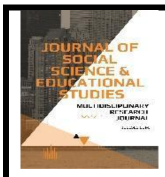

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FUZZY DELPHI ANALYSIS OF THE MAIN CONSTRUCT OF PROJECT-BASED STEM TEACHING MODEL BY IMPLEMENTING RAPPORT ELEMENTS FOR MATHEMATICS PRIMARY SCHOOL

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ABSTRACT

Rapport element is an important element which need to be implemented in teaching and learning process of mathematic in primary schools. The main focus of implementing rapport elements in teaching and learning process is to increase students' motivation and achievement especially for mathematic in primary schools. This research aimed to identify the main constructs of project-based STEM teaching model by implementing rapport elements for mathematic primary schools. The samples involved 15 experts of university's lecturer, the teacher's training institute (IPG) lecturers, and SISC+ officers in a District Education Office (PPD). The sampling technique used in this research was a purposive sampling and it has qualified all the requirements needed. The data were analyzed using the Fuzzy Delphi Method (FDM). The findings of this study have produced the main constructs for project-based STEM teaching model by implementing rapport elements for mathematic primary schools and the order of priority of those constructs.

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INTRODUCTION

The implementation of various reinforcement strategies is improving from time to time in order to prepare a student to face the reality and career in future. One of the aspects which has been highlighted in Malaysia Education Blueprint (2013-2025) is the educational transformation of Science, Technology, Engineering and Mathematic (STEM). It is the continuation of the first wave which emphasized the quality of STEM reinforcement including curriculum reinforcement aspects, teacher's assessment and training, and the development of various modes teaching model (Kementerian Pendidikan Malaysia, KPM, 2018)

STEM Literacy Education was first introduced in Malaysia in 2014 and it is in line with the needs of the current modern and fast -paced world of education. According to Fazilah, Umi, Othman and Siti (2020), the process of integrating STEM teaching and learning has now become the focus of the Ministry of Education through teacher training and courses to ensure that the knowledge that will be implemented can be well delivered. Teacher is the most important individual to assist the aspiration of changes in education transformation of the country. The characteristics of a quality teacher are when teachers successfully explored the potential and abilities of students through a variety of teaching and learning approaches, creating a variety of teaching aids appropriate to the topics to be taught, able to produce excellent students academically, as well as in co-curricular, attitude and spiritually, able to solve problems creatively and critically, good in technology, and carry a good leadership (Nasurdin, Norazlin & Siti Rahaimah, 2018). A quality teacher will be able to plan teaching and learning process creatively and innovatively in order to produce interesting teaching aids and methods, in line with the Ministry of Education initiative which emphasized the 21st Century Learning (PAK21) towards producing knowledgeable and highly-skilled students to compete in the international level (KPM, 2018).

LITERATURE REVIEW

Mathematic is one of the subjects in STEM elements which was introduced in the Malaysia Education Blueprint. Being able to understand and mastering the number concepts and basic calculation skills are the core integration in order to ensure students mastery and maintain their interest in the subject from primary to higher level. The announcement of Malaysia Education Blueprint has emphasized on the improvement of quality aspects in Malaysia's STEM education. Among the STEM initiatives vision which has been introduced by the Ministry of Education (MOE) is to make Malaysia as a country with qualities and sufficient human capitals in STEM field in order to spur the country's development and economy in the future (KPM, 2018).

To realize the aspiration and vision, MOE has initiated measures to achieve the aspirations which aimed to increase student's interest in STEM through variety of learning approaches in or outside the classroom, increase the teacher's knowledge, skills and abilities in carrying out the STEM education through the teacher's competencies development program, and increase students and people awareness via STEM education awareness campaign in different levels (Halim, 2018). The integration of STEM education in school is able to provide an open opportunity to the teachers and students in exploring a friendlier education approach in order to improve the student's creativity and critical thinking in producing projects in mathematic subject (Aini Aziziah et al., 2017). The STEM education also emphasizes the 4C competency-based concepts, which are Communication, Collaboration, Creativity,and Critical thinking which contained in the main elements of 21st Century Learning (PAK21). The STEM education also emphasizes the 4C competency-based concepts of Communication, Collaboration, Creativity and Critical Thinking which are contained in the key elements of 21st Century Learning (PAK21).

