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RESEARCH ARTICLE

Construct Validity of the Knowledge and Skills in a Geography STEM Education Instrument among Prospective Teachers: Confirmatory Factor Analysis

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Abstract Science, Technology, Engineering, and Mathematics (STEM) subjects refer to school education policies and curriculum options to increase competitiveness in science and technology for students. Geography connects STEM disciplines with the application of geographical technology and tools, which can better understand cross-disciplinary phenomena to address critical problems. This study was carried out to validate the construct of the knowledge and skills in a geography STEM education instrument among prospective teachers in Malaysia. The respondents consisted of 400 students of semesters one to eight from the Bachelor of Education in Geography program, Universiti Pendidikan Sultan Idris, Perak, Malaysia, who were selected using a simple random sampling technique. The constructs studied were the knowledge and skills in geography STEM education. The data were analyzed descriptively and inferentially using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) for item component grouping. The analysis results showed that the reliability value of Cronbach's alpha was at a high classification, which exceeded 0.70. The result of the EFA showed two components generated from the knowledge construct: STEM Knowledge and Applied Knowledge, and one component from the skill construct known as STEM Skill. Regarding the measurement model, CFA results showed that the solution was suitable and acceptable based on the suggested indicators. Therefore, the 25-item measurement model developed is suitable to

1.Introduction

Education plays a vital role in economic development and in realizing the development of a country. Therefore, the teaching and learning (T&L) process in the classroom is a significant determinant of a country's future success. Looking at the current global economic competition, the success of a country depends on the knowledge, skills, and competencies possessed by its citizens. Thus, it is not surprising that a nation with highly educated citizens can actively generate the economy for the sake of the nation's prosperity. Education is also the foundation of a united nation. Through education, individuals will gain the opportunity to improve their quality of life, become successful community members, and actively contribute to national development (Ministry of Higher Education Malaysia, 2013).

Geography as a discipline explains the world around us, for example, by investigating the diversity of environments, places, peoples, and cultures, inequalities that exist within and between places, reliance on the environment for survival, attachment to place, and connections between places and people all over the world. Quality education in science and technology should be emphasized, as the world, today is more oriented to the development of science and technology. The involvement of students in science and technology T&L can form individuals with the ability to think critically and solve problems through the skills and knowledge they gained during T&L sessions. The Ministry of Education via the Malaysian Education Development Plan for 2013 to 2025 has also planned various strategies to strengthen science, technology, engineering, and mathematics (STEM) subjects through new approaches, such as strengthening the curriculum and incorporating high-level thinking skills. Emphasis on STEM is among the 100 key initiatives of the PPPM, including using information and communication technology (ICT) in the classroom, adding more time for science teaching, and enhancing teachers' development of knowledge and skills. The geography curriculum in schools today has gone through many iterations, particularly during the twentieth century, but there is a significant difference in how geographical knowledge is applied now.

STEM is integrated teaching or approach aimed at teaching the core concepts of science, technology, engineering, and mathematics (Chaniel Fan & Ritz, 2014).

This STEM approach has been selected to prepare young people with the skills that meet the workforce's needs in the 21st century (Salinger & Zuga, 2009). However, identifying and developing education programs in workforce skills in the 21st century is not easy, as these skills continue to change as technology and innovations change. Therefore, it is important to ensure that young people, especially students at the tertiary level, can integrate STEM knowledge and skills to identify and solve complex world problems. The Scientific Revolution and the vast disparity between religion and science, especially in Europe, and a prolonged emphasis shows that on gaining national power through geopolitical knowledge and exploration. This implied that geography thrived even more.

In the context of Malaysia, STEM refers to the education policy and school curriculum options to enhance competitiveness in science and technology to students as enshrined in the 2013–2025 Malaysia Education Blueprint (PPPM), which emphasizes STEM education at the school level to higher education with support from various stakeholders (Fazurawati, 2018). According to Shahiron (2018), STEM education has become a priority for schools and universities to uplift and strengthen those fields for the younger generation. At the same time, STEM education also emphasizes the concept of 4C components of communication, cooperation, creativity, and critical thinking (4K-*Komunikasi, Kerjasama, Kreativiti, and Pemikiran Kritikal*) as contained in the 21st Century Learning (PAK-21) and Higher Order Thinking Skills (KBAT). The development of these four components in STEM education is indirectly seen as producing a young generation capable of solving varieties of complex problems. Although the Ministry of Education does not require STEM to be in the subject of geography, it should be noted that geography is a subject that has elements of science and mathematics indirectly.

