Concept Modification Approach to Pedestrian Safety: A Strategy for Modifying Young Children's Existing Conceptual Framework of Speed

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1. Introduction

Research carried out at La Trobe University (Cross, 1988 and Cross and Mehegan, 1988) has demonstrated that children most at risk of pedestrian accidents in the age-range of four to nine years (Jarvis, 1983, Figure 1) have conceptions of speed that are radically different from an adult conception of speed.

------ insert Figure 1 ------

Children have been shown to hold a wide range of naive concepts about their natural and human made environment (Osborne and Freyberg, 1985 and Driver, Guesne and Tiberghien, 1985). Indeed, a recent bibliography published by Pfundt and Duit (1988) lists some 1600 references of studies into naive concepts (sometimes called 'Children's Science'). This research program has been carried out by Science Education researchers in many countries and the results have largely been circulated to those involved in schooling. The research has focused on the discovery of the naive concepts that children, and older students hold, rather than strategies to counter their repertoire of beliefs.

Within the framework of Kelly's (1955) constructivist theory of intellectual development, it has been proposed that children deal in mini-theories in order to make sense of their world (Claxton, 1984). When a mini-theory fails it is modified by the child to take into account the reason for the failure. However, quite basic concepts are continually returned to during the course of a science experience and, at the very least, a proportion of students retain their early mini-theories into adulthood. These factors support the suggestions that 'children's

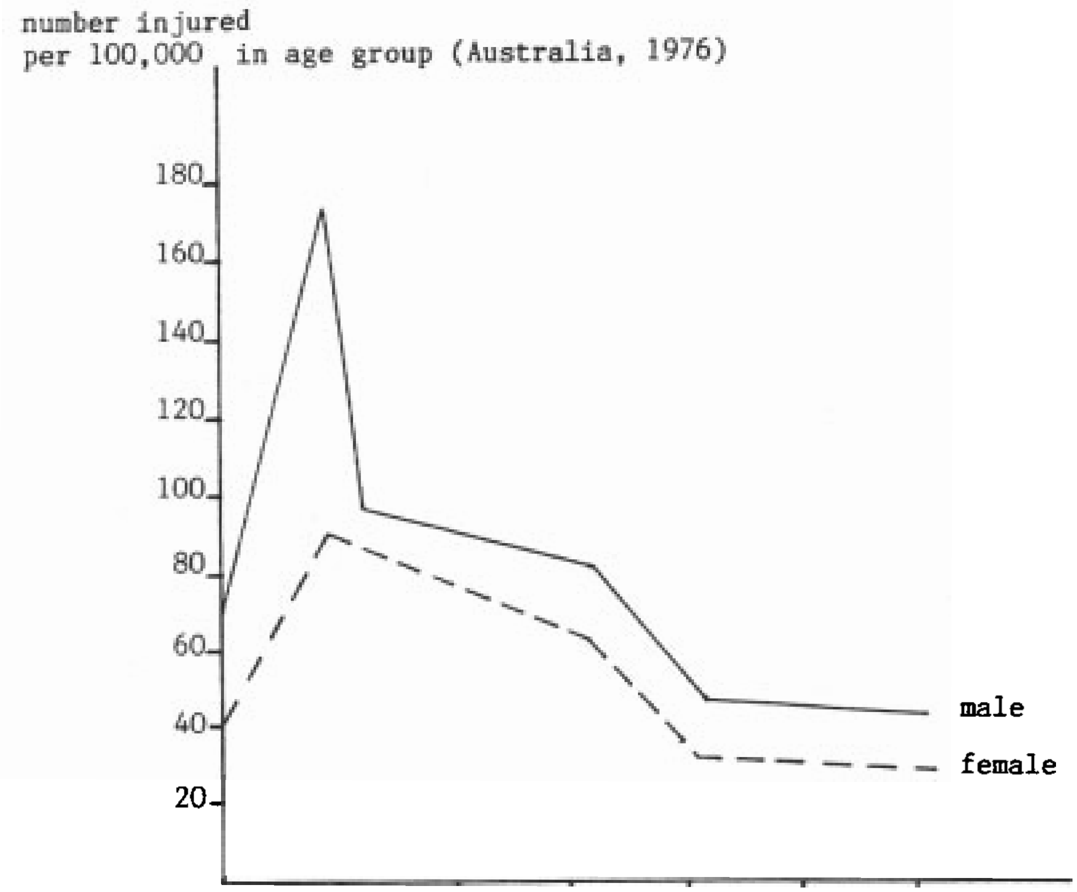

Figure I. Graph of pedestrian accidents versus age (Jarvis, 1983).

