Children's Perspectives on Mathematics and Game Playing

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This paper reports on data collected from a larger study investigating the effect of game playing on students' mathematical learning and motivation. The study was conducted in three schools with 240 students participating in four different treatment groups. This paper reports some of the results of interviews with students to gather data on their attitudes towards mathematics and game playing. The interview data collected from a sample of students in the three game playing groups pertaining to attitudes are presented and discussed below.

Throughout time it seems that games have been a part of people's lives. Anthropologists have studied unique games played by ancient people, relative to their time, place and environment (Barta & Schaelling, 1998). Bright, Harvey and Wheeler (1985) argued "that games have evolved along with civilisation. It seems that games survive and are played because people enjoy playing them" (p.1). Games can bring people together in a communal atmosphere, and it has been suggested that the tradition and ritual of games offer opportunities to link learning with cultural and historical understandings (Griffiths & Clyne, 1995).

Games are seen to be fun, not only motivating but ensuring full engagement, particularly through reflection and discussion, on which constructive learning depends (Booker, 1996). It is usually assumed that games will motivate students, resulting in more willing engagement and hence improved learning of mathematics. This paper reports on data collected from a larger study investigating the effect of game playing on students' mathematical learning and motivation.

The Benefits and Effectiveness of Games for Mathematics Teaching

In general, there appears to be an acceptance that game playing is beneficial. It has been proposed that children learn through social interaction, by talking, listening, and actively exploring concepts with their peers, in whole class, small group or individual activities (Trafton & Bloom, 1990) and that mathematical games are valuable for stimulating and encouraging mathematical discussion between groups of children and between pupil and teacher (Ernest, 1986). Booker (1996) stated that an advantage of playing games with peers is the immediate feedback children receive. Discussion occurs when problems arise. There are no long delays waiting for the teacher to reconcile difficulties. Children are able to articulate and clarify or express their lack of mathematical understanding. It seems that discussion generated when playing games may encourage children's mathematical understanding. Whilst playing a game, children have shown a need to predict, test, make generalisations, justify decisions and check the proceedings of the game (Oldfield, 1991). Students may build on their prior knowledge and form links between the game and their everyday surroundings.

It has been argued that differences in children's attitudes to mathematics are noticeable when playing games. Burnett (1992) considered that mathematical games capture children's enthusiasm and create environments favourable for learning. Research by Bright, et al. (1985) reported that games generate enthusiasm, excitement, total involvement and

enjoyment. Ernest (1986) argued that pupils become motivated, they immerse themselves in the activity, and over a period of time can enhance their attitude towards the subject when playing games. Griffiths and Clyne (1995) observed when students are enjoying what they are doing, when they are motivated, when they have an interest in the outcome, it is more likely that learning will take place. Games may motivate children to learn. For children who do not enjoy mathematics, games allow teachers a way of building the students' interest (Sullivan, 1993). Although instructional games are a means of learning mathematical concepts, and providing an alternative to more formal teaching methods, this does not guarantee that learning will take place (Burnett, 1992).

Motivation

In delineating views on mathematical games an underlying theme seems to be participants' response to game playing situations. A focus of this research is the relationship between games and student responses to mathematics. A key factor here is the potential of games to stimulate intrinsic motivation through enjoyment and success.

Middleton and Spanias (1999) defined motivation as "reasons individuals have for behaving in a given manner in a given situation. They exist as part of one's goal structures, one's beliefs about what is important, and they determine whether or not one will engage in a given pursuit" (p.66). For the purpose of this paper, this definition of motivation is adopted.

Middleton and Spanias (1999) outlined two types of academic motivation—intrinsic and extrinsic motivation. Intrinsic motivation occurs when students engage in learning "for its own sake" and they enjoy it. Extrinsic motivation takes place when students learn in order to secure a reward, eg. good marks, favourable opinion from others, or to avoid punishment and parental disapproval. Dickinson and Butt (1989) suggested that a major influence on motivation is the students' perception of how successful they are in the mathematics classroom and to what they attribute that success. They need to feel that success in mathematics is attributable to their ability and effort.

Motivation is a general problem in mathematics because of society's acceptance of poor attitudes about the potential for success in mathematics (Kloosterman & Gorman, 1990). Motivation is seen to have an affect on attitude; attitude is defined as a way of thinking, acting and feeling that affect development (Thorndike & Barnhart, 1968). Children enter school with an attitude towards learning that is derived from their home environment (Lumsden, 1994). Upon starting school, children's attitude to learning becomes performance related. How children assess their success and failure impacts on their approach to subsequent learning situations (Lumsden, 1994). In a study exploring the factors affecting students' attitude towards mathematics achievement, Reynolds and Walberg (1992) stated that previous attitude had the most powerful influence on subsequent attitudes, although other factors, including motivation, were notable. A link was found between attitude and instructional exposure. The quality of instructional exposure, time-on-task (Reynolds & Walberg, 1992), and the relationship between student and teacher and other mentors are all factors further influencing attitude. A student who has previously held a negative attitude towards mathematics will tend to enter the mathematics classroom with a negative attitude but success in mathematics is seen as a way to overcome negative attitudes (Reynolds & Walberg, 1992). When a student feels they can succeed, they are in turn motivated, motivation is tied into this belief that one can succeed (Kloosterman & Gorman, 1990). It is understood that students feeling successful

in the mathematics classroom are more confident and task-involved. Students who are task-involved are motivated to learn (Kloosterman & Gorman, 1990).

Such observations on motivation underpin my interest in potential links between mathematical games and motivation, the development of positive attitudes, and success. This has lead to the development of a model (see Figure 1) that is being used to inform research questions, and subsequent interview and observation schedules. The basic assumption is that a student who feels successful in the mathematics classroom may have a higher level of motivation, and thus in turn, hold a positive attitude towards mathematics. If games prove to be a way of motivating students, the question is whether this assists in increasing students' level of success and developing positive attitudes.

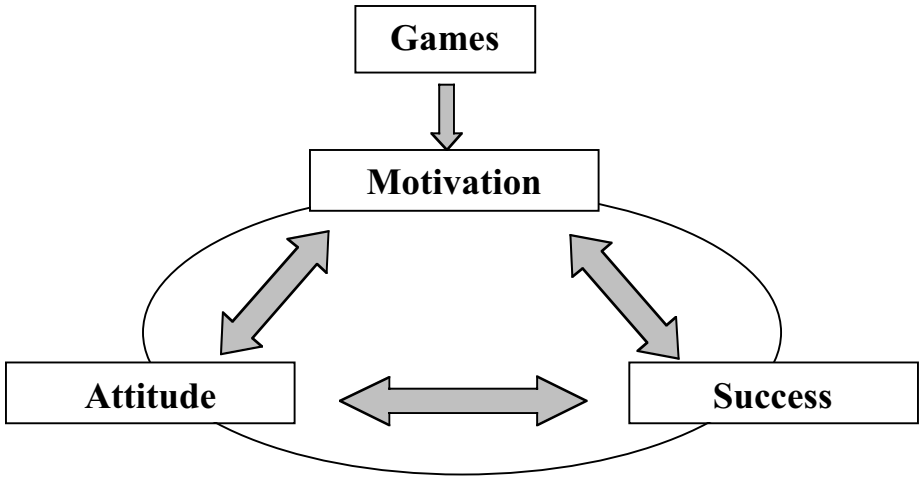

Figure 1. The role of games in motivation, attitude and success.

In summary, relevant literature suggests that motivation plays an important role in student learning. There are many factors influencing motivation including attitude and success in the mathematical classroom. Activities that are enjoyable and stimulating are seen to build on intrinsic motivation, games may be one possibility. This paper reports on the findings of students' interview data examining their attitudes towards game playing and the learning of mathematics.