STEM, which results from the development of Science, Technology, and Innovation (STI) education in the country, has been given priority since the 1960s. The science field in STI is a platform to present ideas or thoughts that can be tested, repeated, and verified (McLelland, 2006). Generally, science is an orderly approach to studying the world. The early writing of Weaver (1948) argues that problems can be addressed by science based on laws and logic and can be measured. Three scholars in the geography field — Immanuel Kant, Alexander von Humboldt, and Alfred Hettner — have stated that geography is part of the science branch (Weaver, 1948). This is also acknowledged by the National Science Foundation (NSF) in America, one of the promoting bodies of STEM education development that supports geography as a STEM research initiative. The science sub-discipline in geography can be seen through geospatial science (Rajibul et. al, 2015). The engineering technology in geospatial science combines computer geo, geographic information science, geographic information technology, and geographic information system applications. The technologies in geography include earth satellite devices, geographic information systems, and global positioning systems, and an extensive range of automated environmental checks.

Geography connects STEM disciplines with applications to technology and geographic tools that can explain in detail and provide an understanding of cross-disciplinary phenomena in dealing with significant problems encountered. However, geography is neglected as part of STEM education by some parties (Dangermond, 2013). Therefore, integrating STEM into various fields is important to increase student interest in STEM despite being in the art and social science streams, such as the geography field. The advantage of integrating STEM education into all fields' content at all levels is that it will provide students with creative problem-solving skills before they have to decide on the courses of study in school (Meyrick, 2011). STEM-based teaching and its integration into geography subjects are crucial in preparing students to face challenges and become globally competitive. Therefore, through an attractive T&L, it can increase student interest and inclination towards STEM so that human capital with STEM knowledge and skills will make Malaysia a sustainable competitive, and dynamic nation globally.

STEM Elements in Geography

STEM elements in geography cover two measurements: the knowledge and skills that need to be provided to students. STEM knowledge is an idea, theory, concept, principle, and understanding of the STEM field, especially in the subject curriculum. The planned and developed curriculum aims to deliver sufficient knowledge, skills, and values through activities provided by lecturers in or out of class during teaching and learning (T&L). The acquisition of progressive and dynamic STEM knowledge is important so that students can get the latest knowledge and developments in the STEM field itself (Ministry of Education Malaysia, 2016).

STEM education is an integrated approach to learning that provides appropriate and relevant learning experiences for students. STEM's T&L is more than merely a transfer of knowledge, as it also involves students and equips them with critical-thinking, problem-solving, creative, and collaborative skills, ultimately establishing a link among school, the workplace, the community, and the global economy (Science Foundation Arizona, 2013). STEM also helps students understand and apply mathematical and science content, the foundation of success at higher learning levels and careers. According to the NSW Department of Education (2017), the principles of learning and pedagogic integration of STEM education include the following:

i) The existing knowledge of the students can strengthen and provide a solid foundation for building new knowledge. STEM education allows students to activate and hone the knowledge they already have at a more dynamic level.
ii) Student motivation can determine the direction and maintain the knowledge learned in the STEM field. Students can determine what, when, and how they learn. Motivation plays an important role in the quality of learning. Therefore, STEM education builds a high level of interest and motivation.
iii) Smoothness can be developed in student knowledge. Students should have skill components and integrated training, and they should know when to apply the STEM education learned. Students learn the knowledge and skills needed to carry out complex tasks to develop smoothness.
iv) Practices combined with effective feedback can improve

the quality of learning. STEM education provides students with specific design challenges and persistent feedback from peers and lecturers, and self-assessment on every solution.

v) To become self-oriented, students must learn to monitor and adapt their approach to learning. STEM involves students in group design activities that encourage them to be responsible for their planning, self-assessment, monitoring, and reflection.

