

Nota Penyelidikan / Research Note

Mathematics Remedial Intervention for Indigenous Pupils with Learning Difficulties: Does It Work?

Campur Tangan Pemulihan Matematik bagi Murid Orang Asli yang Mengalami Kesukaran dalam Pembelajaran: Adakah Ia Berfungsi?

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ABSTRACT

A systematic and explicit instruction using the concrete-representation-abstract sequence is commonly used for diagnostic and remedial approaches. However, this instructional approach might prevent pupils with learning difficulties to think and reason during mathematics learning. In this study, the authors integrated behaviorist and constructivist approach to help indigenous pupils learn addition and subtraction of whole number using manipulative and drawings. The usual practice in mathematics remediation and effect of an alternative instructional approach were investigated. Using a case study design, a teacher and six indigenous pupils were involved. Data was collected using observation, pupils' work, and interview. Analysis process involved transcribing, segmenting, coding, creating themes, and inter-relating themes. Results indicated that explicit instruction and drill-and-practice were commonly used in the mathematics remediation classroom. Pupils were weak in conceptual understanding and also arithmetic skills. However, participation in mathematical processes and extensive use of physical, pictorial, and symbolic representations of mathematical ideas had helped the participating pupils gained firm conceptual understanding of addition and subtraction, and thus improved their arithmetic skills. Some pupils responded positively towards constructivist approach of instruction but others still needed explicit and individual instruction from their teacher.

Keywords: Conceptual understanding, concrete materials, drawings, integrated approach, procedural knowledge

ABSTRAK

Satu arahan yang sistematik dan jelas menggunakan urutan konkrit perwakilan-abstrak biasanya digunakan dalam pendekatan diagnostik dan pemulihan. Walau bagaimanapun, pendekatan pengajaran ini mungkin menghalang murid dengan kesukaran pembelajaran untuk berfikir dan logik semasa pembelajaran matematik. Dalam kajian ini, penulis mengdefinisikan pendekatan behaviorist dan konstruktivis untuk membantu murid-murid orang asli belajar tentang penambahan dan penolakan nombor bulat menggunakan manipulasi dan lukisan. Amalan biasa dalam pemulihan matematik dan kesan pendekatan pengajaran alternatif telah disiasat. Menggunakan reka bentuk kajian kes, seorang guru dan enam murid asli terlibat. Data telah dikumpulkan menggunakan pemerhatian, kerja murid, dan temu bual. Proses analisis melibatkan menyalin, mengumpul, pengekodan, mewujudkan tema, dan saling berkaitan tema. Keputusan menunjukkan bahawa arahan yang jelas, dan 'gerudi dan amalan' biasa digunakan dalam kelas pemulihan matematik. Murid-murid didapati lemah dalam pemahaman konsep dan juga kemahiran aritmetik. Walau bagaimanapun, penyertaan dalam proses matematik dan penggunaan meluas fizikal, representasi bergambar, dan simbolik idea matematik telah membantu murid-murid yang mengambil bahagian mendapat kefahaman jelas tentang konsep penambahan dan penolakan, dan dengan itu meningkatkan kemahiran aritmetik mereka. Sesetengah murid bertindak balas secara positif ke arah pendekatan konstruktivis, tetapi yang lain masih memerlukan arahan yang jelas dan secara individu daripada guru mereka.

Kata kunci: Pemahaman konseptual, bahan konkrit, lukisan, pendekatan bersepadu, pengetahuan procedural

INTRODUCTION

Development of mathematical knowledge is fundamental in mathematics learning. Available research on effective

mathematics instruction for pupils with learning difficulties is modest (Ketterlin-Geller et al. 2008; Bryant et al. 2008). Lack of knowledge in providing effective instruction to these pupils might result in

insufficient instructional support for them. Apart from that, most of the work related to mathematics learning of these pupils focuses on the use of instructional approach which is based on a behaviorist framework of learning (Cawley & Parmer 1992; Mercer & Miller 1992; Fuchs & Fuchs 2001; Tournaki 2003; Bryant et al. 2008). A demonstration-prompt-practice sequence is commonly used for providing systematic and explicit instruction.

