Are Mathematics Manipulatives being used in schools.

If so how? If not why not?

Paul Swan, Linda Marshall, Paula Mildenhall, Geoff White & Terry de Jong

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Abstract

Mathematics manipulative materials may be found in every school. As part of a larger research project involving the use of mathematics manipulative materials in Western Australian schools a survey of their use was sent to all Primary and Middle Years schools; a comprehensive literature review was carried out, teachers were interviewed individually and as part of focus groups and school visits were made. Data were collected, collated and general trends noted. This paper reports on how mathematics manipulative materials are being used in schools in Western Australia.

Introduction

We all know of storerooms in schools where mathematics materials or manipulatives sit, unused and gathering dust. Often an inspired teacher purchases some as a ‘pet’ project, and when the teacher moves from the school, the enthusiasm wanes and the materials lie unloved, and often with their purpose not understood. Alternatively materials are purchased as a part of a new trend that has its day and is then forgotten. Or they are purchased as a result of a skilled sales person who convinces staff that the materials will solve all of their problems in mathematics. Another scenario for purchase of materials that later lay dormant is that the staff is told they have only a short time span in which to make their choices before the end of a budget period, so catalogues are accessed and decisions made in haste.

The ECU team, in collaboration with Industry Partners The Association of Independent Schools of WA (AISWA) and R.I.C. Publications, were awarded a grant (Hands On Heads On: The effective use of manipulatives – both physical and virtual) to investigate the use of mathematics manipulative materials in primary and designated middle schools.

Anecdotal evidence, classroom observations, and Gilbert and Bush (1988) would suggest that the use of mathematics manipulative materials decreases through the year levels, and that many schools have materials that are not used.

Research Method

Our research questions focused primarily on ascertaining what, where (year levels) and how manipulative materials were being used, and their perceived efficacy in enhancing the learning of mathematics. Given the “mapping” features of the required data, survey research was considered to be the most appropriate method to initially address this aim. More specifically, the representative and descriptive character of the requisite data necessitated the administration 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 samples in terms of simple proportions and percentages of people who respond in this way or that to different questions” (Punch, 1998, p. 78). Determining the state of the application of mathematics manipulative materials entailed finding out simple proportions and percentages of, for example, the frequency with which certain manipulative materials were being used across the full range of year levels in WA primary and middle school classrooms. Determining the nature of the application of maths manipulative materials involved identifying the views and opinions of teachers on existing conditions such as main hindrances, advantages and disadvantages of using them in the classroom.
A survey was developed to question and collect data on the way that manipulative materials are being used, with follow-up interviews with sample teachers to probe further. A four-page survey (See Appendix) was sent to all teachers from all sectors (DETWA, AISWA and Catholic Education) at every Primary School, District High School and designated Middle Schools in Western Australia.

We were able to find only five previous examples of surveys being used to gather data on the use of mathematics manipulative materials. 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 manipulative materials in secondary school mathematics classrooms; Howard, Perry and Tracey (1997) compared primary and secondary school teachers’ views on the use of mathematics manipulative materials; 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 sample

We had responses from 820 teachers from 250 schools, which represents approximately one-third of all Western Australian schools, with at least one teacher from each of the schools, but up to 15 from some. The responses came from teachers in large metropolitan primary schools, District High Schools (Years K to 10), and remote Aboriginal community schools. They encompassed many religious and educational philosophies, from Catholic, Anglican, Lutheran and Islamic colleges to Montessori and alternative schools. Interviewees were chosen from those teachers who decided to reveal their identity and indicated that they would be prepared to participate in an interview or focus group.

Prior to reporting the results of the survey and follow up interviews it should be noted that the majority of the 820 respondents came from early childhood settings. Over half of the responses (51.7%) came from teachers from Pre-Primary to Year 2. Teachers in the middle primary years (Years 3 – 5) made up 29.5% of the respondents; the upper primary years (Years 6 and 7) were represented by 15.3%; while the secondary years (Years 8 and 9) consisted of only 3.6%. A similar pattern was found in a study by Hatfield (1994) where, of her 87 respondents, 61% were K- 3 teachers.

How often are manipulative materials used?

Teachers were given boxes to tick for how often they used manipulative materials in their classrooms. This choice consisted of daily, several times a week, once a week, every couple of week, about once a month, never and other. Table 1, below, highlights the use of manipulative materials.