The Approach to the Research

The data presented below were part of a larger study conducted with 210 grade 5 and 6 students (9 to 11 year olds) from three working class schools in southern Melbourne. The students were placed into four experimental groups. Two of the groups played games over different periods of time, 20 minutes or 35 minutes, to explore if there is a difference in the findings if children played games for a short time (up to 20 minutes) or for a longer period (more than 30 minutes). The third group engaging in approximately 15 minutes of focused discussion of the strategies employed by the students during and after 20 minutes of game playing. The fourth group participated in activities that addressed the same mathematical concept as those in the games, i.e., multiplication and division of decimals, in a more traditional way. The period of the study was 14 weeks and data were collected via written

tests, researcher observation, student conversations, student interviews, attitude scales, and student documents.

The stage of the research being reported on here involved the use of two games aimed at developing children's understanding of decimal fraction operations. This focus was selected because decimals are a key concept in the grade 5-6 curriculum. *Guestimate* (Swan, 1996) is a calculator game based on multiplication of decimals. The aim of the game is to be the first player to hit the target of 100.*** (* indicates decimal places in the number). Player one begins by entering a two-digit number between 10 and 99. Player two can only multiply this number by another number so that the answer will hit the target. The players take it in turn until they reach the target. *Guestimate* was also played using only division. In this version the students are to reach a target of 80.***.

Hone on the Range (Brannan, 1983) followed the same procedure as *Guestimate*. However, in *Hone on the Range* the players aim for a target between a given range of numbers (e.g., 750 to 780). The players decide on the target range. *Hone on the Range* was played using either only multiplication or only division.

Student Interviews

The student interview data are examined in this paper. Interviewing was one preferred method to gather alternative perspectives into the students' responses to game playing and learning in the mathematics classroom. Interviewing has the potential to provide further insights into the students' experience that may be overlooked in other forms of data collection, and can assist in developing meaningful understandings of the climate of the mathematics classroom (Zevenbergen, 1998).

Twenty randomly selected students were interviewed from the three game playing groups. Although the same interview questions were asked of all participants, similar to a structured interview, they were open-ended in nature to allow for a description of the students' experiences. Figure 2 highlights the interview questions reviewed in this paper. The interview questions allowed for clarification of the students' attitude towards mathematics and games. The interviews were audio-taped and at times videotaped.

Questions
Has there been a time that you liked maths? Tell me about it
Has there been a time that you hated maths? Tell me about it.
Was there a particular time that you thought these maths games were fun? Tell me about it.
Has there been a time that you thought, "Hey, I am learning this". Tell me about it.

Figure 2. A Sample of the designated interview questions.

During the interview, the students played a game of *Guestimate* with the author and were required to make decisions on which number to enter for their turn and their opponents. The playing time varied amongst students.

Children's Perspectives

The following section presents the results of a section of the data collected during the interviews of six children, Coco, Cate, Austin, Kenny, Jacqui and Abel (all names are pseudonyms), from the three game-playing groups. Coco a year 5 child, from the *Focused*

instruction game playing group, was considered slightly above average in mathematics according to her teacher. Cate, a year 6 student, had partnered Coco on one occasion. She was considered an average mathematics student. Austin and Kenny, year 6s, from the *20 minute game playing* group were partners in all sessions and were considered highly competent in mathematics. Jacqui, year 6, and Abel, year 5, from the *35 minute game playing* group, were considered average student in mathematics and were not paired during the sessions. In this paper, data reported are from two children from each of the three treatment groups. As their opinions were not necessarily representative of the other children in their groups, no between-group comparison is being made at this stage.

Positive and Negative Attitudes Towards Mathematics

The students' positive views towards mathematics appear to support research findings that children are motivated and feel success in the classroom when they are having "fun". Children's attitudes varied depending on the type of activity, the year level or impact of the teacher.

