**Abstract**

This project investigated the question: Does using Information and Communication Technology (ICT) as a teaching and learning tool in middle schools make a difference to academic rigour, and if so how? The project on society and environment was conducted at a Perth, Australia metropolitan middle school with two classes each completing two open-ended tasks (in digital and print mode) over two school terms, with the same teacher. Analysis of data showed that students displayed high quality intellectual work using both digital and print modes of learning. Overall the print mode provided greater academic rigour for students than the digital mode. This finding stands in contrast, if not contradiction, to another finding of the study; namely, that students working in digital mode engaged in more social and collaborative interaction and demonstrated more independent problem-solving ability than students working in print mode.

**Introduction**

During the past 15 years, countries such as Australia (Chadbourne, 2001; Luke, 2003) and the US (McEwin, Dickinson, & Jenkins, 2003) have seen the growth of separate middle schools for young adolescents. While welcomed in some quarters, this development has raised concerns with some educators. Arguably the most damaging criticism is that middle schooling undermines academic rigour. Critics argue, for example:

> Overemphasis on the social, emotional, and physical needs of the middle school student has led to neglect of academic competencies. (Bradley cited in Beane, 1999, p.4)

The most frequent criticism of middle schools is that their so-called “child-centred” pedagogy has failed miserably with regard to academic achievement, behaviour control, and every other imaginable measure of
what some critics consider to be serious and rigorous education (Beane, 1999, p.3).

I think we should abandon the whole middle school concept. Middle schools are a disaster. They slow down the intellectual progress that kids make in elementary schools, and they effectively preclude readiness for college for many minority kids (Mitchell cited in Norton, 2003).

Support for these criticisms tends to take the form of impressionistic and circumstantial evidence. Direct, research-based data have not been collected or reported. Also, while these criticisms have been characterised by inadequate conceptualisation of what constitutes ‘academic rigour’ (Chadbourne, 2003) they nevertheless have been influential in persuading some education officials in the US to call for the elimination of middle schools (Herszenhorn, 2004).

Given the seriousness of this issue, should ICT (Information and Communication Technology) be seen as part of the problem or part of the solution? Certainly ICT occupies an important place within middle schooling, largely on the assumption that, “New technologies enable us to make curricula more interdisciplinary and more engaging” (Raebeck, 1998, p.108). However, what impact do new technologies have upon the intellectual quality of students work in supporting academic rigour? In an effort to answer this question, we conducted a small scale research project during 2004-2005 aimed at investigating the question: Does using ICT as a teaching and learning tool in middle schools make a difference to academic rigour in the subject of Society and Environment (S&E), and if so, how? Apart from our discipline-based expertise, we chose S&E for this study because the inquiry focus of its pedagogy gives ICT particular significance as a research tool. Three of us teach in a middle school pre-service teacher education course and the fourth is a learning team teacher at the project school.

Research Plan, Method, and Conceptual Considerations

The design of our project fell largely within the qualitative research paradigm (Denzin & Lincoln, 2003). This was appropriate given that it comprised the following: a small scale, single site; longitudinal investigation; fieldwork interviews with students and observations of their classroom activities; and an interpretative analysis of students' written work. At the same time, we anticipated being able to process and present some of the qualitative data in basic quantitative form.

We conducted the project at the middle school campus of a Perth metropolitan school, which was recently physically and philosophically restructured into a purpose-built middle school and a separate senior school campus. The middle school comprised four Year 8-9 learning communities which had state-of-the-art technology and catered to 512 students. It was staffed mostly with merit-selected teachers (new appointments are merit-selected) and its practices were informed by middle schooling principles. The existing senior high school (Years 8-12) recognised early adolescence as a distinct phase and restructured the existing senior high school into two new, purpose-built campuses on the existing
senior high school grounds. The middle school catered to students in Years 8-9 and the senior school catered to students in Years 10-12.

Within the middle school, at our project site, each of the four Year 8-9 learning communities consisted of about 125 students and a small interdisciplinary team of teachers. Each of the communities had its own rooms, resources, timetable, name, and identity. Each was expected to develop the climate, culture, and structure of a small community and operate as a small adolescent-centered sub-school, not a traditional junior high school (Pendergast & Bahr, 2005).

