MIXED INSTRUCTIONAL APPROACH FOR REMEDIAL MATHEMATICS LEARNING AND MOTIVATION OF STUDENTS WITH LEARNING DIFFICULTIES

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To my beloved family

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ABSTRACT

Explicit instruction is commonly used in intervention for students with mathematics learning difficulties. Some researches reveal that it is effective in improving arithmetic skills. However, there are research findings which indicate the mastery of conceptual understanding and mathematical process skills were ignored through explicit instruction in intervention. This research was aimed to investigate the teaching and learning processes, and the motivational aspect, during usual practice and a remedial intervention. The intervention was carried out following an instructional model developed in this study. It was based on a mixed instructional approach which included the behaviorist and constructivist approaches. Instruction was carried out in concrete-representation-abstract sequence. Content of the instruction emphasized conceptual and procedural knowledge. Provision of intrinsic and extrinsic motivation was emphasized. The intervention was aimed at enhancing mathematical knowledge and process skills, and increasing motivation towards learning, of students. A case study was carried out in a suburban school and involved a remediation program teacher and his five students. Data was collected and analyzed using a qualitative approach. Results showed that the regular and remediation classroom teachers usually applied explicit instruction and guided practice. During remedial intervention, the participating teacher used explicit instruction initially and gradually changed to the constructivist approach. The findings indicated that students with learning difficulties were able to improve their mathematical knowledge and mathematical processes through application of the instructional model during intervention. Questioning for active thinking during explicit instruction could engage the students in active sense-making and mathematical processes. Their motivation was also increased. However, students experienced cognitive burden if they are required to perform active thinking and understand mathematics through the use of manipulative and drawing.

ABSTRAK

Pengajaran eksplisit digunakan secara umum dalam intervensi untuk pelajar dengan masalah pembelajaran matematik. Sesetengah penyelidik mendapati kaedah ini berkesan dalam meningkatkan kemahiran aritmetik. Namun, terdapat hasil kajian yang menunjukkan bahawa penguasaan pemahaman konsep dan kemahiran proses matematik diabaikan dengan pengajaran eksplisit dalam intervensi. Kajian ini bertujuan menyelidik proses pengajaran dan pembelajaran semasa amalan biasa dan intervensi pemulihan. Intervensi ini dijalankan dengan menggunakan sebuah model pengajaran yang dibina dalam kajian ini. Model ini dibina berdasarkan pendekatan pengajaran yang menggabungkan pendekatan tingkah laku dan konstruktivisme. Proses pengajaran dijalankan dalam turutan konkrit-perwakilan-abstrak. Pengetahuan yang disampaikan merangkumi konsep dan prosedur. Motivasi dalaman dan luaran ditekankan. Intervensi ini bertujuan meningkatkan pengetahuan matematik dan kemahiran proses matematik, serta motivasi belajar, di kalangan pelajar. Satu kajian kes telah dijalankan di sebuah sekolah luar bandar dan melibatkan seorang guru program pemulihan serta lima orang pelajarnya. Data dikumpul dan dianalisis dengan menggunakan pendekatan kualitatif. Dapatan kajian menunjukkan bahawa guru kelas biasa dan guru pemulihan biasanya menggunakan pengajaran eksplisit dan latihan terbimbing. Dalam intervensi pemulihan, guru berkenaan menggunakan pengajaran eksplisit pada awalnya, dan secara perlahan-lahan menukarkannya kepada pendekatan konstruktivisme. Dapatan kajian menunjukkan bahawa pelajar dengan masalah pembelajaran berupaya meningkatkan pengetahuan dan kemahiran proses matematik melalui aplikasi model pengajaran dalam intervensi. Penyoalan untuk pemikiran aktif semasa pengajaran eksplisit dapat melibatkan pelajar dalam penaakulan aktif dan proses matematik. Motivasi mereka juga dipertingkatkan. Namun, pelajar mengalami beban kognitif jika mereka dikehendaki menjalankan pemikiran aktif dan memahami matematik melalui penggunaan bahan manipulatif serta kaedah melukis.

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LIST OF ABBREVIATIONS

ASSURE	-	Analyze, State, Select, Utilize, Require, Evaluate
BAF	-	Basic Addition Facts
BPG	-	*Bahagian Pendidikan Guru*
BPK	-	*Bahagian Pembangunan Kurikulum*
CSA	-	concrete-semiconcrete-abstract
CRA	-	concrete-representation-abstract
EPRD	-	Educational Planning and Research Division
JPK	-	*Jabatan Pendidikan Khas*
KBSR	-	*Kurikulum Baru Sekolah Rendah*
KSSR	-	*Kurikulum Standard Sekolah Rendah*
MOE	-	Ministry of Education
NCTM	-	National Council of Teachers of Mathematics
3M	-	*Membaca, menulis dan mengira*

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CHAPTER 1

INTRODUCTION

1.1 Overview

Expanding access and improving the quality of education at all levels have been a continuing national development objective throughout Malaysia's five-year development plans and other transformation programs. Various strategies and approaches were implemented to meet the diverse learning styles and needs of students. With elements of democratization and equity underlining the Education Act 1996, education system in Malaysia has programs to accommodate all students in learning. Students who are at-risk of learning or those with disabilities have the option to be placed in remedial classes, inclusive classrooms or classes for students with learning difficulties.

Remedial education is one of the important features of primary education in Malaysia. The remedial classes draw from the rationale that some students are slow in learning and often lagging behind their peers. Low performance of students may be due to the incapacity of the teachers or problems specific to the child such as ill heath, lack of concentration or less exposure to the subject taught, parental background or his/her innate capacity to learn. Teachers should identify the areas of difficulties experienced by these students and devise remedial teaching strategies to help them overcome their problems in learning. Without necessary guidance, mastery of the basic skills may become a hindrance in their later learning and adding stress to their emotional aspect besides academic achievement.

