Beliefs about the Use of Calculators in an Upper Primary Mathematics Classroom: A Partial Application of the Theory of Planned Behaviour

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This study surveyed a sample of teachers ($N = 115$) with a questionnaire using the theory of planned behaviour (TPB). It examined primary school teacher intentions to allow students to use calculators in the classroom and the influences upon these intentions. Key salient behavioural, normative and control beliefs held by the teachers are analysed and evaluated according to their respective contribution to attitudes, perceptions of influence by the social environment, and perceived behavioural control.

Although calculators have been available since 1965 their progress into schools has not been an orderly transition and instead has attracted considerable controversy. In 1986, a UNESCO study lamented the lack of Australian research upon calculators (Blane & Willis, 1986), yet the research that had been completed locally and overseas reflected strong opposition to their use in primary schools and this early opposition has tended to exert a continuing influence (Howard, 1992). Research and debate over student use of calculators has ranged across issues such as: access and equity; the impact upon basic skills; and the use of calculators to enhance the teaching and learning contexts. Of interest is how have primary school teachers been influenced by this debate? What do they believe about student use of calculators and who has the greatest influence upon their beliefs? Research is needed in this area to provide information to assist in the understanding of teacher behavioural intentions and to assist teachers in their process of critical reflection of current practice. A recent study (White, 1996; White, 1997; White, in press) uncovered and categorised the range of beliefs held by NSW primary teachers towards the use of calculators by their students. However this study was unable to indicate which of these beliefs provided the basis for teacher intentions or behaviour. This current study attempts to do this by applying the constructs and instruments of the model titled the Theory of Planned Behaviour (TPB). It aims to sort the beliefs uncovered by the earlier study indicating their relative importance in the formation of teacher behavioural intentions.

Theoretical Issues

The Theory of Planned Behaviour (TPB; Ajzen, 1985, 1987, 1988) is an extension of the Theory of Reasoned Action (TRA; Fishbein and Ajzen,1975) and both have been very successful in predicting behaviour over a wide range of contexts and both come from an objectivist (positivist) stance. This stance has been the target of a great deal of criticism (see for example Lather, 1991) and it is beyond the scope of this paper, however some brief comment is provided. This study does not adopt a positivist perspective in its use of TPB as it is not interested in predicting behaviour. It uses TPB to sort the teacher beliefs and to indicate their relative importance in the formation of teacher behavioural intentions. Thus the use of TPB resonates with an interpretative paradigm. Not surprisingly there are differing opinions about the wisdom of mixing paradigms. Whereas Guba and Lincoln (1988) believe that paradigm distinctions are real and critically important to research, others such as Cook and Reichardt (1979) believe that they are artificial and irrelevant to method choice and others such as Entwistle (1984) emphasise the crucial importance of the perspective and intention of the researcher.

According to TRA the immediate determinant of behaviour is intention and two major factors determine a teacher's behavioural intention: a personal or attitudinal component; and a social or normative component. The attitudinal component measures the teacher's attitude towards performing the behaviour and "is simply a person's general feeling of favorableness or unfavorableness for that concept" (Ajzen and Fishbein, 1980, p. 54). The second or normative component of the theory deals with the influence of the

social environment upon intention and behaviour. This is a measure of the teacher's perception of whether most important people support or don't support the performance of the behaviour. This implies that a teacher will usually intend to perform a behaviour that is positively evaluated and has the support of significant others. If TRA was to stop at this point we would have very little information to assist our understanding of behaviour. However, both components can be investigated further. Attitude towards a behaviour is determined by the product of the teacher's beliefs about performing the action and the evaluation of the outcomes of the action. Subjective norm is determined by the product of the teacher's beliefs of social expectations to perform the behaviour and the motivation to comply with these expectations. In the final analysis then, TRA attempts to explain a teacher's behaviour in terms of beliefs which represent the information (be it correct or incorrect) that the teacher has about their situation. Successful predictions of behaviour using TRA have been done of such diverse areas as voting behaviour (Fishbein, Ajzen & Hinkle, 1980), family planning (Fishbein, Jaccard, Davidson, Ajzen & Loken, 1980), consumer behaviour (Fishbein & Ajzen, 1980), weight reduction (Sejwacz, Fishbein & Ajzen, 1980), changing alcoholic behaviour (Fishbein, Ajzen & McArdle, 1980), smoking behaviour (Fishbein, 1982), infant feeding (Manstead, Proffitt & Smart, 1983), seatbelt use (Budd, North, & Spencer, 1984), and continuing education (Prior, 1990)

TPB expanded TRA in order to include the construct of perceived behavioural control (PBC). Ajzen (1988) proposed that it would be important as a determinant of intention when the individual had previous knowledge or experience of the behaviour in question. In this study it is probable that teachers would have had knowledge or experience of the behaviour included in the questionnaire. Other researchers have had similiar views such as Budd, North, and Spencer (1984) and Wittenbraker, Gibbs, and Kahle (1983) who included past behaviour as a determinant of behavioural intention when using TRA. Fewer studies have been published using TPB, however Schifter and Ajzen (1985) studied perceived control and weight loss and Ajzen and Madden (1986) used the theory to predict undergraduates' course performance. Parker, Manstead, Stadling, Reason and Baxter (1992) made an assessment of the ability of TPB to account for the intentions of driver's to commit driving violations and concluded that "the addition of perceived behavioral control led to significant increments in the amount of explained variance of intentions, thereby supporting the theory" (p. 94). For the purposes of this paper, only the salient beliefs used in regard to the constructs of attitude, subjective norm and perceived behavioural control will be examined and reported.

Method

TPB requires behaviour to be carefully defined. This was done by means of the scenario below which was taken from the earlier study (White 1996; White, 1997; White, in press) as it produced a high level of agreement among teachers.

> *Scenario 1:* You are teaching mathematics to your class at the usual time and place. You want the class to complete an exercise. You consider a range of options before insisting that the students use calculators. (In this study a calculator can include any of the range of available handheld four operational models).

A questionnaire was constructed according to TPB consisted of 28 semantic differential scales and was applied to a sample chosen randomly from across the population of primary teachers who worked at a NSW Department of School Education primary school and who taught mathematics to years 5 and/or 6. Two letters of the alphabet were randomly selected and schools whose name began with those letters were eligible for selection providing they met certain conditions. The teachers that were approached, belonged to schools:

(i) that had an enrollment above 100 as listed in the 1993 Directory of Government Schools in New South Wales (DSE, 1993). The purpose of this condition was to eliminate the very small schools. It was felt that these schools would have composite classes with too broad a range of abilities in the one class. That is, the class would have

three or more year levels within the one class (years 4-6). It is argued that the teaching strategies employed by the teachers at these schools are likely to be different from those employed in larger schools. A question was included to monitor the levels within the classes of the teachers in the study. A disadvantage, however of this condition, was the reduction in the number of country schools in the sample.
(ii) that were not designated as a 'special' (SSP) school. Again it is argued that the teaching strategies employed by the teachers are different from those employed in larger schools.
A total of 119 teachers returned the questionnaire and the data was entered into a spreadsheet and the software program Statview 4.0 was used to analyse the data. A decision was made not to include four returns because of the amount of missing data.

The questionnaire asked teachers to imagine behaving in the manner described by the scenario and to rate their response on each of the 28 scales. There was one scale for the direct measure of intention to perform the behaviour (endpoints likely/unlikely) and three taking a direct measure of attitude (endpoints good/bad, beneficial/harmful, wise/foolish) which were later combined into a single index (Direct attitude index - DAI). A belief-based attitudinal index (BBAI) was also calculated. The behavioural beliefs were selected from across the continuum developed in the earlier study and are listed in Table 1.

Table 1
Beliefs about Allowing Students to Use Calculators in the Classroom

My decision to allow my students to use calculators in the classroom:
1. would result in familiarity with their use
2. would promote laziness and dependence
3. would result in them working faster and saving time
4. would result in students just accepting answers and not thinking
5. would help them simplify complex problems and assist their problem solving
6. would make it easier for them to cheat

The strength of the belief was measured on a bipolar 7 point scale (endpoints likely/unlikely) with a score of 3 signifying a strong positive belief strength and -3 signifying the opposite. The evaluation outcome was also measured on a similar scale (endpoints good/bad). The BBAI was constructed using the summed products of the six beliefs and the resultant scores ranged from 54 which indicated a very positive attitude towards the behaviour in question to a score of -54 which indicated the opposite (refer to Table 3).

There was one scale to measure teacher perceptions of the overall influence of important others and a corresponding scale to measure teacher willingness to comply with this influence. The product of these two scales produced one direct measure of subjective norm (SND). A belief-based index of subjective norm (SNB) was similarly obtained by summing the products of each of four normative beliefs about salient referents (Principal/supervisor, Parents, Students, Other Teachers) with their corresponding motivations to comply. To complete the TPB model there were two scales (endpoints of full-control/no-control, easy/difficult) to measure perceived behavioural control and these were combined to give one index (PBC). Finally there were four questions which gathered information on the teacher's sex, teaching experience in years, approximate age, and year level now taught.

Results

The demographic results of the sample if summarised using modal characteristics indicated that the teacher was likely to be female; aged between 36 and 45; with 11 to 15 years teaching experience; and with a class of only year 6 students.

Table 2
Constructs of the Theory of Planned Behaviour: Mean Values and Standard Deviations

	Mean	Standard deviation
Attitude toward behaviour		
Direct. DAI	3.95	3.58
Belief product. BBAI	14.04	11.46
Subjective norm.		
Direct. SND	0.61	2.24
Belief product. SNB	2.23	7.44
Control belief. PBC	4.29	1.30
Behavioural intention.	1.06	1.78

Note: The table contains both the direct measures and the summed product measures of attitude and subjective norm. For attitudes the direct measure range is -9 to 9 and the product measure is -54 to 54. The subjective norm direct measure range is -3 to 3 and the product measure range is -36 to 36. The behavioural intention range is -3 to 3. The control belief range is -6 to 6.

The descriptive statistics of the constructs ofTPB listed in Table 2 show that the majority of teachers' intended to allow students to use calculators within the clasroom. These intentions were influenced by: the teacher attitudes towards the behaviour which were positive on both direct and belief-based measures; the subjective norm measures which indicated that overall, the teachers perceived encouragement by their social environment; and the perceived behavioural control index which suggested that teachers felt they had a high degree of control over the decision and that it would be fairly easy to implement.

While the direct measures such as DAI are sufficient for prediction purposes they do little to assist the understanding of the intention or behaviour. The belief-based product measures are more useful such as those listed in Table 3. BBAI was formed by summing six products of the belief with the corresponding outcome evaluation. Responses to the first belief were very strong with approximately 99% of teachers indicating that it was likely to happen and 1% who disagreed. Evaluations were also very strong with 99% of teachers rating it as good. The corresponding paired products produced a strong positive attitudinal measure for approximately 98% of teachers and a negative result for 2%.

Responses to the belief that using calculators in class would promote laziness and dependence saw 71% of teachers regarding this as unlikely, 14% undecided and only 15% regarding it as likely. Evaluations produced 30% of teachers rating it as bad , 30% undecided and approximately 39% rating it favourably. The paired products produced a mean that was slightly negative the result of pairs being 30% positive, 33% negative and a zero for 37% of teachers. .

Responses to the third belief indicated that approximately 85% of teachers felt that it was likely with 5% undecided and 9% rating it as unlikely. Evaluations produced 75% of teachers rating it as good with 10% undecided and 15% rating it as bad. The paired products produced approximately 75% of scores that were positive, 10% negative and a zero result for 15%.

Responses to the fourth belief indicated that 27% of teachers felt it likely that using calculators in class would result in students just accepting answers and not thinking,with 10% undecided, and 63% rated it as unlikely. Evaluations produced 17% of teachers rating it as good , 24% undecided and approximately 59% rating it as bad. The paired products produced a slightly positive mean from 42% that were positive, 30% negative and a zero for 28%.

Table 3
The Means, Standard Deviations, and Frequency Distribution of the product of Behavioural Beliefs and corresponding Outcome Evaluations (n=115).

Class	1 familiar with use	2 laziness dependance	3 faster work	4 not thinking	5 problem solving	6 easy cheat
9 to 7	42	5	18	3	26	4
6 to 4	65	11	49	24	63	8
3 to 1	6	18	19	21	17	17
0	0	43	17	32	7	56
-1 to -3	1	9	7	18	2	12
-4 to -6	1	26	3	14	0	16
-7 to -9	0	3	2	3	0	2
Mean	6.1	-0.4	3.3	0.3	4.8	0.1
St. Dev.	2.7	3.9	3.8	3.6	2.9	3.3

Responses to the fifth belief indicated 93% of teachers felt that it was likely that using calculators in class would help students simplify complex problems and assist their problem solving with 4% undecided and 3% rating it as unlikely. Evaluations produced 94% with a rating of good , 4% undecided and a 2% bad rating. The attitudinal product pairs were 92% positive, 2% negative and a zero for 6%.

Responses to the final belief indicated 22% of teachers felt it was likely calculators would make it easier for students to cheat, with 57% rating it as unlikely, and 22% undecided. Evaluations produced a 27% good rating, a 31% bad rating and 42% undecided. The products produced a slightly positive mean from pairs that were 25% positive, 26% negative and a zero result for 49%.

Table 4
The Mean, Standard Deviation and Frequency Distribution of the product of Normative Beliefs and the corresponding Motivations to Comply (n=115).

Class	Principal	Parents	Students	Other teachers
9 - 7	3	2	1	1
6 - 5	11	18	20	15
3 - 1	24	24	23	20
0	53	53	50	62
-1 - -3	17	9	13	10
-4 - -6	6	8	5	6
-7 - -9	1	1	3	1
Mean	0.7	0.5	0.6	0.4
St. Dev.	2.8	2.7	2.8	2.4

The normative beliefs derive from two sources. The overall SND involved the normative belief concerning Important Others which showed a 41% perception of approval, a 19% perception of opposition and a 40% zero result. The motivation to comply had with teachers indicating 47% wanting to comply, 29% who did not and 24% who gave a zero. The products produced a weak positive mean from pairs which were 30% positive, 20% negative and a large 50% were zero.

An examination of the belief-based measure SNB consisting of the summed

products of four salient referents listed in Table 4, produced similar weak results. The four products had large zero scores and the means were very slight. An examination of the underlying beliefs such as the belief concerning support by the Principal/supervisor produced 40% of teachers who perceived support, 14% who perceived opposition, and 36% who recorded neither. The results for the Parents indicated approximately 28% of teachers who perceived support, 34% who perceived opposition, and a 38% zero result. Influence by the Students produced 54% of teachers who perceived support; 13% who perceived opposition; and 33% who recorded neither. And finally the results for the Other Teachers indicated approximately 44% of teachers who perceived support, 12% who perceived opposition, and 42% who recorded neither. Teachers also indicated that they were more inclined to comply firstly with the wishes of their Principal/Supervisor then parents, the other teachers and finally the students.

The results for PBC indicated that 98% perceived they had some control over allowing students to use calculators, with 50% indicating very strong control. The underlying beliefs indicated that the majority of teachers perceived almost full control over the behaviour and that it was quite easy to perform. The responses to the control belief were stronger in comparison to the belief about the ease of performance which had a far greater range.

Discusssion

In this study, the constructs of TPB were applied to the salient beliefs and referents identified by an earlier study. Teachers indicated a positive intention towards student use of calculators. According to TPB this was determined by attitude, subjective norm and perceived behavioural control. Both measures of attitude were positive towards the behaviour. An examination of the underlying beliefs revealed that the positive beliefs had the greatest impact upon attitude formation. Thus attitude was strongly influenced by student gains in familarity of use, speed of computational facility and the assistance gained in problem solving of complex problems. The beliefs involving negative outcomes resulted in greater zero scores and approximately even distributions of negative and positive evaluations, suggesting that some teachers thought that the outcomes would entail more advantages than disadvantages. Thus beliefs about calculators causing laziness, dependency, blind acceptance of answers, lack of encouragement of thinking skills and cheating did not dampen the attitude of the majority of teachers towards calculator use.

The influence of the social environment upon intention was positive and the salient normative beliefs indicated perceptions of strong support from their students and other teachers, moderate support from their Principal/supervisor and opposition from the parents. Teachers indicated that they were more inclined to comply with the wishes of their Principal/supervisor and parents than either the other teachers or the students.

The influence of perceived behavioural control upon intention was positive and indicated that the a large majority of teachers perceived that they had control over performing their intentions.

The importance of the constructs of TPB is best illustrated by an example. The normative belief about parental influence indicated that more teachers perceived a negative pressure than a positive one. As most teachers also indicated a wish to comply with the wishes of the parents, simplistically we would expect a negative contribution to the influence of the social environment. This was not so and the slight positive mean illustrates the strength of the model which lies in the product pairing of corresponding results. By keeping the measures paired, we are in a better position to correctly interpret the teacher's response. For example, a teacher who perceives a strong opposition by parents towards calculator use (score -3) but is strongly motivated against complying with this pressure (score -3), is likely to have a positive intention towards the behaviour (score -3x-3=9). This example cautions against making too great a use of either component of the product and supports the need for a model to deal with the complexity of social pressures and their associated motivations to comply.

Conclusion

The constructs of the TPB model were used to analyse a number of behavioural, normative and control beliefs uncovered by an earlier study. The results of the current study indicated that the majority of upper primary teachers surveyed intended to have their students use calculators in the classroom. An examination of these intentions revealed a positive attitude towards this intention, a perception of approval from the social environment, and a perception of personal control over the implementation of the intention. A further examination concentrating upon the salient beliefs allowed them to be sorted as to their contribution to attitude, perceived control or subjective norm. According to TPB these beliefs underpin teacher behavioural intention and ultimately teacher behaviour. Thus this examination of teacher beliefs, outcomes, evaluations, motivations to comply, attitudes, perceptions of social influence and behavioural control provides a useful input into the process of understanding the teacher intention of allowing student calculator use in the classroom. From the accumulation of data from such investigations, teachers and others will be in a better position to understand, to reflect upon and to possibly change the way their world operates.

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