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STUDENTS’ IMPRESSIONS OF THE VALUE OF GAMES FOR
THE LEARNING OF MATHEMATICS

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The use of mathematical games in primary classrooms is commonplace in Australia. This paper reports on key findings from a larger investigation exploring the impact of games on mathematical learning, student attitudes, and behaviours. 222 Grade 5 and 6 children were taught multiplication and division of decimal numbers using calculator games. This paper raises questions about the students’ attitudes towards games as a vehicle for learning mathematics. One aspect reported in this paper is an apparent difference between students’ attitudes to games usage when data were collected quantitatively compared with qualitatively.

INTRODUCTION

Games can ignite the interest of children through anticipation of competition, challenge, and fun (Owens, 2005). An assumption underlying this doctoral research was that a novel pedagogical approach may have a positive affect on students’ attitudes towards mathematics and classroom engagement. The research questions were (a) “Does the use of games contribute to mathematical learning?” and (b) “What are the relationships between games, learning, and student responses?” This paper focuses on the latter question. It is an important question because understanding varied pedagogical approaches that assist mathematics education and improve students’ attitudes and behaviours is vital. The motivation of students is a general concern because of society’s acceptance of poor attitudes to the potential for success in mathematics (Kloosterman & Gorman, 1990).

A great deal of research and interest has surrounded the area of attitudes and mathematics (e.g., Leder, 1987; McLeod, 1992; Reynolds & Walberg, 1992). For the purpose of this paper McLeod’s (1992) definition of attitudes is adopted: “affective responses that involve positive or negative feelings of moderate intensity and reasonable stability” (p. 581). McLeod attributes time elapsed to the development of an attitude, and notes that changes in students’ attitudes may have a long lasting effect.

Children enter school with an attitude towards learning that is derived from their home environment but once they start school, attitudes become performance related as success or failure impact approaches to subsequent situations (Lumsden, 1994; Reynolds & Walberg, 1992). Other factors include motivation, the quality of instruction, time-on-task, and classroom conversations (Reynolds & Walberg, 1992, Hammond & Vincent, 1998). Students’ also develop responses through interaction...
Learned responses to school activities form from this interaction and understanding. This may then impact on students’ attitudes as they get older, when positive attitudes towards mathematics appear to decline (Dossey, Mullis, Lindquist, & Chambers, 1988). These factors informed the research when considering the second research question: What are the relationships between games, learning, and student responses?

METHODOLOGY

The research was conducted with 222 Grade 5 and 6 students from eight classes in three Melbourne schools. The children undertook two experimental teaching programme sessions per week for four weeks, a total of eight sessions.

Two forms of data collection were used: 5-point attitude scales (administered pre-, post- and delayed post-intervention) resulted in qualitative data, and semi-structured student interviews (conducted post-intervention) with 18 randomly-selected children resulted in quantitative data that gave greater insights into the impact of game-playing on both concept development and attitudes. 121 students successfully completed all three attitude scales. Therefore, only the data from these students were considered. Other data were collected via achievement tests, and researcher observations, however, this paper focuses on the attitudes scales and interviews, and mainly on the statement “Maths games help me to learn maths”. Themes were identified from the interview transcripts on the basis of the comments being either representative of the interviewed group or their giving a differing perspective.

RESULTS AND DISCUSSION

Table 1 presents the frequency of responses to the rating scale for each question on the pre-intervention scale. Overall, at this stage the students had a positive attitude to mathematics games as a vehicle for learning mathematics, suggesting positive prior experiences with mathematical games.

Table 1

<table>
<thead>
<tr>
<th>Attitude Statements</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maths games help me to learn maths</td>
<td>46</td>
<td>45</td>
<td>19</td>
<td>9</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 2 illustrates the shifts in the children’s attitude immediately after the teaching programme period. The change column represents the difference on the Likert scales between the pre-intervention and the post-intervention. The students’ pre-
intervention results were subtracted from their post-intervention results to gain an indication of any shifts in attitudes.

