INSTRUCTIONAL GAMES: A MEANINGFUL CONTEXT FOR LEARNING

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Consistent with a growing awareness of constructivism and child centred learning and teaching approaches, a research project is presented where instructional games were implemented into a classroom setting. The project allowed the children's mathematical concepts to be developed and their understanding consolidated and reinforced by creating an environment which used language as a bridge between the children's informal mathematical knowledge and abstract mathematical concepts.

""The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him (her) accordingly"

Ausubel, School Learning, 1968.

Many educators, researchers, and members of the general public are becoming increasingly more aware and accepting of child centred approaches to learning and teaching. As a result children are being encouraged to talk about and share their ideas and conjectures with peers and important others without fear of rejection or reprimand. A child's previous experience not only influences her/his acquisition of in-school knowledge, it influences the constructed realities of other learners.

Numeration skills continue to play an important role in both primary and lower secondary mathematics curriculums. This intuitive sense for number is vital for further mathematical learning and essential for future placement in the workforce (Carl, 1989; Resnick, 1989; Booker, Briggs, Davey & Nisbet, 1992). Consequently it becomes pertinent for schools to adopt sequential and meaningfully developed mathematics programs, especially within the areas of skill and concept. The *National Statement On Mathematics for Australian Schools* (1991) and Queensland's current P-10 syllabus documents (1987) reflect these concerns by linking conceptual understanding with procedural understanding via the delayed introduction of written algorithms and by encouraging the use of technology and problem solving activities in the classroom.

This numerical understanding can be achieved by engaging in sequentially planned activities that begin with the manipulation of concrete referents and gradually move toward pictorial or semi-symbolic representations which in turn evolve into mental images. This sequence is accomplished by making important links between a child's everyday language and more formal mathematical discourse, until abstract mathematical concepts finally emerge in the form of meaningful symbols.

Thus, knowledge is expressed and sustained by a diversity of negotiated mediums. For instance, language has long been a means of expressing and maintaining the mathematical concepts that enhance daily living. Consequently, the role of language in the learning of more formal mathematics is crucial because the informal language with which it begins facilitates meaningful learning and comprehension as well as the acquisition of new constructs. It is these new constructs which lay the groundwork for the understanding of further abstract mathematical concepts. This is strikingly affirmed in a journal entry of an eleven year old girl in a study conducted by Richards (1990):

> "Language helps our maths by being able to write, use words, use symbols, being able to read and listen. We share our ideas, challenge ourselves, maybe help others and correct them, be able to have our own opinion. It helps explain things, making discoveries, understanding things, setting goals for yourself, learning, knowing" (Page 14).

Support for the role language plays in the formation of conscious reasoning may be seen in the work of Vygotsky (1978). Similarly, work by van Oers (1992) and Voigt (1992) emphasise the importance of language in the development of shared mathematical understandings because mathematics is a human activity rather than a body of knowledge to be learnt alone. The development of environments that encourage children to discuss and justify their thoughts and conjectures is increasingly seen to be an important means of resolving conflicting viewpoints and establishing communally shared understandings (Vygotsky, 1978; Hand, 1990). This has also been prominent in recent constructivist perspectives on learning (Yackel, Cobb, Wood & Merkel, 1990):

> "Our goal is to have students develop mathematical concepts and relationships in ways that are personally meaningful. Although students construct their own mathematical understandings, they do not do so in isolation. Interactions with both other students and the teacher give rise to crucial learning opportunities" (Page 34 - 35).

THE ROLE OF INSTRUCTIONAL GAMES IN LEARNING

Play is a fundamental part of children's learning. It is their way of making sense of the world around them through situations which are engaging, familiar and non-threatening. Furthermore, games create a social setting that is rich with real world experiences. Games can be used at various stages of instruction, both to introduce new concepts and to consolidate established ideas and processes. Moreover, they allow children to use and understand mathematical language and social organisation in a purposeful way.

The essence of this paper comes from a research project designed to examine the viability of a school-based program using instructional games (Burnett, 1991). The program was introduced into a grade one classroom in a school on Brisbane's southside. At least one or both of the children's parents worked, either in their own business or as company employees. Each class within the school was formed heterogeneously, leading to a wide range of ability levels. While the school's mathematics program developed number understanding first, followed by the addition concept and basic facts a parallel development of measurement, time, patterning, graphing, construction, shape and money also occured.

The study used an ethnographic paradigm in conjunction with the philosophical theory of constructivism. This allowed the researcher and teacher involved to engage the class in an act of sense making that enabled the children to formulate multiple meanings and solve existing problems in both a social and formal setting (Confrey, 1987; Clements, 1991; Burnett, 1992). Use of video transcripts, journal entries and formative assessment brought out the social context as a whole rather then fragmenting it into many seemingly unrelated pieces. Furthermore it showed that when games and hands-on activities were combined in an environment with multiple learning styles and small group work, all contributed to the development of the children's numerical concepts. As a consequence instructional games were found to be of significant help in a child's construction of mathematical knowledge and the fostering of cooperative social skills (Burnett, 1991).

In particular, number knowledge was found to play a fundamental role for success in other areas such as money. The children were able to assist each other's learning by modelling their own understanding and were able to resolve the majority of tensions as they occured.

