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Exploring the Use of Mathematics Manipulative Materials: Is It What We Think It Is?

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ABSTRACT

The use of mathematics manipulative materials such as counters and Base Ten Blocks is common in many Australian classrooms. Seemingly there is an unchallenged assumption that the use of manipulative materials in the teaching of mathematics is a key to learning about mathematics concepts, and this is supported by the mathematics manipulatives industry. Teachers who are time poor and under pressure are either looking for a miracle manipulative to solve all their problems with teaching a particular topic such as fractions, or have abandoned the use of manipulatives in favour of textbooks.

This paper reports on a survey and follow-up interviews designed to explore key issues in the use of mathematics manipulative materials in the teaching of mathematics. It also reports on the collaboration between Edith Cowan University, the Independent School sector in Western Australia and R.I.C. Publications, an international publisher and supplier of mathematics manipulative materials based in Western Australia. The aim was to look into the state of play of the use of mathematics manipulative materials in primary schools in Western Australia. To this end, a survey was sent to all teachers in primary and designated middle schools in Western Australia (Pre-Primary to Year Ten; ages 4 – 14), providing us with an initial insight into their use. Further evidence based on a comprehensive literature review, school visits, interviews and teacher workshops is used to review the current state of play as to the use of mathematics manipulative materials in classrooms and to respond to issues raised in the surveys and interviews. This paper compares the data obtained from the survey and interviews.

INTRODUCTION

In the sixties, the use of mathematics manipulatives was often justified on the basis of the ancient proverb:

I hear and I forget
I see and I remember
I do and I understand.

This proverb is still being used as a justification for the use of mathematics manipulatives. While this proverb has a ring of truth to it, given that the use of mathematics manipulatives is encouraged in the teaching of mathematics, particularly in the early years, research evidence is required to indicate whether the use of mathematics manipulatives is effective and if so, under what conditions. Similarly, if mathematics manipulatives are not effective, why is this the case and can adjustments be made to improve the situation or should the use of mathematics manipulatives be discouraged in some cases?

The following quote from Ball (1992) resonated with the researchers:

Whether termed manipulatives, concrete materials, or concrete objects, physical materials are widely touted as crucial to the improvement of mathematics learning (p. 16).

In their experience and from their observations of teachers, the researchers believe that teachers of children aged 5 – 11 and especially those aged 5 – 8 in Western Australia use mathematics manipulatives without questioning the appropriateness or value of the manipulative being used. There tends to be a belief that mathematics manipulatives are inherently good and that lessons that make use of mathematics manipulatives are pedagogically sound.

The researchers set out to gather evidence as to the use of mathematics manipulatives in Western Australian schools and the reasons teachers were choosing to use mathematics manipulatives or not. A comprehensive survey (see Appendix) was sent to all primary and middle schools in Western Australia and teachers in these schools were invited to respond to a series of items. A limitation of survey methodology is the quality of responses in relation to ‘depth’ of meaning (McMurray, Pace & Scott, 2004). Therefore follow up interviews were conducted in order to verify data collected via the survey and to probe further as to the reasons behind the answers that were provided. At the same time a comprehensive literature review was conducted so that comparisons to previous research could be made.

The initial results of the survey have been reported elsewhere (Marshall & Swan, 2007; Swan, Marshall & White, 2007; Swan, Marshall, de Jong, Mildenhall & White, 2007). In this paper selected aspects of the survey data will be reported in a more comprehensive fashion and insights gained from the interviews will be linked with the survey data to provide a richer picture of the use of mathematics manipulatives in Western Australian primary and middle schools. To better understand the data, a comprehensive literature review was undertaken. Prior to reporting the data a brief overview of the literature is provided to offer a context for the report that follows.