The methods of knowledge delivered and learned by humans have evolved over the last few decades. Success in learning requires students to seek experience, carry out disciplinary relationships, and follow contextual settings. Students should be allowed to learn the same teaching materials and different moods and lenses (Stohlmann et.al, 2012). STEM skills are the efficiency and competency to explore, solve problems, design, and produce products. The skills can be obtained through activities, projects, or assignments. STEM skills comprise process skills and technical skills. Process skills are the skills used in the process of learning and applying knowledge in solving problems. They involve science process skills, mathematical process skills, design skills, and information technology skills. Technical skills involve psychomotor skills, including manipulation skills, management skills, and the handling of materials, tools, and machines in the right and safe way (Ministry of Education Malaysia, 2016).

The goal of STEM education for students is to apply and use every fundamental element of every situation encountered in everyday life (Bybee, 2010). In a study by Suwarma, Astuti, and Endah (2015), the skills acquired from STEM education include skills to adapt to non-routine situations, complex communication skills in verbal or non-verbal information processing, self-management and development skills, and system thinking skills, which is the ability to understand the overall system work as well as how a change in action affects the system. Hence, the STEM knowledge and skills aspects play an important role in balancing the geography education field. The formation of these two aspects is very much needed, like an implicit essence between the theory and practice, which leads to the best and effective delivery of knowledge.

2. Methods

This study is a survey study using a questionnaire. The selection of the questionnaire technique was aimed to measure two study variables, namely STEM education knowledge and STEM education skills. In fact, Creswell (2002) explains that the design of a survey study is one of the quantitative study procedures that allow researchers to administer a survey to population samples to describe the population's attitude, opinion, behavior, or characteristics. Therefore, in this study, the survey method was the most suitable because the focus was to study the matter/situation that was happening and practiced.

Study Location

The study was conducted at the Universiti Pendidikan Sultan Idris (UPSI) in Tanjong Malim, Perak, Malaysia. This study location was selected because the university is an educational institution that train prospective teachers to become professional teachers in Malaysian schools. In addition, UPSI is one of the public universities in Malaysia. UPSI, which is situated in Tanjung Malim, Perak Darul Ridzuan, has two campuses, namely Sultan Abdul Jalil Shah Campus (KSAJS) and Sultan Azlan Shah Campus (KSAS).

Study Population and Sample

This study involved a population of 539 students from semester one to the final semester, except for semester six of the Bachelor of Education (Geography) programme at UPSI in Tanjong Malim, Perak, Malaysia. Through a simple random sampling, 400 students were selected as the study sample, as suggested by Meyers, Gamst, and Guarino (2006) with a sample size of 40 people for 25 questionnaire items. Table 1 descriptively shows the frequency and percentage of respondents' background according to semester (Semester 1:16.8%, Semester 2:8.0%, Semester 3:17.0%, Semester 4:10%, Semester 7:9.3% and Semester 8:9.3%) where a total of 400 students had been involved in this study.

Data Analysis

A reliability test was conducted for each construct, and it was found that the reliability value exceeded 0.7, while confirmatory factor analysis (CFA) was performed to determine the construct validity. The CFA was operated on the measurement model based on the hypothesized factor using the Analysis Moment of Structure (AMOS 18). The program uses the maximum likelihood estimation to generate an estimate in a full-fledged measurement model. In order to determine the compatibility of the measurement model, the following compatibility indices were examined: (i) the minimum value of the deviations between the observed data and the hypothesized model was divided by the degree of freedom (CMIN/df); (ii) comparative of fit index (CFI); (iii) Tucker Lewis index (TLI); (iv) incremental fit index (IFI); and (v) the root mean square error of approximation (RMSEA). Arbuckle (1997), Hair et al. (2006),

Table 1. Background of Respondents

Faculty	Number of Population	Percentage (%)	Number of Samples
Semester 1	90	16.8	67
Semester 2	43	8.0	32
Semester 3	92	17.0	68
Semester 4	54	10.0	40
Semester 5	120	22.3	89
Semester 7	90	16.8	67
Semester 8	50	9.3	37
Total	539	100	400

and Arbuckle and Wothke (1999) state that a model is compatible when the compatibility indices show:

i) CMIN/df with a value between 1 and 5 is considered acceptable or an acceptable fit between the model and data;
ii) The CFI, IFI, and TLI indices approaching 1.00 show a compatible match;
iii) The RMSEA index of .08 or less indicates a reasonable and acceptable estimate error.