The organization and operation of small learning communities in middle schools throughout Australia have much in common with American schools for young adolescents based on the philosophy of middle schooling. This philosophy is presented in a range of publications, most noticeably those produced by the National Middle School Association (NMSA). Overall the growth of middle schools in Australia has more parallels with a similar development in the US than with middle years reforms in Britain (McEwin, Dickinson, & Jenkins, 1996; Doda & Thompson, 2002).

The project took place in three phases over two school terms. As indicated in Table 1, the research plan involved: (1) two classes (Class A & Class B) from the project middle school completing two open-ended tasks over two school terms; (2) each task being completed by one class using digital text and the other class using print text; (3) each class during each school term completing one task using digital text and another task using print text; and (4) each task being completed over two one-hour consecutive sessions.

Table 1

*Organization of the Project*

<table>
<thead>
<tr>
<th>Schedule</th>
<th>Class A</th>
<th>Class B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year</strong></td>
<td><strong>Term</strong></td>
<td>Task 1</td>
</tr>
<tr>
<td>2004</td>
<td>4</td>
<td>Digital text</td>
</tr>
<tr>
<td>2005</td>
<td>1</td>
<td>Task 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Print text</td>
</tr>
</tbody>
</table>

The two classes had the same teacher for the two tasks (a total of eight one-hour
sessions). Two researchers attended these sessions and acted as process observers, particularly with respect to interactions between teacher and students, between the students themselves, and between students and their learning technologies (digital and print). Except for different technologies (digital and print), arrangements for each class were similar: same teacher, same tasks at same time of year, same task instructions, same process observers, and same learning communities. The study proceeded in three phases.

**Phase 1: Preparation of the Conceptual and Methodological Ground**

Phase 1 involved developing academically-challenging tasks as well as a lesson format to introduce the tasks and process observation schedules. It also involved selecting standards for 'levelling' the work completed by students as part of the two tasks set for them (see Appendix 1). In more detail:

(1) The academically-challenging tasks involved a question that arose from the S&E learning area and to which virtually all students could construct an answer within two consecutive one-hour sessions.

(2) The lesson format used to introduce students to academically-challenging tasks was consistent with the principles of middle schooling pedagogy (Jackson & Davis, 2000; Zemelman et al., 1998).

(3) Standards used to determine the academic rigour of each student's work were selected from the current S&E Progress Maps (2005) developed by the Education Department of Western Australia (see Appendix 1).

(4) The conceptualisation of the project was informed largely from three sources, namely: the principles of middle schooling curriculum and pedagogy (e.g., Jackson & Davis, 2000); research on elements of intellectual quality, authentic academic achievement, and productive pedagogies (e.g., Lingard, Ladwig, Mills, Bahr, & Chant, 2001; Newmann and Associates, 1966; and Pohl, 2002); and studies on the relationship between constructivism and academic rigour (e.g., Krause, Bochner & Duchesne, 2003).

**Phase 2: Student Completion of the Two Tasks**

The students completed each of the two tasks during two separate but consecutive one hour sessions conducted by the ‘project teacher’. For each task, students were given the same written resource material (in either digital PDF or printed text form) and asked to develop answers to the following briefs.

**Task 1:** You have been appointed as a consultant for the Western Australian Government Minister for Water Resources. The Minister has asked you to prepare a press release where you suggest three solutions to Perth’s water supply problem. One of the solutions should be presented as your preferred option and justified using data.
Phase 3: Collecting and Analysing Data

Data for the study came from four sources: students' written work completed as part of the two tasks; process observations made by the researchers during the eight one-hour sessions; discussion at the end of each task between the project teacher and the three university researchers; and 60 minute interviews at the end of Task 2 with four students from each class, coded S1-S8 in this article. The interviews focussed on the students' perceptions of what difference ICT made to the academic rigour, intellectual quality, and standards of their work in S&E.

Findings

The central research question required answers to sub questions, namely: Does using ICT in middle schools make a difference to academic rigour? If so, why or how? With respect to the first of these sub questions, Table 2 shows the academic levels achieved by Class A and Class B in Tasks 1 and 2 in the digital and print modes. Determining the academic level of each student's work was undertaken by the S&E teacher who had taken all the classes for the two tasks. The data in Table 2 show that print mode sessions produced higher levels of academic rigour than the digital mode sessions, and that students achieved higher standards of academic rigour in Task 2 than in Task 1.