The concrete-representation-abstract (CRA) sequence is recommended as a way to teaching pupils with learning difficulties to understand mathematical concepts, operations, and applications (Mercer & Miller 1992). Pupils may learn concepts or procedures of mathematics through hands-on manipulation of concrete objects. Next, pupils learn to model mathematical knowledge using pictorial representations. To develop fluency with the pictorial representations, instruction is focused on abstract representations of mathematical knowledge. Several researches (Mercer & Miller 1992; Bryant et al. 2008; Flores 2009) support the use of this strategy based on systematic and explicit instruction in facilitating a pupil's understanding of mathematics ideas.

Explicit and systematic instruction that involves a CRA sequence appears to be a moderate approach for supporting pupils with learning difficulties in learning mathematics (Ketterlin-Geller et al. 2008) but pupils with learning difficulties can only benefit from their learning if they are encouraged to think and reason. Merely perform steps in solving problems by following what is demonstrated does not help children to internalize the concepts and thus might not understand those steps. This view is supported by Ma (1999) that pupils' misconceptions in mathematics are likely a result of being taught rules and algorithms which are demonstrated by their teacher in early mathematics. Teachers with traditional disposition might use materials to demonstrate procedures for their pupils to re-enact. Besides, within special education setting, diagnostic and remedial approaches (Moscardini 2009) which are based on the traditional learning theories are commonly used to support pupils with learning difficulties. As a result, pupils might be involved in learning activities that foster over-reliance on prescriptive pedagogies that prevent them from active thinking and sense-making process. Although pupils are able to apply certain concepts and perform procedures during initial instruction, they might not maintain their knowledge and skills over time (Ketterlin-Geller et al. 2008). Furthermore, if pupils are not involved in learning activities that promote problem solving, reasoning, and communication (Cawley & Parmer 1992), they will not be able to make sense of mathematics in order to gain conceptual understanding as well as procedural knowledge.

ALTERNATIVE INSTRUCTIONAL METHOD

Instructional activities in this research project were planned in order to help native pupils at the Ulu Baram area in mastering arithmetic skill of addition and subtraction. Hence, we design our instructional method by considering the following aspects: (1) conceptual and procedural knowledge, (2) integrated instructional approach, and (3) concrete materials and drawings.

CONCEPTUAL AND PROCEDURAL KNOWLEDGE

Pupils should construct their knowledge through active participation in learning activities. Instructional activities which are meant to develop pupils' conceptual understanding tend to downplay the development of skill proficiency (Evans 2007). If traditional algorithms are introduced only until pupils have gained a strong understanding of basic concept, pupils with learning difficulties might only learn traditional algorithms when they are in their fourth year of schooling (Evans 2007). Therefore, Rittle-Johnson, Siegler & Alibali (2001) suggested an iterative model that asserted the interactive relationship between conceptual and procedural knowledge. When both are emphasized during instruction, pupils develop their conceptual understanding optimally and become procedurally proficient as they have more cognitive resources to apply their knowledge and skills. Hence, teachers should provide instruction which makes explicit links between procedural knowledge and conceptual understanding (Evans 2007) in the effort to support pupils in gaining "a balance and connection between computational proficiency and conceptual understanding" (National Council of Teachers of Mathematics 2000).

In developing pupils' computational fluency with addition and subtraction, they are required to learn the procedures for particular algorithms which are supported by sufficient conceptual understanding (Reys et al. 2007). Concept of place value supports the computation of whole numbers and might help pupils work efficiently with the algorithms. As pupils explore algorithms for addition and subtraction, they could participate in trading activities which is accompanied by renaming activities (Reys et al. 2007). Pupils could learn to quantify sets of objects by grouping by ten and use the structure of the written notation to record the information about grouping.

Fluency with basic addition also requires many experiences in counting objects (Reys et al. 2007; Byrnes 2008). Pupils group objects together and use a counting strategy to find the total number of objects. In this process, pupils build a part-part-whole schema for numbers (Resnick 1989; Van de Walle 2001). They need to understand the key principles of additive composition by which parts are combined to form a whole. Manipulating concrete objects in a meaningful context

might promote acquisition of part-part-whole schema for numbers. As they develop a concrete understanding of addition, they may use a more efficient counting strategy. After sufficient manipulation with objects, pupils should be encouraged to make its transition to pictures and symbols (Thompson 1991). As pupils might have problems with the symbolic mode before building up meaningful referents for the symbols, Byrnes (2008) suggested beginning addition using simple, orally presented word problems.