Hence, mathematic subject on 21st century in Malaysia should be integrated with knowledge and implementation of 21st century skills, to ensure the students are able to master the knowledge, skills and positive moral values, and to achieve the requirement needed in facing the occupation fields and 21st century social environment. Therefore, the teaching models used in teaching and learning process should be based on the PAK21 elements (4C) and values integrated with STEM which is more practical and authentic. Among the approaches with PAK21 elements is through the Project-Based Learning (PBL) (KPM, 2018). PBL applied the 5E Model elements which are *Engagement*, *Exploration*, *Explanation*, *Elaboration* and *Evaluation* can be implemented in the teaching model in order to cater the needs and able to produce a more effective teaching and learning process (Siti Nabila, Muzirah Musa, Fainida Rahmat, Nurul Akmal, & Nor Azian, 2019).

PBL is an effective teaching practice which can be implemented since primary school (Leung, 2020). According to Nasurdin, et al. (2018), the usage of multiple approaches in learning able to help the students to understand the learning contents better and increasing their motivation to learn in the classroom. PBL with active learning elements and students-centred approaches can help in expanding the 21st century skills, such as creativity and critical thinking skills to generate ideas in order to produce related products or projects. Authentic tasks are also a feature of the STEM Learning process produced by students. It is able to help the students to implement newly acquired knowledge with prior knowledge, to help students to analyze data and information in the process of generating ideas and learning (Zakiah, Saomi, Syara, Hidayat & Hendriana, 2018).

The 5E Model is one of the suitable teaching models to be implemented in PBL (Jiuhua, Chong & Yang, 2017). The 5E Model is the teaching model that was suggested in the STEM integration in school through the Malaysia Education Blueprint 2013-2025 (KPM, 2018). The 5E Model is potentially able to change the conventional teaching approaches and give the students opportunities to explore and gaining knowledge as much as possible (Jiuhua et al., 2017). This model is also able to stimulate and help the teachers to use the student's prior knowledge and help the students constructing new knowledge, subsequently increasing the student's motivation during the learning process in the classroom.

Besides 5E Model, Gullapyan Model will also be integrated in the project-based STEM teaching model by implementing rapport elements to strengthen the developed teaching model. Gullapyan Model (2020) is a teaching model that was built by Gullapyan in the year 2020, which contained 4 main steps, such as 'get to know the students', 'classroom environment', 'execute the teaching strategies or methods', and students' involvement. This model emphasized on the needs of implementation rapport element in three main aspects which are, cognitive, behavioural, and affective aspects during learning process. This model is also able to help students in improving their motivation and achievements due to the existence of implementation of rapport element in the classroom environment (Gullapyan, 2020; Jumiran, Masri, Adnan & Tahir, 2022). This is in line with the research findings by Fazilah, Umi and Ahmad Fauzi (2020), that shown implementation of rapport element can increase the students' achievements in academic, emotion, social and behaviour.

The implementation of rapport elements among students is very useful quality skill for the students who are involved in mathematic learning, and played an important role in obtaining the desired results from the learning process in the classroom (Fredricks, Filsecker & Lawson, 2016; Gopal, Salim & Ayub, 2019). This element has a significant relationship with achievement, performance, learning outcomes, endurance, achievement and attendance, and students' adherence in the classroom to mathematic subject (Fredricks et al., 2016, Sherno et al., 2016). The implementation of rapport elements is also can be referred to a students' psychological approach which brought it to learning process, and to gain more knowledge, skills or abilities (Eccles & Wang, 2012; Razali, Sulaiman, Ayub & Majid, 2022). Jumiran et al. (2022), Lam et al. (2014), Wang and Holcombe (2010) stated that the implementation of rapport elements is not just a commitment, students involvement or participation, but it involved their feelings and emotions during learning process.