> *Interviewer (I): Has there been a time that you liked maths? Tell me about it.*
>
> Coco: Well last year I wasn't very good at maths, like I dropped big time and then this year I brought my maths up and now I'm at one of the head of the class or that's what I think in maths. It's fun like if you know what you are doing. You can have more fun doing maths when you know what you are doing. Like if you are struggling with it then it's not as fun because like last year I was struggling with it and I didn't find maths a fun subject but it's quite fun now.
>
> Cate: Sometimes, when I was a lot younger I used to love maths. I suppose I just liked school when I was little. I used to like everything. And then in Grade 4 we used to learn maths games and I liked it then. Last year was a little bit harder when we had Mrs A, we always used to do a lot of maths off the board. And this year it's been OK. It's been pretty good, well depending on what we're doing. If we are doing like games or something a lot easier not just copying off the blackboard it's more fun.
>
> Abel: In Grade 1 and 2 it was all right. Then it started to get a bit annoying. (Grade 1 and 2) was easy and it was fun. Easy work made it fun.
>
> Jacqui: Sometimes, depends what we're doing. Like, if we're doing times or if we're doing games.
>
> Kenny: Yeah, sometimes, it depends what we're doing, really. I don't know like exactly when I've had fun but, when she gives work to us and I can decide if it's fun or not. I like doing some times tables because we play a game and I'll have fun playing that. And then when Miss D calls out a sum and we sort of write it down. That's fun! And the speed tests too, I like them.

The students were clearly able to articulate times in which they liked mathematics. It appears that the ease with which a student is able to engage in a task enhances the students' enjoyment of mathematics. Games were seen as activities that contributed to this enjoyment as opposed to a traditional, transmissive style of teaching as indicated by Cate.

The students were asked to comment on a time when they hated maths. The data revealed that the children were concerned with the repetitive nature of some mathematics lessons and disliked testing.

> *I: Has there been a time that you hated maths? Tell me about it.*
>
> Coco: Well it's like really really easy stuff like you already know it and Mr B keeps on explaining and explaining it because there are people in the grade who don't understand it. And you just want to get on with it except he keeps explaining it and it's too easy.
>
> Cate: Probably last year. Well sometimes I hated it because we kept just [doing] boring writing off the board and filling out sheets, it wasn't very fun. Just maths problems, you know, plus sums, minus, anything, it was just writing off the board and it wasn't as fun as writing in your book. It was alright though, just sometimes.

Abel: Some of it (Grade 3) was pretty fun but then it kind of got a bit boring, a bit too easy, because it was just going over like some of the maths in Grade 2.

Jacqui: Yes, when we're doing stuff that I don't really like things that I already know and we're getting taught it again. Like for the year 5s.

It appears that these students are at times bored and potentially disengaged in the mathematics classroom due to repetition of instruction or revision of previously taught concepts. This boredom may affect the students' attitude towards mathematics now and in the future. Games were not perceived as boring and repetitive by the students and therefore have the potential to overcome the students' negative attitude towards mathematics.

Children's Perspectives of Their Learning

The following comments reveal students' recollections of moments that they felt they were learning. Some children stated that they felt that they were learning through game playing.

I: Has there been a time that you thought, "Hey, I am learning this'? Tell me about it.

Coco: Well in grade 4, I remember we had to learn our 6 times tables. It was with Miss K and we did this thing where you banged on the table tops but went round the classroom and I think it took me, 2 days and I only knew my 6 times tables so it was like really fun but easy that way.

Cate: Last year I learnt a lot because…we did a lot off the board, and this year Mr B's helped me understand a lot more. So now I think I'm learning more when I have someone telling me how to do it and then showing me how, then showing me on paper or on the board and then I know how to do it myself. See I don't learn very much when someone just gives me a piece of paper and doesn't explain anything to me. I need everything to be explained before I understand. …With the games that we've been playing, the first time that I won we were either on zero or right above like up way past 100. And then when I finally got it, I thought I'm learning how to use a calculator and I'm learning which way to make it go up and which way to go down.

Abel: When I was learning, I think I was in Grade 3. I was learning my 3 times tables. I learnt up to 5s in Grade 3, then in Grade 4 I just learnt the rest. And I really learned them. Because they're pretty good, like easy and fun. Because we used to play times tables games *Around the world* and *Footy tables* and *Times table champs*.

Austin: Yeah, the first time I timesed numbers I really didn't know at first but then I got the hang of it and I realised I was learning something. I was about in grade 2. Then I felt like I could do it, like, independently, by myself. And that was sort of fun. It was like when we did fractions I didn't know the top and the bottom. And now I know what they're called and stuff.