Table 2

<table>
<thead>
<tr>
<th>Year and Term</th>
<th>Class and Task</th>
<th>Curriculum Framework of Western Australia</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>*NS</td>
<td>**ND</td>
</tr>
<tr>
<td>2004 Term 4</td>
<td>Class A Task 1</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Digital</td>
<td></td>
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<td></td>
<td>Class B Task 1</td>
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<td></td>
<td>Print</td>
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<tr>
<td>2005 Term 1</td>
<td>Class B Task 2</td>
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<tr>
<td></td>
<td>Digital</td>
<td></td>
<td></td>
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<td></td>
<td>Class A Task 2</td>
<td></td>
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<td></td>
<td>Print</td>
<td></td>
<td></td>
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</tbody>
</table>
In the digital task (Task 1) Class A (Table 2) shows a high percentage of students who had either not submitted work to be marked (32%) or who had not demonstrated attainment of a level (24%). This discrepancy between Class A and Class B could be explained by the following reasons: Unlike Class B, Class A: (1) lost time in transitioning between classes; (2) was unfamiliar with the teacher; (3) required more technical help; and (4) encountered problems specific to laptops.

Differences Between the Digital and Print Modes

Table 3 shows that student levels of academic attainment were higher in print mode than in digital mode. No students achieved Level 4 in the digital mode and only 28% achieved Level 3 in the digital mode, compared with 64% in the print mode. Lower levels of academic attainment were demonstrated in the digital mode. Reasons for these differences will be presented later.

Table 3

Academic Levels in Digital and Print Modes

<table>
<thead>
<tr>
<th>Curriculum Framework of Western Australia Levels *</th>
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</thead>
<tbody>
<tr>
<td>Mode (Combined Tasks 1 and 2)</td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
<tr>
<td>Digital mode (all students)</td>
</tr>
<tr>
<td>Print mode (all students)</td>
</tr>
<tr>
<td>Total number of students</td>
</tr>
</tbody>
</table>

* Excluding NS (not submitted) and ND (not demonstrated) students

Differences between Task 1 and Task 2

Table 4 shows that both classes performed at a lower level in Task 1, regardless of whether the task was digital or print based. No students achieved Level 4 in Task 1 and only 25% achieved Level 3, compared with 66.8% of students in Task 2. Another
noteworthy result is that Class A performed at a lower level of achievement in Task 1 than Class B (as shown in Table 2).

Table 4

*Excluding NS (not submitted) and ND (not demonstrated) students

Discussion of Findings

Factors that explain why students achieved higher academic levels in the print mode than in the digital mode, and in Task 2 than in Task 1, can be identified from an analysis of the reflections and observations made by the students, project teacher, and two process observers.

Explanations for Higher Academic Levels in Print Than Digital Mode

Four sets of factors account for students achieving higher academic levels when working in the print mode compared with the digital mode.

Technology Factors

Technology was identified by all participants as the major reason for higher levels of academic work resulting from the print mode sessions. The observers noted that many
students were not confident with the digital mode. Some of the students had trouble logging on initially and, as outlined below, there were on-going technical problems as well as problems associated with the location of computers.

Many students’ technical skills were not at the expected standard, which surprised the teacher but not the students. As S3 commented, “Some people aren’t all that educated with computers.”

Students found the online templates hard to find and download, and they had to change between screens. According to S1, “I needed more help on the computer one because of …how to get the draft press release folders.” Digitally literate students had a different perspective. S7 said, “It was all written down on the computer, ‘How to write a press release' and stuff,” and S3 added, “On the computer one it was already down on the computer, so we figured it out by ourselves.”

Most students lacked familiarity with PDF documents though two students recalled using a PDF document in a science lesson. Another student scrolled to the end of the PDF document and asked a class member, “Where's the index?” However, some students found the PDF document easier to use than a textbook. S7 explained, “The PDF one was easy because you could do a word find thing and just find …[information] on the computer.” S8 said, “You can highlight words and find key words easier.”

Other student technical difficulties included students not being able to read the computer screen because of glare and a number of students not knowing how to email their work to the teacher.

Students exhibited a higher comfort level with print resources. More students demonstrated more high-quality skills for seeking and extracting information from print texts than from digital texts. Once the information was located, students had no trouble transferring it to ‘hard copy' templates.