Therefore, a guideline is needed by teachers in order for it to be used as an overall reference to plan and implement the teaching process in the classroom. There are many studies related to the determination of the usability of teaching model which was developed in improving the learning process in the classroom (Nurulrabihah, 2020; Abdul Muqsith, 2018; Mohd Ridhuan, 2016). Research findings by Nurulrabihah (2020) proved that the usage of computational thinking teaching model developed in the study can assist teachers in planning the teaching process in order to ease the students learning process. Besides, the research done by Abdul Muqsith (2018) also showed that the model was practical and suitable to be used as a reference by the educators, and gave an impact to the students learning process. For example, the research done by Mohd Ridhuan (2016) showed that the model that was developed was able to improve the skills and values of the students from the engineering course program. The research findings that were discussed showed that the usage of the model was successfully helping in a smooth teaching and learning process. Hence, the findings are clearly show that the development of systematic teaching model is able to be a reference for the teachers in planning and performing the project-based STEM teaching model by implementing rapport elements for mathematic primary schools.

METHODOLOGY

This research adopts Fuzzy Dephy Method (FDM) which has been chosen based on the debates mentioned by Nurulrabihah Mat Noah, Saedah Siraj, Siti Hajar Halili, Mohd Ridhuan Mohd Jamil, and Zaharah Husin (2019), said that the FDM can be useful in collecting expert's consensus as regards to the research problems. The sample of this research involved 15 experts as suggested by Adler and Zigler (1996). The research instrument that has been used and distributed to experts is a set of questionnaires consisting of 5 constructs. In implementing FDM, the constructs that have been amended after an interview session with the experts involved will be selected and arranged. This amendment also has considered the results of the analysis of literature reviews that have been done.

The next process was the process of obtaining approval from a group of experts to contribute their expertise in providing relevant ideas and proper improvisation of the construct elements that have been proposed. The 15 selected experts are comprised of university lecturers, lecturers from Teacher Training Institute (IPG) and the SISC+ officers in a District Education Office (PPD). The questionnaire instruments were distributed to the experts physically as well as via email containing the main constructs that had been agreed and improved. These experts were requested to state their level of agreement upon the items using a 7-point Likert Scale, *Sangat-sangat Setuju/ Strongly agree, Sangat Setuju/ Likely agree, Setuju/ Agree, Sederhana Setuju/ Moderate agree Tidak Setuju/ Disagree, Sangat Tidak Setuju/ Likely disagree, and Sangat-sangat tidak setuju/ Strongly disagree.* The collected data was transformed into fuzzy number and being analysed by using the Microsoft Excel.

Sampling Method

According to Ocampo, Ebisa, Ombe and Geen Escoto (2018), the number of subject experts does not need to be large as there is no strong relationship between the number of experts and the quality of consensus to be gathered from the group discussions. Therefore, 15 subject experts have been chosen based on the suggestion of Adler and Ziglio (1996) and Jones and Twiss (1978). Based on Adler and Ziglio (1996), the suitable number of experts is in between of 10 to 15, and if there is a high uniformity among the chosen experts. Other than that, the chosen experts are needed to fulfil the requirements by having the related educational background with their research as well as able to support the research idea on achieving the consensus among the experts (Pill, 1971). The experts are chosen based on following features:

a) Involving the mixture of many experts from various group of skills under the heterogenous group (Somerville, 2007).
b) Having knowledge on their respective studies (Swanson & Holton, 2009) which at least having master of Mathematics, STEM or Educational Psychologist
c) Experience in their respective research, the experts must have experience in their respective research for at least 5 years (Berliner, 2004).
d) The experts are able to commit until the research is done implemented.
e) The experts do not work for their own self- interest while doing the research. This is to avoid any biasness while doing the research.

Table 1 show the profile of expert

Table 1. *List of Expert in Fuzzy Delphi Method*

Expert	Academic Qualification	Expertise	Experience
E1	Doctor of Philosophy	Professor Expert in Mathematics Education at Public University	26 Years
E2	Doctor of Philosophy	Senior Lecturer Expert in Mathematics Education at Public University	23 Years