science' is resistent to change and/or the educational experience that ought to enable students to modify their mini-theories often does not!

Four possible outcomes have been proposed for the situation where children are taught concepts that are in direct conflict with their prior beliefs (Gilbert, Osborne and Fensham, 1982). These are: no conceptual change occurs (undisturbed outcomes); two theories are developed that are mutually exclusive and are used according to circumstances (the mini-theory is reserved for the realities of living and the formally taught concept used in the unreal atmosphere of school); the naive concept may actually be reinforced as a result of the teaching process (reinforced outcome); and finally the desired result, the naive concept (mini-theory) is rejected or modified as a result of teaching process. If these propositions are correct, their implications for educators are considerable and require curriculum developers to take into account the students' prior beliefs when devising curriculum materials. The teacher needs to be aware of the fact that children hold a range of concepts, so that teaching strategies can be adopted to enhance the chance of the desired result occurring - that is cognitive change. Unfortunately, the present state of research does not give the teacher a clear guide as to how to proceed.

Some help can be gleaned from the suggestions tentatively put forward by Champagne, Gunstone and Klopfer (1983). They promote the idea of 'Ideational Confrontation' as a teaching strategy to enable students to realize that their naive concepts are incompatible with the concepts taught by the teacher. In this way it is hoped that students will discard redundant mini-theories through the weight of contradictory evidence presented by the teacher. In the classroom we are dealing with a multi-faceted problem due to the range and diversity of mini-theories which may be held by different members of the class. To cater for the range in the classroom, as rich a teaching environment as possible is required, so that the conceptual challenge can act as a net which covers as many cases as possible. With respect to the present research, primary teachers are, generally speaking, skilled in providing a rich learning environment for children. They often teach via themes which enable them to draw on a vast range of learning experiences, from art to mathematics. It is the diversity of their approach, their skill at acting as a resource, their encouragement of creativity and their desire to include all children in the learning process which gives considerable cause for optimism.

2. Young Children's Concept of Speed

A number of factors that may be important in contributing to the high rate of child pedestrian accidents have been considered by researchers. Perhaps the most frequently cited factor is the problem of young children's erratic behaviour Jarvis (op.cit.). Children appear to be responsible for the vast majority of the 'active' accidents that occur. Frequently they appear, according to drivers involved in accidents, to have dashed out into the road. In this respect it is interesting to note that, 'alone of all those (incidents) in which adults can do potential harm to children, the adult is seldom held responsible when the children are in fact harmed' (Howarth and Repetto-Wright, 1978, p.11). The authors do not question the proposition that young children may be to blame in this way for any particular accident. Certainly there is a great deal of support for the proposition that young children's apparent unpredictability is a major cause and perhaps the dominating factor in the accident profiles. For example:

'children often run across in front of approaching traffic' (van der Molen, 1983, p.19),

: Sandels (1975) has reported that children are subject to sudden impulses that cause them to run into the road,

: young children are heavily involved in accidents caused by 'suddenly dashing onto the road' (Coote, 1976, p.3).

However, the authors wish to question whether it is valid to attribute irrational behaviour as the cause of all, or even the majority, of child pedestrian accidents.

A number of other factors have been identified as contributing to the high involvement rate of children (see Figure 1). Avery (1974) reviewed a number of these including, research into peripheral vision and hearing; the low attention span of children; and lack of understanding of the crossing rules. It is not surprising that children do not appear to understand the crossing rules given that most adults, and probably their parents, ignore these rules and simply interact with traffic. Also, where the rules are taught as a formula to be applied, understanding in the sense of realising the purpose of the rules could be absent.

