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Research Article

Development Of a Pattern Learning Module for Early Mathematics Based on Flipped Classroom with Augmented Reality

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Abstract: The topic of pattern in early childhood is commonly regarded as easy, but little research has been done on students' mastery level at a deeper level. Students' inability to master the topic of the pattern will affect their performance in the subject when they are required to manipulate and apply this knowledge at a higher level. This research is done to develop a module called EM-Flip which intends to increase students' understanding of the topic of pattern in Early Mathematics based on Flipped classroom concept, using the application of Augmented Reality in TADIKA. 120 teachers and parents, and 25 students from TADIKA around Petaling Jaya, Selangor, Malaysia were involved as respondents in this study. The method used for this study is a combination of five stages of the ADDIE model and three phases of Design and Development Research (DDR) using the Fuzzy Delphi Methodology through a consensus from 10 field experts. Overall, the research found that there is a gap between students' mastery in the topic of pattern which is students are more likely to master the practice on easy sequencing pattern as compared to additional sequencing pattern. The analysis of the results uncovers a few significant findings: teachers need a more interactive module, students' creativity is still under-developed, and there are challenges in terms of the support from surrounding and parents at home. This, therefore, proved that the use of EM-Flip Module that integrates the interactive element with the Flipped classroom concept is crucial in the education setting nowadays.

Keywords: Flip classroom, Augmented Reality, Fuzzy Delphi Technique, pattern, interactive.

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1. Introduction

The issue of early childhood education in Malaysia is getting more and more attention today. It is common knowledge that quality education should be implemented and emphasized from an early stage and not just given attention when students need to sit for an important examination.Student's achievement in the subject of Mathematics is closely related to student's mastery of learning Early Mathematics while in kindergarten. Failure to master these basic concepts will have a huge impact on them while continuing learning at the primary and secondary school levels. Memorized teaching techniques need to be given a new lease of life by recognizing the abilities of students to be helped by teachers so that learning sessions become interesting and effective and students can apply the methods of Mathematics in their daily lives.In this study, Constructivism theory is used as the basic theory of study because Constructivism can be expressed as a process in which a person builds his understanding of a knowledge that has been imparted to him by using experience and knowledge adapted by him (Saunders, 1992).The Theory of Cognitive Development by Jean Piaget is a branch of the Theory of Constructivism. According to Jean Piaget (1970), children aged 5 to 6 years in the pre-operational phase will be more likely to solve the simplest Mathematical problems such as the concept of 4 by 2 addition operations.Among the latest teaching methods mentioned in PPPM 2013-2025 is the teaching method through the concept of Flipped Classroom. Through the expansion of this method at the preschool level, the government is focusing on teaching and learning strategies (T&L), classroom layout, and parental involvement in the student learning process.The addition of technological elements in the concept of a flipped classroom is also able to increase the percentage increase in the mastery of Early Mathematics. Therefore, in this study, this Early Mathematics module focuses on one of the topics in Early Mathematics which is patterns. Researchers integrated the teaching of Early Mathematics using the concept of Flipped Classroom alongside the Augmented Reality application.

2.Significance Of The Study

Undoubtedly, the subject of Mathematics is indeed difficult to learn, but with this appropriate teaching approach all children at an early stage are able to improve their achievement (Clarke, Baker, & Chard, 2007; Doabler, 2011). The current technological boom is undeniable and includes its impact on the world of education.

The injection of technological elements and the use of the internet in education are among the things that are given attention (Naquiah Nahar, 2017). Technology in education needs to be integrated as a mechanism for the delivery of teaching and learning to children (Wan Anita &Azizah, 2013).The modules that have been developed place more emphasis on manual learning using the question-and-answer method of several sets of questions. This drill focuses on how students can understand teaching and learning sessions well to strengthen students with learning sessions in the classroom.There are also several software and applications sold in the market for children to explore the learning of the subject. However, the best teaching materials implemented in applications that are on the market must be interactive, meet and in line with the curriculum in the school, and then be able tocontributes to student learning objectives (Nor Aizal, 2015; Nooriza and Effandi, 2015).

3.Review Of Related Studies

Analysis of previous studies using meta-analysis shows that there are researchers who use the DDR approach combined with several instructional design models such as the ADDIE model.A study on the design and development of educational multimedia Course Software Seksualiti Malaysia (MSE) has been conducted by **Azizah (2009)**. **Mohamad, Muslimin, Norazah, Ahmad Zamri and Pajuzi, (2016)**conducted study on design and development of mobile learning applications for microeconomic. **Aliza (2017)** conducted a study on the development of arthis interactive module in teaching and learning art history. Among other studies that have been carried out related to the title of the pattern is the knowledge of kindergarten children about the beginning of fractions**(Siong Peng, Wan Kamsiah, Noraini, 2012)**anda study on the awareness of the importance of mastering pattern titles in early childhood conducted by **Sharifah NorulAkmar and Nor Adlina(2014)**.**Abdul Sani, Norshafinaz; Yunus and Faridah (2018)**conducted study on the practice of planning, implementation and assessment in the teaching and learning process of renumerationin private kindergartens.Undoubtedly some modules that combine the use of AR applications and the use of AR applications in education have been proven to have a positive impact on student learning and the use of Augmented Reality can improve students' visualization abilities **(Ramli, M. F., & Musa, R., 2020).**

4.Objectives Of The Study

- To identify the needs for pattern learning module for Early Mathematics to improve teaching and learning skills with the concept of Flipped Classroom using augmented reality.
- To design and develop pattern learning modules for Early Mathematics to enhance teaching and learning skills with the concept of Flipped Classroomusing augmented reality.
- To implement a pattern learning module for Early Mathematics on teachers, students, and parents to obtain the validity and reliability of the Flipped Classroomconceptual module using augmented reality.
- To evaluate the effectiveness of the use of pattern development modules for Early Mathematics to improve teaching and learning skills with the concept of Flipped Classroomusing augmented reality.

5.Population And Sample

The population includes prospective teachers of Petaling Jaya, Selangor. This research involved a total of 120 respondents from teachers and parents with 25 students in Petaling Jaya. They were selected by a purposive sampling technique.

6.1.Statistical Techniques Used in the Present Study

Descriptive statistics (mean and frequency) with analysis of student achievement records were used to analyze the data. Fuzzy Delphi Method (FDM) were used to design and develop the learning module.

6.2.Data Analysis and Interpretation

Table.1.showing the main items of the EM-Flip module based on the FDM analysis that has been implemented to obtain the percentage of expert consensus.

Rules Shape	Triangular Fuzzy Numbers		Fuzzy Evaluation				Accepted / Not Accepted	Ranking
	Threshold, Value, d	Expert Consensus, %	m1	m2	m3	Fuzzy Score (A)		
Shape	0.115	100.0%	0.786	0.929	0.986	0.900	Accepted	1
Colour	0.156	100.0%	0.757	0.900	0.971	0.876	Accepted	2
Alphabet	0.208	87.5%	0.643	0.814	0.929	0.795	Accepted	4
Object	0.192	100.00%	0.729	0.871	0.957	0.852	Accepted	3

Interpretation of table-1

The Delphi Fuzzy technique has conditions that must be met to accept the sub-components that have been listed:

a) Triangular *Fuzzy* Numbers
- Threshold value (d) ≤ 0.2
- Percentage of the experts' consensus ≥ 75.0%

b) Defuzzification Process
- Fuzzy Score (A) ≥ α – cut = 0

At this stage, there are five items listed and the threshold value results show only four pattern order type items that comply with the first condition of Triangular Fuzzy Numbers. They are shape (d = 0.115), colour (d = 0.156), alphabet (d = 0.208) and object (d = 0.192). The fourth item (number) was removed from the content component.

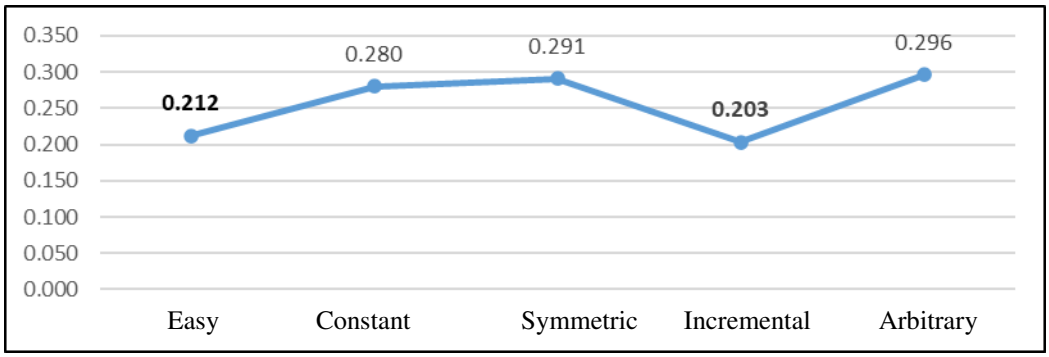
Table.2.showing thedimension type findings items based on expert consensus and fuzzy scores.

Sub component	Triangular Fuzzy Numbers		Fuzzy Evaluation				Expert Consensus	Ranking
	Threshold value, d	*Expert Consensus(%)*	*m1*	*m2*	*m3*	*Fuzzy Score (A)*		
Easy Interval	0.212	90.0%	0.660	0.820	0.930	0.803	Accepted	2
Incremental Interval	0.203	90.00%	0.680	0.840	0.940	0.820	Accepted	1

Interpretation of table-2

At this stage, there are five items listed and the threshold value results show only two sub components that comply with the first condition of Triangular Fuzzy Numbers. They are the easy interval and incremental interval. The rest of the tree sub components have been rejected by the experts.

Figure 1. showing the Threshold value (d) for dimension patterns using Fuzzy Delphi Technique



Interpretation of figure-1

There were two items for dimension type accepted based on expert consensus; easy interval and incremental interval. Based on the findings from the expert consensus, it can be concluded that the items accepted in the EM-Flip module for this pattern title are patterns that have a variety of shapes, colors, letters, and objects. Meanwhile, for the pattern with dimension type, the findings show that dimension with simple interval (ABBABB)and also incremental interval (ABABBABBB),with the Threshold value of 0.212 and 0.203, are the components that are accepted to be included in this EM-Flip module.

Table.3. showing themean and standard deviation for parental involvement includes support from the family aspect and involvement in the child's learning at home.

No	Construct of Parent's Involvement	N	Mean	Standard Deviation (SD)	Interpretation
i.	Support from family	60	4.15	1.11	High
ii.	Parent's involvement	60	2.30	1.31	Low

Interpretation of table-3

The research findings showed that respondents "strongly agreed" to the support provided at home in terms of environment and time with children (Mean = 4.15, SD = 1.11). While for the second construct, the construct related to parental involvement in children's learning, the respondent showed a "low" score, which is very low, especially in topics such as geometry, distance, and pattern (Mean = 2.30, SD = 1.31). In summary, respondents in the context of this study stated that support to provide a good environment for children is high, but parents are less helpful to be involved in children's learning.

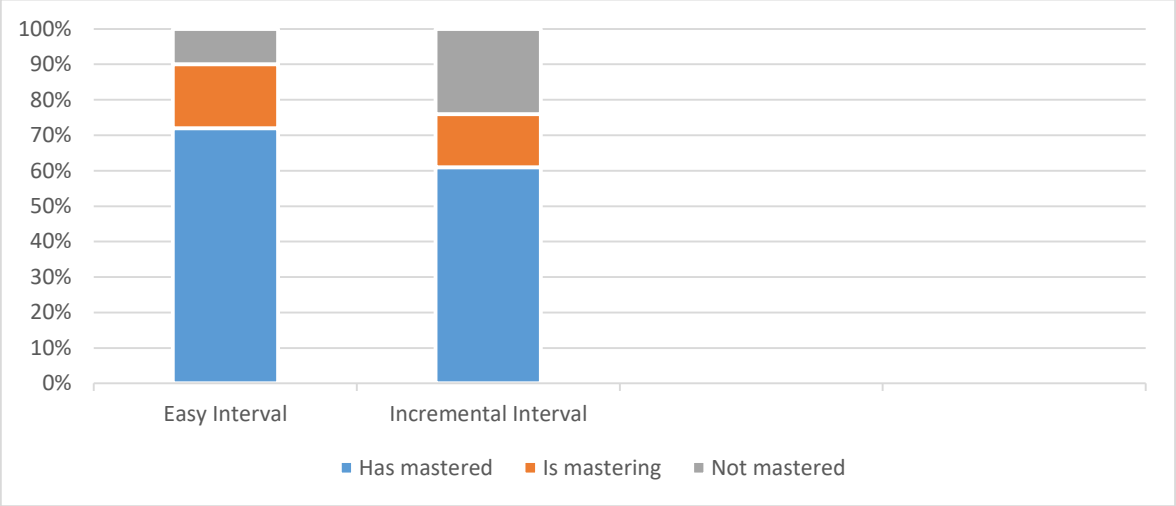
Table.4. showingthe percentage for students' achievement after using AR application

Activity	Dimension of Patterns	Students number (N)			Total (N)	Achievement (%)			Total (%)
		Has mastered	Is mastering	Not mastered		Has mastered	Is mastering	Not mastered	
Group Activity 1	Easy	18	5	2	25	72	18	10	100
	Incremental	15	5	5	25	61	15	24	100
Group Activity 2	Easy	17	6	2	25	66	22	12	100
	Incremental	5	9	11	25	15	40	45	100