Table 2

*Interval Changes (Pre-intervention and Post-intervention) in Responses to: Maths Games Help Me to Learn Maths (n = 121)*

<table>
<thead>
<tr>
<th>Change</th>
<th>Frequency</th>
<th>Percent %</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
<td>5</td>
<td>4.1</td>
</tr>
<tr>
<td>-3</td>
<td>6</td>
<td>5.0</td>
</tr>
<tr>
<td>-2</td>
<td>17</td>
<td>14.0</td>
</tr>
<tr>
<td>-1</td>
<td>24</td>
<td>19.8</td>
</tr>
<tr>
<td>0</td>
<td>48</td>
<td>39.7</td>
</tr>
<tr>
<td>1</td>
<td>15</td>
<td>12.4</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Nearly 40% of the students in the game-playing groups did not exhibit a shift in attitude between the pre-instructional period and immediately after it. Seventeen percent of students felt that games helped them learn maths, whilst 43% more felt that games were not helpful. This latter response was not anticipated.

To provide an alternative perspective on the shifts in attitude, longer-term changes were examined through the delayed-instructional scale. Table 3 illustrates the shifts in the children’s attitude 10 weeks after the teaching programme period.

Table 3

*Interval Changes (Pre-intervention and Delayed Post-intervention) in Responses to: Maths Games Help Me to Learn Maths (n = 121)*

<table>
<thead>
<tr>
<th>Change</th>
<th>Frequency</th>
<th>Percent %</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
<td>8</td>
<td>6.6</td>
</tr>
<tr>
<td>-3</td>
<td>8</td>
<td>6.6</td>
</tr>
<tr>
<td>-2</td>
<td>15</td>
<td>12.4</td>
</tr>
<tr>
<td>-1</td>
<td>28</td>
<td>23.2</td>
</tr>
<tr>
<td>0</td>
<td>45</td>
<td>37.2</td>
</tr>
<tr>
<td>1</td>
<td>13</td>
<td>10.7</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>.8</td>
</tr>
</tbody>
</table>
Over 37% of the students in the game-playing groups did not indicate a shift in attitude over the whole 14-week period, and 14% responded with a more positive attitude, whilst 49% indicated that the mathematics games did not help them to learn. It appears that the games employed seemed to have resulted in less positive attitudes towards learning mathematics through the use of games - a surprising result as the students had seemed to enjoy the games and demonstrated a developing understanding of key concepts.

Some possible explanations for the negative trend in the attitude scales are:

- The games were addressing both content and process that were quite advanced for these students.
- The effect of these games was disequilibrating, in that it was creating cognitive conflict with previous issues of multiplication; e.g., multiplying always results in bigger number, and so created a desirable but disconcerting uncertainty.
- It was observed that some children became bored with playing the same types of games twice a week over the four-week period.
- The students may have become fatigued with answering the same questions on the Likert scale and in turn answered more negatively.
- Likert scales may not provide an accurate measure of the students’ attitudes and need to be read in conjunction with other data, such as interviews.

In order to gain insights into the students’ perceptions of their learning during the game-playing sessions, students were asked the following question, “Has there been a time during playing the games that you thought, ‘Hey, I am learning this?’ If so, tell me about it.” The examples of learning during game-playing presented below included: recounting the effect of key mathematical concepts addressed in the games; using problem-solving strategies; and the use of tools to assist learning.

Several children referred to learning about the effect of multiplication and division of decimals, and commented on related strategies they had used; e.g., “Yeah, a couple of times, when I thought, ‘Oh, this number gets it down to this and then that number will get it up higher’” (Andrea).

A number of children offered more detailed responses to the question; illustrating the problem-solving strategies that they used to assist their learning. For example:

Frazer: When I played the games I didn’t know what it would do if I times it by a point, like just a point and a tenth, or just a whole number and a whole number and a tenth or hundredths or a thousandth. That’s what I didn’t know. When I experimented with it then I found that point 1 is 10 to the 100 or something. It goes lower than with a whole number and a whole number and a tenth or a hundredth … and with just a whole number would go higher anyway. And, so that’s how I learned how to times and what would happen. That’s how I knew, that’s how I got it first shot, because I learnt how to do it when I was experimenting.
It seems that Frazer used trial and error to develop an understanding of the effect of multiplying fractions. Frazer’s teacher considered him to be a highly motivated and proficient mathematics student, but similar understandings were developed by those who lack confidence and view themselves as poor mathematicians, as in the case of Katie.

Katie had indicated many times throughout the study that she was “hopeless at maths”. However, it appears that the use of calculators in the games helped free Katie to experiment, test theories, and build the key mathematical concepts. For example:

Katie: Oh when I figure out that I can actually bring it up and down without going, “Oh, how do I do that?” and sort of wondering without asking somebody. Because you can try anything with a calculator. Which is good because you can always put it back, it’s not like writing it. And you can sort of like trial, I can just keep trying, it just makes it easier without anybody watching you. Yeah, without everyone going “That’s wrong”, got to rub it out now or keep it there because you know like every time in class you know I rub out the right answer sometimes. … if you hear anyone coming up saying you can’t put it like that you can just clear it and put it back in again and work it out more without writing it down. You’re using your head.