INTEGRATED INSTRUCTIONAL APPROACH

People from a different cultural background might react differently to the verbal and nonverbal classroom interaction and management techniques (Borich 2011). For example, several studies indicate that Asian pupils respond more positively to a quiet and private environment. Hence, teachers should not simply enumerate learning theories more effectively (McNally 2004). Instead, Lambe (2003) suggested that teachers from a different culture must spend time with their pupils in order to understand them especially their way of learning. The process of teaching and learning benefits pupils best if it is nurtured, not by applying methods which are assumed valid and appropriate for everyone. Although it is difficult to accommodate individual needs of every pupil, teachers need to balance their pupils' individual dispositions with instructional methods expected by general academic institutions and scholars.

In identifying a suitable instructional approach to help native pupils learn mathematics, we consider integrating two different approaches: (1) behaviourist framework of learning, and (2) constructivist approach. Although these approaches are often presented as opposites, Gurganus (2007) and Lang & Evans (2006) thought this view is inaccurate. Teachers often blend these approaches and they can actually compliment the limitation of each other. Behaviourism stresses repetitive practice by the student until the required knowledge and skills are mastered through direct instruction. On the other hand, a cognitivist approach requires pupils to construct personal representations of knowledge through active individual experiences within the social context of the classroom. Lang & Evans (2006) recommended that pupils should construct personal meaning through direct instruction. The general background information is presented and followed by the constructivist approach which is focusing on particular problems and applications.

Through explicit instruction, content of knowledge is delivered in small steps and pupils practice after each step. Pupils are provided guidance during initial practice but guidance is reduced gradually. Lang & Evans (2006) suggested that the procedure should not be rigid. Responsibility should be transferred to pupils

gradually as they are taught to observe and activate their prior knowledge. In the process, pupils construct meaning and organize their ideas. Thus, interactive approaches which involve discussion among pupils and teacher are recommended (Lang & Evans 2006). Apart from that, pupils should be encouraged to solve problems in small groups in problem contexts which are related to their real life experiences (O'Donnell et al. 2007; Slavin 2009). Slavin (2009) also suggested the use of scaffolding to encourage pupils to reflect and make sense of mathematics.

Both approaches are constructed and communicated by scholars in the Western academic institutions through a systematic method of research derived from empiric and rationalist thought (Lambe 2003). These thoughts influence deeply the Western epistemological assumptions which are assumed to be the most valid or reliable way to understand social phenomena. Native children learn and understand their environment and culture (McKay 2005) in their own way of knowing, teaching and learning (McNally 2004). Indigenous education and mainstream education are very different but each can accommodate the other. Hence, we must be willing to observe and reflect on assumptions and expectations if we want to help indigenous children learn mathematics, especially those who have learning difficulties in mathematics.

CONCRETE MATERIALS AND DRAWINGS

Typically, pupils with learning difficulties in arithmetic face problems in executing arithmetic procedures and might face difficulties in representing arithmetic facts or retrieving facts from their long-term memory (Micallef & Prior 2004). Many of them are poor problem solvers and might show some improvement in execution of arithmetic procedures but there is no reliable change in number of facts that can be retrieved from their memory. Thus, most of them might prefer to use less advanced counting techniques in computing basic facts such as counting with models or concrete objects (Carpenter & Moser 1982; Baroody 1987) and counting techniques suggested by Groen & Parkman (1972) including counting all by sum, counting all from first addend or from second addend, and counting on from smaller addend or from larger addend. As a result, they might be burdened in their working memory while executing arithmetic procedures (Das & Janzen 2004).

In view of the above problems faced by pupils with learning difficulties, pupils of this research project were encouraged to explore the use of both models and drawings in solving arithmetic problems. To ensure that pupils learn algorithms with understanding, not by rote, Reys et al. (2007) also suggested the use of manipulative materials. Materials function as a link between a real-life problem situation and the abstract algorithm. It also helps pupils to recognize that what is written down

represents real objects and actions. Besides, Thompson (1991) recommended that adequate time should be provided to encourage pupils manipulate the materials and make its transition to pictures and symbols. Mayer & Wittrock (2006) also supported the view that when pupils are not used to hands-on activities, cognitive load may actually increase. Hence, pupils must be given sufficient time in this process.

Regarding the use of concrete materials in mathematics instruction, teachers must be aware that materials themselves carry no actual mathematical information (Moscardini 2009; Reys et al. 2007; Thompson 1994). Hence, the role of concrete materials in pupils' learning process to build conceptual understanding and master procedural skills must be given attention to. In the process of manipulating concrete materials, teachers must consciously encourage pupils to develop their understanding of the relationships within the number system and to establish connections between concepts and processes (Moscardini 2009).

