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Needs Analysis of Doctor Worm's Module in Improving Multiplication Skills among Year Four Low Achievers

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Abstract
Mathematics is one of the major subjects in primary school education in Malaysia. Among the basic arithmetic skills, single-digit multiplication is important as it is the basis for other mathematics operations. Nevertheless, it had become a challenging task for pupils when they still unable to master the skills even by Year Four. This study investigates the needs and the elements that are needed for a proposed learning module of single-digit multiplication skills. The module will be known as Doctor WoRM's Module. Quantitative approaches were used in this study. The participants in the study were 50 teachers from National-Type Chinese Primary School (SJKC) in Manjung District, Perak State. Descriptive analysis of percentages was used to analyse the results of the needs analysis survey. There is 96 percent of the participants think that module as a teaching aid can enhance the multiplication skills among low achievers. All of the participants claimed that mastery of single-digit multiplication is an important skill in mathematics. In this survey, the participants had voted for the multiplication facts that they think the low achievers might face difficulty in, since the multiplication facts of one and two only reached 8 percent, so the researcher had decided to drop the multiplication facts of one and two. Subsequently, multiplication facts from three until nine will be focused in this module as their percentages range is between 30 percent until 96 percent. The results from the needs analysis survey showed that there is a need to develop a module for multiplication skills. This study implicates that a module needs to be developed in order to improve the multiplication skills among low achievers.
Keywords: Multiplication, Mathematics, Low Achievers, Module.

Introduction

Today, the place and role of mathematics in the national curriculum is a very important, from the key skills essential for adaption to the world we live in, to discipline-specific skills (Voinea, & Purcaru, 2013). However, there is an increasing problem happened in many countries, that is the achievement in mathematics education has become lower in recent years (Figueiredo, Bidarra, & Bostad, 2016). Self-guided learning and teamwork with an appropriate tool and minimalist instruction increased pupils' intrinsic motivation toward learning mathematics, whereas the traditional mathematics lessons, in which the motivation is more extrinsic due to the teacher's active role, were less appealing to them (Eronen, & Karna, 2017). According to which pupils recognize that they know less about multiplication and division than addition and subtraction, and therefore are less confident in their multiplication and division judgement (Lortie-Forgues, & Siegler, 2016). Many students struggle with higher mathematics because lack of mastery in basic mathematics facts (Johnson, & Street, 2013).

The traditional method of teaching multiplication used to be memorization methods. The traditional mathematics teaching interprets logic training by forcedly memorizing formulas and definition composed by abstract symbols (Chang, & Yang, 2016). It is undeniable that memorization method is good for multiplication learning. However, the concept of multiplication should be understood by the pupils before memorization occurred.

This paper presents the literature review on four sessions, which are game-based learning, arithmetic, multiplication, and low achievers. Then, the data of Module Needs Analysis Survey were analysed and discussed. At the end, a module entitled DoCtor WoRM's Module is designed based on game-based learning, and it contains three materials namely Teacher's Manual, Pupil's Activity Book, and interactive game. This study investigates the needs and the elements that are needed for a proposed learning module of single-digit multiplication skills. The objective of this study is to identify the module needs in multiplication skills among the Year Four low achievers in National-Type Chinese School (SJKC).

Literature Review

The literature review includes game-based learning, arithmetic, multiplication, and low achievers.

Game-Based Learning

Game-based learning is defined as a type of game play which has defined learning outcomes (Cojocariu, & Boghian, 2014). Game-based learning activities are well-accepted and appreciated by students (Katmada, Mavridis, & Tsiatsos, 2014). Game-based learning of mathematics may include points and stars, would involve redesigning the homework activities, using artificial conflict and rules of play, to make them more interesting and engaging (Plass, Homer, & Kinzer, 2015).

In educational field, computer games in particular are very good at providing appropriate and timely feedback (Whitton, 2012). It is important to develop techniques such as digital game that can help pupils to improve their performance across different types of learning and assessment settings (Hussain et al., 2014). Game-based learning is an educational approach that positing that engagement is a critical aspect of learning (Hamari, Shernoff, & Rowe, 2015).