Next, the following were examined if the model was found to be incompatible.

i) Examining the load factor of each item, which must exceed the recommended value according to the number of samples. Load factor represents the relationship between the latent variable and the item or indicator (Hair et al., 2006; Kline, 2005);
ii) Examining the residual standards, and values between 2.58 and 4.00 were considered to be maintained or dropped, while values greater than 4.00 must be dropped;
iii) Examining the index modification to repair the model (Bryne, 2010; Hair et al., 2006; Kline, 2005). In order to establish the constructs of the model, the centralized validity and discriminant validity tests were performed.

Centralized validity is based on construct reliability of 0.70 and above (Hair et al., 2006). It is also assessed based on an examination of the coefficient of each item loading significantly as well as the average variance extracted for a latent variable (Anderson & Gerbing 1988; Fornell & Larcker, 1981; Hair et al., 2006). Discriminant validity is assessed by making a comparison between squared correlations between two constructs with an average variance quoted, respectively. If the average variance is quoted above the squared correlation, then the discriminant validity is achieved (Hair et al., 2006). In this study, CFA was used to examine the validity of the constructs of the study instrument.

Instrument

This study used a questionnaire as a research instrument consisting of three sections: A, B, and C (Table 2). Section A

Table 2. Respondents' Questionnaire Information

Part	Constructs	Number of Item	Source of Item
Profile of Respondent	Gender Races Ages Semester	5	Built according to study needs
STEM Education Knowledge		13	Ministry of Education (2016)
STEM Education Skills		12	Ministry of Education (2016)

Table 3. Items Constructs of Knowledge and Skill of STEM Geography Education

Construct	Item	Statement
Knowledge	D1	I am knowledgeable about the concepts in STEM Education.
	D2	I am knowledgeable about the characteristics of T&L in STEM Education.
	D3	STEM Education opens the student's mind to identify real-world problems.
	D4	I know how to conduct investigations through inquiries
	D5	I am knowledgeable in using quantitative methods.
	D6	I was knowledgeable using computational thinking like designing the system.
	D7	I know how to build a model/prototype.
	D8	I am well-acquainted with repeating the creation process that can improve the product.
	D9	I have learned using my own words about a phenomenon.
	D10	I am knowledgeable to analyze the data obtained.
	D11	I am knowledgeable to present information data.
	D12	I am well-versed in explaining the results of the invention.
	D13	I know communicating clearly can increase my self-esteem.
Skills	K1	I can ask questions about real-world problems.
	K2	I apply science in solving problems.
	K3	I was able to conduct investigations via inquiry.
	K4	I am good at using quantitative methods.
	K5	I have computer skills.
	K6	I am good at developing a model/prototype.
	K7	I can repeat the process they create to improve the product.
	K8	I am good at explaining something natural phenomenon.
	K9	I am good at analyzing data.
	K10	I am proficient at presenting data in graphic form (table/graph).
	K11	I can answer by explaining the result of the invention.
	K12	I am good at handling the tools used in the right and safe way.

contained the respondent's profile information, while Sections B and C covered the study construct information, including knowledge and skills of geography STEM education. Table 3 shows in detail the constructs, items, and statements of this study. This study does not involve a perception study but a survey study to identify items that measure the stem knowledge construct and item skills. Each item built has been through b [process (i) expert validity (ii) face validity and reliability analysis.