Remediation is usually intended for students who are struggling in their academic achievement (National Council of Teachers of Mathematics, NCTM, 2007a). It involves "actions taken to reverse established patterns of achievement by these students". The support offered to these students is usually focused on the content that they should have mastered (Slavin, 2009). Teachers provide supplemental instruction for that content such as re-teaching material that is not yet mastered by students. The strategy covers any pre-requisite concepts or skills needed to understand a particular objective. In Malaysia, mathematics remediation is intended to help students overcome their learning difficulties in mathematics learning (Nik Azis, 1996). In this process, students are assigned to a remediation class teacher and taught systematically according to their ability. Nik Azis (1996) suggested that emphasis should be placed on a student's development in the aspects of concept understanding, mastery of skills, and appreciation of the subject. Hence, teachers should understand the developmental process of schema of mathematics knowledge. They should be aware of their students' personal characteristics as well as the learning environment which are inter-related with effective learning.

Mathematics is inherently related to a learning approach which requires active and hands-on activities (Gurganus, 2007). The emphasis should be placed on the child-centred activity. Teachers involve students in active interactions and provide meaningful and authentic contexts. They also plan developmental and inter-related content for instruction. The role of the teachers is to engage students in solving engaging problems and create classroom atmosphere for active participation, exploration, and sense making, in mathematics.

In the Primary School New Curriculum (known as *Kurikulum Baru Sekolah Rendah* in Malay Language, KBSR) which was introduced in the year 1983 (Ministry of Education Malaysia, MOE, 2001; MOE, 2003), and Primary School Standard Curriculum (known as *Kurikulum Standard Sekolah Rendah* in Malay Language, KSSR) which replaced KBSR in the year 2010 (MOE, 2010), focus is placed on mastery of basic skills such as reading, writing and arithmetic. These skills were known as 3M in Malay Language. At the end of primary education, students are expected to acquire the basic skills of 3M. Their progress was monitored from time to time using various assessment methods. Students who were

identified as having learning difficulties, especially in 3M, were placed in remediation class. The implementation of the remediation program is based on a guide book prepared by the Department of Special Education (known as *Jabatan Pendidikan Khas* or JPK in Malay). According to JPK (2003a), the Special Remediation Program is intended to help students as early as possible to overcome difficulties in learning so that the students are able to progress to the next stage of schooling.

As the main purpose is to help students to be placed in the regular classroom with their peers, students are expected to not only master basic skills but also to build self-confidence and positive attitude towards mathematics learning. Researchers found that students with learning difficulties might show low level of motivation in their mathematics learning (Fuchs, Fuchs, Powell, Seethaler, Cirino, and Fletcher, 2008; Westwood, 2003; Bell, 1978). Thus, teachers should motivate learning of students to regulate their attention and behaviour, and to work hard. Through the use of a student-centred instructional approach and the use of manipulative and drawing, teachers might be able to engage their students in active learning.

1.2 Background of the study

Generally about 5 to 10% of school children are facing difficulties in learning concepts and basic skills of mathematics (Bryant, Bryant, Gersten, Scammaca, and Chavez, 2008a; Fuchs *et al.*, 2008; Evans, 2007; Westwood, 2003). Westwood (2003) suggested that students with learning difficulties are not attributable to any disability, and their difficulties might due to socio-economic, cultural, or linguistic disadvantage. In Malaysia, these students are often assigned to a remediation program. They often show characteristics such as unable to learn mathematics at the pace and performance expected by their schools. They might demonstrate a negative attitude in mathematics and are not confident in their effort to learn mathematics. Many of these students fail to master the mathematical knowledge and skills required in a variety of context.

Although remediation program is officially implemented in primary schools, it was not given emphasis during implementation by some schools and teachers (Poon, Yeo and Noor Azlan, 2012; Mathialagan, 2000; Rashida, 1996). Research findings indicated that many remediation class teachers needed more training and knowledge to carry out instruction more effectively due to insufficient references and guidelines on effective pedagogy for students with learning difficulties. For instance, Poon *et al.* (2012) studied the teaching and learning process using a case study research design at a primary school in Malaysia. Findings show that explicit instruction and drill-and-practice approaches were implemented in the mathematics remediation classroom. The teacher preferred the traditional instructional approaches with the assumption that this approach is appropriate for students deemed as 'hard to teach'. Obviously, the teacher had either ignored or might not be aware of the flexibility in using explicit instruction or constructivist approach in instruction for teaching remediation class students as indicated in some curricular materials such as guide book, module and document.

Many researchers and educators suggested that instruction for these students should be provided through diagnostic and remediation approaches such as drill-and-practice or direct and explicit instruction (Flores, 2009a; Flores, 2009b; Bryant *et al.,* 2008a.; Bryant, Bryant, Gersten, Scammaca, Funk, Winter, Shih, and Pool, 2008b; Fuchs *et al.*, 2008; Tournaki, 2003; Fuchs and Fuchs, 2001; Mercer and Miller, 1992). Though, the above approaches might involve students in learning activities that foster over-reliance on prescriptive pedagogies that prevent them from active thinking and sense-making process (Moscardini, 2009; Ketterlin-Geller, Chard, and Fien, 2008). Lacking of experiences in these authentic processes might prevent the students from learning mathematical knowledge and process skills which they need to progress to higher mathematics learning.

In the delivery of learning materials to students, the concrete-representational-abstract (CRA) sequence is commonly used in remediating students' weakness in mathematics concept understanding and mastery of basic arithmetic skills. Many research findings showed that this strategy is effective in helping student master conceptual understanding of mathematics (Flores, 2009a; Flores, 2009b; Bryant *et al.*, 2008a; Bryant *et al.*, 2008b; Fuchs *et al.*, 2008; Tournaki, 2003;

Fuchs and Fuchs, 2001; Mercer and Miller, 1992). Using direct and explicit instruction, and drill-and-practice, remediation students are taught using this sequence in learning basic facts and algorithm for operations of whole numbers. Students are expected to progress developmentally but it is not applied effectively in actual implementation (Gurganus, 2007).