REVIEW OF THE LITERATURE

Uttal, Scudder and DeLoache (1997) noted that the literature is somewhat ambivalent about the use of mathematics manipulatives. They explained that, ‘research on the effectiveness of manipulatives has failed to demonstrate a clear consistent advantage for manipulatives over more traditional methods of instruction’ (p. 38). When probing deeper it appears that this statement was made in the light of studies that focus on the acquisition of traditional arithmetic skills such as using algorithms to add three-digit numbers. While the use of manipulatives such as Multibase Arithmetic Blocks (MAB) have often been linked to the development of algorithmic arithmetical skills, as the name suggests, the authors were more interested in the ways that manipulatives can promote thinking on the part of the students using them. Ineffectual use of manipulatives is often linked with the use of mathematics manipulatives as a demonstration tool. This is often the case with the use of MAB where students are taught to copy a particular procedure using the blocks in order to reach a specific goal such as the development of an algorithm for three-digit addition. The advent of Interactive Whiteboards has focussed further attention on whether mathematics manipulatives are used as a demonstration piece or as an explorative tool.

Prior to the advent of Interactive Whiteboards, Sowell (1989) performed a meta-analysis of much of the literature on the use of mathematics manipulatives to that time. The results indicated that short-term use of mathematics manipulatives was not effective and that long-term use was more effective. A critical factor, however, is the teacher. Teachers who lack conviction as to the efficacy of the use of mathematics manipulatives will be less likely to persevere with their use, and implement systems for their distribution and collection. Committed teachers still require training in how to make effective use of specific mathematics manipulatives.

The literature often refers to the use of mathematics manipulatives or concrete materials as creating a bridge from the ‘concrete to the abstract’ (Heddens, 1986). The issue of transferability of knowledge is an issue that causes debate in the literature. For example, does the manipulating of MAB improve a student’s understanding of place value, and if so does this impact on the development of the traditional paper and pencil algorithms? (Howden, 1986). The debate in the literature tends to focus on the acquisition of traditional skills rather than the development of mathematical thinking. The teacher appears to play the key role in choosing appropriate mathematics manipulatives, sequencing their use in a particular way and structuring the learning experience. It should also be noted that the use of mathematics manipulatives should not be seen purely as a means to an end, that is the development of traditional arithmetic skills, but really as a catalyst for deepening mathematical understanding. In order to achieve this, the skilful teacher will need to encourage the students to talk about, discuss and explain their understandings gleaned from ‘playing’ with the mathematical manipulative. Language is the main tool in helping to make the bridge from the ‘concrete to the abstract’.

This brief overview of the literature on the effectiveness of using mathematical manipulatives in the teaching of mathematics has indicated that teachers play a key role in structuring when and how mathematics manipulatives are used to support learning. Teachers’ pedagogical content knowledge and profound knowledge of the particular concept come into play (Ma, 1999; Shulman, 1986, 1987). Teachers need to have a deep understanding of the mathematics they plan to teach; they need to know how the particular mathematics manipulative may be used to support the development of a specific mathematics concept; they need to know the learner and they need to be able to manage the learning environment (for example collection and distribution of materials) in order to be effective teachers of mathematics.

To gain a better understanding of how teachers use mathematics manipulatives, a survey and follow up interviews were conducted. Prior to creating the survey, the literature review was performed to examine whether previous surveys of manipulative use had been carried out and what the findings suggested.

SURVEYS OF THE USE OF MATHEMATICS MANIPULATIVES

Five previous examples of surveys being used to gather data on the use of mathematics manipulatives were found. Three Australian studies were carried out in primary and secondary schools in New South Wales. Howard, Perry and Lindsey (1996) presented some initial baseline data on the use of manipulatives in secondary school mathematics classrooms; Howard, Perry and Tracey (1997) compared primary and secondary school teachers’ views on the use of mathematics manipulatives; and Howard, Perry, and Conroy, (1995) looked at the use of concrete material in Years K to 6. Hatfield (1994) surveyed the use of manipulative devices in elementary schools (K – 6) in Arizona; and Gilbert and Bush (1988) studied the familiarity, availability, and use of manipulative devices in mathematics at the primary level across twenty-one states in the USA. The results from these studies will be compared with the data collected in our survey.

Prior to sharing the results from the survey and follow up interviews, the researchers wish to set the context or framework chosen to support the research. A brief explanation of the construction of the survey follows along with the reasons behind the choice of questions.

