Research in Science Education 1989, 19, 221 - 230

MEASURING STUDENTS' ATTITUDES AND PERCEPTIONS ABOUT TECHNOLOGY: A MULTIDIMENSIONAL CONCEPT

Leonie J Rennie and David F Treagust

The purpose of this paper is to describe an affective scale which has been designed to measure students' attitudes and perceptions about technology. The need to develop the scale came from efforts to evaluate two separate curriculum projects in primary and secondary schools in Western Australia. The first of these at the upper primary level was a project sponsored by the Technology and Industry Development Authority, which developed three technology modules: Recreational Technology and Toys, The Perth Zoo: A New Look, and Technology and Leisure. Subsequently, a grant from the Curriculum Development Centre has been used to implement a trial and evaluation of these modules (Kinnear, Treagust & Rennie, 1989). As part of this evaluation, an affective instrument suitable for use with children aged 10 to 12 years was required.

The secondary school technology project was initiated by the Ministry of Education in Western Australia, which invited schools to submit a proposal to become Technology High Schools. Six schools were funded to introduce technology into their curriculum, and each school is now working to do this according to their own plans. As their curriculum goals were formulated, the technology education coordinators from the two Technology Senior High Schools in metropolitan Perth requested assistance with an instrument to assess changes in students' attitudes and perceptions about technology throughout the school year.

MEASUREMENT OF STUDENTS' ATTITUDES AND PERCEPTIONS ABOUT TECHNOLOGY

The most extensive research into students' attitudes about technology has been carried out in the Netherlands as the Pupils' Attitudes Towards Technology (PATT) Project (Raat & de Vries,1986; Raat, de Klerk Wolters & de Vries,1987; Raat, Coenen-van den Bergh, de Klerk Wolters & de Vries, 1988). In this project two questionnaires, an attitude instrument and a concept instrument, have been developed on the basis of comprehensive trials in more than a dozen countries around the world, including Australia (Rennie & Parker, 1985). The attitude instrument developed by the PATT project questionnaire contains 60 Likert-type items with a five-point response format including an undecided category. There are six subscales measuring interest, gender, consequences, difficulty, curriculum and careers in technology. The 28-item concept instrument has a three point (agree - disagree - don't know) response format. Both instruments have been developed for students aged 13 to 15 years.

In addition to the questionnaires, several countries have used the PATT essay topic to explore, in a less direct way, the opinions and perceptions students have about technology. Rennie and Sillitto (1988) reported on the use of the essay topic in a Western Australian sample of 13-year-old students. A number of other projects in the Netherlands and elsewhere have made use of the instruments developed in the PATT studies.

In this paper, the development of the Attitudes and Perceptions About Technology scale is described. The development has been in two stages. In the first stage, a questionnaire was prepared for use in the upper primary levels, and in the second stage, a longer version of this instrument was adapted for use at the secondary level.

DEVELOPMENT OF THE ATTITUDES AND PERCEPTIONS ABOUT TECHNOLOGY SCALE

Stage 1: Primary School Version

The questionnaire to be used in the primary schools was required to measure the students' attitudes and perceptions about technology, and particularly their understanding of technology as a problem-solving, design process, which was the integrating feature of the modules developed in the Primary Technology Project. Another aspect of the project was its focus on the inclusion of girls, and so additional items of the questionnaire were needed to reflect this aspect of the project. The development of the questionnaire began with a pool of 42 items. A number of items referring to interest and careers in technology, its difficulty, and gender in technology were selected from the PATT attitude scale (Raat et al, 1987), and reworded slightly to match more closely the target age group of 11- and 12-year-olds. Additional items were written to reflect the design process perspective used in the modules. The contents of the items were given face validity by members of the project team.

Because the children were younger than the PATT study group, and because the questionnaire included items about the nature of technology, as well as attitudes towards it, a three point, rather than a five point, response format was used. The three response choices are agree - don't know - disagree. Students were asked to use the 'don't know' response if they didn't know, weren't sure or couldn't decide. A preliminary trial of the questionnaire with a small group of 11-year-old students indicated no confusion with, or ambiguity in, the wording of the items, nor the directions for response. The 42-item preliminary questionnaire was piloted using seven classes from two government primary schools. One school was situated in an area of low socio-economic level and, as it was a small school, had only one class at each of the seven grade levels. The Years 5, 6 and 7 classes all completed the questionnaire. The second school was larger and situated in an area of middle socio-economic level. The two Year 7 classes, a Year 6 class and a split class of Year 5 and 6 students completed the questionnaire. The questionnaires were administered by the usual class teacher, who was asked to assist any child needing help, but not to discuss technology nor its meaning until after the questionnaires were collected. No teacher reported any difficulties in administering the questionnaire.

There were 83 boys and 73 girls in the pilot sample. The responses were scored 1 for disagree, 2 for don't know and 3 for agree. Analysis of the responses to the 42 items resulted in the deletion of eight items. Six items were deleted because they had means close to the extreme representing a positive attitude or perception about technology, and thus would be likely to show a 'ceiling effect' if the technology questionnaire was used in a pretest-posttest administration. Two further items were deleted because they had very low inter-item correlations. The final version of the scale contains 27 items measuring students' attitudes and perceptions about technology. In addition, there are seven items focussing on gender issues.

The primary school version of the Attitudes and Perceptions About Technology scale has been administered to eight classes in the seven schools where the three primary technology modules are being trialled. Students have completed the questionnaire prior to and after doing the topic as part of the evaluation of the modules. In this paper, however, no results of analysis comparing the pre and post test data are reported (see Kinnear et al, 1989).

Stage 2: Secondary School Version

The need for an instrument to measure students' attitudes and perceptions about technology arose when teachers at the two largest technology schools began to search for a way to evaluate the work they were doing in implementing technology into the curriculum in their schools. The smallest of the technology schools, a district high school, had already used the primary version of the questionnaire because it was trialling one of the technology modules in its primary grades. Partly for this reason, and partly because of the need for a fairly short questionnaire, the secondary school version of the Attitudes and Perceptions About Technology scale was based on the primary version of the instrument. Development of the secondary questionnaire began with the 27 items measuring attitudes and perceptions about technology. Six new items were added about the meaning of technology, which increased the length to 33 items. The three point response format of the Primary Technology Questionnaire was retained, and the same directions were used. Although it was not a focus of the secondary project, the seven gender items supplementing the primary version were also included in the instrument at the request of one of the teachers, but were not considered to be part of the scale.

ADMINISTRATION AND ANALYSIS OF THE ATTITUDES AND PERCEPTIONS ABOUT TECHNOLOGY SCALE

The scale was administered by classroom teachers to all of the Year 8 students in two Perth Metropolitan Senior High Schools. The sample of 506 students comprised 299 boys and 207 girls. The detailed analysis presented here is based on this sample of students. The first analyses focused on the response distributions of the 33 items. A feature of the results from the PATT studies was the high frequency of use of the 'don't know' response, particularly for females. This seemed to reflect both a lack of knowledge and an unwillingness to make a commitment to either agree or disagree with the statement (de Klerk Wolters,1987; Rennie,1988). In the present questionnaire, the 'don't know' response was used by 25% or more of the sample on 29 of the 33 items, and on 32 of the items, a greater proportion of girls than boys chose this response. Perhaps not surprisingly, for students of this age, the three items referring to a career in technology attracted the highest proportion of "don't know" responses.

The items were scored 1, 2 and 3 for the disagree, don't know and agree categories, respectively. Items with negative wording were reverse-scored. The decision about including the 'don't know' responses in scoring the items was not made lightly. Shrigley and Koballa (1984), in referring to the usual five-point Likert response format, recommend that "good" attitude items should cluster at each end of the response continuum. Further, they suggest that an item with an undecided response rate of 25% or higher should be considered "suspect". The situation is different here. Many of the items refer to perceptions about what technology is, rather than students' emotional reactions towards it, and previous research suggests that many students of this age have little knowledge about technology (Rennie & Parker 1985; Rennie & Sillitto, 1988). In fact, if the technology curriculum program is successful, a major outcome will be the clarification of students' attitudes and perceptions about technology, which would be reflected in a lower usage of the "don't know" category when the posttest is administered.

The dimensionality of the instrument was determined using both parametric and nonparametric techniques. The reason for this related to the use of a three- point response format, which made the assumption of interval measurement rather risky. The parametric analysis first considered inter-item correlations, means and standard deviations of the items. Items which had low inter-item correlations (<.2), means close to the extremes (<1.3 or >2.7) and small standard deviations (<0.6) were identified. Eight items were identified as having one of these undesirable criteria. The nonparametric examination of items was based on a dichotomous scoring of the items, using 1 for agreement with the positive direction of the item and 0 otherwise. The criteria set for satisfactory performance related to the mean (<.2 or >.8) and inter-item correlations (phi >.2). Three items failed this scrutiny on both examinations. These were items 7, 11 and 39 which had low inter-item correlations. These items were deleted from further analysis.

The remaining 30 items were subjected to a principal components analysis and a cluster analysis. The principal components analysis resulted in the extraction of 9 components with eigenvalues greater than unity accounting for 56.4% of the variance. However, a scree test indicated that seven components was an acceptable solution (the eighth and ninth components had eigenvalues less than 1.1), and so seven components were rotated using a varimax rotation. The resulting solution is shown in Table 1. Reference to the item wording indicated that Factor I was an interest factor. Factor III contained the three items relating to a career in technology, and thus the overlap of these three items with Factor I is clearly interpretable. The items loading on Factor II refer to technology as a design process, and those in Factor V refer to the diversity of technology. Item 13, which has its variance split between these two factors, reads "In technology there are opportunities to think things up for yourself". Factor IV contains three negatively worded items which suggest that you have to be clever to study technology, and so refer to difficulty. The items forming Factor VI refer to technology as a way of problem-solving and the two items of Factor VII relate to the importance of technology.

Table 1 Factor Loadings for Seven-Factor Solution of the Attitudes and Perceptions About Technology Scale (Varimax Rotation)

Item	I	II	III	IV	V	VI	VII
21	.84						
15	.75						
28	.72						
29	.71						
32	.66						
22	.65						
37	.55						
4		.67					
14		.55					
18		.52					
5		.51					
2		.49					
13		.47			.36		
34		.36					
12	.38		.72				
27	.44		.70				
23	.47		.64				
8				.75			
26				.73			
3				.71			
40					.62		
38					.61		
36					.53		
35					.51		
1					.39		
6						.81	
9						.63	
16						.61	
17							.77
20							.74

Note: Only factor loadings exceeding .30 are reported

The second investigation of the dimensionality of the data used an average linkage cluster analysis based on the matrix of phi correlation coefficients. It was found that a six cluster solution gave precisely the same grouping of items as the factor analysis, except that the interest and career items were clustered together. On this basis it was decided to investigate the formation of subscales from the 30 items. Seven scales were formed following the grouping of items from the factor analysis, and means, standard deviations and alpha reliability coefficients are reported in Table 2. The means are reported as mean item scores using the three point response scoring method. The items which form the seven scales are obtainable by request from the authors.

Table 2 Statistics for Subscales of the Attitudes and Perceptions About Technology Scale

Factor	Scale Name	Number of items	Mean *	SD	Alpha
I	Interest	7.	2.21	.54	.84
II	Career	3	2.03	.56	.82
I and III	Interest/Career	10	2.15	.48	.87
II	Design	7	2.54	.35	.56
IV	Difficulty	3	2.43	.58	.63
V	Diversity	5	2.01	.46	.46
VI	Problem solving	3	2.44	.51	.53
VII	Importance	2	2.45	.56	.43

* Means are reported as the mean item score

The Interest scale comprised seven items, and typical items read "I would like to learn technology at school" and "I am interested in technology". The Career scale included three items such as "I would enjoy a job in technology". These two scales had a correlation of .57, and could be combined to form a single ten item scale. The statistics for this combined scale are included in Table 2. The seven items forming the Design scale referred to technology as a design process and included items referring to designing, making and testing models. Typical items are "In technology there are opportunities to think things up for yourself" and "Making things is part of technology". Two three-item scales referred to technology as a Problem-solving process ("Technology is finding the best solution to a problem") and the Difficulty of Technology ("You have to be clever to study technology"). Seven negatively worded items which perceived technology rather narrowly, in terms of its products, were grouped together into a scale which was named Diversity. It included items such as "Technology mainly concerns computers and similar equipment". The final two items referred to technology as important and needed by everyone, and were grouped under the heading Importance.

The mean item scores for the subscales are all above 2.00. In particular, students appear to have positive perceptions about technology as a design and problem solving process, and that people do not have to be clever to work in technology. The reliabilities of the subscales vary between .43 for the two-item Importance subscale and .87 for the ten-item Interest/Career scale. The low reliabilities of the Problem-solving and Importance subscale could be improved by adding additional items as the concepts are clear-cut. The Diversity subscale, is more complex. The items are varied and their common element (as they are negatively worded) is a narrow conception of the nature of technology. The addition of other items would need careful consideration. The subscales are conceptually distinct, and the correlations between them, reported in Table 3, indicate that when the Interest and Career scales are combined, they are empirically distinct. The intercorrelations are generally low, and although some are statistically significant (a function of the large sample) they are not practically significant. This finding lends support to the divergent validity of the subscales.

Table 3 Correlations between the Subscales of the Attitudes and Perceptions about Technology Scale.

	Interest/ Career	Design	Difficulty	Diversity	Problem Solving
Interest/Career					
Design	.08*				
Difficulty	.12*	.06			
Diversity	.08*	.11*	.24**		
Problem-solving	.14*	.21**	-.05	.05	
Importance	.06	.07	-.04	.02	.10*

* $p < .05$ ** $p < .01$

This paper has described the development of an instrument, Attitudes and Perceptions About Technology, which was developed and trialled with upper primary and lower secondary students in Western Australian schools. The 30 items (which had 27 in common with the primary version of the instrument) had a seven factor structure. The subscales formed from these factors had moderate to high reliabilities and their low intercorrelations demonstrated the multidimensionality of the technology concept. The instrument is currently in use in Western Australian schools to evaluate students' attitudes and perceptions about technology as a result of specifically designed programs for technology education at both the primary and secondary levels.

REFERENCES

KINNEAR, A., TREAGUST, D.F., & RENNIE, L.J. (1989). Trialling and Evaluation of Technology Curriculum Materials for Upper Primary Grades. Report prepared for the Curriculum Development Centre, Canberra.

de KLERK WOLTERS, F. (1987). Vier havo-vwo en een mbo over techniek. MENT - Project, Eindhoven University of Technology, Eindhoven, the Netherlands.

RAAT, J.H., COENEN-van den BERGH, R., de KLERK WOLTERS, F, & de VRIES, M. (1988). Report PATT-3 Conference Vol 1, Framework for Technology Education. Eindhoven University of Technology, Eindhoven, the Netherlands.

RAAT, J.H., de KLERK WOLTERS, F, & de VRIES, M. (1987). Report PATT Conference Vol 1, Proceedings. Eindhoven University of Technology. Eindhoven, the Netherlands.

RAAT, J.H., & de VRIES, M. (1986). What do girls and boys think of technology? Pupils' attitude toward technology. Eindhoven University of Technology, Eindhoven, the Netherlands.

RENNIE, L.J. (1988). How can we make technology interesting for girls? Invited address to PATT-3 Conference: Basic Principles of School Technology. Eindhoven University of Technology, Eindhoven, the Netherlands.

RENNIE, L.J., & PARKER, L.H. (1985). Technology Awareness: An International Survey. Proceedings of the Eleventh Annual Science Education Conference (pp. 59- 64), Western Australian Institute of Technology, Perth, Western Australia.

RENNIE, L. J., & SILLITTO, F.J. (1988). The meaning of technology: Perceptions from the essays of Year 8 students. The Australian Science Teachers Journal, 34(4), 68-76.

SHRIGLEY, R.L., & KOBALLA, T. R. Jr. (1984). Attitude measurement: Judging the emotional intensity of Likert-type science attitude statements. Journal of Research in Science Teaching, 21, 111-118.