E3	Doctor of Philosophy	Lecturer Expert in Mathematics Education at Teachers Training Institute	24 Years
E4	Doctor of Philosophy	Lecturer Expert in Mathematics Education at Teachers Training Institute	18 Years
E5	Doctor of Philosophy	Lecturer Expert in Mathematics Education at Teachers Training Institute	25 Years
E6	Doctor of Philosophy	Lecturer Expert in Mathematics Education at Teachers Training Institute	22 Years
E7	Doctor of Philosophy	Officer Expert in Mathematics Education at Teachers Training Institute	11 Years
E8	Masters	Excellent Lecturer Expert in Mathematics Education at Teachers Training Institute	22 Years
E9	Doctor of Philosophy	Senior Lecturer Expert in STEM Education at Public University	13 Years
E10	Doctor of Philosophy	Lecturer Expert in STEM Education at Teacher Training Institute	25 Years
E11	Doctor of Philosophy	Senior Lecturer Expert in Educational Psychologist at Private University	27 Years
E12	Doctor of Philosophy	Lecturer Expert in Educational Psychologist at Teachers Training Institute	30 Years
E13	Doctor of Philosophy	Lecturer Expert in Educational Psychologist at Teachers Training Institute	23 Years
E14	Doctor of Philosophy	Lecturer Expert in Educational Psychologist at Teachers Training Institute	23 Years
E15	Masters	SISC+ Officer Expert in Mathematics Education at District Education Office	24 Years

RESEARCH FINDINGS AND DISCUSSIONS

The Fuzzy Delphi consensus over the main constructs for project-based STEM teaching model with the implementation of rapport elements for mathematic primary schools will be discussed as in the following.

Table 2. *The Main Construct of The Project-Based STEM Teaching Model by Implementing Rapport Elements for Mathematic Primary*

No	Main Construct
1	Learning Objective
2	Learning Activities
3	Evaluation
4	Reflection
5	Rapport

Table 3 shows the threshold value (d), the percentage of consensus from the expert, defuzzication and ranking of the item.

Table 3. *The Threshold Value (d), The Percentage of Consensus from The Expert, Defuzzication and Ranking of The Item for The Main Construct of Teaching Model.*

EXPERT	**MAIN CONSTRUCT**				
	1	**2**	**3**	**4**	**5**
E1	0.076	0.031	0.066	0.112	0.020
E2	0.078	0.031	0.066	0.041	0.132
E3	0.318	0.122	0.327	0.041	0.020
E4	0.076	0.031	0.066	0.041	0.020
E5	0.078	0.031	0.066	0.041	0.020
E6	0.076	0.031	0.066	0.041	0.020
E7	0.076	0.031	0.066	0.041	0.020
E8	0.076	0.031	0.066	0.041	0.020
E9	0.076	0.031	0.066	0.041	0.020
E10	0.078	0.031	0.088	0.041	0.020
E11	0.078	0.031	0.066	0.041	0.020
E12	0.076	0.031	0.066	0.041	0.020
E13	0.078	0.122	0.088	0.112	0.132
E14	0.076	0.122	0.088	0.112	0.020
E15	0.076	0.031	0.088	0.112	0.020
Threshold Value (d) for each construct	0.093	0.049	0.089	0.060	0.035
The expert's consensus (%)	93	100	93	100	100
Ranking (item)	5	2	4	3	1

Based on Table 3, all the threshold values of construct (d) are below the threshold of 0.2, which indicates that the items have been agreed by the expert. Nurulrabihah (2020) states that if the average value and expert consensus is less than the threshold value, 0.2, then this indicates that the expert has agreed upon the matter under study. The percentage of the expert's consensus showed that all the items has exceeded 75%. All the defuzzification values for each item also have exceeded α-cut = 0.5 value. This showed that each construct is important as the main construct in developing the project-based STEM teaching model by implementing rapport elements for mathematic. The main construct is organized based on the importance as shown in Table 4.

Table 4. *Ranking for Main Construct*

No	Main Construct	Rank
1	Learning Objective	5
2	Learning Activities	2
3	Evaluation	4
4	Reflection	3
5	Rapport	1

The table 6 shows the score value of defuzzification (fuzzy score) for each construct for the project-based STEM teaching model with the implementing of rapport elements for mathematic primary schools. Based on the defuzzification score value shows the ranking for each construct that needs to be prioritized by the experts in carrying out of the project-based STEM teaching model by implementing rapport elements in teaching mathematic.

Table 5. *Main Construct Based on Fuzzy Score Evaluation*

Rank	Main Construct	Fuzzy Score Evaluation
5	Learning Objective	0.916
2	Learning Activities	0.947
4	Evaluation	0.922
3	Reflection	0.940
1	Rapport	0.953

The result of the defuzzification score value for each main construct of the teaching model showed that all the presented constructs are accepted by all the experts. Table 5 shows that the construct on the development of rapport is ranked at first with 0.953 defuzzication score, followed by the learning activities with its fuzzy score at 0.947 that is ranked at second. The third place is reflection at 0.940. Next, the evaluation with the fuzzy score of 0.922 is placed at fourth. The fifth place is the learning objective with fuzzy score of 0.916.

