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ABSTRACT

This paper reports on one dimension of a longitudinal study that researched the impact on student creativity of a unique intervention program for elementary (year 6 and year 7) students. The intervention was based on the Australian National Profile and Statement for the curriculum area of Technology. The intervention program comprised project-based, collaborative, and thematically-integrated curriculum units of work that incorporated all eight Australian Key Learning Areas (KLAs). A pre-test/post-test control group design investigation was undertaken with 520 students from seven schools and 24 class groups that were randomly divided into three treatment groups. One group (10 classes) formed the control group. Another seven classes received the year-long intervention program, while the remaining seven classes received the intervention, but with the added seamless integration of information and communication technologies (ICTs). The effect of the intervention on the personal dimension of student creativity was assessed using the Creativity Checklist, an instrument that was developed during the study. The results suggest that the purposeful integration of computer technology with the intervention program positively affects the personal creativity characteristics of students. (Contains 30 references.) (Author/MES)

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Abstract

This paper reports on one dimension of a longitudinal study that researched the impact on student creativity of a unique intervention program for elementary students. The intervention was based on the National Profile and Statement (Curriculum Corporation, 1994a, 1994b) for the curriculum area of Technology. The intervention program comprised project-based, collaborative and thematically-integrated curriculum units of work that incorporated all eight Australian Key Learning Areas (KLAs).

A pre-test/post-test control group design investigation (Campbell & Stanley, 1963) was undertaken with 520 students from seven schools and 24 class groups that were randomly divided into three treatment groups. One group (10 classes) formed the control group. Another seven classes received the year-long intervention program, while the remaining seven classes received the intervention, but with the added seamless integration of information and communication technologies (ICTs). The effect of the intervention on the *personal* dimension of student creativity was assessed using the *Creativity Checklist*, an instrument that was developed during the study. The results suggest that the purposeful integration of computer technology with the intervention program positively affects the personal creativity characteristics of students.

Introduction

The curriculum area of Technology is one of eight Australian nationally agreed Key Learning Areas (KLAs), and is primarily concerned with challenging students to *design*, *make* and *appraise* products and or processes to meet a need and in response to a novel problem. The Curriculum Corporation (1994a) defines Technology as "the purposeful application of knowledge, experience and resources to create products and processes that meet human needs" (p. 3). Technology could therefore be perceived to be an intellectually creative problem-solving process that is applied in a range of culturally valued domains. Thus, curriculum programs dealing with Technology should be linked to the accumulated psychological research on intelligence and intellectual development, and the closely related research dealing with creativity and problem solving, in order to provide the programs with a sound theoretical basis.

Intelligence, as used in this study, is defined as a unique set of abilities or proclivities, the possession of which affords the individual the ability to solve problems, or to create novel products, valuable in the specific cultural setting in which they are created. Intelligence is thus viewed as a pluralistic cognitive construct (Biggs & Moore, 1993; Gardner, 1983). Further, an individual's creative processes and products could be perceived as the *mirror* through which to view the upper limits of intellectual ability in specific domains.

Creativity, giftedness, prodigiousness, expertise and even genius are terms that are repeatedly and often inconsistently used throughout the literature pertaining to intelligence and intellectual development. Gardner (1993a) proposes a general framework and definitions for these terms in what he calls the "giftedness matrix" (p. 50). Creative is a term Gardner states, that is generally reserved for those individuals who fashion products that are initially seen to be novel within a domain, but which are ultimately recognized as acceptable and even valued within a specific culture.

Early research by Getzels and Jackson (1962) and Wallach and Kogan (1965) contrasted highly intelligent versus highly creative students, and found that while the two traits are not the same, there is good evidence that creativity and intelligence are related. More recent research by Davis and Rimm (1998) found that a base level of intelligence is essential for creative productivity, but above a threshold (about IQ=120), there is virtually no relationship between measured intelligence and creativity. This result is supported in the literature by numerous other researchers, among them MacKinnon (1978), and Walberg and Herbig (1991). Walberg and Herbig noted that the brightest students are not necessarily the best at creativity, and that higher levels of intelligence are less important to creativity than are other psychological traits. Thus, general intelligence as measured by IQ tests, does not necessarily dictate who will and who will not be creative. Further, true creativity, of the sort which has been defined here, and which is generally most culturally valued, namely the ability to solve novel problems or fashion unique products in a specific domain, could not be measured accurately with traditional pen-and-paper intelligence tests.

The Intervention

The Technology KLA curriculum documents refer to the use of an interactive problem-solving process to create complex products in response to open-ended instructions (Curriculum Corporation, 1994a, 1994b). An intervention program, comprising four school-term length project-based, thematically integrated units of work, was developed based on these documents. The intervention was designed as a unique method of implementing the national curriculum in elementary classrooms. The four units of the intervention were entitled: Toys-by-Us, Medieval Europe, Settlement and Colonisation and, Multiculturalism in Australia.

Each unit was a fully integrated curriculum unit of work that utilised the skills, processes and understandings specific to the Technology learning area in order to enhance outcomes for students across all curriculum areas. For example, the Toys-by-Us unit challenged students to design and make a new toy that a particular age group would like, as well as design and make the packaging for the toy, and create an advertising campaign to help market the toy, including an appropriate advertising poster, magazine advertisement, television or radio jingle (See handouts).

Thus, each of the four units challenged students to use the complex and highly personal processes of analysis, synthesis and reflection, in their efforts to create a domain-specific product. It is proposed, that through involvement in such Technology units, students will develop their creative problem-solving skills and processes, which will then be transferable to all curriculum areas (Gagné & Smith, cited in Brown, 1987; Kuhn, 1986; Nickerson, 1989).

A similar creative problem-solving process was followed in all four units. In addition to the basic cyclical Technology problem-solving process comprising the four stages of investigating, designing, making and evaluating (IDME), each unit also contained teachers notes and curriculum links to the other seven key learning areas. Each project ran for approximately 6-8 weeks. Teachers attended two, two-hour professional development sessions at the start and half way through each term or unit, in order to reflect, plan and share their experiences and expertise.

The design task for each unit required the students to work as a member of a four-person production team. Each production team was assembled based on Gardner's (1983) theory of multiple intelligences. Each team contained at least one student who was strong in each of the seven primary intelligences outlined by Gardner. Thus, within each team, there was *at least one* person who was able to perform any task that the project required. Therefore each team was well placed to be able to fulfil successfully all parts of the complex, multi-faceted design task.

The Intervention Plus Computers

It would seem plausible to assert from the accumulated literature pertaining to computers in education that student learning outcomes should be enhanced by the curriculum integration of computer technologies. According to Hamza and Alhalabi (1999) a teacher's primary role is to educate students to think, to learn and to make creative connections that they previously might not have made. They believe that computers can assist students to creatively bridge prior and new knowledge by (1) facilitating the establishment and maintenance of communities of learners; (2) providing a safe environment in which creative behaviour and risk taking is valued; (3) providing students with divergent imagery, including mindmapping tools; (4) providing students with cognitive tools with which to learn critically and creatively; and (5) providing students with multiple means of organising, representing and presenting information. Jonassen (1996), and Jonassen, Carr and Yueh (1998) also believe that the computer's divergent imagery and mindmapping tools can be productively used in classrooms to enhance critical thinking and creativity. They emphasise the use of computing tools for semantic organization, dynamic modelling, information interpretation and knowledge construction.

There is also extensive support in the literature for the idea that computer-mediated communities of learners can facilitate the development of higher order thinking, problem solving and creativity (DeCorte, et al., 1999; Karre, 1994; Scardamalia & Bereiter, 1995). Certainly, computers provide students with multiple means of organising, representing and presenting information. For example, some mathematics educators such as Kaput (1992), and Lesh and Doerr (1998) have argued that hypermedia systems offer a radical new range of representational opportunities that have the potential to provide students with greater opportunities for creating mathematical knowledge. Further, many studies have found that providing access to multimedia authoring software can enable students to explore and produce highly creative ways of organising and presenting information to different audiences (Parker, 1999; Riley & Brown, 1998).

Thus, the computer, as the second industrial revolution (Simon, 1987), has the potential to increase the power of the intellect, just as the invention of the steam engine amplified and boosted the physical power of humans. Schools have a well-documented history of using technologies such as pencils, paper, books, an abacus or calculator to support or extend the power of the intellect. The personal computer is a recent classroom addition to this range of technological tools (Rowe, 1993). But it is not enough to view the computer simply as an intelligence amplifier. Computer tools not only amplify individual capabilities, they also serve to dramatically alter cognitive tasks. Computers both increase the speed and efficiency of our mental efforts, and they also alter the problem-solving tasks themselves and, in so doing, they alter the cognitive processes we use to solve problems (Proctor & Burnett, 1996). Therefore, the computer should be seen as not only having the potential to amplify human mental capabilities, but also of providing a catalyst for intellectual development.

Purpose of the Study

This study assessed the impact of the intervention program described above on the creativity of three groups of students. One group experienced only the intervention program, without specific reference to classroom computer tools, while a second group was actively encouraged to use their available classroom computing resources to support their creative endeavours within the intervention program. The third group comprised a non-intervention control group.

While the curriculum units were identical for the two intervention groups, the intervention group labelled Program+Computers (P+C) specifically integrated computing tools with the curriculum units, while the Program Only (PO) intervention group did not use computers to facilitate their creative problem-solving. The hypothesis underpinning the specific integration of classroom computing tools into the intervention program is that when computer technology is seamlessly integrated into the curriculum program, especially a program such as this which encourages creativity, the computer technology will become a medium of expression for students, a catalyst for intellectual development, and will support excellence in teaching and learning and in thinking about and with computers (Proctor, 1999).