<table>
<thead>
<tr>
<th>Year Level</th>
<th>Daily</th>
<th>Several times a week</th>
<th>Once a week</th>
<th>Every couple of weeks</th>
<th>About once a month</th>
<th>Never</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>PP</td>
<td>82.6</td>
<td>17.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 1</td>
<td>47.8</td>
<td>47.8</td>
<td>3.3</td>
<td>1.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 2</td>
<td>29.9</td>
<td>58.4</td>
<td>6.4</td>
<td>5.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 3</td>
<td>19.6</td>
<td>63</td>
<td>4.3</td>
<td>6.5</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
</tr>
</tbody>
</table>
Table 1: How often teachers use manipulative materials (percentage of each year level)

<table>
<thead>
<tr>
<th>Year</th>
<th>19.5</th>
<th>29.3</th>
<th>31.7</th>
<th>9.8</th>
<th>2.4</th>
<th>7.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 5</td>
<td>20.9</td>
<td>32.6</td>
<td>25.6</td>
<td>7.0</td>
<td>7.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Year 6</td>
<td>9.1</td>
<td>38.6</td>
<td>15.9</td>
<td>25.0</td>
<td>9.1</td>
<td>2.3</td>
</tr>
<tr>
<td>Year 7</td>
<td>4.5</td>
<td>45.5</td>
<td>4.5</td>
<td>13.6</td>
<td>31.8</td>
<td></td>
</tr>
<tr>
<td>Year 8</td>
<td>20.0</td>
<td>10.0</td>
<td>50.0</td>
<td>10.0</td>
<td>10.0</td>
<td></td>
</tr>
<tr>
<td>Year 9</td>
<td>40.0</td>
<td>60.0</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

It is no surprise that most teachers in Pre-Primary use manipulative material on a daily basis. Even those teachers who nominated ‘several times a week’ were probably differentiating between ‘mathematics manipulative materials’ and the many other manipulatives they use. As suspected at the outset of this research, the amount of use of manipulative materials drop as the year levels of the children progress. In Years 2 – 7, manipulative materials are still listed as being used several times a week; every couple of weeks in Year 8 (the first year of secondary schooling in most Western Australian schools); and about once a month in Year 9. This backs up the findings of Gilbert and Bush (1988) who made the point that “the overall use of materials decreases as grade level increases”. Howard et al (1996) also found that the use of manipulative materials in secondary classrooms was low, especially when compared to such use in primary school classrooms.

**Hindrances to using mathematics manipulative materials in the classroom.**

Teachers were given a list of 13 possible impediments to the use of manipulative materials 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 manipulative materials 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 manipulative materials. What is interesting is that classroom control and management of manipulative materials 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.

**Implications**

Manipulative material materials are found in every primary school, albeit often in storerooms rather than in classrooms or better still the hands of children. It is clear from the survey results that teachers believe that the use of mathematics manipulative materials 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 manipulative materials 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 manipulative materials is made.
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 using manipulative material materials to teach mathematics. Follow up focus groups indicated that recent changes to Kindergartens in Western Australia have meant that Kindergarten budgets have been reduced. Kindergarten teachers have therefore felt financial pressure and therefore this may have been in mind when completing the survey.

The following comments provide further explanation of this perceived hindrance.

- *Not enough equipment for whole class at the same time.*
- *If we had more manipulatives available, I would use them more frequently.* *(Upper primary teacher with 5 – 10 years experience)*
- *Never seem to be enough [mathematics manipulative materials].*
- *Each class should have basic sets of manipulatives all the time. If teachers have to go and look for them, they won’t use them and kids will miss out.*

The researchers found the following comment to be particularly disturbing, but given that the comment was made anonymously, were unable to check the statement and find out more. There was no reason, however, to believe that the statement was false.

- *Some schools are asking teachers to pay for lost or damaged equipment in class when on loan, there is a reluctance to use them (reported by a class teacher working in a government school)*

Certainly if this is the case, the researchers can appreciate why mathematics manipulative materials may not be used in that particular school. School visits, group and individual interviews highlighted that the way purchases are made and mathematics manipulative materials are stored varies greatly across schools. In some instances the ‘maths co-ordinator’ orders what he/she considers appropriate from the latest catalogue that arrives in the school. Other schools form committees who make recommendations as to what should be purchased. Sometimes clusters, such as the junior primary cluster are given part of the school mathematics budget and allowed to buy the mathematics manipulative materials that the teachers feel are appropriate. At times teachers admit to having to spend their budget before a certain deadline, so little ‘real’ thought is given to the purchases.