This research program was carried out with the hypothesis that a proportion of the so called erratic, unpredictable crossing manoeuvres made by children are in fact logically consistent with their own conceptual framework. The fact that drivers and researchers have observed children behaving in a different manner to their expectation, that is within an adult conceptual framework, has caused them to label the actions of all children in this situation as 'impulsive' and irrational. This we believe is an understandable error and illustrates the way in which society often views children as small adults rather than as human beings who very often have a totally naive and yet consistent set of understandings about natural and human constructed phenomena. A typical example of this is that a large number of children believe that the Sun travels round the Earth or goes to sleep at night. These deductions are perfectly consistent with acute observation. The Sun appears to move during the day. The child's egocentric view of the universe is that the universe is like them. Such beliefs produce idiosyncratic concepts.

Research previously carried out (Cross and Mehegan, op.cit. and Cross, op.cit.) supports the proposition that a large proportion of children hold naive concepts of speed. The findings show that the proportion of children having a concept of speed that is in conflict with the needs of the traffic situation reduces as the age increases (Table 1).

------ insert Table 1 ------

Young children's concept of speed can be summarised as follows:

<u>If two vehicles travel at different speeds the vehicle travelling the slower speed can travel the same or a greater distance than</u>

TABLE 1

Percentage of Children Currently Applying the Speed Concept to the Tasks by Age.

Age	N	Tasks+ 1	2	3	4
4.0 - 4.11	28	4*	7	32	36
5.0 - 5.11	44	11	11	41	45
6.0 - 6.11	34	24	59	71	76
7.0 - 7.11	29	28	72	72	90
8.0 - 8.11	22	50	77	77	100
9.0 - 9.11	18	56	89	94	100

* Percentage

\+ Tasks 1-4 relate to different elements of structured play designed to determine the nature of their naive concept.
(Cross and Mehegan, op.cit., p.258)

the vehicle travelling at the higher speed in the same time.

At first sight this may appear to be totally illogical, and so it is, from the scientific point of view. However, if children do not relate the two independent variables of distance and time to the dependent variable speed then speed can be independent of the other two and not affect distance and time. Such a situation leads logically, within the false framework of independence, to the above naive and yet consistent belief. In a traffic situation, the potential for conflict becomes immediately apparent. The child makes observations that are then interpreted utilizing his/her conceptual field. The driver conceptualises the situation in a completely different way. The child appears to behave on impulse. How else could the driver explain what appears to be an irrational act? The child, however, has interpreted the data and makes a logical, or rather within the child's conceptualisation, a consistent decision and begins a crossing manoeuvre. The potential dangers in this situation, where the interpretation of data differs between the active participants, is obvious and a cause for alarm. The question that must be asked is: can children in the high risk age-range acquire the same concept of speed as an adult? The answer, here is clearly, yes. The research indicates that although the proportion of the youngest children operating with a scientifically valid concept is low, the proportion increases rapidly with age, as children adjust their mini-theories through the experience gained by active participation as pedestrians and general involvement with traffic (see the previous research). This indicator of successful adaption of naive concepts or perhaps the ability or luck to have the correct initial concept, has encouraged the authors to devise a teaching unit specifically aimed at addressing the concept of speed, which could be part of a primary science experience for all children.

3. The Teaching Program

The curriculum development has been described elsewhere (Cross and Pitkethly, 1989). Suffice to say here, it has involved an integrated approach in which many aspects of learning and experience are utilized in accordance with the best of modern practice in primary education. For example, it incorporates dance; craft; measurement; acting and role play; and cooperation between children in important socializing ways. There are six core lessons and a number of enrichment activities. the program is designed to take about six weeks to maximize the opportunities for cognitive change. Each of the lessons is designed to challenge existing concepts and this is best done over a long period to maximize the potential for conceptual change by long term, oft repeated challenges rather than a short term assault. However, it must be said that there does not appear to be any evidence to support this particular proposition.