PURPOSE OF RESEARCH

This research investigated the current practice in the mathematics remediation classroom at a primary school located at the interior area of Ulu Baram. With the understanding gathered at the site, instructional activities were planned to help pupils with learning difficulties in mathematics learn mathematical knowledge based on an integrated approach. Effect of implementation of these instructional activities was studied. Hence, this research was carried out to investigate:

1. the current practice of teaching and learning in mathematics remediation for pupils with mathematics learning difficulties, and
2. the effect of instructional activities applied to improve mathematical knowledge of pupils with learning difficulties based on (i) an integrated instructional approach, and (ii) manipulation of concrete materials and drawings.

METHOD OF RESEARCH

RESEARCH DESIGN

This research was carried out to investigate instructional practice in a mathematics remediation classroom. Hence, a case study research design (Creswell 2008; Merriam 1998) was used to understand the process of teaching and learning. Besides obtaining an in-depth understanding of the usual practice and later the effect of instruction planned by us, it also enabled us to reflect on that process (Merriam 1998).

SETTING AND PARTICIPANTS

Participants of this research were a remediation teacher and her pupils from a primary school in the interior area at Ulu Baram. Most of the pupils in this school were native from nearby villages. The teacher is a native who was posted to the school and had six years of experience in teaching pupils with learning difficulties in mathematics. Six pupils were selected for this research project after administration of a screening test. All of them could count whole numbers up to 50 and could get basic addition facts by counting on from the second addend but they still needed remedial intervention in concept of place value and arithmetic skills of addition and subtraction of whole number. All the six pupils are Penan children. Max and Diane were pupils of Year 4 and Year 3. Tom and Rex were in Year 2. Sandy and Esther were also Year 2 pupils but they only started their schooling two months before the research was started. Instead of such short schooling experience, these two girls were able to master skill in counting.

COLLECTION AND ANALYSIS OF DATA

To understand the teaching and learning process of the usual practice and the remedial intervention prepared for this research, we used classroom observations, interviews with teacher, and pupils' work and tests. Data collected with qualitative approach from classroom observation was recorded in the form of video clips and analyzed using a qualitative approach recommended by Creswell (2008) which involved transcribing, segmenting, coding, creating themes, and inter-relating themes. To obtain a holistic understanding of the pupils' work such as drawings and answer sheets, we compared it with the related video clips of classroom observation. It also enabled us to understand the conditions under which the pupils produce their work.

INSTRUCTIONAL ACTIVITIES

Conceptual understanding and procedural knowledge of addition and subtraction were emphasized and taught simultaneously. Pupils participated in classroom activities which were carried out in two stages.

At the first stage, pupils used concrete materials such as straws to illustrate a problem situation which was explained by their teacher. Subsequently, they needed to solve an arithmetic problem based on their understanding obtained from the manipulation of the concrete materials.

Next, pupils were required to represent a problem situation using drawings after a problem situation was explained and illustrated using concrete materials. Afterwards, they were required to solve arithmetic problems using drawing.

Finally, pupils were asked to solve a problem which was read to them using their preferred strategy. At this stage, they were also given individual practices with support from their teacher.

FINDINGS

PRE-INTERVENTION: CURRENT PRACTICE OF TEACHING AND LEARNING

The children who participated in this research project preferred quiet and relaxing environment for teaching and learning. They became panic easily if their teacher talked loudly as they liked people to talk gently and slowly. They were found not used to talk in class. According to the headmaster and their teachers, these children were naturally shy and sensitive. During instructional activities, we found that although they were slow in doing their work, they were careful and always tried to do it correctly. The pupils' attendance record indicated that Rex tended to escape from school. He explained that he was not interested in school and mathematics learning was boring.

All the pupils could count the correct number of straws to represent a number shown to them. However, when they were asked to explain the meaning of the numeral in the tens and ones, they could not answer or show with the straws. For instance, if the teacher wrote '16', the pupils would count sixteen straws correctly and show them to the class. If she pointed to the '6' in '16', all the pupils would be able to show six straws. However, if she pointed to the '1' in '16', they showed one straw and said it's 'one'.

All the pupils were very confident in using finger to count on from the second addend for arithmetic combinations of addition. For example, when they wanted to compute '3 + 4', they would point to their head and say 'three in head, four on fingers'. Then they would put up four fingers and say 'four, five, six, seven' before writing the answer on paper. Although this strategy is considered immature, these pupils could perform it correctly, quickly and confidently. For basic subtraction facts, they would put up their fingers according to the minuend in the combination. Then they would put down the fingers one by one by counting up to the number of the subtrahend. However, they did not know any strategy to get basic subtraction facts if the minuend was more than 10.

We found that these pupils did not know when they should apply addition and subtraction. When a problem situation was explained to them, they did not know which number operation to use in solving the problem. For a given mathematical sentence of addition, they also could not tell a story or situation which could represent it. The concept of part-part-whole of addition was never taught. Pupils did not know when they should use the

skill of addition. They also had difficulties in learning addition and subtraction with regrouping. Their main problem was in the procedure of regrouping due to lack of understanding in place value and the procedure.

The teacher usually used explicit instruction and drill-and-practice approach in the mathematics remediation classroom. First, she would explain and demonstrate the steps in solving an arithmetic problem. Pupils observed and listened to her explanation. This was followed by guided practice. Pupils were instructed to copy mathematical sentences from the blackboard and change that to standard written form. However, all of them made mistakes as shown in Figure 1. Hence, their teacher showed them the standard written form for every question on the blackboard. She did not do any explanation. Pupils simply copied that into their exercise book.

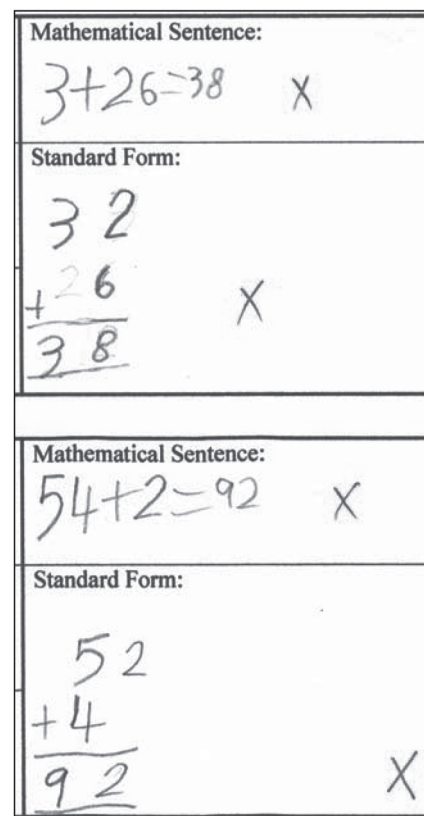


FIGURE 1. Mistakes of a Participating Pupil

STAGE 1: MANIPULATION OF CONCRETE MATERIALS

Initially, the teacher asked the pupils what they liked to do at their leisure time. She found that the boys liked to go hunting birds and fishing with their father. So she explained a problem involving addition without regrouping to find the total number of fish caught by Max and his father. Pupils were required to write a mathematical sentence following a situation explained by the teacher. Sandy and Diane arranged two groups of straws on the table. The teacher wrote ' + = ' on the blackboard and asked pupils to write the addends. Max,

Diane, Tom and Sandy wrote the addends correctly. However, Rex and Esther did not response. Thus, the teacher helped them by explaining very explicitly that the first two squares should be filled with the number of objects in two groups that were to be combined. She held two groups of straws in her hands and explained the problem situation again. After all the pupils had filled up the addends, Max combined the two groups of straws and counted them while Rex tied every ten straws into a bundle. The teacher asked them how many bundles and how many straws they had altogether. Thus Max counted the bundles while Rex counted the unit straws left and they told her the correct answer. As there was only one square left, the pupils had no difficulty in writing the total number of straws in the math sentence. Yet, when they were asked to explain the meaning of the mathematical sentence, they kept quiet. The teacher was surprised that Rex who had been passive in class for the first time showed his initiative to learn and to participate in an instructional activity.