Digital game-based learning is any combination of educational content and computer games (Prensky, 2007). Digital games have become an important part in children's life, irrespective of the type of digital games, media, and reasons for their engagement with the media (Chuang, &

Tsai, 2015). A formative, corrective feedback, and interaction parameters matched to the learning characteristics of the targeted pupils should be included while designing a game (Figueiredo, Godejord, Rodrigues, & Perez, 2016). For future studies, investigating the effectiveness of game-based remedial instruction on learning motivation and attitudes related to mathematics learning remains an important issue (Lin et al., 2016).

Since game has become an effective way to improve learning, especially for children who love to play in nature, so the researcher decided to implement game-based learning in the intervention of DoCtor WoRM's Module. Besides having fun, the pupils are expected to build their knowledge and skills from the interactive game. This interactive game will act as reinforcement in the lesson for the pupils to understand the steps to solve multiplication and to complete some activities for single-digit multiplication facts.

Arithmetic

Arithmetic skills refer to the ability to combine numbers. Simple arithmetic refers to operations of addition, subtraction, multiplication, and division with smaller values of numbers (Andin, Ronnberg, & Rudner, 2013). Arithmetic fluency is the speed and efficiency with which correct solutions to numerical computations are generated. It is thought to represent a scaffold upon which higher-level mathematical skills are built. The early arithmetic ability is important as it supports the acquisition of higher mathematical competence (Price, Mazocco, & Ansari, 2013). Since these skills are very important, effective ways need to be designed to improve the children's conceptual understanding at critical points in development by delineating the boundaries of their arithmetic intuition (McCrink, Shafto, & Barth, 2016).

Children's mental representations may be more tied to specifics such as problem format and arithmetic operation than are those for adults (Walker, Bajic, Mickes, Kwak, & Rickard, 2013). To engage young children into practicing their arithmetic skills, game could be an excellent candidate (van der Ven, Segers, Takashima, & Verhoeven, 2017). Besides, most pupils enjoyed earning stickers, and this use appeared to help pupils gain arithmetic fluency (Paul, & Vaidya, 2013). It is important to mention that mental arithmetic plays an important role in elementary mathematics education in both China and the United States (Ding, Liu, Xu, Wang, & Zhang, 2016).

In summary, arithmetic skills play a very important role in the teaching and learning of mathematics subject in primary school. It involves four basic mathematics operations, which are addition, subtraction, multiplication, and division. Pupils need to master the basic arithmetic skills before they achieved a higher level of arithmetic fluency. Hence, the researcher designs a module involving an interactive game as it is a suitable tool to help pupils in practicing their arithmetic skills.

Multiplication

As one of the four basic mathematical operations, multiplication is an important skill learnt in primary education. Especially mastery of the single-digit tables of multiplication is an important aim of primary education, as it forms the basis for other operations such as division and multi-digit multiplication (Ven, Straatemeier, Jansen, Klinkerberg, & Maas, 2015). The teaching of multiplication provides some particular challenges for teachers in order to help pupils to develop a conceptual understanding of these operations (Bicknell, Young-Loveridge, & Nguyen, 2016).

Pupils' problem in learning mathematics especially in the operation of the basic multiplication facts started since they were in Year Two where they need to learn the multiplication tables from one to five and the tables from six to nine when they were in Year Three (Ahmat, Mohamed, Azmee, & Adham, 2017). Multiplication could be solved by repetitive additions, but this strategy put high demands on verbal working memory and increases the risk of mistakes (Clercq-Quaegebeur, Casalis, Vilette, Lemaitre, & Vallee, 2017).

Children are generally presented with the viewpoint that multiplication is more challenging than addition. For example, multiplication facts are more likely to be taught in a memorized, rote way than addition facts and addition concepts are introduced several years before multiplication concepts in the course of early schooling (McCrink, Shafto, & Barth, 2016). For multiplication and division, the direction of effect varies with the size of the operands. Multiplying numbers above one always yields a product greater than either multiplicand, but multiplying numbers between zero and one never does (Lortie-Forgues, & Siegler, 2016).