Many students with mathematics learning difficulty do not have adequate learning experiences with the enactive and iconic mode (Reys, Lindquist, Lambdin, and Smith, 2007). Teachers tend to ignore the 'bridging between levels' that is provided by language as they do not emphasize self-talk, communication among students, and teacher-directed scaffolding in the classroom. Some teachers move too quickly from the concrete level into the representational and symbolic form of learning. In some classrooms, children learn conceptual understanding using concrete manipulative far longer than needed and thus become too dependent on the use of concrete manipulative. Some teachers were also found omitting the representational level. There were also teachers who teach mathematics merely at abstract level.

Research findings of Poon *et al.* (2012) showed that students were taught using straws or fingers as tool to retrieve basic addition facts rather than to understand mathematical concepts. Some of the activities suggested in curricular materials (JPK, 2003a; JPK, 2003b) could be used to help students understand concepts and procedures by using concrete objects and pictures. Learning activities based on these concrete objects might be helpful to students in their understanding but these activities did not seem to help students to develop mental strategy for number operations and fact-retrieval strategy. Drawing as an instructional and learning strategy was also ignored. Moreover, the curricular materials do not show application of concrete materials, pictures and word problem-solving in a systematic way.

In carrying out mathematics remediation, generally teachers over-emphasize the mastery of mathematics automacy in solving arithmetic problems (Poon *et al.*, 2012; Moscardini, 2009; Ketterlin-Geller *et al.*, 2008; Cawley and Parmar, 1992). As a result, the focus of mathematics remediation is merely on mastery of basic

procedural knowledge and arithmetic skills. Mathematical process skills which could help students in solving mathematical problems are not emphasized but the mastery of arithmetic skills and basic knowledge is overemphasized (Poon *et al.*, 2012; Moscardini, 2009; Cawley and Parmar, 1992). Students might experience learning difficulties when learning mathematics at higher level because of the lacking of higher order thinking skill and mathematical process skills.

Students who experience difficulties in learning mathematics may also experience problems in using their cognitive skills to understand mathematics and solve problems (Bell, 1978). Based on Piaget's theory on intellectual development, students in primary school might still have not reached the concrete operational stage. They can perform logical operations with limitation to concrete objects (Slavin, 2009; Nik Azis, 1996). Mathematics teachers who ignore students' cognitive difficulties which are caused by intellectual development may affect students' conceptual understanding of mathematics. The students' problem might become worse if their teacher teaches procedural knowledge using numerals and mathematical symbols only. Consequently, these students face difficulties when they have to transfer their procedural knowledge into solving word problems with a variety of contexts.

On the other hand, some students with mathematics learning difficulties might face social, emotional and motivational problems (Bell, 1978). They are anxious and not confident when they have to do mathematics. Social problem might arise when they avoid working together with their peers because of low self-esteem which is caused by frequent failure in solving mathematical problems. In their perception, mathematics is for students who are "born expert" in this subject only. In the study Yuen, Westwood and Wong (2008), students with special learning difficulties were found holding relatively weaker beliefs than students without learning problems. They also showed very low-level beliefs about their own capabilities. To help these students in the instructional activities during mathematics remediation, teachers could involve them in activities which are enjoyable in a favourable environment. Teachers can plan learning outcomes which can be achieved in an appropriate period of time, and give them continuous encouragement.

A critical aspect in deciding the application of an instructional approach is the individual differences of students (Gurganus, 2007). Some students who are having difficulty in learning mathematics might experience difficulties with the indirect and inductive approaches. They come to school with a variety of past experiences and knowledge. Hence, teachers need to apply different approaches in classroom teaching and learning to comply with their individual differences. They should be able to determine prior knowledge and experiences of their students, provide suitable instructional activities, and evaluate the outcomes of the mathematics learning in their classrooms. "Many of the elements of constructivist teaching and learning are, in fact, very appropriate for students with disabilities and other learning problems" (Gurganus, 2007). The intensive-explicit instruction of behavioural learning theory and the constructivist approaches might be compatible. They may support the limitations of each other. By using these two different approaches in a mixed mode, teachers could provide authentic and meaningful learning environments that would promote mathematical processes while enable systematic and essential learning.

1.3 Statement of problem

Mathematics remediation programs in Malaysia aim to develop automacy among students with learning difficulties so that they can solve problems and continue their study in regular class (JPK, 2003a; BPG, 2009; BPK, 2012b). According to the guide book, module and documents provided to teachers, the focus of remediation in mathematics is commonly placed on mastery of basic facts and arithmetic skills. Although conceptual understanding is emphasized, teaching and learning materials are separated from authentic mathematical processes which were emphasized by the national mathematics curriculum (MOE, 2010). To learn knowledge and skills of mathematics at higher level, apart from strong conceptual understanding, the students should also master mathematical process skills before they are confident and fluent in application of mathematical knowledge.

Mathematical processes with emphasis on constructivist approach were not clearly defined by JPK (2003a, 2003b), BPG (2009) and BPK (2012a, 2012b). JPK

(2003) seemed to support a teacher-directed approach. On the other hand, activities provided by BPG (2009) indicated involvement of students in active thinking and problem-solving. In the documents provided by BPK (2012a, 2012b), teachers are given a list of instructional approaches, and they are suggested to use a variety of approaches in delivering learning materials. However, the activities provided by BPK (2012b) seem to suggest a more teacher-directed approach, specifically teacher-directed practice and individual practice for drilling purpose.

Teaching and learning activities suggested by JPK (2003a, 2003b), BPG (2009) and BPK (2012b) are intended to help students understand mathematical concepts using concrete objects and pictures but learning of strategy to develop basic skills such as fact-retrieval strategy is not emphasized. Apart from that, in the absence of a meaningful problem-context in each problem-solving activity, students might not have opportunity to practice mathematical process skills.