One school sent in a comprehensive mathematics plan that linked the manipulative materials to particular mathematics concepts that were main focus for the school. Clearly a great deal of thought had been given to how mathematics manipulative materials could be used to support children’s learning. This well articulated plan may be contrasted with the school who contacted the researchers during the course of the research indicating difficulties in spending their $11 000 mathematics manipulative materials budget, particularly since they had spent $8 000 the year before. This was not a new school being ‘set up’ but rather an older school. There was no evidence of any long term purchasing plan, links to particular mathematics concepts or to professional development of teachers in how to use these manipulative materials.

**Behaviour management** was cited as a hindrance to the use of manipulative materials. Here is a selection of comments that help illuminate the issue.

- *Year 6/7 kids often use them as missiles.*
• Students just want to build towers.

• Children make bridges and towers with the b[expletive] things (middle primary teacher, with more than fifteen years experience).

• Manipulatives often prove problematic behaviourally (comment made by a teacher working in a prestigious private school for boys).

• Some children off task throw them around.

When reviewing the survey data and particularly the written comments made by teachers it was evident that behaviour management issues were cited more by middle and upper primary teachers than those teaching children in the early years of school. Some Kindergarten to Year 3 teachers made comments that it was their job to manage hindrances to manipulative material use and overcome any issues. It may be that children in the early years are easier to manage. It appears, however, that if teachers really believe mathematics manipulative materials to be integral to the learning of mathematics then they will employ strategies for overcoming hindrances to their use. The following comment summarises this:

• An effective teacher would not allow any of the above points [referring to the 13 hindrances that teachers were asked to rank in the survey] to hinder their use.

Organisation of manipulative materials is certainly an issue for teachers, who often made comments on the survey about issues of borrowing and returning materials. It appears that in some schools the borrowing of mathematics manipulative materials comes under the auspices of the library. In some cases not only is the tub of Pattern Blocks accessioned but also the individual blocks are numbered. Visits to school mathematics storerooms by the researchers would suggest that many manipulative materials are in disarray, not labelled or worse still mislabelled, with pieces missing or in disrepair. It also appears that while some schools keep an up to date inventory, in others there is no record of purchases or where the manipulative materials are stored. The researchers plan to collect further data on this issue because clearly while this issue is hindering the effective use of manipulative materials, it is one that could be fixed with minimal effort.

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. Indications from the first few focus groups that have been conducted also suggest that the majority of teachers attending these groups were teachers in the early years who have been teaching for 15 years or longer. Data from this survey and others (Gilbert ands Bush, 1988) suggest that the use of manipulative materials reduces as grade level increases. It would make sense, therefore, that teachers in the Kindergarten to Year two range would show more interest in manipulative materials. After conducting the first two focus groups, three of the researchers noted that for teachers with 15 years or more experience there was somewhat of a nostalgic note to their comments. These comments seem to focus on a time when the curriculum was less packed and children were given time to explore and use manipulative materials more. When asked about why they seem to be under pressure to ‘cover more’ in the early years, comments about their middle and upper primary colleagues expecting more, state tests at Year 3 and broad comments about ‘the system’ and ‘the curriculum’ were made. Further focus groups and teacher interviews will serve to illuminate these comments further.

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 which at the time was undergoing curriculum upheavals. These pressures would have been foremost in mind when the surveys arrived, as teacher would have been writing end of year student reports. It was interesting to note that not only were most responses made by K – 2 teachers, 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 commented on ‘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. The results of this data will be reported later.

**Conclusion**

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 manipulative materials. 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 require 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 are part of a carefully designed purchasing plan. They are carefully managed and kept on an inventory. This does not appear to be the case with mathematics manipulative materials in many schools. The researchers plan to explore this phenomenon further.

The next phase of this research aims to examine the learning theory behind the use of manipulative materials. Teachers in this survey overwhelming stated that they felt manipulative materials helped children learn. What is of interest to the researchers is whether this is truly the case and if so under what conditions?

**References**