RESEARCH FRAMEWORK

One goal of this study was to determine the state and nature of the use of mathematics manipulatives in Western Australian primary and middle schools. (In Western Australia, primary school students range from ages 4 to 12; designated middle schools’ students are from ages 10 to 14). The researchers wanted to find out what, where (year levels) and how manipulatives were being used, and teachers’ perceptions of their efficacy in enhancing the learning of mathematics. The survey gave the

opportunity for the researchers to gain a broad impression of the issues associated with manipulative use, and enabled the researchers to compare the data with previously published survey data.

The representative and descriptive character of the data that was being collected necessitated the creation of a descriptive survey. This form of survey ‘aims to estimate as precisely as possible the nature of existing conditions’ (Burns, 1997, p. 467), and ‘describe some sample in terms of simple proportions and percentages of people who respond in this way or that to different questions’ (Punch, 1998, p. 78). Some of the data collected were quantitative, where the state of the application of mathematics manipulatives was determined by calculating simple proportions and percentages of items such as the frequency with which a particular manipulative is used across the full range of year levels being studied. Qualitative data took the form of identifying the views and opinions of teachers on conditions such as hindrances, and advantages and disadvantages of using mathematics manipulatives in the classroom. Interviews were used to clarify some of these responses.

The descriptive survey questionnaire was designed with three considerations: Firstly, a representative sample across a large and diverse number of WA primary and middle schools was required. Many of these schools were located in regional and remote areas and were thus inaccessible to the researchers. Secondly, in view of the potentially large sample, the survey offered the most efficient and cost effective method of gathering data. Thirdly, to enhance reliability and validity of the study, a structured instrument was required to maximise standardisation of responses.

These considerations were countered by typical disadvantages of using a descriptive survey questionnaire. Although the number of returns was exceptional, with returns from 820 teachers in 250 schools, and therefore reflective of a legitimate representative sample, the qualitative data elicited by the questionnaire did not offer enough depth to explore more complex issues associated with, for instance, respondents’ reasons for choosing particular mathematics manipulatives to use in their classrooms. Interview data was required in order to corroborate and explore the evidence collected via the survey instrument. Interviewees were selected from teachers who had indicated their willingness to participate in this stage of the research, and the selections were made to get as wide a range as possible of year levels taught, number of years of teaching, and urban, rural or remote locations. Comparisons were made to the literature; in particular previous data collected via survey research.

The resultant data set was huge, much larger than the researchers had imagined. In this paper the researchers will report on questions 11 – 13, which deal with issues related to teachers’ beliefs about the use of mathematics manipulatives. Discussion of earlier findings may be found in Marshall & Swan, 2007; Swan, Marshall & White, 2007; and Swan, Marshall, de Jong, Mildenhall & White, 2007. These particular questions probed perceived advantages and disadvantages of manipulative use and hindrances to their use. Overall, the responses indicate how important the teacher is to the effective use of mathematics manipulatives in the classroom

RESULTS

The results are reported question by question. In each case the question is provided and simple numerical data is provided. Support data gleaned from written comments made on the survey document and verbal comments made during the follow up interviews are then provided. These comments help to illuminate what the teachers meant when responding to the questions. Questions are open to interpretation and as such the written and verbal responses help to clarify the data and add richness to the research.

Question 11: What are the main advantages of using manipulatives in the classroom?

Question 11 asked teachers to comment on what they perceived to be the main advantages of using manipulatives in the classroom. Most participants described more than one advantage, and responses were grouped, where possible, into a number of categories. The most common comment, from 155

participants, centred on manipulatives being a visual aid, or that they assisted in concrete visualisation. The next most common comment, from 135 participants, was that they provided hands-on learning, followed by building better understanding (from 126 participants). Many teachers felt that the use of manipulatives helped to engage students, or provided them with enjoyment or were ‘fun’ (from 120 participants). On a similar vein were the comments that they heighten interest or provide motivation (71 participants).

There were many comments on how the use of manipulatives can help children to grasp concepts or reinforce them (61 participants); how they can be used to introduce concepts (36); that they help the abstract become concrete, and that it is easier to go from the concrete to the abstract (33). Many comments were made on advantages other than those that were directly mathematical. These included that the use of manipulatives appealed to all styles of learning (48 participants); encouraged oral language (23); improved children’s fine motor skills (12); provided opportunities for collaborative learning to occur (9); addressed multiple intelligences (6), and all learning abilities (4); and allowed for peer tutoring (4).