Table 4. Reliability of Study Questionnaire

Constructs	Number of Item	Alpha Cronbach Value
STEM Education Knowledge	13	.936
STEM Education Skills	12	.936

Instrument Reliability

Table 4 shows the reliability of the element for knowledge and skills of geography STEM education, with a Cronbach's alpha value that measures the internal consistency of the constructs. According to Babbie (1992), Cronbach's alpha values are classified based on reliability index classification, where values of 0.90–1.00 are considered very high, 0.70–0.89 high, 0.30–0.69 moderate, and 0.00–0.30 low. The results of the analysis show that Cronbach's alpha values were in the high and very high classification of more than 0.70. The instrument in this study had high reliability according to Babbie's (1992) classification

3. Results and Discussion

Respondents' Background

Table 5 shows the respondents' background, which consists of 400 Bachelor of Education (ISMP) in Geography students at UPSI. The findings show 109 male respondents (27.3%) and 291 female respondents (72.8%). Regarding the racial background of the respondents, the findings showed that the majority of the ISMP Geography students in this study were Malays, with 290 individuals (72.5%), followed by 100 individuals of other races and 10 Chinese individuals. Additionally, the findings of the respondents' age showed that the majority were 23 years old (31%), followed by respondents who were 21 years old (21%), 22 years old (19.3%), 24 years old (16.3%), and 20 and 25 years old (6.3% each).

Exploratory Factor Analysis (EFA) of the Knowledge Construct of Geography STEM

Education

The results of the EFA on the measuring instrument of geography STEM education knowledge indicated that the anti-image correlation analysis procedure had a correlation coefficient value greater than 0.5, which gave the impression that the factor analysis could be carried out. The sampling adequacy measurement of Kaiser–Meyer–Olkin (KMO) and Bartlett's Test of Sphericity showed that the KMO value was 0.945, and Bartlett's Test of Sphericity was significant with a chi-square value of 4142.996 at the degree of freedom of 78.

Factor analysis was carried out by the researchers determining the number of factors to be extracted into two, as categorized in the questionnaire. Table 4.6 shows the

Table 5. Respondents' Background

Respondents' Background		N	%
Gender	Male	109	27.3
	Female	291	72.8
	Total	400	100
Races	Malay	290	72.5
	Chinese	10	2.5
	Other	100	25.0
	Total	400	100
Ages	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

Table 6. Compatibility Test of the Use of Factor Analysis and Item Uniformity of KMO and Bartlett's Test on the Construct of

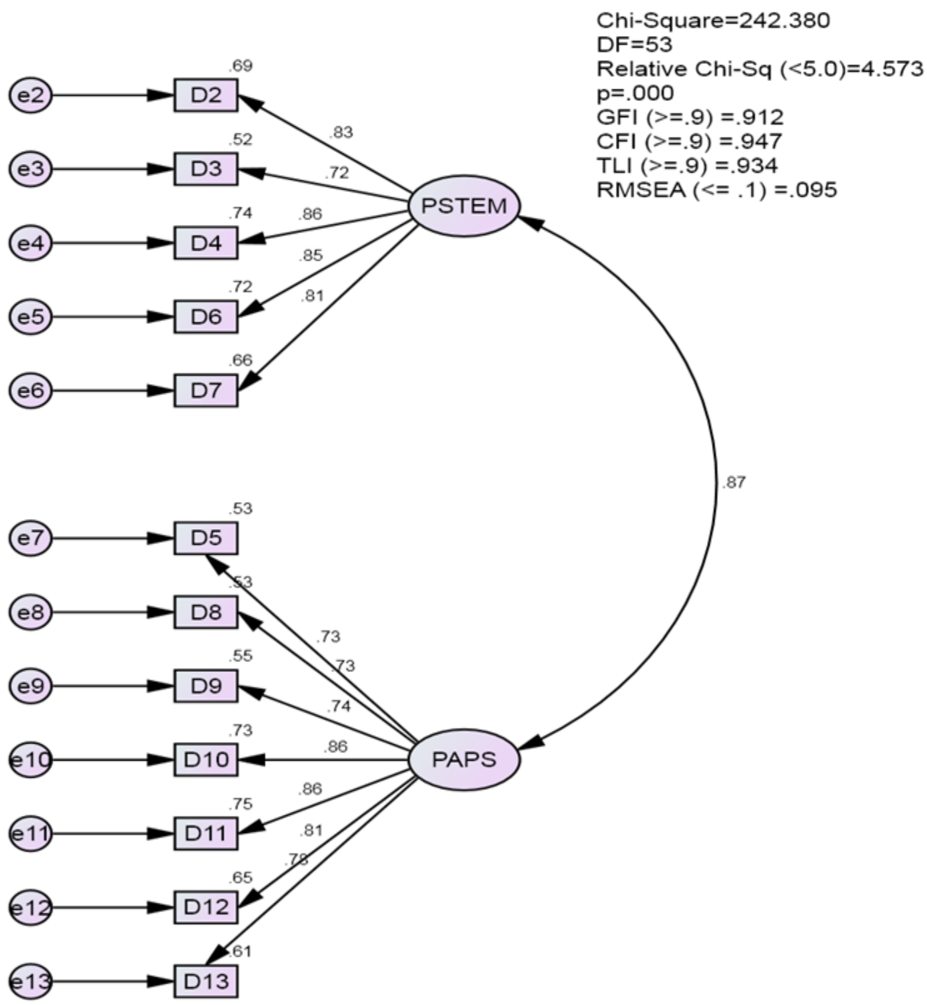
Kaiser-Meyer-Olkin	*A measure of Sampling Adequacy*	0.945
Bartlett's Test of Sphericity	*Approx. Chi-Square Sphericity*	4142.996
	df	78
	Sig.	0.000