Multiplication as one of the basic arithmetic skills must be mastered by the pupils. However, the low achievers may not be able to acquire this skill as planned in the syllabus due to the different level of verbal working memory. These pupils may even face problems in solving single-digit multiplication and memorizing multiplication tables. Hence, this study will focus on single-digit multiplication facts from three to nine, and the targeted participants are the Year Four low achievers.

Low Achievers

In fact, the low achievers are capable of meaningful learning in mathematics. They even have the potential for much more, and should not be neglected (Broza, & Kolikant, 2015). Thus, how to help low achievers learn has become an important issue (Hsiao, Yang, Wei, Chang, & Lan, 2016). Low achievers may need additional and perhaps explicit pedagogical approaches to inspire more complex representational thinking in mathematics and ways in which this thinking can be made visible through verbalizations (Kotsopoulos, Cordy, & Langemeyer, 2015).

The computer-assisted mathematical learning system can also serve as a supplementary tool that helps teachers with remedial instruction and enhances the problem-solving ability of low achievers (Huang, Liu, & Chang, 2012). In line with this, educational computer game without appropriate learning strategies was found to be insufficient in helping pupils improve their learning. This means that when teachers want to use educational computer games to assist pupils in improving their learning, they should pay more attention to the choice of these games in order to make sure that these games have been embedded appropriate learning strategies. Otherwise, pupils tend to easily give up learning when they faced with frustration, especially for low achievers (Huang, & Huang, 2015).

In conclusion, low achievers are pupils who attain low academic achievement yet they are not qualified for special educational services. These special needs pupils will face problems when they need to learn in the same classroom with the mainstream pupils. In other words, they must be given a proper education suitable with their academic achievement level. Hence, the researcher decided to design a module involving an interactive game based on the needs of these low achievers in order to acquire the basic arithmetic skills.

Methodology

According to the previous literature, low achievers face difficulties in learning arithmetic skills in mathematics subject. In order to assist these pupils in improving their learning, a learning module entitled DoCtor WoRM's Module will be developed. The purpose of this study is to investigate the needs of the module to be constructed through the data from Module Needs Assessment Survey Questionnaire.

Results

Prior to the module development stage, a survey on 50 teachers were conducted to investigate the needs to construct a learning module. The findings were analysed using descriptive analysis of percentage. Module Needs Assessment Survey Questionnaire contains four parts of information, which are; (1) Part A demographic data; (2) Part B teaching and learning; (3) Part C module development and design; and (4) Part D suggestion.

Part A: Demographic Data

Purposive sampling was employed to select teachers from Manjung district. All subjects expressed a desire to participate in the survey. There are a total of 50 teachers participating in the survey. The inclusion criteria of this survey are; (1) they must be teacher from National-Type Chinese Primary School (SJKC); and (2) they must be teaching the subject of remedial education, mathematics or special education.

The participants involved in this study are the teachers from four different SJKC in Manjung district. The 50 participating teachers included nine males and 41 females. There are 12 participants teaching in urban area while 38 teachers are teaching in rural area. Regarding to academic achievement, 14 participants completed diploma education, 29 participants completed degree or master education, while seven participants ticked [others] for this item. Among all the participants, six participants have less than five years teaching experience, six participants have between six to ten years teaching experience, eight participants have eleven to fifteen years teaching experience, whereas 30 participants have more than 16 years teaching experience. Figure 1 shows the teaching experiences of the participants in this study.

