DOCUMENT RESUME

ED 390 697 SE 057 536

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TITLE	How Do My Students Believe They Learn?
PUB DATE	28 Sep 95
NOTE	13p.; Paper presented at the Annual Conference of the Australian Science Teachers' Association (44th, Australia, September 1995).
PUB TYPE	Guides - General (050) -- Speeches/Conference Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Case Studies; *Concept Formation; *Constructivism (Learning); Elementary Secondary Education; Foreign Countries; *Learning Strategies; *Metacognition; Misconceptions: Science Instruction
IDENTIFIERS	Australia

ABSTRACT

Teachers who attempt to promote metacognitive learning strategies in their pupils usually encounter resistance because the pupils believe that they should be instructed by a teacher. One step in overcoming such resistance is to help students to recognize and discuss their implicit views. This document describes a repertory grid which can be used to facilitate this process. The most common form of the grid uses a triadic method in which the person is asked to decide which two of three elements of roughly the same class resemble each other more than they do the third element. The repertory grid presented in this document was devised in an effort to find out how Australian students judge or construe the value of various teaching approaches as to whether they help them learn science well and was pilot tested with a small sample of students of different ages. The strategies used by the students provided useful information about the constructs they were using to judge v luable learning activities. Elicitation of the grids and discussion with the individual students showed that they all saw activities which demanded more personal involvement as helping them learn science better. (JRH)

HOW DO MY STUDENTS BELIEVE THEY LEARN?

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Paper prepared for CONASTA 44

Conference of the Australian Science Teachers' Association

28 September, 1995

ABSTRACT

Teachers who attempt to promote metacognitive learning strategies in their pupils usually encounter resistance, because the pupils believe they should "be taught". One step in overcoming such resistance is to help students to recognise and discuss their implicit views. The repertory grid is one instrument which can be used to facilitate this process.

This presentation will give an example of such a use of the instrument and participants will have the opportunity to complete a grid themselves. This will allow them to make explicit their personal views of effective learning, and to discuss the application of the instrument with students.

INTRODUCTION

Much of the emphasis in recent science education research has been on a constructivist approach to learning, but has encountered restrictions arising from students' reluctance to alter their current ideas (von Glaserfeld, 1988). Interest in a constructivist approach in science education has been paralleled by a resurgence of interest, in education generally, in ways of enhancing students' understanding of their own learning, often termed a metacognitive approach to learning (Baird and Northfield, 1993; Biggs, 1991).

A Metacognitive Approach

The difficulties teachers experience in using such approaches is well known from anecdotal evidence, and also well documented. Ian Mitchell (1993) described

'three aspects of students' views on learning that are major barriers to change:

(i) *They are unfamiliar with situations which require active, independent thinking;*

(ii) *They do not accept that more and better thinking will lead to better performance;*

(iii) *They have very conservative views about the range of acceptableteacher behaviours and classroom activities;* (p.62).

Judie Mitchell (1993) also noted that: "recognising the existence of the student's conservative views of what was 'real work' was a critical factor in the way we developed our strategies" (p.85).

In an analysis of the results of the PEEL project, Ian Mitchell (1992) also commented that "in our first year we had seriously underestimated both the extent of change needed in [students' conceptions and attitudes] and the difficulty associated with trying to change students' behaviours in ways that they could not conceive of and did not support" (p. 79).

A Constructivist Approach

A constructivist approach to teaching in science suffers from the difficulties recognised by the theory as characteristic of learning. As von Glaserfeld noted the "pattern of maintaining categorisations, concepts and, indeed, whole theories until some experience makes their adequacy questionable, is a universal pattern from the constructivist point of view" (1988, p.85).

Teachers have found that this reluctance means that students are not willing to alter their firmly held views, in any real and lasting way, unless almost overwhelming evidence is presented which contradicts it. While, originally, the constructivist approach suggested devising experiments which would confront misconceptions by producing "conceptual conflict", it has now been suggested that a more efficient way to challenge current inadequate science conceptions may include the elicitation of students' ideas followed by the presentation and explanation of alternative concepts or theories for comparison of the evidence for each alternative (Driver & Oldham, 1986, p.118). This approach may also be effective for challenging students' beliefs about learning.

REPERTORY GRIDS

The repertory grid is based on Personal Construct Theory, which was articulated by George Kelly (1963), who was originally a physicist. As its name suggests, this theory takes a constructivist perspective, describing all people as "personal scientists" in their attempts to make sense of the world. The term "construct" is used to describe how a person currently judges or "construes" the meaning of something. Constructs are viewed as being useful in judging and comparing examples or 'elements' that resemble others, or differ from them. Repertory grids represent an approach which helps student make explicit the way they view some 'construct', and can be used for the complex area of 'learning science'. A sample grid is shown below as Table 1.

1. Put crosses on the two circles indicating the LIKE pair.

As ways of learning science, what do the pair have in common?	E1	E2	E3	E4	E5	E6	As ways of learning science what makes the other activity different?
	O	O	O				
				O	O	O	
	O		O		O		
		O		O		O	
		O	O	O			
	O		O			O	
An activity I find helps me learn science well							An activity I find does not help me learn science
	Copying notes from the boa::d or text book	Making my own notes or concept map at the end of a topic	Following directions to do practical work	Designing a way to test whether an idea about science "works" or is right	Listing my own questions or problems about a topic	Watching a science video or litening to a talk about science	

2. On the left write a description of the way in which the two are alike. On the right write a description of how the third activity is different from the other two.

3. Rate all six activities on each description on the LEFT.

Use a 5 point scale: 5= VERY STRONGLY LIKE THIS,
4=VERY LIKE THIS; 3= NEITHER LIKE NOR UNLIKE THIS;
2= NOT LIKE THIS; 1= ALMOST THE OPPOSITE OF THIS.

The repertory grid interview was developed by Kelly as a means of eliciting a person's view about a construct. The most common form of the grid uses a 'triadic' method, in which the person is asked to decide which two, of three 'elements' of roughly the same 'class' resemble each other more then they do the third element. These 'elements' are often people, and must then be people known to the interviewee, such as students in a teacher's class, or members of a person's family. Alternatively they can be events, such as listening to a lecture or constructing a concept map. The interviewee is asked to explain how the paired elements resemble each other, and, usually, why the third element was judged to be different. It is this 'why' which is most important: it clarifies the criteria being used to judge the elements. A final step involves rating or ranking each element on each construct that has been elicited.

An Example of Use

In an effort to find out how students judge or "construe" the value of various teaching approaches as to whether they help them learn science well, a repertory grid was devised and used with a small sample of students of different ages. This was seen as a pilot study, to check the difficulty of the approach at various ages, and to see whether the range of strategies used as elements were sufficiently varied to elicit the students' views of learning.

The blank grid used is that shown above as Table I. It is important in such a grid that the elements represent a range, in this case of strategies requiring different types of student involvement. A sample completed grid is shown as Table 2 below.

The students, in this pilot study, were members of one family, a boy aged 11, and girls aged 13, 15 and 20, in Grades 6, 8, and 9 of school and in third year of a non-science based University degree. None had any prior experience with such a grid, but each was given individual instructions about its completion. All except the 13 year-old were high achievers in science. All names given here are pseudonyms.

The participants were first directed to compare the three elements indicated on the first line by the three circles, and to put crosses in the circles of the two of these that they saw as more alike as ways of learning science. They were then asked to write in the box on the left of the line an answer to the question "As ways of learning science, what do the pair have in common?". They then wrote, in the box on the right, an answer to the question "As a way of learning science what makes the other activity different?". These paired descriptions form the two 'poles' of the 'construct' by which the students have judged similarity and difference for these three elements. Each then worked down the other five such lines, comparing, on each line, the three activities indicated by circles.

Having completed this stage, each was then asked to rate each of the six elements, on each line according to how much they matched the left hand description. The verbal descriptors for the five point scale are shown on the blank grid. The description "An activity I find helps me learn science well" was provided on a seventh line, and each was asked to rate all elements on this description. This was useful to indicate each one's opinion of the quality of each activity as it contributes to science learning.

TABLE 2: SAMPLE COMPLETED GRID

1. Put crosses on the two circles indicating the LIKE pair.

As ways of learning science, what do the pair have in common?	E1	E2	E3	E4	E5	E6	As a way of learning science what makes the other activity different?
Both involve writing	⊗ 5	⊗ 4	O 1	3	3	1	It's more practical
Both involve thinking	2	4	2	⊗ 4	⊗ 4	O 1	You listen and watch
Both copying/ following instructions	⊗ 5	2	⊗ 5	2	O 1	1	Think of your own things
Uses writing	5	⊗ 5	1	⊗ 5	5	O 1	No writing involved
Use what you think is important	1	⊗ 5	O 1	⊗ 5	5	1	Have set work to do
Uses writing	O 5	5	⊗ 1	5	5	⊗ 1	No writing involved
An activity I find helps me learn science well	2	4	2	5	5	3	An activity I find does not help me learn science
	Copying notes from the board or text book	Making my own notes or concept map at the end of a topic	Following directions to do practical work	Designing a way to test whether an idea about science "works" or is right	Listing my own questions or problems about a topic	Watching a science video or listening to a talk about science	

2. On the left write a description of the way in which the two are alike.
On the right write a description of how the third activity is different from the other two.
3. Rate all six activities on each description on the LEFT.
Use a 5 point scale: 5= VERY STRONGLY LIKE THIS,

7

5

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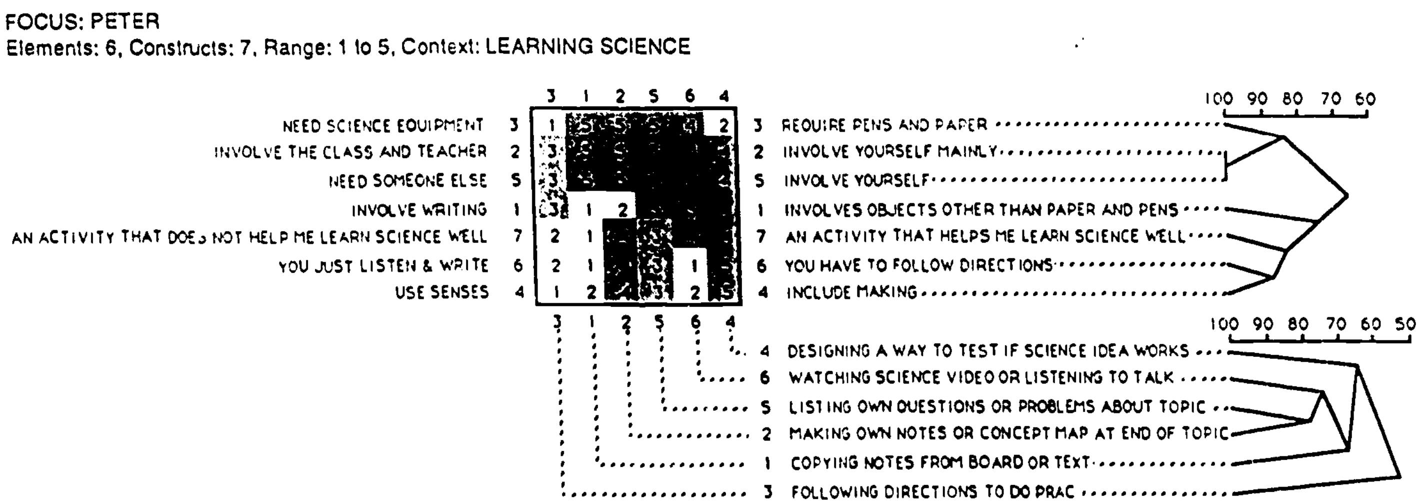
RESULTS

A computer program known as "RepGrid 2" (Centre for Person-Computer Studies, 1990) was used in the analysis of results. It could also have been used to elicit grids. The analysis used was that known as "Focus" which involves cluster analysis, rearranging both rows and columns so that the constructs and elements which were rated most similarly are closest together. The program may reverse the left and right descriptions of some rows so that comparisons are clear. This process suggests that descriptions at one side of the focused grids could be described as "positive" poles, the others as "negative", but this judgement is an inference only, and should be checked with the person who constructed the grid. The focused grids are shown as Tables with the discussion of each student's responses. The program also provides "matching scores" for both elements and constructs, based on the rating each person gave, and shows these scores diagrammatically.

Peter

Peter is aged 11 and is in Year 6 of primary school. He is particularly interested in science, and is a member of a science club at school. Two of his constructs were virtually identical, (constructs 2 and 5); as his focused grid shows, he rated all elements identically on these two constructs. Though constructs 3 and 1 were also similar in wording, Peter rated some elements very differently on these two. The grid was interesting in that he did not award a maximum rating to any of the activities, as means of learning science well, though he did award the second highest rating to three activities: 'watching a science video or listening to a talk about science', 'making your ow noes f concept map at the end of a topic' and 'designing a way to test if a science idea works'. Table 3 below shows Peter's focused grid.

TABLE 3: PETER'S FOCUSED GRID



The two constructs Peter rated as most similar were those involving his own ideas: 'making your own notes or concept map at the end of a topic', and 'listing your own problems or questions about a topic'. When these two appeared as two elements of a triad on one line he described them as alike because they "involve yourself".

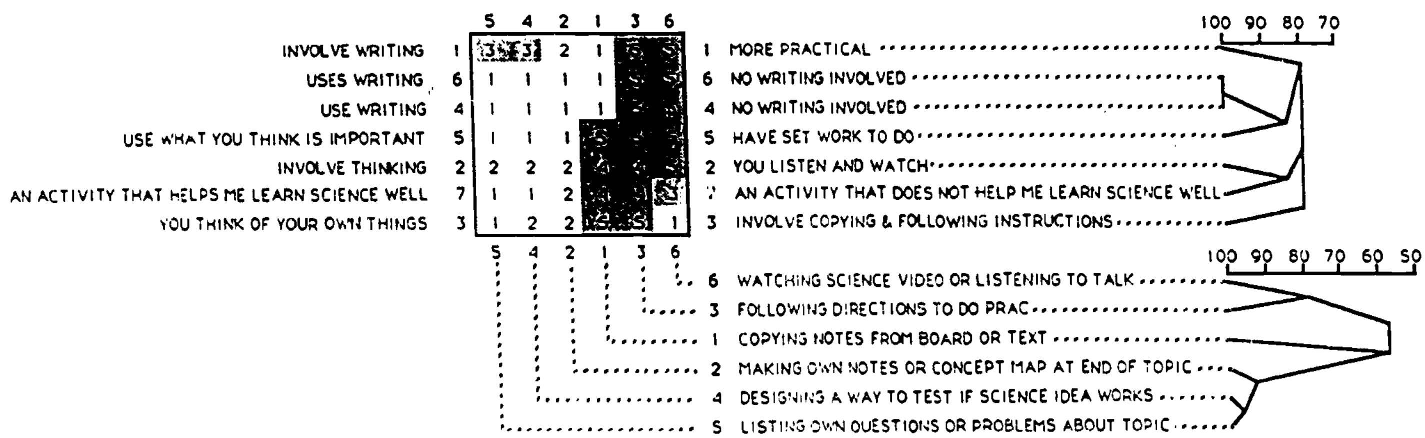
The patterns of linkage among constructs were interesting, suggesting that Peter saw following directions and making as similar, as well as involving other people and using science equipment.

Thea

Thea, aged 13 and in Year 8, her second year of High school, produced only four different constructs, apart from the one provided ("an activity that helps you learn science well"), and judged activities according to whether they involved writing or thinking, used "what you think is important", or allowed you to "think of your own things". Table 4 below shows her focused grid.

TABLE 4: THEA'S FOCUSED GRID

FOCUS: THEA13
Elements: 6, Constructs: 7, Range: 1 to 5, Context: LEARNING SCIENCE



The construct linked most closely to the provided construct "an activity that helps you learn science well" was construct 2 which contrasted "involve thinking" with "you listen and watch". The next one linked to that pair was " you think of your own things - involve copying and following instruction". Thea conveyed the idea that strategies that promote active learning were more helpful to her than those which encouraged or allowed her to be passive. She confirmed this, in conversation, saying that she wished her class did more of these activities.

The rearranged elements on the focused grid confirmed that she saw two of the more passive activities: "watching a science video or listening to a talk" and "following directions to do prac." as similar. However "copying notes from the board or text" was not closely linked to these two, possibly because she saw the criterion of "involving writing" as important, and this activity did involve writing, while the other two do not. She also rated the other three, more "active" strategies very similarly to each other.

Brigid

Brigid, aged 15 and in Year 9, noted the degree of independent thinking in several constructs, but did not have any identical constructs in either her wording or her ratings. The most closely linked constructs were those numbered 1 and 3, "not thinking, concentrating on instructions - thinking about topic, trying to understand more" and "concentrate on directions, not why you are doing it - these are each person's ideas, understanding of topic". Table 5 below shows her focused grid.

TABLE 5: BRIGID'S FOCUSED GRID

FOCUS: brigid
Elements: 6, Constructs: 7, Range: 1 to 5, Context: LEARNING SCIENCE

Construct (pole 1)		3	1	6	2	5	4		Construct (pole 5)
NOT THINKING FOR YOURSELF	4	1	1	1	4	4	5	4	DESIGN OWN CONCEPT, BASED ON OWN IDEAS
CONCENTRATE ON DIRECTIONS, NOT WHY	3	1	1	3	4	[illegible]	5	3	EACH PERSON'S IDEAS, UNDERSTANDING
NOT THINKING, CONCENTRATING ON INSTRUCTIONS	1	1	1	3	5	4	5	1	THINKING, TRYING TO UNDERSTAND
NOT THINKING FOR YOURSELF	5	1	1	2	5	5	5	5	THINKING TO MAKE TOPIC CLEARER TO YOU
USE INITIATIVE, TRY TO UNDERSTAND	2	2	1	2	4	5	5	2	WATCHING, LISTENING, NOT WRITING
WATCH AND LISTEN, SOMEONE ELSE THINKS	6	2	1	1	5	5	5	6	TAKING PART, NOT JUST WATCH AND LISTEN
ACTIVITY THAT DOESN'T HELP ME LEARN SCIENCE	7	3	3	3	5	4	4	7	ACTIVITY THAT HELPS ME LEARN SCIENCE WELL

Elements:
4 DESIGNING WAY TO TEST IF SCIENCE IDEA WORKS
5 LISTING OWN QUESTIONS OR PROBLEMS
2 MAKING OWN NOTES OR CONCEPT MAP AT END OF TOPIC
6 WATCHING SCIENCE VIDEO OR LISTENING TO SPEAKER
1 COPYING NOTES FROM BOARD OR TEXT
3 FOLLOWING DIRECTIONS TO DO PRAC

All Brigid's constructs were linked to each other before the total group of constructs was linked with the provided one "an activity that helps me learn science well". This suggested that she judged a combination of these constructs as promoting good learning. Brigid's ratings produced what the science teacher would see as a distinct grouping of the three "passive" strategies and a separate group of the three "active" ones.

Wilma

Wilma, aged 20, had completed two and a half years of a university course in Town Planning and had been a high achiever in science subjects at school.

TABLE 6: WILMA'S FOCUSED GRID

FOCUS: WILMA20
Elements: 6, Constructs: 7, Range: 1 to 5, Context: SCIENCE LEARNING

Construct (pole 1)		1	3	6	2	4	5		Construct (pole 5)
DON'T HAVE TO THINK	5	1	2	2	4	4	5	5	USE OWN IDEAS TO MODIFY WHAT YOU'VE BEEN TOLD
PASSIVE ACTIVITIES	6	1	2	2	4	5	5	6	PRACTICAL - ACTUALLY DO SOMETHING
INVOLVE COPYING RATHER THAN THINKING	1	1	2	2	4	5	5	1	MODIFIES OTHER PEOPLE'S IDEAS BY ADDING OWN
INVOLVE COPYING RATHER THAN THINKING	3	1	2	2	4	5	5	3	QUESTION IDEAS
PASSIVE LEARNING	2	1	2	2	4	5	5	2	ACTIVE LEARNING: QUESTION WHAT YOU'RE TOLD
PASSIVE LEARNING	4	1	2	2	4	5	4	4	USE OWN IDEAS TO CHANGE WHAT YOU'RE TOLD
ACTIVITY THAT DOES NOT HELP ME LEARN	7	3	3	3	5	5	5	7	ACTIVITY THAT HELPS ME LEARN SCIENCE WELL