For many students, an ability to multiply numbers appears to be an important hurdle that children recall learning. Engaging activities, such as games, associated with "times tables" have seemed to assist in the students' proficiency. The students have associated the feeling of success with fun. For Austin, like many students, an ability to work independently of the teacher and others helps to build confidence through achieving success in the classroom.

Attitude Towards Mathematical Games

The students were asked to comment on a time when they thought games were fun.

I: Was there a particular time that you thought these maths games were fun? Tell me about it.

Coco: Yeah they were fun but I rathered (sic) the one when we had to get to 100 more than the Hone on the range, because I like the challenge more than just taking the easy way out. Than just taking the easy way out.

Cate: In 'Hone on the Range' I thought that one was more fun than the others because it was a lot easier. Because you don't have to get a specific number you just have to get in between one number and another number. Just the first game we played, it was harder because you had to land exactly on 100.

Abel: Yeah, all the time. They were a bit different because we usually write work in a book, and that kind of stuff.

Jacqui: Yep. I like the times ones better than the division. It was a lot easier. The ones where you had to get a certain number, like 75 to 80 or something.

Austin: Yeah, the first time we played I felt like it was better than doing maths on the board because it was a bit easier and we could learn things by not writing down. It was like playing games with your friends. That's what I felt. Oh, I felt like I was learning but I wasn't learning much.

Kenny: Yeah, at the very very start. I like learning like new things so that's why I was glad to be able to play this. I'd never ever timesed decimals or divided and I learned about what they do to a whole number.

All the students agreed that the games were fun, but the degree of difficulty of the game impacted on their levels of enjoyment. The students revealed conflicting views about the games: some students seek a challenge to make the game interesting and fun, while others feel that easier games are more pleasurable. The games were viewed as a diversion from the typical classroom routine and as an opportunity to learn a new mathematical concept. Although the games were dealing with seemingly difficult concepts, the students freely engaged with them and found the experience enjoyable. It is feasible that the difficulty of the concepts may have affected the students' preference towards the easier variations of the game. However, one student enjoyed the challenge that the *Guestimate* posed.

Summary of Implications for Teaching

Games have the potential for students to associate learning of mathematical concepts with enjoyable mathematics episodes. This may assist in developing a positive attitude towards mathematics and learning.

The students interviewed were able to articulate both positive and negative experiences associated with mathematics games. The attributes associated with the positive experiences were seen to be having a feeling of success, an ability to engage with tasks easily, and participate in an enjoyable activity. Game playing has the potential for children to develop a positive attitude towards mathematics as it is has the characteristics associated with a positive experience. The students interviewed perceived games as fun. They are often easy to play and a feeling of success can be derived from not only winning but also through making a strategic move.

The students interviewed also voiced instances when they disliked mathematics, citing the repetitive actions of teachers; this was as a result of tedious activities or explanations. It could be noted that teachers need to monitor the frequency of games usage and seek feedback from the class.

A point of interest was that some children felt they were learning when they participated in enjoyable activities. Games were seen to be such an activity that assisted in their learning. Enjoyment may be derived from a feeling of success. Students found that explanations of the mathematical concept assisted in their learning. A game playing session that incorporates focused discussion about the strategies employed by the students may provide an avenue of learning for students. The games are not only viewed as fun but also the children would have the opportunity to engage in meaningful dialogue about the

mathematical concepts and strategies underpinning the games. Children should be encouraged to share strategies and ideas through whole class and one-on-one discussion. Although the aim of a game is to win and therefore may impact on the students desire to share acquired tactics, an environment of sharing and support would assist in children revealing their strategies.

An important factor for teachers to consider is the children's understanding of a link between learning and enjoyable tasks. In summary, the interview data provide a picture of the students' attitudes on mathematics and game playing. When asked for a time in which the students felt they were learning, the students recalled fun activities. Games may have the potential to provide students with a mathematically focused activity while engaging them through a perception of fun.

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