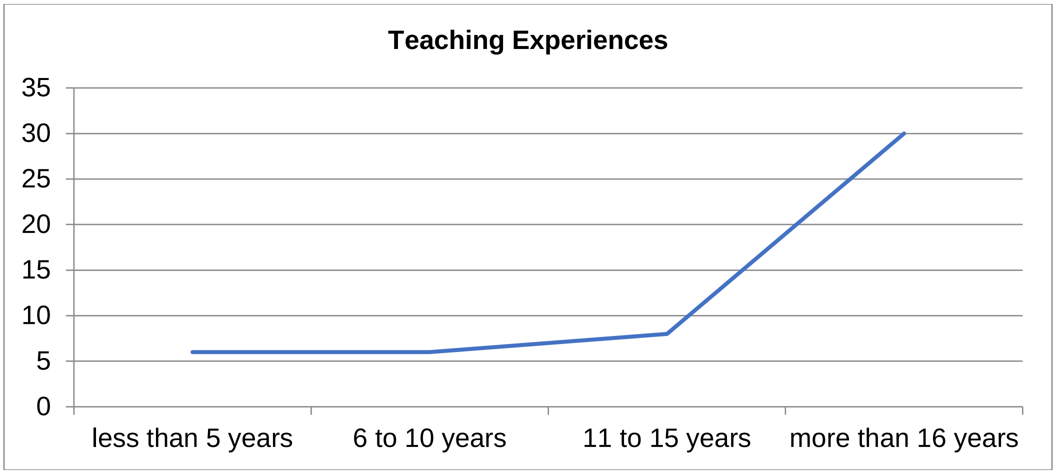

Figure 1 Teaching Experiences of the Participants

Part B: Teaching and Learning

Part B in Module Needs Assessment Survey Questionnaire is relevant to teaching and learning. In short, it is about the problems teachers might face in teaching and learning involving Year Four low achievers. The participants are required to choose [YES] or [NO] for the statements and tick [✓] in the space provided.

Table 1

Descriptive Analysis of Percentage for Part B Teaching and Learning

No.	Statements	YES	NO
1.	I have inadequate skills to handle / teach low achievers.	48%	52%
2.	I faced problems in planning activities for low achievers.	42%	29%
3.	I faced problems when teaching low achievers.	46%	54%
4.	I think that module as a teaching aid can enhance the multiplication skills among low achievers.	96%	4%
5	Teaching multiplication skills is relevant for Year Four low achievers.	100%	0%
6.	Mastery of single-digit multiplication is an important skill in Mathematics.	100%	0%
7.	Low achievers faced difficulty in solving the following multiplication facts:		
	Multiplication facts of 1	8%	92%
	Multiplication facts of 2	8%	92%
	Multiplication facts of 3	30%	70%
	Multiplication facts of 4	30%	70%
	Multiplication facts of 5	36%	64%
	Multiplication facts of 6	76%	24%
	Multiplication facts of 7	90%	10%
	Multiplication facts of 8	94%	6%
	Multiplication facts of 9	96%	4%

Table 1 shows the descriptive analysis of percentage for Part B teaching and learning in Module Needs Assessment Survey Questionnaire. The data shows that majority (96 percent) of the participants think that module as a teaching aid can enhance the multiplication skills, whereas there are only four percent of the participant did not agree on it. Besides, all (100 percent) of the participants think that teaching multiplication skills is relevant for Year Four low achievers, and mastery of single-digit multiplication is an important skills in mathematics.

Next, item number seven is to investigate the difficulty of Year Four low achievers face while solving single-digit multiplication facts. Since most (92 percent) of the participants ticked [NO] for multiplication facts of one and two, the researcher decided to drop these multiplication facts in the module. There were 30 percent of the participants ticked [YES] for multiplication facts of three and four. Meanwhile, there were 36 percent of participants ticked [YES] for multiplication facts of five. On the other hand, majority of the participants ticked [YES] for multiplication facts of six, seven, eight, and nine, which are 76 percent, 90 percent, 94 percent, and 96 percent respectively. Thus, the researcher had decided to involved multiplication facts of three until nine into DoCtor WoRM's Module. Figure 2 shows the multiplication facts in which Year Four low achievers faced difficulty.

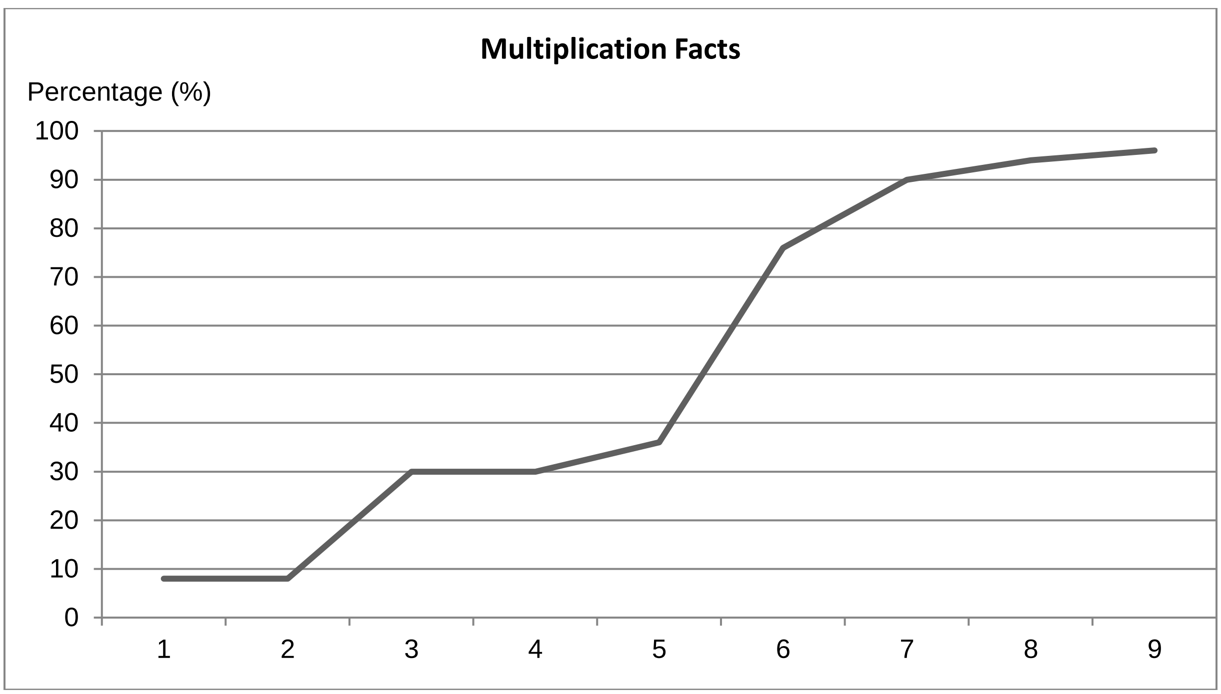

Figure 2 Multiplication Facts in which Year Four Low Achievers Faced Difficulty

Part C: Module Development and Design

Part C is relevant to module development and design. In other words, it is about the module development and design suitable for teaching and learning of multiplication skills among Year Four low achievers. The participants are required to choose [YES] or [NO] for the statements and tick [✓] in the space provided.

Table 2

Descriptive Analysis of Percentage for Part C Module Development and Design

No.	Statements	YES	NO
1.	Game-based learning should be an element in the module.	94%	6%
s2.	Mastery learning should be applied in the learning of low achievers.	96%	4%
3.	The following activities are suitable for low achievers to master multiplication skills.		
	Step 1: Drawing the intersecting lines.	96%	4%
	Step 2: Counting the intersection points.	92%	8%
	Step 3: Writing the multiplication sentences.	88%	12%
	Step 4: Reading the multiplication sentences.	90%	10%
	Step 5: Memorizing the multiplication facts.	92%	8%
4.	A module should contain the following materials:		
	Guidance and lesson plans for teachers.	96%	4%
	Exercise worksheets for pupils.	92%	8%
	Multimedia interaction game.	94%	6%
5.	Choose ONE basic skill to master single-digit multiplication facts.		
	Mathematics sentences.	64%	-
	Vertical algorithm for multiplication.	36%	-

Table 2 shows the descriptive analysis of percentage for Part C Module Development and Design. There were 94 percent of the participants agreed on game-based learning to be an element in the module, while 96 percent of the participants agreed on mastery learning to be applied in the learning of low achievers. Likewise, most of the participants agreed that five important steps in the module are suitable for low achievers to master multiplication skills. Step one shows the highest rate (96 percent) and step three shows the lowest rate (88 percent), while step two, step four, and step five shows the rate of 92 percent, 90 percent, and 92 percent respectively. So, the five steps in DoCtor WoRM's Module are /D/ draw the intersecting lines, /C/ count the intersection points, /W/ write the multiplication sentence, /R/ read the multiplication sentence, and /M/ memorize the multiplication facts. Figure 3 shows five steps in DoCtor WoRM's Module.

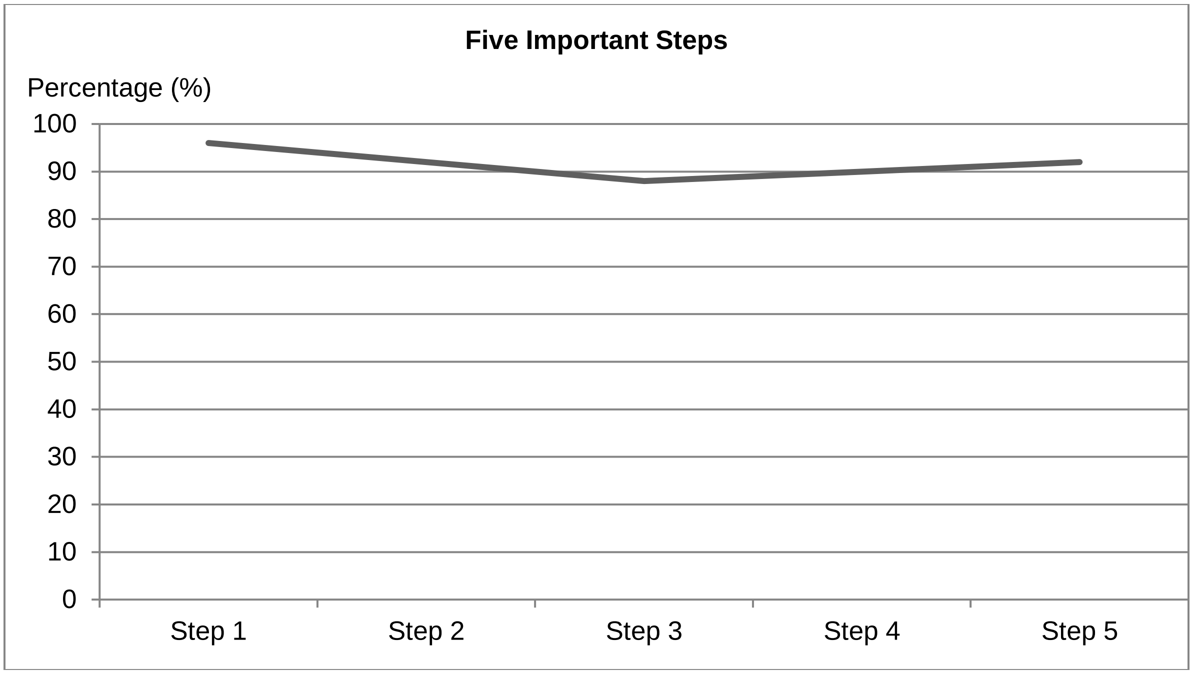

Figure 3 Five Important Steps in DoCtor WoRM's Module

Consequently, the data also shows that majority of the participants agreed on three materials in the module. There are 96 percent of the participants agreed with the guidance and lesson plans for teachers, 92 percent of them agreed with the exercise worksheets for pupils, and 94 percent of them agreed on a multimedia interactive game. Hence, the researcher decided to design a module contains three materials, which are Teacher's Manual, Pupil's Activity Book, and interactive game. Finally, majority of the participants had chosen mathematics sentences (64 percent) instead of vertical algorithm for multiplication (36 percent). Thus, the items in the module are constructed in the form of mathematics sentences.