This following transcript highlights the negotiation of understanding between a grade one child and more knowledgeable other:

Child1:	One, two, three, four (She places four 2 cent pieces on the ground in front of herself).
Grade7:	How much is there? (Points to the coins Child1 has just counted).
Child1:	That is four two's.
Grade7:	What's the next one? (Pauses waiting for the child to respond). Seven. (Referring to the value of the object in the next question on the stencil). That's eight cents (Refers to the value of the coins that Child1 has just put out).
Child1:	(Checks that she has put out eight cents). Take that one away. (Points to the fourth 2 cent piece. The Grade7 removes it). What's that? (Refers to the value of the three remaining coins).

The child is aware that she has eight cents in front of her but only requires seven. She realises that four 2 cent pieces is too much but seems unsure as to what she should do next:

Grade7: That's six, so you need one more. (Child1 finds a one cent coin and puts it next to the other coins she has in front of her. Grade7 and Child1 count the coins together). So count them up...Two, four, six,.......

Child1: Six, eight.

Grade7: No, that's only one. (Points to the 1 cent piece).

The grade 7 child, a group helper, reinforces the value inherent in our money system by modelling. This seemed necessary despite the grade one child's ablility to recognise the symbols on the coins:

Child1: Two, four, six, ...

Grade7: Seven.

Therefore it appears that number knowledge laid the way for success in other areas of mathematics, particularly with money as the children had to recognise the symbol on the coin, and then understand the patterning and value organisation inherent in our money and number systems.

The children were able to model their understanding for each other:

Child1: (Picks up a card from the centre of the gameboard). Hmm.

Child2: (Looks over her shoulder and points to the written algorithm on the card). You count six and two more.

Child2 reminds the first child of the counting-on strategy they had previously learnt. This allows child2 to obtain an answer to the algorithm which both agree upon.

Child1: Eight.

Child2: Yep.

And again in this next instance one child is able to share her/his understanding with another:

Child2: (Picks up a card and looks at it, he does not seem sure about what is written).

Child1: (Looks at the card child1 is holding and reads it for him). Thirty.

Child2: (Repeats child1). Thirty.

Child1: So it 's three tens.

Child2 was able not only to read the number which was written on the card for child1, but was also able to share that thirty is made up of three tens.

At times, power plays occurred within the groups. In this instance a decision about whether to tell another child a correct answer evolved:

Child4: 3 and 6 is.......

Child1: I know what it is. (Looks over at the card Child4 is holding).

Child2: So do I. (Children wait quietly for Child4's answer).

Child4: Is ......is 10.

Voices: (In unison). No.

Child8: No, you put it back.

Child8 reinforces the rules of the game by telling child4 to put the card back in the centre. She/he then tries to convince the other children in the group not to tell child4 the correct answer even though they have been encouraged to share their ideas and understanding with each other:

Child1: (Checks the answer by using three fingers to count on). Hey, do you want me to tell you?

Child8: No, don't tell him.

Child1: Yes........

Child8: No.

Child1: Well....he.....

Child8: You can't tell ......

Child4: Well I already know it.

Child7: 9.

Child3: It doesn't matter.

Initially the children were eased into cooperative groups in an attempt to shift them away from their self-centred, individualistic behaviour to being members of a whole class group. As the year progressed and their understanding of the mathematical ideas and reasons grew their interactions became increasingly autonomous. For instance, the children were able to reinforce the ideas of the games without overt direction from the teacher, researcher or grade seven children who came to help:

Child1:	(Picks up the dice and throws it). Nine. (All the children watch intensely as she moves her counter along the board. Child5 claps her hands and cheers).
Child6:	Yah, pick up a card.
Child1:	(Reaches over to the cards in the centre of the board and takes the card on top. After she has looked at the written algorithm she turns it around for the other children to see what is written). Five. (The other children look and appear to agree. The card is placed in the discard pile on the board). Arr Harr I get another turn. (She picks up the dice and throws it again). Six.
Child2:	You don't, she doesn't get two turns! (Children all start to talk together then stop realising that nobody can be heard or understood).
Child5 & 6:	(Say in unison nodding their heads). Yes she does.
Child5:	(Points to the cards in the centre of the board). If she knows the answer to it she gets another turn.
Child6:	If you don't know, if you don't know the answer.....(Child1 has moved her counter, Child6 looks at where she has stopped). Did you land on a star? (Some of the Children respond that she had not). Your go A____. (Child1 passes the dice to Child2). When it gets to J_____ (Points to Child3) and then to R_____ (Points to Child4) it will get to me (Points to himself).

Consequently rich interactions took place between the children that allowed them to share their ideas and understanding of mathematical concepts and the game's social structures. Their ability to negotiate these early mathematical meanings appeared to strengthen their knowledge and lay the groundwork for success in other areas of mathematics.

CONCLUSION

While the results may be seen to be exclusive to a specific group of children in their first year of formal schooling, the majority of ideas and resources are readily adaptable to any class or school. Instructional mathematics games when used in the social setting of a classroom can, and do, benefit the development of children's early numeration concepts as the children are able to reconstruct mathematics in a manner which is both meaningful and purposeful. This environment also encourages children to talk with peers and the teacher and work with materials in groups or alone as the need arises.

However it must be emphasised that it is not simply that the games provide the teaching: they are only a means of allowing learning. Rather, it is the discussion which stems from the games and the social context which seems to facilitate the learning. Thus, the implementation of similar programs into other school settings would appear viable especially as the teacher is able to individualise instruction and cater for individual strengths and weaknesses while the children gain important social skills at the same time.

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