The program has been designed with the assumption that children do have naive concepts of speed. The lessons involve a progression from the simplest concept of movement to the ability to analyse, by comparison, distance and time variables in terms of speed. The increasing intellectual demand is illustrated in Figure 2 and an outline of the lessons in Table 2.

------ insert Figure 2 ------

------ insert Table 2 ------

It is not necessary for the children to know that they are learning about road safety since the objective is to modify the concept of speed. In this way the program does not make direct demands on traditional road safety educational programs. It does however contribute in important ways. Road safety education is necessary and vitally important but it is not sufficient without addressing the problem of the child's prior understandings of which the concept of speed is one important element.

4. Method

Two primary schools in Metropolitan Melbourne were selected for this study. Both schools are located in what can best be described as 'blue collar' areas. They both contain a mix of ethnic groups and were considered typical of urban primary schools in Melbourne.

Each school had two Grade 1 classes, that is children in their second full year of schooling (preparatory class is the first year). One of the schools did in fact have some children in the participating classes who were in their first year of schooling. These are called composite grades. Children were selected at random for the testing program from those whose parents had given their permission for their child to participate. Where possible, only children with two years of schooling were tested. However, it was necessary to make up the number of testees with a few of the younger children.

CONCEPTUAL DEVELOPMENT

Speed		Speed depends upon the distance travelled in a given time.
Time factor	:	Fast car takes less time to cover a fixed distance than a slower car.
Distance factor	:	Fast car travels further than the slower car in the same time.
Fast wins	:	Fast object gets there quicker than slow object.
Fast and slow movement	:	Movement can be fast or slow and fast movement takes you further than slow movement.
Movement	:	Involves change of position.

Figure 2. Development of the Concept of Speed (Cross and Pitkethly, 1988)

Table 2

Teaching Unit on Concept of Speed

Lesson	Activities	Lesson outcomes	Desired cognition
1. Movement	Working in groups children investigate the movement of 4 objects, egg, cube, etc.	To determine how some things move and to find out how we can tell if something has moved.	We are made aware of movement by some relative displacement and things move in a variety of ways.
2. Fast and slow movements	Activities are set within the format of modern educational dance.	Children experience fast and slow encounter the distance factor through set increments of time set by the music.	To understand that fast and slow give rise to difference in distances danced (travelled).
3. Fast wins	Children role-play animal races with puppets.	Children experience in a non-competitive way the effect of speed on distance travelled or time taken.	It is implied that a faster object always wins, arrives sooner or covers greater distance in the same time; at this state the connection between speed, distance and time is not made.
4. Distance factor	Children role-play a journey to the seaside using fast and slow cars and a journey prepared on a strip of paper. The journey is timed.	The fast car not only wins but also gets further in a given time.	The variable, time, is held constant. The fast car car travels further than the slow car. Therefore <u>distance covered is related to speed</u>.
5. Time factor	Children sit round a large cloth in which a circle is drawn. Fast and slow cars travel round the circle.	The time taken differs for the fast and slow cars.	The time taken for a fast object is less than that for a slow object to travel the same distance.
6. Speed	Children sit in large circle and the teacher has a strip of paper to act as a road; two cars travel towards each other, one is fast and the other is slow. Children clap.	Children see that they move for the same length of time but cover different distances.	<u>Speed depends upon distance and time</u>. If the time is fixed the distances travelled by two objects of different speed will be different.

The procedure was to conduct the kerbside tests on a sample of between 10-12 children for both the active and control classes in each school. The testing procedure has previously been described (Cross, 1988) and involved two separate tests to investigate the children's concept of speed in terms of the distance factor controlling for time and the time factor controlling for distance. Two identical cars were used for all the tests and all tests were carried out with the child at the kerbside. Responses were taped and subsequently analysed. Children were not only asked to make decisions on the basis of their observations of the two cars, one of which was 'fast' (accelerated to 55-60 kph) and the other which was 'slow' (accelerated to 30-35 kph), but were also asked to explain the reasons for their choice. The responses of the children were then collated. Both the control class and the active class in each school were pre-tested and post-tested over a two-three week period with the exception of the post-test for school B. Continued bad weather not only forced the suspension of the tests at the completion of the teaching of the program but also forced testing in very poor conditions on cold, rainy days. It is felt, by the authors, that the discomfort felt by children and the researchers alike during this process affected the results somewhat, as children were anxious to return to the warmth of the classroom.

