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Capturing and comparing students conceptions of technology

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Abstract
This paper reviews the development of a research methodology to capture conceptions of technology in a form such that the conception of one individual can be compared with those of others.

Although other studies have been undertaken in this field they have in the main been concerned with values and attitudes towards technology. The methodology which is reported in this paper utilises 'agree - disagree' responses to statements in a questionnaire to generate a 'conception statement' for each respondent. This 'conception statement' is constructed from a statement bank via a predetermined option matrix. The written statement allows respondents to confirm that their conception is correctly recorded. The methodology also allows the conceptions of a number of individuals to be compared both graphically and numerically. The range and frequency of identical conceptions can be determined for any sample of individuals.

The paper concludes with a brief consideration of the areas for research in which such a methodology might be applied.

This paper reviews the development of a research methodology which enables a student’s conception of technology to be captured and subsequently compared with the conceptions held by other individuals.

Other studies have been undertaken in this field. Typically they fall into one of three categories: perceptions of; conceptions of; and attitudes towards technology. Whilst the titles of other research enquiries state that perceptions and/or conceptions have been explored, the published reports suggest that no effective distinction has been made. However, in the context of this inquiry a clear distinction is made between these notions. A student’s perception is understood by this author to be evanescent in nature, a momentary impression which fades quickly; as the student reflects on these perceptions of technology they form the conception of technology which the student holds. This study is concerned with those conceptions.

Attitudes and conceptions are related but their meanings have to be distinguished. In this study attitude is taken as a ‘settled mode of thinking’; thus this study may explore certain attitudes which students hold to aspects of technology, so as to frame or allow students to articulate their conception.

Constructing a conception of technology

Confused interpretation and articulation of the different conceptions of technology which are held, is in part due to the limited range of language available for description. This issue is explored by Fores and Rey 1. Rather than being able to use a single word to identify an aspect or consequence of technology a phrase has to be used. The limited range of words used to describe aspects of technology have, because of ‘over use’, become associated with a number of meanings. In fact the number of aspects has become so large that these words now convey only a ‘global’ meaning. This association with a global meaning itself exacerbates the difficulties in focusing and articulating a particular conception; work in this area has been reported by Daamen, van de Lans and Midden 2.

We lack specific words to describe the small segments or aspects of technology and thus we lack descriptive ability. This lack of description tends to restrict the articulation of an individual’s conception. To enable a less global - more descriptive statement to be
framed ‘key aspects’ ten later reduced to six were identified which would act as a framework in which a more specific concept of technology could be constructed. This framework would also provide a series of references for subsequent comparative investigation. The identification of these ‘key aspects’ was made following a review of published literature, the research findings of others and the comments of students; gathered by the author whilst conducting peer group interviews for a small preliminary study in this area during the summer term of 1990.

The following aspects frame this investigation:

- Recognising technology activity;
- Participating in technology activity;
- Which subjects teach technology;
- Living with technology;
- Influence on conceptions from outside school;
- The products of technology.

These ‘key aspects’ are by the nature of the inquiry concerned with school students and set its scope. Other researchers might ‘divide the cake’ in a different manner for their work; for example, Raat and de Vries³ note five ‘characteristics of technology’ and in 1986 their instrument contained seven ‘scales’, or areas of interest, which were adapted for the PATT - USA instrument as six ‘scales’, Bame and Dugger ⁴. No doubt a critical observer might identify other areas for inclusion. If a sustainable argument could be presented showing that these areas should be included in this study then at worst the comparison of conceptions reported here would be based on an incomplete view.

Methodology

The methodology used for the preliminary study in 1990 was based on four ‘peer group’ interviews covering a total sample of 20 students. An investigation of a whole school population would not have been feasible using this methodology. The most efficient method of gathering data from the whole school population was the use of a questionnaire.

In considering the type of questions for inclusion within the instrument, it became apparent that the use of closed type questions would provide a more reliable and objective basis for comparisons between students than would open questions. In order to obtain increased differentiation between students the use of a Likert scale was explored in the initial piloting.

The first draft of the instrument contained ninety questions which were arranged into three sections, ‘technology at school’, ‘technology at home’ and ‘technology in other settings’. Questions relating to a particular ‘area of interest’, for example, ‘Recognising technology activity’, were spread through all sections of the instrument and as a consequence responses were difficult to collate back to that particular area of interest during data processing.