Although Katie was using a computational tool in the form of a calculator, she also used mental computation to assist in playing the game, rather than simply trial and error on all occasions. The game atmosphere appears to have been a less threatening setting than the typical mathematics classroom environment for Katie, enabling her to engage openly in developing an understanding of mathematical content.

In summary, it appeared from the interview data that the students felt comfortable with game-playing and were interested in developing strategies for winning, and that the desire to win encouraged them to grapple with mathematical concepts that were beyond the scope of the prescribed curriculum for their level. In fact, the students interviewed were able to share strategies they had developed that highlighted their emerging understanding of the relevant mathematical concepts. Further, it was clear from some of the students’ responses that many were still attempting to create meaning from the concepts addressed in the games. From a constructivist perspective, disequilibrium seemed to prove to be an important step towards engaging students in mathematical learning. Some of the positive reasons given for liking the game-playing were a shift from traditional style teaching, a challenging and enjoyable activity, and potential for social interaction with peers. Some children reported that the games supported learning through the conceptual feedback inherent in each turn, and from engaging in teacher or peer dialogue about the mathematics involved in the activity as the games progressed. The games also appear to have assisted in developing an awareness of other skills such as problem-solving.

Thus the less than positive response to the games displayed in the attitudinal scales was in contrast to the students’ interview data. (It also contrasted with the informal
observations of the researcher and class teachers.) This was puzzling but also very interesting in terms of the methodological choices that researchers make.

It is possible that the use of games previously as a warm up activity or as a reward may have undermined the significance of games as a teaching tool. Baker et al.’s (1981) study found a negative relationship between reward games and students’ completion of class work. Students presented poor quality work in a hurried effort to be rewarded with game-playing. It is possible that the students in this current study had had a similar experience of games being used as a reward or viewed games as a warm up activity before the “real” learning took place. It is also possible that the positioning of the attitude scales on the front of the achievement test may have produced a negative attitude towards the games. Many students have performance anxiety towards the completion of the achievement tests (McDonald, 2001). Therefore, completing the attitude scale, whilst feeling anxious about the impending test, may have caused the students to respond negatively on the scales. The problematic nature of the research methodology is a consideration for future research in this area.

CONCLUSION

One of the aims of this study was to explore students’ attitudes towards games as a vehicle for learning. One barrier for the employment of games as a pedagogical tool may be possible negative attitudes held by students towards the likelihood of the games’ effectiveness in assisting mathematical learning. As the students appeared to appreciate and enjoy games that provided them with a positive learning experience, perhaps the usefulness of games as a tool for learning needs to be made more explicit to the children. Allowing the students an opportunity to communicate the benefits of the game beyond the key mathematical concepts may also draw their attention to the potential of games to provide a positive learning experience.

The games in this current study were viewed as too difficult for some students and lacked challenge for others. Employing activities that cater for all may be problematic for many teachers. In recent years, there has been a movement towards providing open-ended tasks that cater for the differing capabilities of students (Sullivan, Mousley, & Zevenbergen, 2005). A way for teachers to adopt an open-ended approach to games is to consider using games that have different levels built in and challenges that the students can review and adapt while playing. Adapting games to make them less or more challenging can be a whole-class activity. The teacher may ask the students to brainstorm for ways to alter the objectives or mechanics of the game to vary the game’s complexity. This approach to developing the games further provides the students with a sense of ownership of the games and potentially acts as a vehicle for promoting student involvement in the game-playing experience.

In summary, it appeared that the game-playing negatively affected attitudes based on the results of the attitude scale. However, this was not necessarily the case in the interviews and other communications. One of the implications from this is that it is very difficult to get clear indications of people’s attitudes from only one type of data.
source. It is recommended when seeking data about attitudes that a variety of data collection methods are employed.

On balance it appears that assumptions that students will see the usefulness of mathematics games in classrooms are problematic. Specific links should be made to connect the content of the game, and the concepts to be learnt, to the curriculum and to other aspects of mathematics such as problem-solving. Teachers can be encouraged to continue to use games, but should be aware that they need to take specific actions to make sure that they maximise the opportunities of games in the classroom for supporting students’ own knowledge of their mathematical learning.

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References