In particular, this paper will address the following specific research question from the overall study: Is there a difference among the three groups (P+C, PO and Control) when their *personal* creativity characteristics are compared at pre- and post-tests?

Method

Subjects

The subjects involved in this study were 346 year 6 and 174 year 7 students comprising 24 class groups from seven state elementary schools in Brisbane, Australia. The students had a mean age of 10.7 years and 54% were male. Fourteen of the classes from five of the schools were allocated to either of the two intervention groups that were named Program+Computers (P+C) and Program Only (PO). Each of these groups contained seven classes. The other 10 classes in the two remaining schools acted as a non-intervention control group that was named No Program (NP). All seven schools were co-educational, outer-suburban schools with a mixture of socioeconomic groupings ranging from low to moderately high and a heterogeneous mixture of academic ability levels. A total of 520 students were involved in the study and complete data sets were obtained for 438 of these students.

Their teachers grouped students into production teams of between four and six students. The amount of class time spent on each unit averaged 3.5 hours per week for the 14 classes involved in the PO and P+C intervention groups.

The four stages of the Technology process used in each of the units—investigate, design, make and evaluate (IDME) are represented in Figure 1.

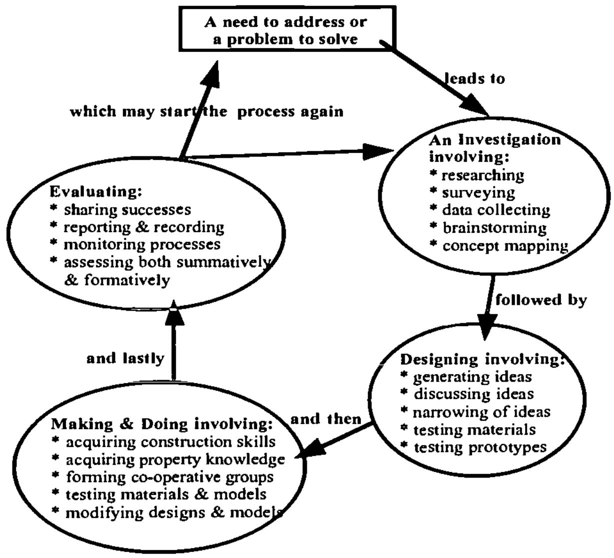

Figure 1. A diagrammatical representation of the four stages in the cyclical Technology IDME process.

Measurement Instrument and Procedures

The personal dimension of student creativity was assessed using the *Creativity Checklist* at the pre-test in February and again at the post-test in December. Class teachers completed the checklist based upon observations of their individual students, made in the classroom context during the course of the study. The Creativity Checklist was designed to rate each student's personal creativity traits on a three-point nominal scale (Rarely, Sometimes, and Often) with regard to nine traits that are considered in the literature to be most commonly used for real-world, goal-directed creativity, namely: fluency, flexibility, originality, elaboration, intrinsic motivation, curiosity or task immersion, risk taking, imagination or intuition, and task complexity or challenge. This approach of profiling an individual's abilities, such as creativity, was recommended by Gardner (1983) and recognizes that an individual's creative proclivity can only be assessed from within a domain (Technology projects) and in light of the judgments of a knowledgeable field of experts (teachers).

Therefore, the primary purpose of the Creativity Checklist was to provide teachers with a simplified observation instrument with which to rate each student's real-world, goal-directed creativity, as it is demonstrated in the classroom setting. Each of the nine items contains several performance indicators to assist teachers to rate elementary students on each item. Also, the meaning of the items was explained to teachers at a professional development session that aimed at reducing the potentially high inferential and subjective nature of the instrument. The scale's reliability and construct validity were assessed from the pre-test data. A factor analysis revealed a single factor solution with an eigenvalue greater than one and accounting for 63.7% of the variance. All nine items of the factor loaded at .68 or greater. It was concluded that the Creativity Checklist has high internal consistency and is a reliable measurement instrument of the theorized construct.

Results

The data were analysed using the Statistical Package for the Social Sciences (SPSS) for Windows (Norusis, Release 10.0.5). A repeated measures ANOVA was used to compare the means of the three treatment groups across time. The analysis indicated a statistically significant group-by-time interaction effect ($F(2,435)=3.54$, $p=.03$) and the pair-wise comparisons using dependent t tests ($p<.01$) were significant for the P+C group only. Table 1 displays the means, standard deviations and significant post hoc results for each of the three treatment groups.