The students preferred to type rather than handwrite the information they found for several reasons: “On the computer it's easier to edit…you just go on to Word and then…pick up more mistakes on the computer” (S6); and, “It's easier to type the words…than handwrite because it's faster and more neat” (S7). Also, students felt that using the books rather than computers to find information made them think more deeply about their topics. When asked which mode challenged their thinking most, S3 said, “The book, because it had illustrations of Aboriginals getting slaughtered and …it made you kind of feel bad.” S1 responded, “Not the Internet, because you don't know if it's true.” S7 preferred the book “because we could discuss it…because we were sitting in a group.”

Within the digital mode, students behaved differently using desktop computers instead of laptops. In the first digital class, 11 students were allocated desktop computers and the remaining 14 were allocated laptop computers. In some cases, the desktop students had to ask other students to leave the equipment, but once students had a desktop they were able to start work almost immediately as the desktops were hardwired. Desktop monitors
were large and easily viewable by teachers and other students. Desktops were arranged along two parallel walls, with some desktops in the center of the area. Students were able to turn or move around with chairs on castors. This mobility allowed them to see what others were doing and to offer and receive help more readily. Interactions occurred across room and across gender.

With laptops, on the other hand, students could not just sit down and begin working. First they had to unlock and check them out from the storage trolley and then take them to their desks. Because some parts of the classroom had better wireless reception than others, students sometimes experienced poor connections. There were also electrical issues with keeping the laptops charged. There was much less interaction amongst laptop students who were seated on non-mobile chairs. Students tended to ‘hunch over’ the laptops while the open face of the laptop gave students somewhere to hide their own faces. One laptop student did virtually no work over two sessions, as he had positioned himself in a corner up against the wall with the laptop angled so that nobody else could see the screen. There appeared to be more off-task behaviour with the laptops. Students were observed accessing the Internet, accessing their email, and sending messages to each other. The teacher believed that he could see if students were accessing off-task sites by reading the taskbar but the students closed or hid the window when the teacher walked past using ‘auto hide’. The teacher believed erroneously that this function had been blocked.

**Teacher Factors**

All participants noted differences between the digital and print mode sessions with respect to teacher delivery and interactions with students. Teaching style varied depending on the mode. The teacher felt more stressed and less in control in the digital classroom and students noticed. The teacher offered more individual than group help in both modes, but offered more whole class help in the print mode. All participants noted differences between the digital and print mode sessions with respect to teacher delivery and interactions with students.

During the introduction in digital mode sessions, particularly in Task 1, rules about the use of the computers and technical information had to be delivered, as well as information about the task. The teacher gave the briefing verbally before students logged on, which meant that students had to write directions and information. The briefing in the first digital class, which had already lost 10 minutes during the intersession transition, lasted 21 minutes, whereas in the print mode there was no need for a technical briefing or for a ‘rules of conduct’ briefing. Students had the hard copy information in front of them and could refer to it as the teacher explained the task.

In the first digital mode session of Task 1, students did not ask questions unless their peers were unable to help. One student, who did almost no work over two digital sessions, said that he would have asked his own teacher for help, but he did not know “this teacher”. Several students were observed pretending to be working until the teacher went away and then asked peers for help. This behaviour was observed three times
within a 20 minute period with one student (S1) who explained that, “We didn't want to get in trouble from… [the teacher].” By the second session, students seemed more familiar and therefore comfortable asking the teacher for help.

The teacher found several situations stressful. Because he did not know the students the teacher did not know which students needed specific help and which ones worked well independently. He also assumed that students would have more technical knowledge than they did.

The teacher thought he was “shorter” and “grumpier” with the digital mode students because they were spread out over a wider physical space which made it harder to get around to all of them. On a related point, one student said that, “[Teachers] …get all stressed when you're at a computer, like every movement you make they're like, ‘Don't do that; don't do this” (S1).

The students’ perception was that they were allowed to work with a partner in print mode, but not in digital mode. As S5 explained, “I think (the teacher) was telling us not to (work together in the digital mode).”

During the print mode sessions, the teacher controlled the situation and facilitated student learning but found this hard to achieve in the digital mode. He had to deal with more behaviour management issues in the digital mode sessions and thought that students found using ICT “more challenging than print” and were “more likely to be off-task”. The students themselves acknowledged that “[Teachers]… can't keep track of everyone” (S1). The teacher was more relaxed with the print mode sessions, as he felt the general supervision and management of student behaviour was easier. Because students were closer together in the print classroom, the teacher was better able to evaluate student and stop the whole class to answer general questions. S7 said, “[The teacher]… had to stay in the class … and keep telling us step-by-step.” The observers noted that the teacher engaged in social banter with the students in the print mode but not at all in the digital mode.