Next, the teacher showed five straws and told the pupils that she had five fish. Then she asked the pupils to find the fish left after two fish were cooked. At first, all of them were very quiet. Suddenly, Diane suggested that three fish were left. Prompted by her teacher, she counted five straws to represent the number of fish they initially had. Then she removed two straws and counted the remaining straws to answer the question. Diane's peers observed quietly. To help pupils connect the ideas to its abstract representation, the teacher wrote ' $- =$ ' on the blackboard and asked them what should be filled in each square. Pupils managed to write a correct mathematical sentence. The teacher praised Diane for her good work and initiative. As first lesson was ended here, we asked Rex what he understood of Diane's action and the math sentence. Surprisingly we found that he was able to connect each number in the math sentence with Diane's action. However, when we asked the pupils to compare ' $+ =$ ' with ' $- =$ ' and tell the difference between these two operations, pupils looked puzzled. Therefore, we asked them to revise the examples given by their teacher earlier: ' $6 + 10 = 16$ ' and ' $5 - 2 = 3$ '. After thinking for a while, Max told us that the number became bigger in the case of ' $6 + 10 = 16$ ' but the number became less in the case of ' $5 - 2 = 3$ '. Diane suggested that they 'get more' in the case of addition but they 'lose something' in the case of subtraction.

STAGE 2: TRANSITION FROM MANIPULATION OF CONCRETE MATERIALS TO DRAWINGS

Pupils were asked to perform a task individually but allowed to discuss with their peers. The teacher drew two leaves and asked pupils what living things would most probably live on the leaves. Diane suggested insects. Hence, the teacher told the story of two groups of insects that lived on two different leaves. This problem

should be solved using addition without regrouping. Tom manipulated straws to illustrate meaning of that problem. Each pupil was given a piece of paper with two leaves drawn on it. First, they were encouraged to draw insects on the paper but soon they found it very hard to draw so many insects. Hence, their teacher guided them to draw simple lines to represent the number of insects in tens and in ones as shown in Figure 2. They also wrote on the paper the number of insects on each leaf. Pupils wrote a math sentence and found the total by counting the drawing of the number of tens and of ones. It seemed very easy for them to write the correct math sentence but they made mistake when changing the math sentence to the standard written form.

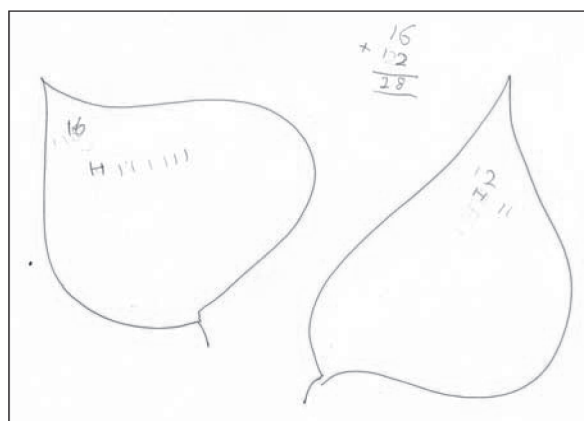


FIGURE 2. Sample Work of a Participating Pupil

The teacher asked them to draw a table with two columns and three rows which we call it as 'place value box'. At the top row, '*pu*' was written to represent tens and '*sa*' was written to represent ones. Then they were guided to fill in the two addends into the middle row. All the pupils, except Esther, were able to fill the answer into the bottom row correctly. Obviously, Esther still could not understand the relation between place value and the standard written form. Hence, the teacher put two boxes in front of Esther. The left box was labelled '*pu*' while the right box was labelled '*sa*'. She asked Esther to draw a 'place value box' on a piece of paper. First, she told Esther that there were six insects living on a leaf and put six straws into the '*sa*' box. Then she asked Esther to write '6' at the '*sa*' column. Next, she asked Esther to fill the second row when she put a bundle of ten straws into the '*pu*' box and said that another ten insects lived at another leaf. She guided Esther to write the numerals and explained the meaning of each numeral in each place by referring to the manipulation of straws. Finally, Esther was guided to find the total number of insects and thus fill the answer in the 'place value box' as shown in Figure 3.

Pupils were encouraged to manipulate straws and draw insects according to the problem situation mentioned by their teacher for the next two problems



FIGURE 3. Sample Work of a Participating Pupils

which involved addition with regrouping and subtraction without regrouping. The teacher prompted them to understand the connection between the manipulation of straws, drawings, mathematical sentence and the standard written form. However, for subtraction with regrouping, the teacher thought it would be very difficult for the pupils and thus she decided to use explicit explanation, demonstration, and discussion with pupils. She explained and demonstrated a way to break a ten to ten ones by drawing. For example, to solve the problem '13 - 5', she guided them to draw a row of ten segments and another three segments below. She explained to the pupils that these segments represented the 13 insects and asked pupils to find the number of insects left if 5 insects flew away. Hence, pupils slashed five segments to get the answer.

STAGE 3: BEHAVIOUR OF PUPILS DURING INDIVIDUAL PRACTICE

During individual practices, Esther had showed that she was not confident of herself in doing mathematics. She approached the teacher very often to check every step of her work and asked the teacher what she should do next. Obviously, she preferred a one-to-one instruction which is teacher-centred. Her peer, Sandy, who also started schooling only two months before this research project, was more independent. Sandy was used to sitting alone when she was doing her work. According to her, doing work together with peers would disturb her and thus she could not concentrate on her work. Sandy and Esther liked to do their work at the table. Max, Rex and Diane were flexible. They could work alone and also work with peers. They liked to work together and often discussed about the algorithm. Tom always worked alone but if any peer approached him to have discussion, he would help them willingly. All these pupils were allowed to choose

their own learning style in order to learn mathematics in a relaxing and favourable environment (Gan & Poon 2008) or the appropriate climate as suggested by Slavin (2009).

We found that all the pupils were drawing segments and lines which represent ones and tens to help them solve the arithmetic problems which involve regrouping. For other problems, they used their immature strategy to get a basic addition or subtraction fact. None of them used straws in solving the problems. They told us that they preferred using drawings because this strategy was 'easy to use'.

DISCUSSION

APPLICATION OF INTEGRATED INSTRUCTIONAL APPROACH

Initially, pupils in this research had shown their insufficient understanding of the key concepts such as place value which contributed to their weakness in arithmetic skills of addition and subtraction. Although they were able to perform counting but their understanding of place value concept was questionable. As the teacher ignored the importance of relating number operations to the concept of place value, pupils did not understand standard written form and tended to make mistakes in changing mathematical sentences to standard written form. In cases of addition with regrouping, some pupils tended to make mistakes after computing the numerals in the ones and writing the sum wrongly. They 'carried' the wrong numeral to the tens and put the other numeral at the ones. They failed to identify the error when they checked their answer. Obviously, they were lack of experiences in connecting place value with symbols and procedures of number operations.

In this research project, pupils were offered opportunities to explore ideas of addition or subtraction and connect that to concept of place value by manipulating concrete objects and drawing. The purpose was to enable them connecting the manipulation of objects and drawing with abstract representation of the ideas in order to gain sufficient conceptual understanding. The concrete representation of the numbers enabled pupils to make comparison of the quantity and thus understand the meaning of the procedures in performing algorithms. Teacher made the connection between the concrete objects with the abstract symbols and procedures explicit to the pupils. Sufficient time and guided exploration were important to help pupil grasped mathematical ideas during our remedial intervention based on an integrated approach and use of concrete objects and drawings. Time pressure was avoided (Slavin 2009) in order to facilitate careful and active thinking during their guided exploration. As some pupils thought that movement and action in manipulating objects were confusing to them, although activities were interesting, they were not

confident on using manipulative to help them in learning. Instruction was carried out in small steps and pupils were given plenty of time to make sense and connect the manipulation of objects to the abstract representation of mathematical ideas. It tended to be more explicit when the teacher helped pupils to construct conceptual understanding by manipulating objects and also during transition from object manipulation to drawings. Pupils needed more guidance from teacher as the manipulative itself carries no meaning as stated by Thompson (1994). However, to motivate pupils in exploration of ideas, their thinking process could be elicited by asking them to make comparison of numbers and of number operations. For example, pupils were asked to compare numbers such as '23' and '32', and number operations such as ' $6 + 10 = 16$ ' and ' $5 - 2 = 3$ '. In this research, pupils also showed their abilities to connect manipulation of objects and math sentence if they were supported by their teacher. Hands-on experiences in a problem-solving context had proved that it helped them to carry out active thinking.