The intention was to design an instrument such that the responses provided by a respondent could be displayed graphically, creating a response ‘profile’ to the questions relating to each ‘area of interest’ rather in the style of the skills attributes profile’ used by McCarthy and Moss ⁵. This would enable the profile of one student to be compared visually with that of another (Figure 1).

Two versions of the first draft instrument were tested in this author’s home institution to explore the inclusion of a mid-point or ‘undecided’ response option. One group of students was given a four point response scale: 1-‘strongly agree’, 2-‘agree’, 3-‘disagree’, 4-‘strongly disagree’, a fifth option was provided with this scale labelled ‘U’-‘don’t understand’. The second group was given a five point scale: 1-‘strongly agree’, 2-‘agree’, 3-‘undecided’ 4-‘disagree’, 5-‘strongly disagree’.

Students in the first group were less likely to use the ‘U’ - ‘don’t understand’ option than students who were given the mid-point ‘undecided’ option. Students stated that it was often easier to indicate ‘undecided’ than to make a decision if they found the question difficult. This tendency was also noted by Rennie⁷ considering the PATT study Likert scale.

Two other aspects were explored in the first draft concerning the layout of the instrument; sub-headings at the start of each section to
Area of interest: Technology as problem solving or invention

Focus the respondents view of technology to that area and the inclusion of a photo stimulus page for each section. Whilst the provision of sub-headings was developed further in the second draft of the instrument, the use of ‘photo sheets’ was not. When students in the trial groups were questioned they felt that the headings had provided some degree of focus and that more should be included, but the ‘photo sheets’ were of questionable use, some students had not referred to them at all.

Whilst it was possible to produce a profile which illustrated differences and similarities between individuals the data was not reliable. Studies which use an instrument with a Likert scale, such as the PATT instrument developed by Raat and de Vries3 or studies which require students to select the option which ‘best’ reflects their view after interpretation of the range of options, have a possible area of weakness. Individual students will place differing interpretations on the scale stages or on response categories and their judgements will be subjective. Whilst subjectivity by the student may be viewed as ‘part and parcel’ of that individual’s conception, should a number of responses be aggregated (in the sense of the Year cohort response to a certain question for example) then the relative importance placed on interpretation of the scale by each student, or the accuracy of the classification undertaken by the researcher (in studies where an analysis is made of open questions) becomes an important consideration.

The visual profile; whilst providing a graphic image, provided no articulation as to what that individual’s conception actually was. In the view of the author this was a fundamental weakness of the instrument in this format; a sustainable argument might also be made in extending this criticism to any study using a scaled method of response which claimed to analyse views rather than reporting comparisons in response rates. The notion of producing a written comment about the respondent’s conception was considered. A written comment, additional to a graphic profile, would allow that individual’s conception to be articulated; thus providing more accessible results and transparency in the process of analysis.

The method of obtaining the ‘statement of conception’ was derived after consideration of the systems used in schools to produce the National Record of Achievement which is ‘statement banked’; and the process used by the careers package ‘Jiig Cal’ in which responses to an attitudes instrument are used to produce a printout of a student’s ‘top ten’ best matches to possible occupations. The intention of the second draft was to produce a ‘matched’ instrument and statement bank. As with the ‘Jiig Cal’ process, the production
Transcription details for statement section 'D' - Questions 13, 14 and 15

<table>
<thead>
<tr>
<th>Questions</th>
<th>Response options ADU</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Solving problems and being involved in technology activity are the same.</td>
<td>A</td>
</tr>
<tr>
<td>14. Only some aspects of technology and solving problems are the same</td>
<td>D</td>
</tr>
<tr>
<td>15. An activity is more likely to be classed as technology because of the knowledge or information it uses than because it solves problems</td>
<td>D</td>
</tr>
</tbody>
</table>

Da. You view technology and problem solving as the same activity. You would probably agree with the following. That if technology is to do with fulfilling human needs any activity which requires humans to make decisions (solve problems) is technology

Db. You feel that technology and problem solving have a common pattern of stages. However, the knowledge or information used to solve problems has more to do with making an activity technology than does the fact that it can be broken down into stages

Dc. You feel an activity is technology because of the type of knowledge it is based on

Dd. You are unclear about linking technology exclusively to problem solving

Table 1

of the ‘statement of conception’ from the responses to the instrument was to be via a precise transcription procedure. The only subjectivity in interpretation of responses lies in the construction of the statement bank and transcription matrix.

Statement comments and questions were linked by a matrix, an example of which is included as Table 1. The use of a Likert scale complicated matters, the response to questions was limited to ‘agree’ or ‘disagree’. A third response option ‘U’ - ‘don’t understand’ was also provided, rather than permitting a respondent to guess either ‘agree’ or ‘disagree’ if they did not understand a question. If a ‘U’ response was made to a question the transcription matrix would generate either a blank section in the ‘conception statement’ or a comment that the student was unclear about a particular area. Even if a section was noted as unclear or not mentioned in the ‘conception statement’ printout for that student, the other information which it contained remained valid.

Responses to the questions in the instrument were processed to obtain a number of outcomes (Figure 2). The responses of groups of individuals were plotted showing frequency of responses (agree, disagree and don’t understand) to each question. The plots were produced by Form and Year groups both as a total sample and by gender groupings (Figures 3 and 4).

The response pattern of each individual was applied to the transcription matrix. The 55 questions provided a record of that individual’s conception as a 29 section listing, each section containing a code identifying the option indicated by the transcription matrix. Each section contained between 2 and 6 options, this provided a range containing more than 1.8 billion possible combinations -
or conceptions.

This listing was the starting point for three further stages in data processing. Firstly the frequency of use of each statement could be determined and plotted in the same way as the response rate to instrument questions. Secondly the listing provided the codes from which statements could be printed from the statement bank to produce the written ‘conception statement’; or to construct the visual ‘conception profile’ (Figure 5). Finally the codings could be reviewed to find the frequency and range of identical lists - hence identical conceptions within the scope of this inquiry. The term ‘range’ refers to the number of different conceptions held by the sample of students.

The reliability of the questionnaire data and the process of generating ‘statements of conception’ was supported in two ways; by interviewing a sample of students and reviewing their interview comments against their ‘conception statement’. These students were also shown a copy of their ‘conception
What experience can account for the view held by the girls in 8D which is apparently at odds with the rest of the sample? Could this be the influence of a particular member of staff, are they currently working in an IT/ electronics module?

Data gathered during full pilot study, July 1996

Figure 3

Q.51 New medicines and drugs are products of technology

Responses by year group shown as % of each year
Is the change towards viewing new medicines and drugs as technology products a result of experiences in Science or History lessons in Year 8 or part and parcel of any student’s experience outside school?

Data gathered during full pilot study, July 1996

Figure 4
'Conception statement profiles'

Numbers 1-6 denote 'areas of interest', letter codes A-BD denotes statement sections. The length of each bar indicates the option used within each statement section. No bar indicates the printing of a 'blank' statement.

Using the methodology

The preliminary investigation of 1990 produced a 'snap shot' of student conceptions of what technology was before schemes of work were formulated to implement the orders for Technology in the National Curriculum. For example, students did not identify work in food and textiles areas, and much of the science curriculum, as being to do with technology. Work with electronics which formed part of the CDT schemes was seen to be technology. A number of traditions of technology teaching have been identified in schools in England and Wales; particularly technology with science, technology with craft and design, STS (Science Technology and Society). In part these traditions have also tended to influence the discussions about technology; in addition to the language restrictions different individuals have had different experiences which have all been introduced as technology.

This paper has been concerned with providing a brief outline of a methodology for investigating students conceptions of technology. From the initial aim of producing a 'snap shot', a methodology has been developed which may enable investigations to be made into fundamental issues of technology education.
Schools in England and Wales have invested much time, energy and resources towards the provision of courses which fulfil the requirements for Technology in the National Curriculum, yet to what extent do these courses influence the development of a student’s conception of technology? Are the conceptions which students hold shaped by influences outside school, from the home or from wider experience in the community and of exposure to the media?

If students conceptions of technology are in fact ‘value added’ by the school, can we identify where this is taking place in the curriculum (or even perhaps particular activities, differing teaching and learning styles or by the approach adopted by a particular member of staff)? What are the benefits to students of the ‘technology rich’ environments available in City Technology Colleges (CTC) and Technology Schools Initiative (TSI) status schools in shaping their conceptions? How does the range of conceptions compare to those of students in other schools?

To what extent is a student’s understanding of technology dependent on cognitive development? Our colleagues who teach Primary Phase students talk about ‘reading readiness’, can a sustainable argument be made for the notion of ‘technology readiness’, how would this influence our future curriculum planning?

Finally, as teachers of technology can we assume that both we and our students share the same meaning of ‘technology’; no doubt we have this in mind as we develop materials and activities for them and as we assess their development. Should we continue to believe that this assumption holds true?

References