Another consideration is the motivational aspect. It is not mentioned explicitly in the curricular materials provided to teachers and students for mathematics remediation programs (JPK, 2003a; JPK, 2003b; BPG, 2009; BPK, 2012b). Research findings show that students with learning difficulties tend to have a lower belief about their own capabilities (Yuen *et al.*, 2008). Thus, it is important that teachers provide a favourable learning environment to engage students in active participation (Slavin, 2009; Gan and Poon, 2008).

In actual implementation, content of instruction was merely focused on basic facts and arithmetic skills (Poon *et al.*, 2012). Poon *et al.* (2012) also found that the participating teacher usually used explicit instruction and drill-and-practice approach in the mathematics remediation classroom. Although manipulative and visual aids are suggested by JPK (2003a, 2003b), BPG (2009), and BPK (2012b), the students merely used straws or fingers for retrieving basic addition facts. The participating teacher did not use manipulative to teach mathematical concepts as she emphasized the learning of arithmetic skills. Obviously, emphasis on procedural knowledge influenced the purpose and use of instructional strategy such as concrete objects and pictures. Gan and Poon (2008) reported similar findings that teachers used explicit instruction to deliver procedural knowledge in order to let their students practice

arithmetic skills. These findings are thus consistent with report from Mathialagan (2000) that many remediation class teachers needed more knowledge and skills in carrying out mathematics remediation.

In a nutshell, the issues of content delivery, instructional strategy, instructional approach and motivation which are discussed above should be given consideration in designing remedial intervention for students with learning difficulties in mathematics. There are deficiencies in the curricular materials provided by JPK, BPG and BPK for mathematics remediation. Teaching and learning in the mathematics remediation classrooms tended to be teacher-directed and needed to be improved. As mathematics learning should be student-initiated and focused on both conceptual and procedural knowledge, obviously there was a gap between the intended curriculum and actual implementation. In light of this, the current research was carried out to develop an instructional model for mathematics remedial intervention, and investigate the teaching and learning during implementation of this model.

1.4 Research objective

In making instructional decisions, researchers need to understand how student learning could be improved. This research was intended to investigate a coherent instructional approach which is based on individual learner needs and contextual circumstances for effective teaching and learning in remediation classrooms. It was based on the perspective of a teacher's instructional approach rather than the perspective of students towards learning.

As indicated by research findings, students were used to learning in a structured and teacher-directed environment (Poon *et al.*, 2012; Flores, 2009a; Flores, 2009b; Bryant *et al.,* 2008a.; Bryant, Bryant, Gersten, Scammaca, Funk, Winter, Shih, and Pool, 2008b; Fuchs *et al.*, 2008; Tournaki, 2003; Fuchs and Fuchs, 2001; Mercer and Miller, 1992) through application of diagnostic and remediation approaches such as drill-and-practice or direct and explicit instruction. Although

these students might show improvement in arithmetic skills, they persist with primitive strategy used in solving arithmetic problems at the expense of development in their mathematical thinking (Moscardini, 2009).

The features of instruction that facilitate acquisition of both conceptual and procedural knowledge do not fall exactly into categories usually used to contrast methods of teaching (NCTM, 2007b), for instance, student-centred versus teacher-centred teaching. The features of instruction that promote skill efficiency might fit into behaviourist framework of teaching and learning, those that promote both conceptual and procedural understanding cut across these common labels. As such, this research was carried out to understand the features of instruction that could help students in enhancing their conceptual and procedural knowledge. To obtain this understanding, the researcher needed to carry out this study based on an intended approach to instruction in order to understand the responses of students towards it.

In short, the researcher used qualitative research approach to understand the current instructional practice in depth and subsequently developed a model of teaching. The objectives of this research are as follow:

1.4.1 investigate the usual practice in the mathematics remediation classroom and regular classroom, in terms of the instructional approach
1.4.2 develop an instructional model for mathematics remedial intervention
1.4.3 explore the teaching process in remedial intervention, in terms of the instructional approach, based on the instructional model developed in this study
1.4.4 explore enhancement of students' mathematical knowledge and mathematical process skills, based on the instructional model developed in this study, and
1.4.5 explore the enhancement of students' motivation, based on the instructional model developed in this study

To understand the teaching and learning process in mathematics remedial intervention, the researcher studied the content of instruction, application of instructional strategy and the instructional approach. The researcher sought understanding of the student learning by focusing on the mathematical knowledge,

mathematical process skills and motivation. At the end of the research, an instructional model for remedial intervention which was based on authentic experiences of observations and interviews was developed.

1.5 Research question

In an effort to change the mathematics remediation classroom which is dominated by rules, formulae and computation, to one that focuses on sense making of mathematical concepts and procedures, the researcher investigated the teaching and learning process during usual mathematics remediation and regular classrooms. Through careful observations and interviews with the research participants, the researcher developed activities for remedial intervention. It was focused on learning of mathematical knowledge and process skills, and the motivation of students, through a mixed instructional approach.

This research is carried out to answer the following research questions:

1.5.1 What was the usual practice in the mathematics remediation classroom and regular classroom in terms of the instructional approach?

1.5.2 How was teaching carried out in the remedial intervention, in terms of the instructional approach, based on the instructional model developed in this study?

1.5.3 What are the mathematical knowledge and mathematical process skills enhanced in the remedial intervention, based on the instructional model developed in this study?

1.5.4 How was motivation of the students enhanced in the remedial intervention, based on the instructional model developed in this study?

In order to understand the teaching and learning process during usual practice and remedial intervention, the researcher applied a qualitative research approach (Creswell, 2008) to study the implementation of teaching and learning processes in the usual remediation classroom and regular classroom. The researcher planned activities together with the teacher in an effort to enhance teaching and learning of

mathematics using a mixed instructional approach. This research method enabled the researcher to explore how a teacher could enhance the teaching and learning in the mathematics remediation classroom, and thus construct a model for instruction in mathematics remedial intervention.