If compared to manipulation of objects, pupils preferred and were more confident to use drawings to help them perform algorithms. Different from the manipulation of objects which was 'ever-changing', pictures and drawings were seemed 'more reliable' as they would not vanish or move. We could explain this situation based on the finding of Mayer & Wittrock (2006) that when pupils are not used to hands-on activities, their cognitive load may actually increase. Pupils had to perform a number of steps when solving problems of subtraction with regrouping. Drawing of segments might help pupils to reduce the work load in their cognitive resource. Thus, they could pay more attention and thinking on executing other steps. On the other hand, when they were asked to use straws to simulate the situation, they had to use their cognitive resource to deal with the manipulation of straws as well as the algorithm. Thus, the two tasks became a burden for their cognitive resource. The skill of drawing segment in representing the tens and ones had enabled them to perform algorithm of subtraction with regrouping successfully. The teacher realized that her pupils failed to answer the questions by merely performing abstract algorithm which was taught through explicit instruction. However, use of drawings had helped pupils to perform the task independently. Opportunities to succeed in performing algorithm had also increased their confidence and interest in learning mathematics. In short, manipulative had helped pupils gain understanding of algorithms while drawing was used as a strategy to perform algorithms. Both strategies motivated these pupils in learning mathematics intrinsically.

FLEXIBLE PLANNING AND IMPLEMENTATION OF INSTRUCTIONAL ACTIVITIES

Active observation and monitoring should be carried out by teacher during instructional activities (Slavin 2009; Reys et al. 2007; Lang & Evans 2006). The information obtained could be used to plan future instructional activities and also to adjust instructional strategy and method during the instruction as pupils with learning difficulties need full support from their teacher who could understand their individual needs and learning style (Gurganus 2007).

The instructional activities were planned to help pupils with mathematics learning difficulties to learn addition of whole numbers using concrete materials and drawings. We intended to observe the response of teacher and her pupils towards the use of exploration and constructivist approach in teaching and learning mathematics as they were used to behaviourist framework of teaching and learning. In applying a problem-solving approach (Slavin 2009) which is supported by constructivist, we found that it was more helpful to pupils when the solution of solving a contextual problem was broken into smaller steps and pupils were guided carefully. Connection between the manipulation of objects and the abstract representation was built step by step. Sufficient time was needed for them to understand the connection of ideas as well as the representation of ideas.

According to Gurganus (2007), every pupils has his or her own learning style, hence the pupils were allowed to do mathematics following their own preferred style. In such a relaxing environment, all the pupils were obviously often used drawing technique to carry out active thinking. Hence, if we would like to motivate these pupils to learn mathematics through active sense-making, drawing as a tool and relaxing learning environment were essential to facilitate their mathematics learning. However, the teacher carried out active monitoring in ensuring that all the pupils were doing active thinking in learning mathematics, not simply copying answers of their peers or following examples demonstrated by teacher.

CONCLUSION

This research project focused on mathematics teaching approach which involved pupils in doing mathematics by manipulating concrete materials and drawing. As suggested by Slavin (2009), the teacher posed a real-life problem and explained the problem situation before facilitating pupils in the learning of problem-solving. Pupils were involved in instruction that emphasized extensive use of physical, pictorial, verbal, and symbolic representations of mathematical ideas. However, in this research, pupils were taught formal and abstract of the mathematical ideas throughout the process in which

they had been working with. Instead of only taught the abstract representation at the end of the mathematical process after pupils had gained firm conceptual understanding which was suggested by Slavin (2009), we find that it was more efficient to learn both simultaneously during the mathematical process. This strategy is also supported by Rittle-Johnson, Siegler & Alibali (2001) who suggested an iterative model that asserted the interactive relationship between conceptual and procedural knowledge.

In short, there are three key aspects which were emphasized in the teaching and learning process of mathematics remedial intervention in this project: conceptual understanding and procedural knowledge, use of manipulative and drawing, and problem-solving approach of teaching and learning. The fundamental concepts that pupils should mastered in order to be able to perform algorithms of addition and subtraction fluently include ideas of place value and meaning of a number operation. For addition and subtraction, problem situation could be based on the part-part-whole concept (Van de Walle 2001). To involve pupils in hands-on activities, teachers should avoid placing time pressure on their pupils. Instead, pupils should be given sufficient time to make sense when they manipulate concrete materials or produce drawings to represent mathematical ideas. Manipulation of concrete materials and use of drawings should be based on a problem context as materials do not carry any meaning (Thompson 1994). In applying a problem-solving approach, Slavin (2009) recommended that problem situations should be based on pupils' existing knowledge and real experiences. Although some pupils respond positively towards teaching and learning which is based on the constructivist approach and other do not, teachers should be tactful and monitor the process of learning actively. For pupils who need explicit and individual instruction, teacher should be flexible in adjusting the instruction. The purpose is to create an appropriate climate during problem-solving process.

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