Many more technical questions than conceptual questions were answered by the teacher in the digital mode sessions, although the perceptions of the teacher and the observers differed from those of the students. The students thought they asked few technical questions.

**Student Factors**

Student behaviour differed from print to digital sessions. This occurred partly because students who completed work digitally in Task 1 experienced technical frustrations, particularly with the cumbersome laptop checkout routine. Most preferred to work on desktops. Students complained that it took longer to log onto the laptops and some did not like the laptop touchpads. Nonetheless, students did appreciate the laptop mobility. S7 said, “You can take them anywhere; just go with some friends or something.”
All participants agreed that students appeared to be more on-task in the print class. However, when enthusiasm for and engagement with a task was high, the relevance of the task was more important than the mode. According to the students:

In a book, you’re more focussed on the text and so is the person next to you…but on the computer you can look, talk to a friend, look back … When you get reading a book…it puts you in that frame of mind, but when you’re with computers it’s too easy to click onto another website (S3).

On the computer you all have different sites and someone may have a way more interesting site than someone else’s and they’ll be more glued to the screen, whereas with a book everyone has the same thing and they can all relate to the same information. And with the book you actually talk about what you’re reading (S1).

However, when asked how they would research topics for either Task 1 or Task 2 in their own time, all students agreed that they would use a computer rather than a book.

More independent learning took place within the digital mode. Students found their own information and were responsible for sending the information to the teacher. Within the print mode, teachers provided students with hard copies. Consequently, students depended on the teacher more and took less responsibility for their own learning.

**Organizational and Interactional Factors**

Transition time from one learning area (subject) session to another was similar in both the digital and the print classes. However, the first digital class started 10 minutes late, due to the time it took for students to get to the classroom from a physical education session.

In the digital mode of Task 2, the teacher decided to use desktops only which saved time but meant students were even more scattered physically. Most students were in the computer section of the building which was divided into two sections and four students were in three different classrooms, all of which made supervision even more difficult.

The mood of the classroom differed depending on the mode. The digital classroom was noisier, more active, and produced more interactions of all types, including inter-gender interactions. The print classroom was quieter and more passive, but showed a greater number of teacher-initiated, student-teacher interactions. Students in the print classroom were located in one area and sat and interacted in single gender groups. There was no movement around the classroom and no interaction between groups. Without the barrier of the laptops, students had good lateral communication within their groups. As a result, “For note taking we did a certain amount and then swapped. It was easier and less time-consuming and [we] helped each other” (S1).

Time spent on most types of interaction was greater in the digital classroom. Student-student technical, social, and supportive interactions were greater in the digital mode,
while conceptual interaction was equally supported by both modes. Student-teacher, technical interactions were greater in the digital mode, as was the frequency of interactions. Student-teacher conceptual conversations were equal across both modes. Student-initiated questions were greater in the digital mode, and teacher-initiated questions were greater in the print mode.

Overall, the print mode resulted in a higher level of academic achievement than the digital mode. However, in terms of constructivist learning, the digital mode rated more highly. The digital mode showed higher levels of student interactions, higher levels of student-initiated questioning, and higher levels of independent learning.

**Reasons for Higher Academic Levels in Task 2**

The level of academic rigour demonstrated by students differed not only between the digital and print modes but also between Task 1 and Task 2.

In Task 1, students and teacher were unfamiliar with each other and with the expectations. The processes and terminology of the task were also unfamiliar to students. Students showed much higher levels of engagement with Task 2.

Interactions between teacher and students in Task 2 were more relaxed, regardless of whether the mode was digital or print, as the teacher and students were familiar with each other and the task format. In the words of S6, “[The teacher] …didn’t have to talk as much because we already knew what a press release was.”

Both classes performed at a lower level of achievement in Task 1 in both digital and print modes perhaps due to a lack of familiarity with the teacher and the process and to a lower level of task engagement. In Task 1, *Solution to Perth’s Water Supply Problem*, students were introduced to the process of brainstorming, notetaking, and writing a press release. According to one student, “This task was hard because I didn't know what to do. [The teacher] had to explain what a press release was and how to properly use the note taking sheet” (S4). Because a similar process was used in Task 2 students found, “The second one was easy because I knew what to do that time” (S4).