component matrix with varimax rotation. The varimax rotation method was performed as it can reduce the number of complex constructs and increase the expected outcome. The results showed that the D1 items were dropped for having an 'anti-image correlation matrix' of less than 0.5. The values of D2, D3, D4, D6, and D7 belonged to component 1, which was STEM knowledge, and D5, D8, D10, D11, D12, and D13 were accumulated in component 2, which was application knowledge. The values shown in Table 4.6 are the coefficient or the loading factor for each item that tends to each factor accumulated. This value shows the correlation relationship between the item and the factor formed, which is the key to understanding the nature of these factors. Next, the CFA was conducted to confirm the results obtained from the EFA. This shows that every item built, except item D1, can measure the knowledge of geography STEM education, as Bybee (2010) mentioned that every STEM education matter should be measured towards a more specific field. This statement is also supported by the framework of Hudson, English, Dawes, King, and Baker (2015). They state that planning, timetables, teaching strategies, knowledge content, problem-solving, and classroom management are the elements and measurements in STEM.

Confirmatory Factor Analysis (CFA) of Geography STEM Education Knowledge

Table 7. Component Matrix with Varimax Rotation of STEM Education Knowledge Construct

Item	Component	
	STEM Knowledge	Applied Knowledge
D2	.876	
D3	.663	
D4	.739	
D6	.725	
D7	.650	
D5		.547
D8		.603
D9		.761
D10		.810
D11		.818
D12		.750
D13		.752



Legend:
PSTEM : STEM Knowledge
PAPS : Applied Knowledge

Figure 1. Second-Level Confirmatory Factor Analysis Model of STEM Knowledge

Construct

After EFA, CFA was performed using the AMOS 20 software to determine the model of CFA for the first and second levels of STEM knowledge. Figure 1 shows the second-level CFA model of geography STEM education knowledge that achieved good compatibility accuracy. This model is a combination of all dimensions of the STEM knowledge construct maintained in the first-level analysis. The model analysis in Figure 1 shows that the model reached a good level of compatibility based on the determined indicator (CMIN = 242.380, DF = 53, CMIN/DF = 4.573, p = .000, GFI = .912, CFI = .947, TLI = .934, RMSEA = .095).

Among the STEM knowledge acquired by the respondents was knowing the characteristics of the T&L of STEM education. STEM education could open the mind to identify global-related issues, and the respondents needed to know how to conduct investigations through inquiries and form the knowledge of building prototypes. Next, as for the STEM knowledge applications, respondents were required to have application knowledge of the use of quantitative methods, repeat the invention process to improve product results, explain the phenomenon that occurs in an easy-to-understand way, analyze data, present information, describe the results of the invention, and communicate confidently. Overall, it can be seen that the aspects contained in the geography STEM education knowledge include two components: STEM knowledge itself and STEM application knowledge in daily life. Therefore, the knowledge related to STEM education and STEM application knowledge plays an important role in improving students' high-level thinking skills.