The results of the analysis showed that the ranking of the main constructs is based on the agreement that are given by the experts. The ranking of the constructs is given as below:

1. Rapport
2. Learning Activities
3. Reflection
4. Evaluation
5. Learning Objective

Based on the defuzzication score analysis, rapport construct had the highest defuzzication score value. The research findings had further strengthened the research done by Thien and Ong (2015), Thien and Darmawan (2016) and Jumiran et al., (2022) about what can PISA 2012 data tell us? According to the research, the implementation of rapport element in learning process was able to improve the student's achievement especially in mathematics. The implementation of rapport element gave advantages to the students to construct their own new knowledge based on their prior knowledge and produced new ideas. The research findings supported the constructivism theory which used students' prior knowledge to relate it with the new knowledge that was constructed in the classroom (Lee & Hannafin, 2016; Wachira Srikoom & Chatree Faikhamta, 2018).

Learning activities's construct was placed the second. Based on the experts' view, this construct is very important in the project-based STEM teaching model by implementing rapport elements in teaching mathematic. This is because, suitable arrangement and selection are very important in learning process. Therefore, the researcher thinks that arranging and selecting activities from the process of searching information to finding solution of mathematics with wisdom is very important so that the students able to acquire meaningful knowledge and suitable to the latest learning context. This construct is extremely important because it can educate and train students to stimulate their creativity and critical thinking, and increase the ability to complete the mathematic project task (Seyedh et al, 2017). Through the learning activities, it's also able to increase the student's involvement during learning process in the classroom and able to improve the achievements and 21st Century skills (Azlida, Tajularipin & Ahmad Fauzi, 2023).

Next construct which is on the third place is reflection (giving and receiving responses related to Strength, Weakness, Opportunity, and Threat). When we talk about reflection construct, the aspect of collaboration was unavoidable. In the project-based STEM teaching model by implementing rapport elements in teaching mathematic, the students will interact with peers and teachers who acted as facilitator. They were not only practise social skill in solving the mathematic task given, but also gaining related technical skill to be used in problem solving, designing and decision making (Hamdi Serin, 2019). Therefore, teachers must always do reflection to improve in order to expand students' knowledge, skills, and attitude towards collaborative learning and lifelong learning.

Assessment construct is on the fourth place. This construct is related to cognitive process which given the opportunities to assess the student's development and knowledge. Through the assessment construct in project-based STEM teaching model, students able to solve the mathematic problem-solving task creatively without solely bonded to any memorizing process in order to produce suitable project to cater the current needs (Nasurdin et al., 2018). Finally, the teaching objective construct is on the final place. In 21st Century Learning, students' prior knowledge must be considered in a planned objective to ensure that they will be able to construct new knowledge in order to solve the given mathematics problem (Fazilah et al., 2020). The students must also be given the opportunity to explore ideas together in a group and to cooperate in providing meaningful solution in the context of mathematics problem-solving in the real world.

Therefore, in reference to the assessment process, the panel of experts agreed to select building rapport, teaching activities, reflection, assessment and teaching objective constructs as the main constructs in the project-based STEM Teaching Model with the implementation of rapport element in primary school mathematics.

CONCLUSION AND RECOMMENDATION

This research shows that the rapport element is an important element that need to be implemented in the teaching and learning process of STEM by applying a project-based for mathematics primary school. Furthermore, the teachers need to implement the rapport element in three main aspects, namely cognitive, affective and behaviour during the learning process to stimulate the creativity as well as to encourage the involvement of the students in the classroom. Along with that, the vision and mission of MoE that focused on the competency concept of 4C, communication, collaborative, creativity and critical thinking that are among the main elements of the 21-st century learning (Azlida et al., 2023). Therefore, the school's curriculum is important to prepare the students with skills and knowledge that are needed to reduce the discrepancy in the process of learning among the students. Hence, the main constructs that are prepared in this research is useful as the guidelines for the mathematics' teachers at primary school to plan and implement the project-based STEM teaching model by implementing rapport elements in teaching mathematic.

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