From a teacher’s perspective, 27 participants commented that the teacher can more easily note what the child is ‘thinking’ through the use of manipulatives. Skemp (1986) makes exactly this point in the video ‘Twice Five Plus the Wings of a Bird’, when he said that the child’s thinking is right there on the table before you. *‘They enable a teacher to see what the children are thinking, especially when they are unable to articulate themselves.’*

There were some inherent warnings included in the comments on the advantages of the use of manipulatives. One teacher made the point that ‘The students sometimes misunderstand the point of the lesson if it is always explained using the same manipulatives’; another that, ‘Sometimes kids will pick up a ‘wrong’ concept from a manipulative so their use needs guidance and supervision and follow-up, then builds better understanding and concepts’. One telling comment was, ‘I would use them more often but budget constraints limit access’.

One teacher succinctly made this point, ‘All children need to learn mathematics with manipulatives. A lot of children need concrete materials to aid in all maths activities for some time. As they become more adept in mental strategies they are able to dispose with the concrete materials. They are essential to all mathematical learning’. Even more succinct was the comment, ‘Ask Piaget’!

Question 12: What are the main disadvantages of using manipulatives in the classroom

Question 12 asked teachers to comment on what they perceived to be the main disadvantages of using manipulatives in the classroom. Many of the responses were mirrored in the list of possible impediments that were provided in question 13 that followed. In that question, which appeared on a later page, teachers were asked to rank from 1 – 13 the possible hindrances to using manipulatives in the classroom. However, this earlier question was included to find out what teachers perceived as the disadvantages to the use of manipulatives, even given that may still not preclude their use.

The highest ranked disadvantage, from 164 participants, was that teachers often do not have enough of the equipment to go around. This is in addition to the comment from a further 45 participants who maintained that they had a problem having the materials ready to use, with easy access, particularly when sharing with other teachers. There were an additional 50 participants who made the point that the cost of manipulatives made their use problematic.

The overall second highest disadvantage was given as children fiddling and not listening to instructions – that they were often a distraction (94 participants). On a similar vein to this, the amount of noise generated with their use was named by 50 participants; behaviour management was mentioned by a further 44 participants; messiness by 20 participants and equipment misuse by 4 participants.

The third disadvantage, with 90 teachers making mention, was storage and organisation of the materials. Another 82 participants discussed the issue of setting up and packing away, with 49 participants commenting on problems with items getting lost, mixed up or damaged; a further 11 participants wrote of not having enough space in the classroom to use them well; and 4 who made mention of the need to audit materials.

Another area of significance was that of time (64 participants); both in having enough time to teach using manipulatives, and time to organise, set up and pack them away. One teacher elaborated on the time issue and storage of materials, saying, 'Time to initially organise the materials [is a disadvantage] but if that's done at the start of the year/ materials stored efficiently it's OK. We had large plastic tubs with basic kit of Attribute/Pattern blocks, geoshapes, 4 types of toy counters, double-sided counters, slides for each class, 1 – 3'. The invitation was then extended to visit the school to view their storeroom organisation.

The final significant category of responses was that of the issue of 'play'. Thirteen participants made comments similar to the following, that manipulatives 'Can be used for 'play' without proper instruction or process being explored. They require teaching, but can be seen as toys'. Or that it was sometimes hard to wean children off reliance on them (11 participants).

There were many other comments that were interesting: 'Hygiene issues – keeping pieces clean'; 'Safety – putting pieces in mouth'; 'Boys – need I say more'; and conversely, 'Can be hard to get girls interested'; 'We need proof/evidence on paper of the children's learning for parents to see'; and 'Can confuse children if not used properly e.g. place value; MAB cube = 600'.

It was comforting to note that 50 participants wrote 'None' as their response to this survey question, with a number of other participants leaving this section blank. Two final similar comments were: 'Nil at Year 2 level' and a middle primary teacher who said, 'I can't see any [disadvantages] except for people with tidy rooms and low budgets'.

Question 13: Impediments to using manipulatives in the classroom.