Initially, the teacher thought there might be some resistance to the Task 2 topic of *Reconciliation* because some students had already completed a unit on *Indigenous Australians*. However, the study found much greater student participation in the whole class brainstorm, and students were much more engaged with the topic. One student commented, “The Aboriginal studies was more interesting because like it’s something that we kind of caused…” (S3). Another student said, “On the water one (Task 1)... we were so bored that we didn't do it. But like this one (Task 2) we were kind of interested in what we were doing” (S1).

**Broad Considerations**

According to the research literature, productive and authentic pedagogies produce high
quality intellectual work from students (Lingard et al., 2001; Newman & Associates, 1996). These pedagogies can be seen in classrooms where students are engaged in knowledge construction, higher order thinking, deep knowledge and understanding, written communication, substantive conversation, problem-based curriculum, metalanguage, knowledge integration, and understandings connected to and of value to the world beyond school. Daniels, Bizar and Zemelamn (2001) portray such classrooms in the following terms.

What makes these classrooms good? They are challenging, authentic, and collaborative … All these students are engaged in complex, serious, meaty issues; they are required to think deeply and share their thinking in a variety of modes of expression; they are experiencing rigor without mortis. Their lessons address real issues in life and in the community, issues that experts in the field still grapple with, understandings gained from careful study that make a difference, work that kids recognize is worth their time. And finally, these classes are truly sociable and collaborative; young people are working in pairs, partnerships, teams, task forces, and study groups; they are learning to lead, to contribute, to carry their weight, to be part of a larger effort; they are learning to operate as most adults do in their professional and social lives – as a member of a community where cooperation and communication are the essence of effectiveness (p.101).

In our project, sessions in both digital and print modes clearly met some of these conditions for academic rigour. For example, they both involved knowledge construction and knowledge as problematic with a connectedness to the world beyond school. To a lesser, though observable degree, they also both involved higher order thinking, elaborate written communication, substantive conversation, and metalanguage. Both modes, then, displayed some ingredients necessary for high intellectual quality work.

Despite the similarities between print and digital modes in demonstrating the elements of productive and authentic pedagogies noted earlier, overall the print mode produced greater academic rigour than the digital mode. This finding stands in contrast, if not contradiction, to another overall finding, namely that striking differences were observed between the two modes in terms of collaboration and independent problem-solving. In the digital mode students were involved in more social and collaborative interactions and demonstrated more independent problem-solving ability than they did in the print mode. This has relevance for the workplace of the future because as Gordon and Elovitz (2002) note, “The ‘new’ workplace relies heavily on technology and values such skills as problem solving, collaborating, and using information and systems knowledge” (p. 31).

Implications

The findings and nature of this study contain implications for school administrators, teachers, and researchers.

At a broad management level, this study supports decisions by education systems to
make a balanced investment in print and digital resources rather than replace one with the other. As such, it has relevance for states such as Texas which is moving towards schools having “to choose between addressing …. needs with traditional textbooks or through a more advanced form of instruction, such as digital instruction” (Associated Press, 2005).

At an individual school level, findings highlight the importance of specific administrative arrangements to maximise cooperative learning within the digital mode such as: planning on the basis of larger chunks of time than traditional 40 minute periods or lessons; organizing desks into smaller groups; and equipping students with swivel chairs on castors and large screen computers.

For individual teachers working in middle schools, the findings of our study provide food for thought with respect to a range of possibilities that can be stated as follows:

(1) Contrary to beliefs in some quarters, many young adolescents do not know more about ICT than their teachers, nor do they all have basic ICT skills; (2) When working with computers in the classroom, some young adolescents can engage in off task ICT activities that are difficult for teachers to detect; (3) Classroom teaching and learning in the digital mode can create added stress for teachers, particularly in the area of managing student behaviour; (4) Technical difficulties of teaching and learning in the digital mode can generate as much discomfort and cognitive dissonance within teachers as within students; (5) The interest level of the learning task can generate a higher degree of student engagement and achievement than the mode of teaching and learning.; (6) The use of ICT does not diminish the need for middle school teachers to devise stimulating, achievable, and demanding tasks for young adolescents in their classrooms; and (7) Teachers who conduct regular focus group discussions with their students are likely to discover that students' perspectives on learning in the digital and print modes contain perceptive and valuable insights.