1.6 Theoretical framework of the research

The researcher studied the current teaching and learning practice in mathematics remediation in depth, and developed a model of teaching as well as a set of modules which illustrates the model. Remedial intervention was intended to enable these students learn mathematical knowledge and process skills. The focus of mathematics instruction in this research is a mixed instructional approach which consists of behavioural learning and constructivist approaches. Through application of this mixed instructional approach, students were involved in mathematical processes when learning mathematics and thus master the mathematical process skills. The ideas involved in this research could be illustrated by a theoretical framework as shown in Figure 1.1 which is developed for this research.

Behavioural learning theory was found effective in helping students mastering basic knowledge and skills in mathematics. For this research, the researcher referred to the 'operant learning' which assumes a more active learner (O'Donnell, Reeve, and Smith, 2007). It is believed that reinforcement increases the likelihood that a desired behaviour will be performed again. O'Donnell *et al.* (2007) suggested that teachers use incentives, prompts, and positive reinforcers.

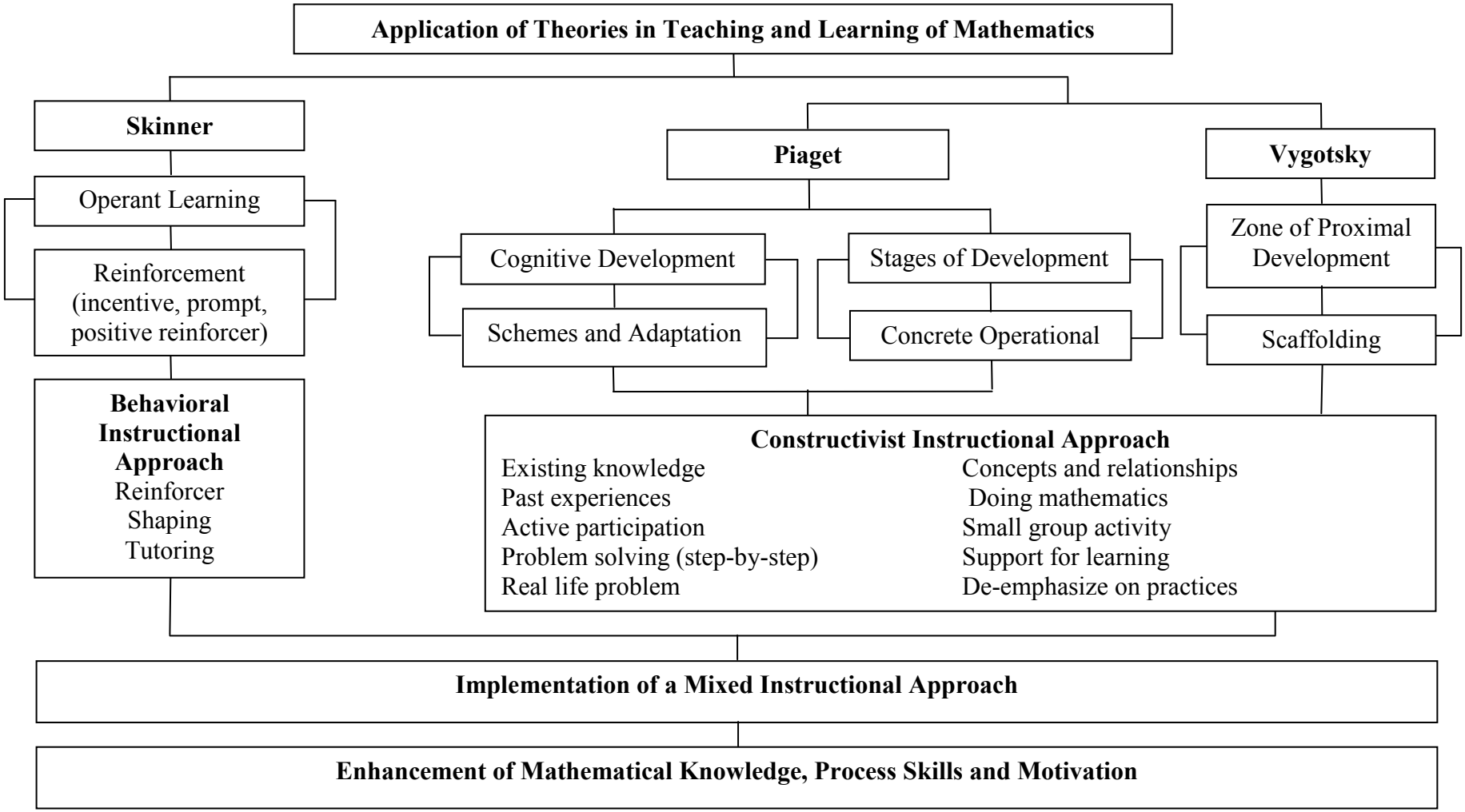

Figure 1.1 Theoretical framework of the research

On the other hand, constructivist approach of teaching and learning is greatly influenced by the ideas of Piaget and Vygotsky (Slavin, 2009). Children's construction of knowledge is a cognitive process which occurs through interaction with their environment. Information from the environment is organized and processed in the children's cognitive structure. By constantly adjusting their schemes, the information is assimilated or accommodated. Therefore, teachers need to provide a learning environment to enable these processes so that learning occurs through construction of ideas.

Teachers also need to understand Piaget's view on stages of cognitive development. For teachers of primary grade students, understanding the abilities of children at the concrete operational stage will help teachers in planning an effective lesson. Children at this stage can form concepts and relationships but concrete objects and familiar situation must be provided in their learning environment. The idea of working in small groups and scaffolding is supported by Vygotsky's idea about 'zone of proximal development' (Slavin, 2009; O'Donnell *et al.*, 2007). In a level of competence, students are unable to solve problems in a certain domain but they can accomplish the task if they receive appropriate guidance from a more capable partner such as a teacher or peers.