Teachers were given a list of 13 possible impediments to the use of manipulatives in their classroom. This list was drawn from the literature (Gilbert & Bush, 1988, Howard et al., 1996; Howard et al., 1997; Hartshorn & Boren, 1990) and from incidental discussions with teachers. By far the four most common impediments were (1) money, (2) behaviour (classroom management), (3) organisation of materials (borrowing/returning, sorting, missing pieces) and (4) space (physical) to use in the classroom. By comparison, Gilbert and Bush (1988) found the main factors hindering increased classroom use of manipulatives to be (1) availability of materials and (2) lack of time. It is unclear whether the availability of materials was in terms of ease of accessing the materials, similar to this study's point (3) or if they were not in the school at all, which may be similar to this study's first point about lack of money.

Teachers in the Hatfield (1994) study were asked to list factors to consider when using manipulatives. What is interesting is that classroom control and management of manipulatives were listed. This is similar to the current research findings. It should be noted that in the current survey teachers were asked to rank hindrances and were given a list to choose from, so the two questions are not exactly the same.

Nevertheless the responses from the Hatfield survey were of interest to the research group. What is of particular interest, however, is that availability of manipulatives and teacher competence in using the manipulatives were listed as Hatfield's top two factors.

Question 14: Teacher Direction or Self-Discovery

Question 14 asked, ‘When using manipulatives, will the students’ experience be based on (1) Teacher direction or (2) Questions arising from self-discovery?’ Of the teachers who completed this question, the majority of participants (397 teachers, or 71%) either ticked both boxes or wrote ‘both’ alongside the question.

Participants were then offered the opportunity to elaborate on their response. Most comments were similar to either ‘Both are important, depending on the task’ or ‘Both – initially it may be teacher directed, but then we move on to self discovery’.

Of those who ticked only the Self Discovery box, comments included, ‘We work in collaborative learning teams and many questions arise from the students’ discovery activities’ and ‘For example, Oh look; if I join mine with ----- then we will have ----’.

Comments from the Teacher Direction teachers included, ‘I find the students do not engage in ‘self-discovery’. They are very dependent on the teacher direction even though I encourage self discovery’, ‘They don’t ‘discover’ without direction, they throw things or build towers – nothing to with lesson outcome’ and ‘Due to availability and time constraints the time available does not allow for much self discovery’.

IMPLICATIONS

Manipulative materials are found in every primary school, albeit often in storerooms rather than in classrooms or better still in the hands of children. It is clear from the survey results that teachers believe that the use of mathematics manipulatives enhances children’s learning of mathematics. It also appears that while this belief is held by over 95% of respondents, Pre-primary to Year two teachers make more use of manipulatives than teachers of older children. It is possible that textbooks play a larger role in mathematics lessons as they move from junior to middle to upper primary and lower secondary school and therefore less use of manipulatives is made. It is also appears that there is a belief by some teachers that the use of manipulatives takes too much time, particularly in upper grades where they make mention of a crowded curriculum. Another possibility is that the introduction of formal National testing (paper and pencil multiple-choice tests with no manipulatives allowed) impacts on teachers’ use of manipulatives.

Survey data can disguise the real reasons behind a particular response. For example, the researchers were surprised that money was listed as the major hindrance to use manipulative materials to teach mathematics. However, recent changes to Kindergartens in Western Australia have meant that Kindergarten budgets have been reduced. Kindergarten teachers have therefore felt financial pressure for the first time, and therefore this may have been in mind when completing the survey.

Organisation of manipulatives is certainly an issue for many teachers who made comments on the survey about issues of borrowing and returning materials. It appears that in some schools the borrowing of mathematics manipulatives comes under the auspices of the library. In some cases not only is the tub of Pattern Blocks accessioned but also individual blocks are numbered. One teacher reported a school edict that any lost pieces would have to be paid for by the teacher who lost them. While the researchers were unable to test the veracity of this statement, it is understandable that if such a claim were true, teachers in that school would be reluctant to make use of manipulatives. Visits to school mathematics storerooms by the researchers would suggest that many manipulatives are in disarray, not labelled or worse still mislabelled, with pieces missing or in disrepair. There were also many examples of different sets of the same manipulatives in the storerooms, which in many instances were incompatible. It also appears that while some schools keep an up to date inventory, in others there is no record of purchases or where the manipulatives are stored. The researchers plan to collect further data on this issue because clearly while this issue is hindering the effective use of manipulatives, it is one that could be fixed with minimal effort.