Exploratory Factor Analysis (EFA) of Geography STEM Education Skills Construct

Table 8 shows the results of the EFA on the measurement tools of STEM education skills, and the anti-image correlation analysis procedure revealed that the value of the correlation coefficient was greater than 0.5, demonstrating that the factor analysis could proceed. The sampling adequacy measurement of KMO and Bartlett's Test of Sphericity showed that the KMO value was 0.939, and Bartlett's Test of Sphericity was significant with a chi-square value of 3323.826 at the degree of freedom of 66.

A factor analysis was performed by the researcher to determine the number of factors to be extracted, but for the STEM skills part of the questionnaire, there was no sub-construct division in the questionnaire. Table 9 shows the component matrix with varimax rotation. The varimax rotation method was performed because it was able to reduce the number of complex constructs and increase the expected outcome. The results showed that the K2, K3, K7, and K8 items were dropped for having an anti-image correlation matrix of less than 0.5. The values of K1, K4, K5, K6, K9, K10, K11, and K12 belonged to one component representing the students' STEM skills. The values shown in Table 4.6 are the coefficients or the loading factor for each item that tends to each factor accumulated. These values show the correlation relationship between the item and the factor formed, which is the key to understanding the nature of these factors. Next, the CFA was conducted to confirm the results obtained from the EFA. This finding was a parallel to a study that found that STEM education applied group work activities. Group or team learning activities in the classroom have had a positive impact on student communication skills. In other words, student communication skills can be enhanced through student activities carried out in groups throughout the study period. The learning technique performed in the learning process determines the learning achievement. A study conducted by Stewart and Knowles (2000) in the United Kingdom found that the skills emphasised were communication and management skills, teamwork, knowledge, ideas, and the ability to learn. According to Zurina (2004), communication is an important tool in strengthening the relationship between group members. In addition, skills such as computer skills, communication skills, language skills, interpersonal skills, flexibility, adaptability, analytic skills, initiative, leadership, self-esteem, and teamwork are among the key assets in today's work market and industry in Malaysia (Zainudin et.al, 2005).

Table 8. Compatibility Test of the Use of Factor Analysis and Item Uniformity of KMO and Bartlett's Test on Students' STEM Skills Construct

Kaiser-Meyer-Olkin	*A measure of Sampling Adequacy*	0.939
Bartlett's Test of Sphericity	*Approx. Chi-Square Sphericity*	3323.826
	df	66
	Sig.	0.000

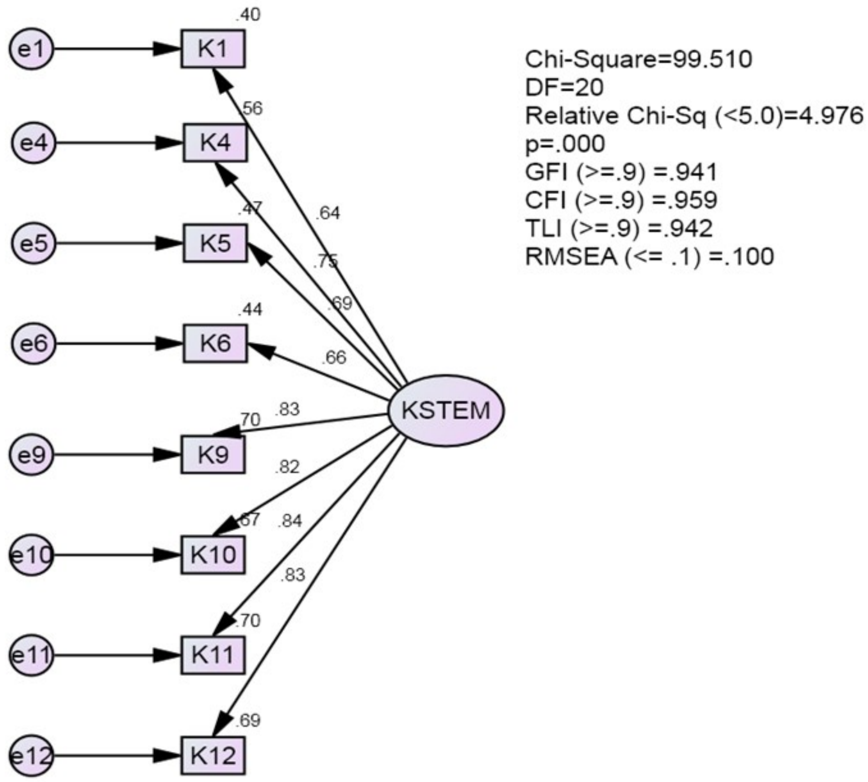
Table 9. Component Matrix with Varimax Rotation of STEM Skills Construct