Part D: Suggestion

Part D is about the suggestion on module development and design suitable in teaching and learning of multiplication skills among Year Four low achievers. The participants are required to write down any suggestion in the space provided.

In this section, some participants had written some suggestions but most participants did not do so. Among the suggestions, two teachers mentioned about the importance of memorizing multiplication table, while the rest suggested some learning games, activities, and methods in learning multiplication. There are two teachers suggested lattice multiplication as an alternative way to learn multiplication, while another teacher suggested a multiplication game of grouping marbles in the paper boxes. Besides, a teacher suggested drawing and colouring activities to build the concept of multiplication among the pupils, and another teacher suggested finger multiplication for single-digit multiplication facts.

In addition to these, there are two teachers stressed on the importance of multimedia interactive game in learning, whereas a teacher suggested on using more visual and concrete materials in teaching and learning of multiplication. Furthermore, there is a teacher suggested the use of simple and clear instructions in the module, and another teacher suggested to have more activities and exercises for low achievers in order to master in multiplication skills. Hence, the researcher had considered these suggestions to design and develop a module entitled DoCtor WoRM's Module.

Discussion

The lack of interest in mathematics occurs in group of low achievers (Voinea, & Purcaru, 2013). However, learning multiplication is an essential part of our child's elementary education (Bicknell, Young-Loveridge, & Nguyen, 2016). Corresponding with this, DoCtor WoRM's Module is designed and developed based on the interpretation of the data from Module Needs Assessment Survey. The aim of this needs analysis is to determine whether there is a need to construct a module on multiplication skills among the low achievers. Meanwhile, the purpose of the module is to improve the achievement of multiplication skills among Year Four low achievers.

A good method or technique can stimulate students' thought or cognitive to understand the basic mathematical concepts (Ahmat et al., 2017). In addition, the theoretical background of a module has to be appropriate and suitable to the objective of each activity in a module (Madihie, & Noah, 2012). Thus, the researcher had carried out a need's analysis survey using a questionnaire. There are four parts in this Module Needs Assessment Survey Questionnaire, which are Part A demographic data, Part B teaching and learning, Part C module development and design, and Part D suggestion.

Traditional mathematics teaching interprets logic training by forcedly memorizing formulas and definition composed by abstract symbols. Cramming way of learning has led to a result that pupils' lack of interest in learning mathematics (Chang, & Yang, 2016). It is necessary to use technology in education to enhance pupils' learning experiences (Yap, 2016). An integration of mastery learning strategies with game-based learning provides greater benefits for pupils learning mathematics (Lin et al., 2016). According to the results, 94 percent of the participants agreed on game-based learning, and 96 percent of participants agreed on mastery learning to be implemented in this module. Thus, the development of DoCtor WoRM's Module is underpinned by mastery learning and game-based learning.

DoCtor WoRM's Module offers a more interactive approach of learning multiplication skills as compare to the traditional method especially for the low achievers. The design and development of this module utilise the three materials, which are Teacher's Manual, Pupil's Activity Book, and interactive game. The use of combination of three tools was more effective than one or two (Dewitt, Siraj, & Alias, 2014). Hence, DoCtor WoRM's Module will be a major pulling factor to the learners as they are interacting with the content in a platform that is accommodating to their learning levels.

Conclusion

DoCtor WoRM's Module is the researchers' effort to improve the multiplication skills among Year Four low achievers in SJKC. DoCtor WoRM's Module offers an interactive way of engaging the learners in learning mathematics, especially in multiplication skills. As well, it is underpinned by mastery learning and game-based learning.

DoCtor WoRM's Module is designed and constructed based on the data from Module Needs Assessment Survey. The data obtained shows that there is a need to construct a module for multiplication facts from three to nine. Hence, development of DoCtor WoRM's Module is highly recommended. Multiplication skills has been simplified into five important steps of drawing, counting, writing, reading, and memorizing so that it is suitable as accommodating to the level of Year Four low achievers.

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