A surprising finding was that despite believing manipulatives enhance children's learning, less than ten percent indicated they had engaged in professional development and only 19% indicated they would like further training in the use of manipulatives. This was considerably less than the 66% in a previous study, which indicated that teachers would like further training in the use of manipulatives (Howard et al., 1997). The previous study was carried out over ten years ago and it is possible that teachers are less likely to engage in professional development as a result of increasing pressures and general dissatisfaction with the state of the profession in Western Australia. In Western Australia a systemic mathematics professional development initiative involving eighteen hours of professional development has tended to 'swamp' teachers and fatigue them. Of particular interest is that this initiative appears to have had little impact on survey responses. Rather, one particular supportive manipulatives supplier seems to have had more impact.

What was of particular interest is the high proportion of K – 2 teachers who completed the survey and also the number of teachers who had been teaching for 15 years or more who took time to complete the survey. Data from this survey and others (Gilbert & Bush, 1988) suggest that the use of manipulatives reduces as grade level increases. It would make sense, therefore, that teachers in the Kindergarten to Year two range would show more interest in manipulatives.

LIMITATIONS

There are several limitations to this research. While the response rate to the survey in terms of the number of school and the number of teachers responding was excellent, the survey was sent only to Western Australian schools. The sample was therefore restricted to one state of Australia that at the time was undergoing curriculum upheavals. These pressures would have been foremost in mind when the surveys arrived, as teachers would have been writing end of year student reports. It was interesting to note that not only did K – 2 teachers make most responses, but they also made far more written clarifications outlining the reasons why they made particular choices. Typical written responses from teachers of upper primary and secondary classes were short or non-existent. This meant that not only were more surveys completed by teachers of K – 2 children, but also these teachers gave far more written clarification of comments and therefore the data may be skewed by these teachers.

The researchers were also aware that teachers receive many surveys. Several Principals phoned to say that teachers regularly receive surveys, most of which end up in the bin. On the whole these Principals were supportive of the research but felt that teachers were suffering from 'survey fatigue'. The researchers were also aware that some teachers might quickly tick a few boxes or sometimes simply write what they think the researchers might like to read and therefore focus groups, teacher interviews and group interviews were also carried out to verify what the survey data suggested.

CONCLUSION

While the research is still in its infancy the data collected from the survey has started to paint a picture of manipulative use in the teaching of mathematics in primary and middle years classrooms. Previous research by Gilbert and Bush (1988) suggested that manipulative use reduces as grade level increases. The data from our survey would appear to confirm that finding. Reasons for this reduction in manipulative use may relate to increased use of textbooks, a view that using manipulatives is 'babyish', or a lack of awareness of how manipulatives may be used to develop mathematics concepts with older children. Another possible reason for this reduction may be the impact of State and National testing in Years 3, 5, 7 and 9.

Data on the most commonly used manipulatives will assist teacher educators when planning mathematics education courses. Also teacher educators will be able to assist new teachers to manage

the issues such as classroom management of manipulatives so that this no longer impedes the use of manipulatives.

As with most research, the survey raised further questions that require in-depth research. For example money was ranked as the number one impediment to the use of manipulatives. This result was surprising, given that it was not mentioned in previous survey research. Computers may be found in every primary school and require replacement every three to five years and yet there seems little concern about the money required to purchase them, maintain them, load software on to them and connect them to printers and the Internet. It is possible that computers are viewed in a different way to manipulative materials and therefore treated differently. They have become part of a carefully designed purchasing plan that is carefully managed and kept with a current inventory. This does not appear to be the case with mathematics manipulatives in many schools.

Throughout this paper, the argument has been made that manipulatives on their own do not teach – teachers do. Children can often look very busy (active) with manipulatives but that does not necessarily mean that children are learning. Clements (1999) noted that simply using manipulatives as part of a mathematics lesson does not guarantee success.