5. Results and Analysis

Table 3 gives the results expressed as children operating with the correct concept of speed or some naive concept. This data has not been analysed statistically due to the sample size and because the research program is naturalistic in nature.

------ insert Table 3 ------

Representative samples of the children's explanations are as follows:

Task 1: **"Which car gets to us in the shortest time and why?"**

School A.

Matthew, 6.3 years:

Pre-test, answer incorrect: **"Because that one was first and the other** one was last."

Post-test, answer correct: **"Because he went much faster."**

Travis, 6.9 years:

Pre-test, answer incorrect: **"Because he was in front and the other** one did it for him first."

Post-test, answer correct: **"The second car went faster and it got up** here in the smallest time."

Amie, 6.7 years:

Pre-test, answer incorrect: **"Because he was only driving slow."**

Post-test, answer correct: **"Because it was going much faster than the** last one."

School B.

Angel, 6.11 years:

Pre-test, answer incorrect: **"Because he was going slow."**

Post-test, answer correct: **"The first one was fast and the second** was slow. **The fast one takes not so much time."**

Kate, 6.5 years:

Pre-test, answer incorrect: **"Because that one was behind the other** one."

TABLE 3

Research Data for Individual Children: Showing Improvement and Degradation

SCHOOL A: Active Class

Name	Age	Results[5]				Results[6]				Improvement				Degradation			
		Task 1[1]		Task 2[1]		Task 1		Task 2		Task 1		Task 2		Task 1		Task 2	
		1st[4]	2nd[4]	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Amie	6.7	0[2] 0[3]	0 1	1 1	1 1	1 1	0 1	1 1	1 1	1 1	1 1	0 0	0 0	0 0	0 0	1 0	0 0
Timothy	6.7	1 1	0 0	0 0	0 0	1 1	1 1	0 0	1 0	0 0	1 1	0 0	1 0	0 0	0 0	0 0	0 0
Gary	5.11	0 0	0 0	1 0	1 0	0 0	0 0	1 1	0 0	0 0	0 0	0 1	0 0	0 0	0 0	0 0	1 0
Hasna	5.10	1 1	0 0	0 0	0 0	0 1	1 0	1 0	1 1	0 0	1 0	1 0	1 1	1 0	0 0	0 0	0 0
Bianca	6.3	1 0	0 0	1 1	1 0	1 1	1 1	0 0	1 1	0 1	1 1	0 0	0 1	0 0	0 0	1 1	0 0
Anita	6.9	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Michelle	6.4	1 0	1 0	1 0	1 0	0 0	0 0	1 1	1 1	0 0	0 0	0 1	0 1	1 0	1 0	0 0	0 0
Christopher	6.1	0 0	0 0	0 0	0 0	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	0 0	0 0	0 0	0 0
Matthew	6.3	0 0	1 0	0 0	1 1	1 1	0 0	1 1	1 1	1 1	0 0	1 1	0 0	0 0	1 0	0 0	0 0
Matthew	5.11	1 0	1 0	0 0	1 1	1 1	1 1	1 1	1 1	0 1	0 1	1 1	0 0	0 0	0 0	0 0	0 0
Leigh	6.9	1 0	0 0	1 1	1 1	1 1	1 1	1 1	1 1	0 1	1 1	0 0	0 0	0 0	0 0	0 0	0 0
Travis	6.9	1 0	0 0	0 0	1 1	1 1	1 1	1 1	1 1	0 1	1 1	1 1	0 0	0 0	0 0	0 0	0 0
Renn	6.1	1 0	1 0	0 0	1 0	0 0	1 0	1 0	1 0	0 0	0 0	1 0	0 0	1 0	0 0	0 0	0 0
TOTALS		9 3	5 1	6 4	10 6	9 10	10 8	10 9	12 10	3 7	7 7	6 6	3 4	3 0	2 0	2 1	1 0
GRAND TOTALS		44								43				9			
(Possible score 104)																	

SCHOOL A: Control Class

Name	Age	Results[5]				Results[6]				Improvement				Degradation			
		Task 1[1]		Task 2[1]		Task 1		Task 2		Task 1		Task 2		Task 1		Task 2	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Amanda	6.1	0 0	0 0	1 1	1 1	0 0	0 0	1 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	0 1	0 1
Stephenie	6.4	1 1	0 0	0 0	0 0	0 0	1 0	1 0	1 1	0 0	1 0	1 0	1 1	1 1	0 0	0 0	0 0
Kathleen	6.1	1 0	0 0	1 0	1 0	1 0	0 0	0 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	1 0	0 0
Nikolas	6.2	1 1	1 0	0 0	1 0	1 1	1 0	1 0	1 1	0 0	0 0	1 0	0 1	0 0	0 0	0 0	0 0
Jarrod	7.2	0 0	0 0	0 0	0 0	0 0	0 0	1 1	1 1	0 0	0 0	1 1	1 1	0 0	0 0	0 0	0 0
John	6.3	0 0	1 0	0 0	0 0	0 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Robert	6.4	0 0	1 0	1 0	1 0	0 0	1 0	1 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Matthew	6.5	0 0	1 0	1 1	1 1	0 0	1 0	1 1	1 1	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Shayne	6.10	0 0	0 0	0 0	1 1	0 0	1 0	1 0	1 0	0 0	1 0	1 0	0 0	0 0	0 0	0 0	0 1
Darrell	6.1	0 0	1 0	0 0	0 0	0 0	0 0	1 1	1 1	0 0	0 0	1 1	1 1	0 0	1 0	0 0	0 0
Michelle	6.1	0 0	1 0	1 0	1 0	0 0	1 0	1 0	1 1	0 0	0 0	0 0	0 1	0 0	0 0	0 0	0 0
Melanie	6.9	1 1	1 1	0 0	1 0	0 0	0 0	0 0	1 1	0 0	0 0	0 0	0 1	1 1	1 1	0 0	0 0
Kate	6.1	1 0	1 0	1 1	1 1	0 0	0 0	1 0	1 0	0 0	0 0	0 0	0 0	1 0	1 0	0 1	0 1
TOTALS		5 3	8 1	6 3	9 4	2 1	7 0	10 3	12 7	0 0	2 0	5 2	3 6	3 2	3 1	1 2	0 3
GRAND TOTALS		39								18				15			

