills firmly rooted in place through a variety of geographically-oriented, theoretical and methodological perspectives.

4. CONCLUSION

In facing the challenges of Industry 4.0, the younger generation in particular needs to master the STEM field. This is to produce skilled human capital in the field of future technology and that is core in Industry 4.0. The results of this study show that the knowledge, skills and values of STEM among the ISMP

students in Geography. This finding useful for the Department of Geography and Environment, Faculty of Human Science and UPSI in assessing the syllabus of geography education. The findings also show that the level of knowledge, skills and values in STEM among the ISMP students in Geography are high. The efforts made by the university, faculty and ministries to enhance the values of STEM among students should be praised as their level of knowledge, skills and values in STEM education students are up to standard. In a nutshell, the adoption of the STEM elements in Geography education implicitly will elevate the geography status as part of the STEM disciplines.

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