Their physicality does not carry the meaning of the mathematical idea. They can be used in a rote manner ... They need teachers who can reflect on their students' representations for mathematical ideas and help them develop increasing sophisticated and mathematical representations (p. 3).

Swan and Sparrow (2004) suggested that in the light of the report on effective teachers of numeracy by Askew, Brown, Rhodes, Johnson and William (1997) and the work of Stein and Bovalino (2001) on manipulatives it is clear that teachers play a key role in helping children construct knowledge by helping them to connect ideas. Fifty years have passed since the proverb quoted at the start of this paper was used as a rationale for the use of manipulatives. This is simply not good enough in the twenty-first century. Swan and Sparrow (2004) argued for manipulative use to be effective, a fourth line should be added to the initial proverb:

I talk about it and I connect.

The results of the present study certainly confirm that for mathematics manipulatives to be effective, they must be part of a carefully planned mathematics program. In particular, teachers' own knowledge of the mathematics, the children and the manipulatives need to be sufficient so as they can assist children to connect the use of the manipulatives to the concept being developed.

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3 Please use the table below to add any mathematics manipulatives you use that are not included in the previous list.

Manipulative	Yes	No	Year level(s)	How often used	Individually	Small group	Whole class	Briefly describe how you use this manipulative

4 List the three manipulatives that you use the most.

5 To what extent do you think manipulatives enhance children's learning of mathematics?

not at all	rarely	sometimes	usually	always
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Please elaborate on your response.

6 What do you think are the main advantages of using manipulatives in the classroom?

7 What do you think are the main disadvantages of using manipulatives in the classroom?

8 Teachers were asked to list the main hindrances to using manipulatives in the classroom. (Things that get in the way of your using them.) Please rank their responses from 1 (most important) to 13 (least important).

Behaviour (classroom management)	<input type="checkbox"/>
Classroom management issues (packing up, lost pieces, sorting sets)	<input type="checkbox"/>
Lack of knowledge of how to use the manipulative(s) and what manipulatives are available.	<input type="checkbox"/>
Lack of mathematical content knowledge of how manipulatives may develop specific mathematics concepts.	<input type="checkbox"/>
Money (cost)	<input type="checkbox"/>
Noise level	<input type="checkbox"/>
Organisation of manipulatives (borrowing/returning, sorting)	<input type="checkbox"/>
Parental expectations	<input type="checkbox"/>
Space (physical) to use in classroom	<input type="checkbox"/>
Storage	<input type="checkbox"/>
Student perception that manipulatives are babyish	<input type="checkbox"/>
Teacher perception that manipulatives are for younger children	<input type="checkbox"/>
Time constraints	<input type="checkbox"/>
Other (please elaborate)	<input type="checkbox"/>

9 When using manipulatives, will the students' experiences be based on:

Teacher direction	<input type="checkbox"/>	Questions arising from 'self discovery'?	<input type="checkbox"/>
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Please elaborate on your response.

10 Have you participated in any professional development on the use of manipulatives? Yes No

If yes, please describe.

11 Which manipulatives would you most like help with?

12 Are there any further comments you would like to make on the use of manipulatives?

Thank you for participating in this survey

Please return to: Linda Marshall, School of Education, Edith Cowan University, 100 Joondalup Drive, Joondalup WA 6027

As an additional way of collecting information about the use of manipulatives in schools, we are keen to interview some teachers.

An interview would focus on gaining a deeper understanding of some of the issues raised in this survey.

The aim of the study is to improve the use of manipulatives in classrooms, and to provide quality curriculum material and professional development.

If you are willing to be interviewed on the use of manipulatives in your school, kindly complete the attached consent form and return it with this survey form.

If you wish to remain anonymous, please return only this survey form.

Please note that confidentiality is assured at all times.

Use of Manipulatives in primary and middle school classrooms

Consent to be interviewed form

I have read and understood the information letter provided that explains the research study and I agree to participate in this research study by being interviewed. I understand and consent to the interview being audiotaped. I understand that my participation is voluntary and that I may withdraw at any time. I also understand that no individual or school will be identified when the results are presented or published.

Participant School:	
Participant Name:	
Contact Number:	
Email address (optional):	
Participant Signature:	Date: