Can Creativity be Taught? An Empirical Study

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Faced with the rapid incursion into people's daily lives of a knowledge explosion which sees the world's knowledge base double every eighteen months, largely through technological development, traditional educational functions and forms have been fundamentally challenged. One of those challenges has been for teachers to remain not only sympathetic towards change but to be innovative in their program implementation, so that they instil in their students both confidence and a willingness to experiment with the use of that technology with which they are surrounded (Australian Education Council, 1992). A second challenge is for these same teachers to encourage and teach for creative diversity, so that their students are not only comfortable with the use of technology, but are prepared to engage in such lateral thought as to be technologically creative (Technology Education Task Force, 1986). It is these areas of need or challenge which this paper examines.

One area of current educational research has responded in part to this challenge by focussing attention on a higher plane of cognitive functioning which has been broadly termed metacognitive strategy training. By training students to think analytically about their own learning processes and by providing general and specific strategies for a wide variety of learning environments, students have been able to take greater control of their own thinking and learning. At the same time, students who are taught in this way have been more readily able to attribute their successes and failures to factors which they can themselves control, so that they are increasingly autonomous as learners.

However, while this new direction has meant a fundamental change in some patterns of teaching, it may only represent a new and improved set of tools with which to analyse and learn from the extant body of knowledge. These tools are not designed to extend that knowledge base but rather to more effectively utilise its diversity. The problem is that for new knowledge to be uncovered, students need not only a clarity of thought processes, a sense of control over their own learning and a firm grasp of existing knowledge content, but they also need that creative spark. The question is whether this spark can be either struck initially or even fanned into flame through education generally or, more specifically, cognitive strategy training. Within most educational contexts, there are no specific strategies taught to students to assist them to take that next step towards creative, original thought, even though students are expected to produce such creative and original thought within a variety of academic disciplines. Indeed, there is little evidence to suggest that this creative spark can be fired by cognitive strategy training or, indeed, any other form of training. This becomes one of the crucial questions to be addressed in this paper through a series of four empirical studies, all of which are reported only briefly, since it is the implications of their combined weight that is of most relevance.

In the first study, teacher attitudes towards innovative change are considered, and methods of positively changing those attitudes within a pre-service teacher training program are explored. Then, in a further set of three empirical studies, the effectiveness or otherwise of teaching for creativity and strategy transfer are examined, along with methods of measuring creative response in an applied technology context. Possible reasons for variations in the success of these programs are also considered. The content area chosen for all of these studies is that of technology education.

Study 1.

The paradox of technology education is that, while technology is an area of extremely rapid change, technology educators have been shown consistently to be amongst those least willing to accept change (Carr, 1985; Kirton, Bailey, & Glendenning, 1990). In an attempt to alter this situation, 57 undergraduate technology teacher trainees were given a 14 week course in which they undertook active experimentation with various forms of new technology in order to devise solutions to practical problems (Chester, 1994). Because hardware developments are the area in which technological change is most readily observable and because technology teachers have been shown to be so consistently opposed to hardware development, this was the area of technology change on which the intervention program focussed. A control group (n=26) was employed. Pre and post intervention measures of attitude towards change were obtained for both groups using the Innovativeness Scale (Hurt, Joseph, & Cook, 1977). Individual differences in learning style in terms of the dimensions of the experiential learning model (Kolb, 1976) were also measured using the Learning Styles Questionnaire (Marshall, & Merritt, 1986) in order to determine whether the intervention was more beneficial for one learning style group than another. No significant differences were observed as a result of the intervention, nor was the intervention any more useful to one group than another. It would seem that a predisposition to change is a stable individual difference factor and is relatively resistant to modification.

When innovative teachers are found within the technology curriculum area, the question remains as to whether they are able to directly foster the educational goals of creativity, flexibility and adaptability (NSW, 1989). Since schools often operate to achieve knowledge based learning (Fisher, 1990) rather than creative thinking, these goals seem even more difficult to achieve. In the following set of studies, direct teaching of these skills as forms of cognitive strategy training are considered. The aim of each study was to assess whether differing aspects of the quality of the design process in which students were engaged could be influenced by such direct teaching.

Study 2.

While many authors support the concept of teaching thinking skills, few provide directions for application, relying instead on details of desirable criteria and examples of good practice. An exception is the CoRT Thinking Program of de Bono (1986) which provides hierarchical units of instruction. The CoRT 1 program is a set of ten lessons which aims to broaden student perception by demonstrating a variety of different directions that thinking can follow. In this second study, 17 Grade 8 students were taught this introductory "Breadth" unit (de Bono, 1986) of this program for one 40 minute period a week for ten weeks, while a control group (n=15) received another elective subject. Each group undertook both a pre-test and a post-test, each of which comprised devising a solution to a specific design problem. Assessment of quality in this study was by means of a 9 point scale based on the SOLO Taxonomy (Biggs & Collis, 1982) which provides a Piagetian approach to the evaluation of open-ended responses. One of the dimensions specifically assessed was creativity. No differences were found between groups on any of the pre or post-test measures, suggesting that the thinking program had little observable impact on quality of design solutions. This may have resulted from the form of assessment used, since the possibility of obtaining an observable movement in developmental level of response in the relatively short time frame allowed, was fairly remote. An alternative explanation is that the abstract or general nature of the training meant that there was very little transfer to the task being assessed, even though students had been encouraged to use the strategies taught.

Study 3.

A different approach to both teaching and assessment was taken in the third study. Rather than teaching abstract thinking skills, problem solving strategies were taught to a group of 18 Grade 7 students for 8 weeks for one 40 minute period a week. A control group (n=19) undertook normal Design and Technology (D&T) lessons during this time. Again, a specific commercial program was followed, this being the Creative Problem Solving (Eberle & Stanish, 1990) program which emphasised brain-storming. However, the teaching problems posed were of a fantasy nature, although within the broad realm of the design syllabus, while the test problems were from the D&T syllabus. Assessment was on a five dimensional criterion referenced scale using six points within each dimension. Similar dimensions to those used in the previous study were employed: flexibility; fluency; originality; practicality; and reflectivity. Results again indicated no significant differences between groups. This would seem to further reinforce the earlier suggestion that the teaching situation needs to translate general strategies into specific contexts for the skills taught to be effective.

Study 4.

The final study took precisely that approach. In this case, the teacher adapted a problem solving model (Sellwood, 1991) to be part of a normal classroom routine for a class of 22 Grade 7 students. Problem solving strategies were taught and exercises were undertaken within the context of each lesson and these exercises were related to specific design problems. The intervention was undertaken for a three week period with four 40 minute periods being taught each week. A control group (n=16) received normal D&T lessons on the same topic for the same period of time. A criterion referenced checklist was again devised using similar dimensions to those already mentioned and four raters were used for establishing validity. Post-test results revealed that the experimental group outperformed the control group ($p<.01$) by almost one standard deviation. It seems likely that the direct linking of strategies to the task at hand, coupled with possibly the more intensive exposure to these strategies over a short period of time, produced positive results.

Discussion.

The results of these three studies reflect something of the tension that exists between those who argue for generality and those who propose specificity in cognitive strategy instruction. At the heart of that tension is the issue of the predictability of human behaviour (cf Cziko, 1989). The generalist would propose that human behaviour is reasonably predictable across time and tasks, while the specificist would argue that behaviour is largely determined by specific task and time factors and is not due to general constructs. I would like to use an amalgam of two compatible models (cf. Kirby, 1989) which draws on elements of both of these arguments to explain the results of these latter three studies and to then relate them to the findings from the first study on teacher attitude. The model represents strategy use and learning as occurring within a hierarchical context, while it also suggests an important interaction between general and specific strategies within task performance.

In the hierarchical model (see Fig.1), general strategies would comprise such conscious mental activities as making an effort to inhibit compulsive responses, or attempting to relate a current task to previous tasks. At the same level, those broad factors which are both cognitive and affective, are seen to independently operate on the levels below. On the next level down, the definition of what constitutes a domain is not readily defined, but in an educational context, it would equate with subject areas. So, in the mathematics domain, a domain specific strategy might apply to solving mathematics word problems and could be trying to make an equation or listing all the variables. The model also suggests that the various levels have a differing impact on final task performance, although that impact is mediated by the nature of the task itself. For instance, when a task is very general or, perhaps unfamiliar, then general strategies or those other factors will have the greatest impact on performance. This was clearly demonstrated in a study by Schofield and Kirby (1994) in which subjects' general preferences for learning style were the most powerful predictor of performance in the absence of specific strategy instruction on a map reading task. Habitual or pre-existing strategies almost inevitably come into play when faced with a situation that is either novel or very familiar. Two further questions then arise: at what level does transfer mainly occur; and at what level should intervention be aimed?

Using the model in Fig 1, it is apparent that there is a "trickle-down" effect in operation at all levels. However, the problem with aiming any intervention at the upper levels of such a model is that in many situations such strategy instruction becomes so diffuse by the time it reaches the bottom or task levels, that it is barely discernible. This is because the specific requirements of the task are so immediate and any new general strategies are so far removed from the reality of the moment that old or habitual strategies are likely to come to the fore. Consequently, there seems to be a need for intervention at the lower levels. Yet, it is not feasible to establish a repertoire of task specific strategies that could be broad enough to cope with every learning strategy, which means that there is a need to train learners in both general and domain specific strategies. In other words, transfer does occur but at varying degrees and at all levels, in which case any intervention program should also aim at all of these levels. This appears to have been the strength of the fourth study outlined above. While the first aimed at the general level exclusively and the second and third at more of the domain level, the fourth reinforced the interaction between all three levels. The fact that something as amorphous as creativity benefited from this approach was particularly encouraging.

Conclusion.

In summary, it seems that these studies offer some hope for two of the major problems associated with producing a technologically literate and creative community of the future. In the first place, there is an urgent need to overcome the reluctance of technology teachers to embrace innovation and this may only be possible through pre-service selection procedures. This, in itself, poses major ethical questions. The second problem, teaching for design creativity, appears to be possible, provided that the strategies taught are closely related to the subject matter. Given that these results were also obtained across a broad spectrum of ability groups, such teaching would seem to provide potential for advances in technological creativity within all ability groups in the wider community.

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