Both behavioural learning theories and constructivist approach bring implications to teaching and learning practice in the mathematics classroom. As mentioned by Gurganus (2007), students with learning difficulties might have problems with the indirect approaches. Systematic and explicit instruction should be used to support the limitation of the constructivist approach. For gaining conceptual and procedural understanding, a constructivist approach of instruction is appropriate. However, explicit instruction and practices might help students to become fluent with knowledge and skills.

Mathematical processes in learning mathematics are important for students to acquire mathematics understanding and apply their mathematics knowledge in other contexts. A mixed instructional approach is coherent with learning mathematics through mathematical processes. The skills involved in mathematical processes are complex. However, these skills can be shaped gradually through practice and

guidance from teacher. The processes should not be regarded as separate strand from behavioural learning. A constructivist approach to teaching and learning can support learning mathematics through mathematical processes and also learning mathematical process skills.

Behavioural and constructivist learning approaches could enhance motivation of students towards active learning. Provision of incentives, prompts, and positive reinforcers during student learning processes is intended to engage them in performing the desired behaviours (Slavin, 2009; O'Donnell *et al.*, 2007). Thus, reinforcement could be used to promote students' motivation towards active learning. Piaget's theories imply that students at the concrete operational stage should learn through physical experiences for cognitive development. These experiences could be provided through the use of manipulative and visual aids in hands-on activities to enhance students' motivation in mathematics learning (Slavin, 2009; Reys et al., 2007). Besides, according to the Vygotskian perspective of motivation, students become active learners if they are supported continuously through scaffolding technique and small group learning. Thus, generally the constructivist approach could be used to enhance students' motivation in their learning.

1.7 Conceptual framework of the research

According to Lester (2005), a conceptual framework is "a basic structure of the ideas that serves as the basis of phenomenon that is to be investigated". It explains the main things to be studied including the key factors, constructs or variables (Miles and Huberman, 1995). A conceptual framework was designed for this study, as shown in Figure 1.2, and developed based on literature review on current practice of mathematics remediation and mathematics education. The researcher suggested a few modifications for the current practices in mathematics remediation.

Mathematics learning is particularly related to the constructivist philosophy which promotes hands-on activities and active student interactions in a meaningful

and authentic context with scaffolding of understanding and interrelated content. However, students with mathematics learning difficulties might have problems with the indirect approaches (Gurganus, 2007). Students come into the classroom with a wide range of previous experiences and knowledge. They need different approaches of instruction in the process of constructing understanding. Some might learn mathematics through an indirect approach while others might need more explicit and systematic instruction. Therefore, these two (2) approaches should be mixed to support the limitation of each other.

In terms of knowledge delivered, mathematics learning should not be limited to basic facts and arithmetic skills. Both conceptual and procedural understanding should be emphasized. The delivery of mathematical knowledge in effective instruction should be carried out using the CRA sequence. An important aspect in this research is the acquisition of mathematical process skills which consist of problem solving, communicating, reasoning, representation, and making connection. Since students are required to acquire understanding of the concepts and procedures, and master mathematical process skills, direct instruction model of teaching is not suitable. Behavioural learning approach should be mixed with constructivist approach for mathematics learning. The enhancement of students' motivation towards mathematics learning was also considered in the planning of instructional activities.

1.8 Significance of the research

This research project was intended to understand the teaching and learning process of native students participating in the remediation program at a primary school located at suburb area in Sarawak. By using a qualitative research approach, the researcher was able to identify the difficulties and problems encountered by both teacher and remediation students involved in this program.