	Mean (Standard Deviation)		
	NP(n=168)	PO(n=124)	P+C(n=146)
Pre-test	2.03(0.56)	2.11(0.51)	2.09(0.55) *
Post-test	2.03(0.62)	2.11(0.53)	2.22(0.53) *

Note. NP = No Program Control Group; PO = Program Only Group; P+C = Program + Computers Group. * $p<.01$.

Table 1: A Comparison of Means (with Standard Deviations) Among the Three Treatment Groups for the Creativity Checklist (N = 438)

Figure 2 plots the pre- and post-test means of the three groups. The results indicate that the teachers of the P+C treatment group perceived their students to have enhanced their personal creativity characteristics over time relative to the other two groups.

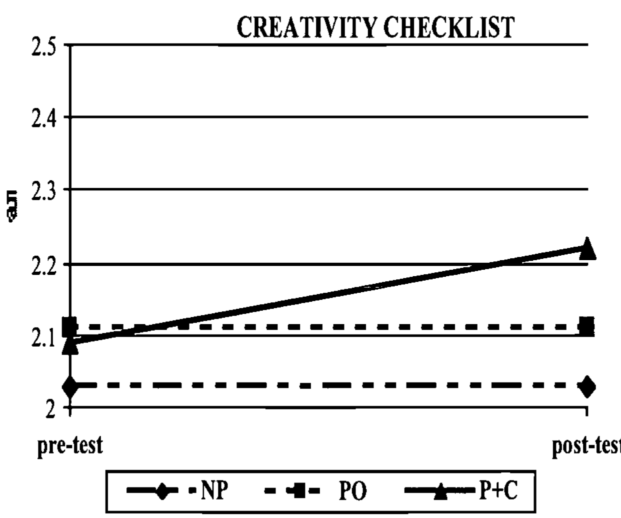

Figure 2: The pre- and post-test means of the three treatment groups for the Creativity Checklist.

Discussion

When the Creativity Checklist data were analysed, a significant group-by-time interaction was achieved, and this appears to have been accounted for by the P+C students displaying significantly more positive personal creativity characteristics at the post-test, than they did at the pre-test. The results indicated that there was not a significant difference among the groups at either testing time. However, the P+C group did show a statistically significant increase in their mean from pre- to post-test. Interestingly, the PO and NP groups' means stayed exactly the same for the duration of the study. These results suggest that the purposeful integration of classroom computer technologies with the Technology intervention program, positively affected the teachers' perceptions of their students' personal creativity characteristics. The intervention alone was not sufficient to enhance the teachers' perceptions of their students' creativity. Why was this?

The basic premise upon which computer technology was integrated into the intervention was that it would become a medium of expression for the students and would support excellence in teaching and learning. The integration of ICTs provided the P+C students with multiple means of organising, representing and presenting information to their various audiences in creative ways (Parker, 1999; Riley & Brown, 1998). The computing tools offered the P+C students a new range of representational opportunities that provided them with greater opportunities for creating and for demonstrating their creativity (Kaput, 1992; Lesh & Doerr, 1998). This enhanced visibility of the students' creativity was possibly what the P+C teachers were responding to, hence the improvement in the P+C group over time.

However, Rowe (1993) suggested that technological tools such as computers not only amplify cognitive capabilities, they also alter the basic fabric of the tasks themselves. Therefore, the computer not only has the potential to amplify existing human mental capabilities, but also to provide a catalyst for intellectual development. Hamza and Alhalabri (1999), and Jonassen (1996) believed that computer *mindtools* could enhance creativity. The P+C students exhibited enhanced creativity. Thus, the result could also be attributed to the integration of ICTs with the intervention, which provided a catalyst for the group's intellectual development. The integration of the classroom computers with the P+C intervention provided the cultural means of empowering cognition, and more specifically creativity.

In the P+C intervention, the computers were intertwined not only with the way in which students might go about tasks, but with the whole context of learning and teaching; and, as a result, the students' personal creativity was enhanced. Due to recent infrastructure projects by the Queensland state education department, all 24 classrooms involved in the study had access to a similar quantity and quality of hardware and software. Therefore, it is not merely the hardware or software available in a classroom that will determine the extent of the computer's input into education, but rather what teachers and students *do* with those computing tools. Rowe (1993) asserts:

> In reality, computers in the classroom are far more than a treatment ... The introduction of computers changes the classroom culture. A fundamental feature of any attempt to evaluate the impact of this technology must thus be a focus on the dynamic interplay between learning processes, students, teachers and the learning context. (pp. 14-15)

These results suggest that, in order to capitalise on the computer as a cognitive tool in the classroom, its integration must also be accompanied by an increased understanding of the teaching and learning processes and their impact on cognitive development.

With economic and political importance being placed on using computers in elementary schools, it is fitting to question the value in terms of cognitive development for students, that is derived from this infusion of computers into the curriculum. What effect will these computers have on our students, teachers, schools, and communities? How do we best implement curriculum initiatives in order to optimise the educational benefits for each individual student?

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