SCHOOL B: Active Class

Name	Age	Results[5] Task 1[1] 1st	Results[5] Task 1[1] 2nd	Results[5] Task 2[1] 1st	Results[5] Task 2[1] 2nd	Results[6] Task 1 1st	Results[6] Task 1 2nd	Results[6] Task 2 1st	Results[6] Task 2 2nd	Improvement Task 1 1st	Improvement Task 1 2nd	Improvement Task 2 1st	Improvement Task 2 2nd	Degradation Task 1 1st	Degradation Task 1 2nd	Degradation Task 2 1st	Degradation Task 2 2nd
Wayne	6.8	0 0	0 0	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	0 0	0 0	0 0	0 0	0 0	0 0
Sarah	6.7	1 0	0 0	1 1	1 1	1 1	0 0	1 1	1 1	0 1	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Sharon	6.5	0 0	1 0	1 0	1 0	0 0	0 0	1 0	1 0	0 0	0 0	0 0	0 0	0 0	1 0	0 0	0 0
Kate	6.5	0 0	1 0	1 0	0 0	1 1	1 1	1 1	1 1	1 1	0 1	0 1	1 1	0 0	0 0	0 0	0 0
Ibrahim	6.9	0 0	0 0	0 0	1 0	0 0	0 0	1 1	0 0	0 0	0 0	1 1	0 0	0 0	0 0	0 0	1 0
Trevor	7.0	0 0	0 0	1 0	1 1	0 0	0 0	1 1	1 1	0 0	0 0	0 1	0 0	0 0	0 0	0 0	0 0
Jaimee	6.2	1 0	0 0	0 0	1 0	0 0	0 0	0 0	1 1	0 0	0 0	0 0	0 1	1 0	0 0	0 0	0 0
Bridget	5.7	0 0	0 0	0 0	0 0	0 0	0 0	1 1	1 1	0 0	0 0	1 1	1 1	0 0	0 0	0 0	0 0
Jacqueline	6.3	0 0	0 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0
Matthew	6.4	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Russell	5.3	0 0	0 0	1 0	1 0	1 0	1 1	1 1	1 1	1 0	1 1	0 1	0 1	0 0	0 0	0 0	0 0
Mohomed	6.11	0 0	0 0	1 1	0 0	1 1	1 0	1 1	1 1	1 1	1 0	0 0	1 1	0 0	0 0	0 0	0 0
Angel	6.11	0 0	1 0	1 0	1 1	1 1	1 1	0 0	1 1	1 1	0 1	0 0	0 0	0 0	0 0	1 0	0 0
TOTALS		3 1	4 1	10 4	10 5	8 6	7 5	11 9	12 10	6 5	4 4	2 5	3 5	1 0	1 0	1 0	1 0
GRAND' TOTALS (Possible score 104)		38								34				4			

SCHOOL B: Control Class

Name	Age	Results[5]				Results[6]				Improvement				Degradation			
		Task 1[1]		Task 2[1]		Task 1		Task 2		Task 1		Task 2		Task 1		Task 2	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Stephanie	5.8	1 1	0 0	0 0	0 0	0 0	0 0	1 1	1 1	0 0	0 0	1 1	1 1	1 1	0 0	0 0	0 0
Stacey	5.5	0 0	0 0	0 0	1 1	1 0	1 0	1 1	1 1	1 0	1 0	1 1	0 0	0 0	0 0	0 0	0 0
Andrew	5.3	0 0	0 0	0 0	1 1	0 0	0 0	1 1	1 1	0 0	0 0	1 1	0 0	0 0	0 0	0 0	0 0
Belinda	6.10	1 1	1 1	1 1	1 1	1 1	1 0	1 1	0 0	0 0	0 0	0 0	0 0	0 0	0 1	0 0	1 1
Damon	6.8	0 0	0 0	1 1	1 0	0 0	0 0	1 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	0 1	0 0
Kirstin	6.5	1 0	1 1	0 0	1 1	1 1	0 0	0 0	0 0	0 1	0 0	0 0	0 0	0 0	1 1	0 0	1 1
John	6.6	0 0	0 0	0 0	1 0	0 0	0 0	0 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Erin	6.4	1 0	0 0	1 1	1 0	1 0	0 0	1 1	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	1 0
Chad	6.6	0 0	0 0	1 0	1 1	0 0	0 0	1 0	1 1	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Jacklyn	5.4	0 0	0 0	1 0	1 1	0 0	0 0	1 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 1
Maree	7.3	0 0	0 0	0 0	1 0	0 0	0 0	1 1	1 1	0 0	0 0	1 1	0 1	0 0	0 0	0 0	0 0
TOTALS		4 2	2 2	5 3	10 6	4 2	2 0	9 6	8 5	1 1	1 0	4 4	1 2	1 1	1 2	0 1	3 3
GRAND TOTALS	34									14				12			
(Possible score 88)																	

1 See Cross (1988) for description of tasks at kerbside. Task 1 time and speed variable, distance constant and task 2, distance and speed variable, time constant.

2 In each table first column refers to judgement and second column refers to explanation.

3 In each table zero indicates incorrect and 1 indicates correct judgement or explanation.

4 Each task was performed twice, the fast and slow cars being switched for the second run.

5 Pretests

6 Post tests

Post-test, answer correct: "The first one didn't take so long because that one went a bit faster and the other one went a bit slower."