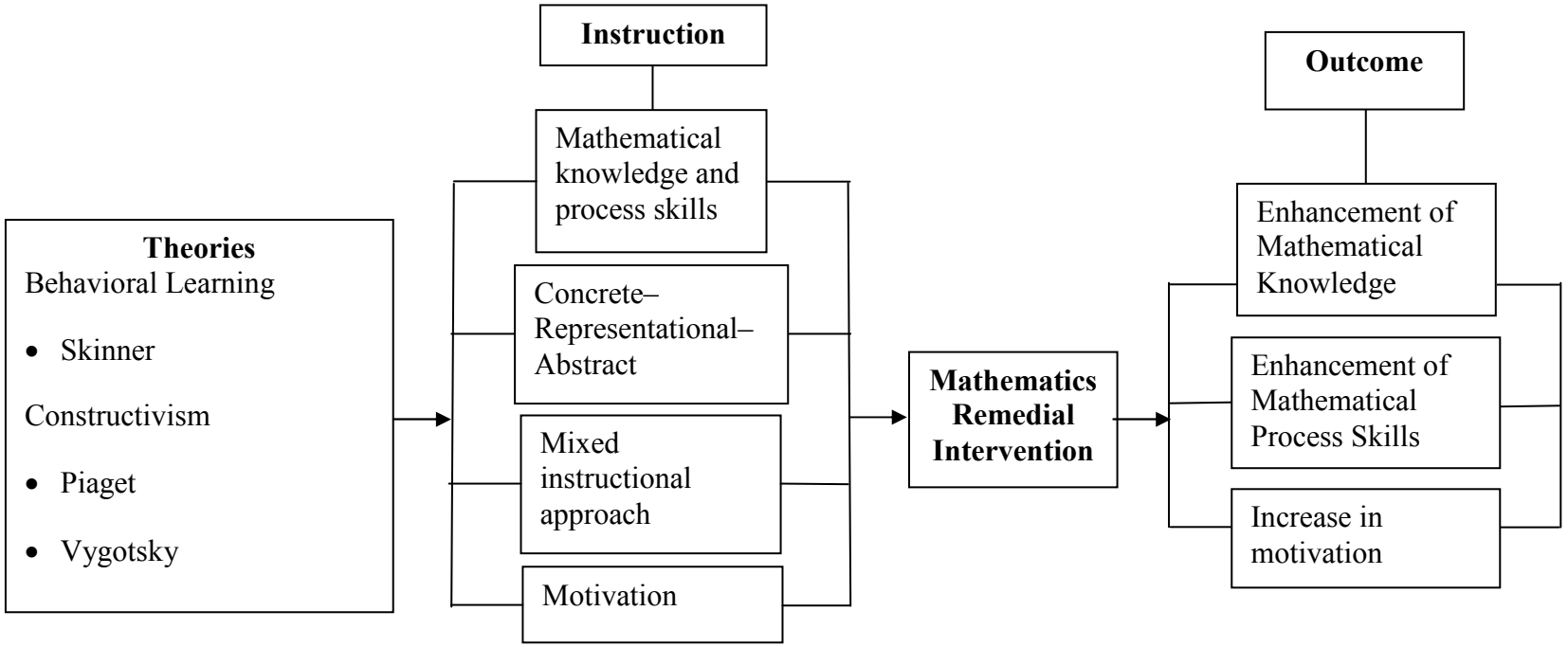

Figure 1.2 Conceptual framework of the research

Findings of this research related to the teaching and learning process of mathematics remediation, particularly about the content taught and instructional approach, might be served to inform the policy makers and curriculum developers of the actual implementation of the remediation program at primary schools in Sarawak. This may lead to curriculum planning of what should be taught and how mathematics should be taught to students who are involved in the Special Remediation Program. Subsequently, the references and resources for teachers involved in this program should be revised.

The findings of this research may also have its implications on the professional development among mathematics teachers and educators. They might be inspired to do further study on how to improve mathematics instruction for remediation students. Since the systematic and explicit instruction does not promote thinking and mathematical process skills (Kettlerlin-Geller *et al.*, 2008; Cawley and Parmar, 1992), an instructional approach which could involve students in doing mathematics actively while learning mathematics effectively should be decided. Involving remediation students in doing mathematics is challenging. Thus, instructional decision making for teaching these students mathematics and mathematical process skills should be made carefully.

Another aspect about teaching mathematics to remediation students is the use of the CRA sequence in learning mathematical knowledge. Teachers and educators should study further on how to use this sequence effectively in teaching mathematics to remediation students.

Inferences from understanding how native students in this research project learn mathematical knowledge and mathematical process skills, especially problem solving skill, may lead the researcher to suggest ways of teaching remediation students those skills. At the end of this research project, the researcher will suggest a model of teaching and modules for mathematics instruction. This model can be referred and used by remediation program teachers in helping their students learn mathematics and mathematical process skills. The modules developed for instruction in this research may be served as reference for teachers in planning classroom activities.

If the curriculum for the Special Remedial Program is revised, students who are selected to join this program and their parents should be confident with the mathematics learning. Their learning will not be limited to mere memorization of facts and computation skills. Instead, they will learn thinking skill and process skills which are important for learning mathematics at higher level and for application of mathematics in actual contexts.

In short, findings of this research would be useful for all the stakeholders in education. Policy makers and curriculum developers can revise the curriculum of mathematics remediation. Mathematics educators can acquire an in-depth understanding of teaching and learning of mathematics in the remediation classroom, and thus develop instructional approach for instruction. Remediation class teachers might obtain a better understanding of the problems and implementation of teaching and learning in remediation classroom. Thus, they can make better instructional decisions for their own students. Besides gaining confidence in learning mathematics in remediation classroom, parents and students may learn more effective approaches to learning mathematics from this research.

1.9 Limitations of the research

The main purpose of this research project is to investigate how a remediation program teacher can carry out mathematics remediation without ignoring mastery of mathematical process skills among students. The research was carried out in a primary school located at suburb area using a case study research design. The research participants are all native students. The researcher sought to understand mathematics learning among these students. Research outcome would be based on the context of the school in the above area.

Problem solving is the foundation for all mathematics teaching since it involves students to work with all other fundamental processes of doing mathematics (Reys *et al.*, 2007). The researcher intended to study how remediation students learn problem solving skill and how problem solving activities can help them improve

their other mathematical process skills which are reasoning, communicating and connecting. The selection of these skills is based on the emphases stated in the mathematics curriculum.

This study makes use of qualitative research techniques involving collecting and analyzing verbal protocols. One limitation of this method is that the process of collecting and coding verbal protocol data is extremely labour intensive (Cai, 1995). Hence, involvement of a large number of participants in this study is not feasible. Furthermore, this research involves a small number of remediation students in a remediation class. Therefore, the outcome of this research is merely descriptive and contextual.

1.10 Definition of terminologies

This section presents the operational definition of terms used in the context of this study.

1.10.1 Mixed instructional approach

A mixed instructional approach refers to the planning and implementation of instruction which includes the knowledge and skills, instructional strategy, and the delivery method. In this research, it consists of the behaviourist framework of learning and the constructivist theories (Joyce, Weil, and Calhoun, 2009; Slavin, 2009; O'Donnell *et al.*, 2007). It is consistent with the balanced view of learning suggested by Gurganus (2007). In implementing remedial intervention for this research, the participating teacher was expected to change his existing instructional practice, which is based on the behavioural learning approach, to a more student-centred approach which is rooted in the constructivist learning approach. The researcher referred to 'operant learning' (Slavin, 2009; O'Donnell *et al.*, 2007) that believed that good consequences influence a person to perform in a desired

behaviour more often. On the other hand, the constructivist educators emphasize cognitive changes in memory capacity, thinking and mental processing (Borich and Tombari, 1997). The researcher studied the teaching and learning process based on the ideas proposed by Piaget and Vygotsky. Information processing theory was also used to understand the cognitive processes occurred.