Interpretation of table-4

The EM-Flip module provides two group activities, group activity 1 and group activity 2. Based on the analysis of student portfolio documents, in group activity 1, students are required to connect the pattern that has been given to them. The findings showed a good percentage of scores for this activity where 72% of the students had mastered the easy interval, and 61% had mastered the incremental interval. In group activity 2, students are required to construct their easy and incremental interval. Findings for this activity have shown that 66% of the students mastered the easy interval. However, as many as 85% of students are and have not mastered the activity of building their incremental interval. Overall, the research has found that the students were more proficient in the exercises in the form of easy interval compared to incremental interval.

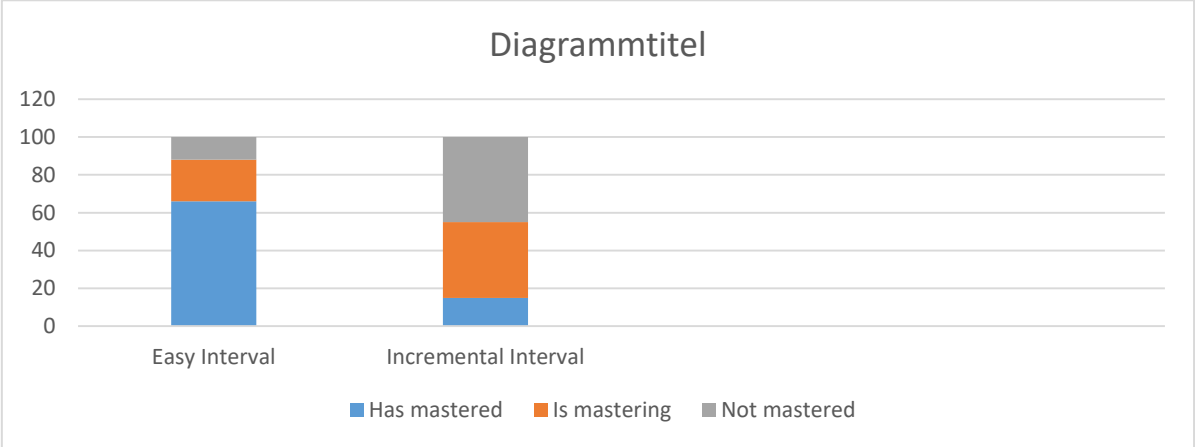
Figure 2. showing thepercentage for students' achievementfor group activity 1



Interpretation of figure-2

It is revealed from the above table that students are able to master the rules and dimensions of easy interval and incremental interval if given help through repetition of pattern rules (shapes, colors, letters and objects).

Figure 3. showing thepercentage for students' achievement for group activity 2



Interpretation of figure-3

It is revealed from the above figure that mastery of the rules and dimensions of patterns should be taught at an early stage before their creativity processes patterns in value when they are five to six years old. The weakness of understanding these basics will lead to their weakness of building patterns according to the level of creativity desired in the next level.

7.Recommendations

- To research strengthening training for early childhood education teachers on the latest teaching and learning concepts such as Flipped Classroom and Blended Learning.

- To develop a complete module in the form of AR applications for appropriate topics combined with the technology for Early Mathematics.
- To strengthen teachers with Technology Training and supply more up -to -date modules.
- Focus on aspects of stimulating and enhancing the level of creativity of students.

8.Conclusion

The technological elements involving this AR application have made this EM-Flip module a more interactive module that is needed by teachers as well as students at the age of 5 to 6 years. This is in line with the exposure to the technology around them and also fulfils the concept of learning while playing that student need in the early stages of schooling. While the concept of Flipped Classroom that is highlighted throughout the process of this study shows that the EM-Flip Module focuses more on activities that stimulate creativity when students are given more authority to discuss and express opinions in class. Among the implications and contributions seen are the impact on students and also the implications on the world of education that occur in the current situation. All parties involved whether teachers, parents or students in TADIKA are advised to be more prepared to accept the changes in current teaching and learning methods where technological elements need to be incorporated in the subject of Early Mathematics. However, detailed studies must be conducted to select appropriate titles combined with technological elements. This is due to the fact that Early Mathematics subjects still need a touch of existing materials to enable students to build their basic knowledge through a solid learning experience. This learning is known as experiential learning. The wisdom of all parties, especially curriculum developers is very important to ensure that the modules provided to teachers are able to support teaching and learning sessions. This is to prevent the occurrence of students dropping out in mastering subjects in school.

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