Elements:
5 LISTING OWN QUESTIONS OR PROBLEMS ABOUT TOPIC
4 DESIGING A WAY TO TEST IF SCIENCE IDEA WORKS
2 MAKING OWN NOTES OR CONCEPT MAP AT END OF TOPIC
6 WATCHING SCIENCE VIDEO OR LISTENING TO TALK
3 FOLLOWING DIRECTIONS TO DO PRAC
1 COPYING NOTES FROM BOARD OR TEXT

She produced only three differently worded descriptions for one pole of the constructs, though the opposite poles were described differently. Her ratings, however, indicated that constructs 1, 2 and 3 were, in fact, virtually identical. Constructs 4 and 5 were also very similar to this group. Like Brigid, the composite group of constructs was linked with the provided description "an activity that helps me learn science well", rather than any single constructs being linked to it.

Wilma's element groupings also produced a similar pattern of "active" and "passive", though she rated "watching a science video or listening to a talk" and "following

Wilma's element groupings also produced a similar pattern of "active" and "passive", though she rated "watching a science video or listening to a talk" and "following directions to do prac." identically, but "copying notes from the board or text" as slightly different from this pair, while Brigid had "copying" and "following direction" linked more closely.

CONCLUSION

The strategies used did provide useful information about the constructs these students were using to judge valuable learning activities. Depending on the age of students it may be helpful to use fewer strategies, which could still elicit as many constructs. The task seemed rather "black and white" for the eldest of the students, but not too difficult for the youngest. The number of elements used, and the triads chosen on the grid for comparison can increase or decrease the difficulty of the task. The circle above "following directions to do practical work" on the last line of the grid may have been better placed above "listing my own questions or problems about a topic", to include each element three times in comparisons.

Use with a whole class would cause difficulties, but use of a computer method of eliciting constructs would mean students could work independently. However students would still need instruction in the use of the program, and this may prove time consuming. Those who have had experience with a large range of teaching/learning activities may be able to generate their own "elements", but it is important to ensure that some represent more "involving" activities or those expected to assist "better" learning, while using some expected to be less so, to provide the contrast so necessary to the procedure. Perhaps provision of a range of elements, with each student asked to add a science activity that they see as most helpful and/or one they see as not helpful to their learning would prove even more effective.

None of the students had difficulty at the stages of comparing the three elements on various lines, after basic instruction, though they did not provide different descriptions for all constructs. When asked to rate all elements on the left hand pole of each construct they had some difficulty if it included a "negative" description, such as "not thinking, just concentrating on what you've been told". This is always a source of difficulty, and some guidance in writing only positives, or using only the positive "concentrating on what you've been told" in these left poles of constructs is worthwhile. Computer elicitation may avoid this problem, as students have to place each element on a line between the two poles. This also increases the utility of the opposite pole of the constructs.

Elicitation of the grids and discussion with the individual students in this pilot study showed that they all saw activates which demanded more personal involvement as helping them learn science better, though Peter also included "watching a science video or listening to a talk about science" as a good way for him to learn, possibly because of his interest, or because, as a primary school student still, this is an unusual activity.

Brigid and Wilma, students with high achievement in science tended to see all activities as relatively helpful, whereas Thea and Peter who were younger, and, in Thea's case, average in achievement, gave less approval to "copying notes from the board or text" (which Peter rated as the opposite of helpful) and "following directions to do prac.". these students do not represent those at the lowest end of the achievement spectrum, but do indicate that more involving strategies were preferred, even by the student whose interest and achievement in science are not high. Use of the method would provide interesting data on which to base the planning of science strategies for use in the classroom.

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