1.10.2 Remediation

NCTM (2007a) suggested that there are conflicting interpretations regarding remediation. Generally, it refers to actions taken to reverse established patterns of achievement by students who are already struggling and need intensive, long-term help. It is the process of re-teaching material which is already taught but not mastered by students. Mathematics remediation is intended for students who lacks mastery of a given mathematical concept and skill. Using an appropriate approach, students are re-taught prerequisite concepts and skills needed to understand a particular concept and master the skill.

1.10.3 Remedial intervention

Intervention is a plan of action implemented by providing instructional activities and materials to support students' learning (NCTM, 2007a). Additional instruction on content that has already been delivered in the classroom is provided to help students who may need extra help. It is normally intended to boost regular classroom instruction, and used to address weaknesses or strengths before they become a problem for the students. Hallahan, Lloyd, Kauffman, Weiss, and Martinez (2005) suggested that remedial interventions should be used to improve mathematical skills such as number operations of students. In this research, remedial intervention is provided to reverse established patterns of achievement by students who are already struggling and need intensive help. Simultaneously, it also provides

instructional activities to address weaknesses of students that might become a problem in their future mathematics learning.

1.10.4 Learning difficulty

Ostad (2008) described students with learning difficulties display the use of developmentally immature problem-solving strategies. They often show weak recall of basic facts in mathematics. They are having moderate learning difficulties as their difficulties are general rather than specific to a curriculum area (Fletcher-Campbell, 2005). Generally, they show slowness of response, and difficulty in recognizing similar concepts. Deficiencies in cognition, memory and language, short attention span, inadequate achievement, social skills deficit, and emotional problems collectively categorize students who are diagnosed as having mild or moderate learning difficulties. These students are definitely different from those with autistic spectrum disorders or specific learning difficulties. As pointed out by Westwood (2003), these students have learning difficulties which are not attributable to any disability or impairment. Indeed, the possible causes include socio-economic, cultural or linguistic disadvantage. Those students who are referred to as 'slow learners' or 'low achievers' certainly fall into this category.

1.10.5 Mathematical knowledge

Knowledge delivered in this study refers to the two (2) types of knowledge in number sense: conceptual knowledge and procedural knowledge (Van de Walle, 2001). Conceptual knowledge in mathematics consists of logical relations that are constructed internally and exists in a person's mind as part of a network of ideas. Mathematical procedural knowledge is knowledge about rules and procedures used in doing routine mathematical tasks and also symbols used to represent mathematics.

1.10.6 Meaning of addition

Reys *et al.* (2007) proposed the use of counters and number-line to introduce the idea that addition means "finding how many in all". This research applied the part-part-whole concept or set model (Cathcart, Pothier, Vance and Bezuk, 2011; Van de Walle, 2001) because it could be used in static situations as well as action situations. Hence, it could facilitate remedial class students understand the meaning of addition. Meaning of addition is also represented by using a number line which is a semi-concrete model (Cathcart *et al.*, 2011).

1.10.7 Basic facts

Basic facts in mathematics refer to the combination of numbers in a particular way (Reys *et al.*, 2007). They are arithmetic facts for addition, subtraction, multiplication, and division. In this research, the researcher studied how the processes of teaching and learning basic addition facts.

1.10.8 Algorithm

Algorithm refers to application of computational skill with procedure (Reys *et al.*, 2007). Computational fluency requires students to use a variety of strategies to do computation and recognize the relationships among the various strategies. Students were guided to learn procedures for counting, computation and grouping. They were required to connect their algorithmic procedures for whole number addition to the concept of place-value.

1.10.9 Concrete-representational-abstract sequence

CRA sequence is a strategy used in remediating students' arithmetic (Mercer and Miller, 1992; Mercer and Miller, 1998). There are three (3) phases in the mathematical activities. In the first phase, teacher uses manipulative to help students understand a concept. During representation phase, students are taught using picture or drawings to represent a concept. Then, in the abstract phase, students use mnemonic strategy to remember the steps in a mathematical skill.

1.10.10 Mathematical process skills

Mathematical process skills which were included in the investigation of this research consist of communication, reasoning, making connection, problem solving, and making representation. All these process skills are emphasized in the primary school mathematics curriculum (MOE, 2010) of our country.

1.10.11 Diagnostic testing

Diagnostic test should be held to enable teachers make diagnostic decisions about a student's strengths and weaknesses, and the reasons of that (Kubiszyn and Borich, 1996). It is also used to determine level of understanding and progress of students in a certain content area and skills. Mercer and Miller (1998) suggested four (4) steps to use diagnostic test which include the hierarchy of the content area, the span of skills, items for each skill, and interpreting student performance.

1.10.12 Diagnostic math interview

Mercer and Miller (1998) recommended the use of interview with participants of a remedial program to assess their math understanding. Such interviews could provide insights into mathematics strategies, processes, products, and social-emotional reactions to math. It is commonly used in administering diagnostic math tests in order to identify specific problems, error patterns, or problem-solving strategies in math.

1.11 Summary

Remediation program is intended to help students with learning difficulties in 3M. These students might encounter cognitive difficulties or face problems in the social, emotion and motivation aspect. In the current practice of mathematics remediation, focus is placed on mastery of basic knowledge as well as skills in number sense. Instructional activities are carried out through drill-and-practice and teacher-centred approach. Concept understanding and mastery of mathematical process skills are often ignored during remediation. Hence, the researcher carried out this research to understand how mathematics remediation could be implemented without ignoring concept understanding and mathematical process skills. Consequently, this research was based on the perspective of teacher's instruction in order to understand students' mathematics learning.

An instructional model was constructed at the end of this research. The outcome of this research may evoke awareness among educators and policy makers who are involved with this program. Teachers who are implementing remediation program can refer to the model produced in this research for their own lesson planning and teaching. In this chapter, the researcher also touched on the limitations of this study and the operational definition of some important terms used in this research.

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