Task 2: "Which car goes the furthest in five claps?"

School A.

Hasna, 5.10 years:

Pre-test, answer incorrect: "Because it was close to seven."

Post-test, answer correct: "Because he was nearer to us because it was a bit faster car."

Michelle, 6.4 years:

Pre-test, answer correct: Unable to give a reason.

Post-test, answer correct: "The first one got up there, the second one got to there. it came faster."

School B.

Bridget, 5.7 years:

Pre-test, answer incorrect: Unable to give a reason.

Post-test, answer correct: "Because it went faster."

Angel, 6.11 years:

Pre-test, answer incorrect: Unable to give a reason.

Post-test, answer correct: "Because it went more. It went faster."

Kate, 6.5 years:

Pre-test, answer correct: Unable to give a reason.

Post-test, answer correct: "The first one went a bit faster and the second a bit slower."

6. Discussion

In research of this kind there are many variables that can affect the judgements of children and, importantly, their verbal responses to questions about their understanding of what they see. Even these explanations can vary from time to time. For example the extremely poor weather conditions for the post-test for school 'B' may have affected the data. However, even given the poor interview conditions, a significant proportion of children who were involved in the teaching program dramatically improved their understanding of the concept of speed. In the traffic situation the child is confronted with an ever changing situation that requires constant reappraisal and a high level of interpretive skill. The initial problem is whether the child has assimilated the correct data. Distractors abound; there are difficulties which arise from the child's size, for example the perspective they gain from an angle of vision that is more 'sky' orientated; inattention can be a problem; limited peripheral vision is proven. All these factors tend to reduce the quality of the decision making process. The child must form a judgement about the safety of the proposed crossing. It is at this level that naive concepts can come into play. The child's interpretation of his observations is the basis for his crossing judgement.

We have found that the concept of speed is highly dependent on the age variable (Cross and Mehegan, op.cit.). And although the link between the increasing likelihood of any particular child having a mature concept of speed and his/her accident vulnerability, as illustrated by the accident statistics, may be entirely fortuitous, it is also possible that there is a causal link. If this is the case then educational programs that deal directly with children's conceptual frameworks are to be encouraged in addition to educational programs such as those that have an emphasis on training which are already being promoted in our schools.

The research described here is supported by a previous 'pilot' project (Cross and Pitkethly, 1989) in which children in the third year of schooling were given the program. The improvement rate of understanding of the 'concept' was also encouraging (Table 4).

------ insert Table 4 ------

The two results together indicate that it is indeed possible to create educational conditions in which conceptual change occurs over the relatively short space of time of a few weeks. Perhaps most significantly the research shows that this change manifests itself in complex real-life situations requiring application of the new conceptual framework in novel and largely unrelated ways to the process of acquiring them. The potential value here is for others to evaluate.

In general terms we would make the following recommendations for child pedestrian safety, or indeed any education in the area of safety:

: Children's rich and diverse repertoire of naive concepts about their environment must be taken into account.

: A cognitive change approach involving the challenging of existing beliefs through a wide variety of learning experiences can achieve fundamental changes in children's conceptual frameworks.

: A road safety program that does not aim to help children become decision makers in their own right fails to maximize the reduction in vulnerability that such programs aim to achieve.

TABLE 4

Percentage of Children Completing Tasks 1 and 2 Correctly* by age+

Age	n	Test 1		Test 2	
		1st	2nd	1st	2nd
5.0 - 5.11	11	18	18	64	64
6.0 - 6.11	13	0	8	54	-
7.0 - 7.11	12	25	8	83	-
8.0 - 9.5	15	27	27	87	93

* Both decision and explanation correct

\+ (Cross and Pitkethly, 1988)

: Because children learn best in idiosyncratic ways, safety education must be richly diverse and integrate itself with the rest of primary education. We advocate a thematic approach based on diversity of experiences but with an emphasis on actually doing through children being involved in hands-on activities.

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