Item	Component
	STEM Skills
K1	.732
K4	.789
K5	.726
K6	.720
K9	.814
K10	.788
K11	.847
K12	.832

Confirmatory Factor Analysis (CFA) of Geography STEM Education Skills Construct

After EFA, the CFA was performed using the AMOS 20 software to determine the first and second levels of the CFA model of the students' STEM skills. Figure 2 shows the second level of the CFA model of the STEM skills constructs, which achieved good matching accuracy. This model is a combination of all dimensions of the STEM skills construct maintained in the first-level analysis. The model analysis in Figure 2 shows that the model formed reached a good level of compatibility based on the determined indicators (CMIN = 99.510, DF = 20, CMIN/DF = 4.976, p = .000, GFI = .941, CFI = .959, TLI = .942, RMSEA = .100).

The STEM module indirectly created a skill that helped



Legend:
KSTEM: STEM Skills

Figure 2. Second Level of Confirmatory Factor Analysis Model of the STEM Skills

students to think critically and rationally. The findings showed that the respondents were curious about the problems that occurred and finding the source and solutions in dealing with the subject; able to use quantitative methods in learning; skilled in the use of computing, developing a model/prototype, analysing, and presenting data; and able to explain in detail and handle the equipment in the right way. A study by Prinsley and Baranyai (2015) on employers' perceptions of those with STEM qualifications, including the attributes and skills possessed in the field of work and workplace value by STEM graduates as well as expectations of STEM graduates for future needs have been implemented. The results of previous studies also show that 15% of the working age population has STEM qualifications, whether in the form of certificates or other academic qualifications. From 2006 to 2011, the number of employees required in the STEM field increased by one fifth of the number of other employment groups. This suggests that foreign countries are able to take full advantage of STEM education and innovation comprehensively (Prinsley & Baranyai, 2015).

The EFA and CFA results showed that centralised validity and discriminant validity can be achieved in this study. The EFA results showed that there were two components of geography STEM education knowledge that had been developed, namely STEM knowledge and application knowledge, while there was only one component for geography STEM education skills. In addition, through this analysis, there were items that had been dropped, where out of 25 initial items built by the researchers, a total of 12 items were accepted to obtain a good compatibility index. Another item was dropped from the geography STEM education knowledge construct with compatibility values of CMIN = 242.380, DF = 53, CMIN/DF = 4.573, p = .000, GFI = .912, CFI = .947, TLI = .934, and RMSEA = .095, in compliance with the conditions determined. For the construct of geography STEM education skills, eight items were accepted to achieve a good compatibility index, while four items were dropped from the construct of geography STEM education skills with the compatibility values of CMIN = 99.510, DF = 20, CMIN/DF = 4.976, p = .000, GFI = .941, CFI = .959, TLI = .942, and RMSEA = .100, in compliance with the conditions determined. Overall, the knowledge and skills model of geography STEM education generated from this CFA process can be used to measure the level of knowledge and skills in climatic geography STEM education of prospective teachers. The production of knowledge and skills of geography STEM education through the model generated in the CFA process among the UPSI student respondents was also timely, because this group will share STEM information as administrators, thinkers, and educators once they start working.

Conclusion

STEM education focuses on real-world issues and problems. Students are required to identify the issues in social, economic, and environmental dimensions as finding the right solutions. STEM learning develops thinking, reasoning, rationalization, teamwork, investigation, and creative skills that students need to apply in every aspect of life. The study conducted directly on prospective Geography teachers who are the main characters to apply this STEM element is very much in line with the government's recommendations. The EFA and CFA analysis results have successfully identified items required of STEM Knowledge and STEM Skills in the context of Geography. Future research should focus on STEAM elements with the addition of artistic elements to empower students to be curious learners who seek creative solutions to real-world problems, which will help them develop the soft and hard skills needed to succeed in college, their careers, and wherever else life takes them.

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