From a research methodology perspective, this study was characterized by a number of limitations. By design, it was a small scale investigation on a single site. Also, though not by design, the class sizes (digital and print mode) were not equivalent, the interest level of the tasks performed by the students was variable, the less interesting task was undertaken by a larger group in the digital mode, the more interesting task was undertaken by a larger group in the print mode, and the teacher was less comfortable in digital than print mode. These limitations need to be considered when evaluating the findings. For instance, they raise the possibility that some differences in student outcomes may be more a function of research design and contextual factors than a result of any differences in the capacity of digital and print modes to deliver academic rigour. As with many qualitative studies then, the findings should not be regarded as definitive but as offering educators a view of one reality.

After completing this study, we took stock of the outcomes and saw value not in replicating it, but in extending it. In several ways the study could be regarded as ‘teacher-controlled’ because, with input from the research team, the teacher set the specific
questions and then selected and limited the materials with which students could work to construct answers to those questions. This restricted student use of print and digital texts. Further research could take a more open and 'student-controlled' approach. For example, with input from the students, the teacher could identify a broad topic for study, brainstorm with the students a variety of issues worthy of investigation, and allow the students to formulate their own research questions. The students could also be allowed to select their own print and digital texts to construct answers. The results of this more open and 'student-controlled' approach could then be compared with the findings of our investigation. The outcome of such a comparison could add impetus to develop strategies that enhance the capacity of ICT in middle school classrooms to raise the intellectual quality of young adolescents' work.

About the Authors

Dr. Rod Chadbourne taught secondary school English in Australia, New Zealand, Britain, and Canada for eight years before taking a teacher education post at Edith Cowan University in Joondalup, Australia in 1973. His current research interests include the philosophy of middle schooling, and strategies for raising the standard and status of teaching as a profession.

Patricia Kershaw has taught in primary and secondary schools in Western Australia. She currently holds a teacher education position at Edith Cowan University, and is completing post-graduate study in education.

Dr Bill Leadbetter taught secondary school history, ancient history, and religious studies. An historian and lecturer in education at Edith Cowan University, he is the author of a number of works relating to the ancient world and an active scholar in a number of areas.

Rick McMahon has been working in education for 13 years. He has worked in rural and metropolitan schools as a teacher, youth education officer, deputy principal, and learning team co-ordinator. His current position is Learning Team Leader (Society & Environment) in a large metropolitan middle school. He is also completing post-graduate study in education.

Send correspondence to:

Patricia Kershaw
Lecturer
School of Education
Edith Cowan University
100 Joondalup Drive
Joondalup WA 6027
Australia

Email: p.kershaw@ecu.edu.au
Phone: +61 8 6304 5978
References


**Appendix 1** – Curriculum Framework Progress Maps, Curriculum Council, Western Australia

| Society and Environment > Investigation, Communication and Participation |
|---|---|---|---|
| Investigation, Communication |
| FOUNDATION | LEVEL 1 | LEVEL 2 | LEVEL 3 |
and Participation

Students investigate the ways people interact with each other and with their environments in order to make informed decisions and implement relevant social action.

<table>
<thead>
<tr>
<th>Planning</th>
<th>Conducting</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICP F.1</td>
<td>ICP F.2</td>
</tr>
<tr>
<td>Displays interest in people and the environment.</td>
<td>Contributes to investigations.</td>
</tr>
<tr>
<td>ICP 1.1</td>
<td>ICP 1.2</td>
</tr>
<tr>
<td>Contributes ideas and identifies relevant information in investigations; and sorts information into a form that enables presentation of a personal view of findings.</td>
<td>Assembles, collects and identifies relevant information in activities.</td>
</tr>
<tr>
<td>ICP 2.1</td>
<td>ICP 2.2</td>
</tr>
<tr>
<td>When given a focus question, can identify aspects to be considered and use simple data-gathering techniques to collect information; and can select and compare relevant, literal, factual information in presenting findings and comparing own interpretation with those of others.</td>
<td>Uses a range of social science techniques to make literal, factual observations and limited records of the data collected.</td>
</tr>
<tr>
<td>ICP 3.1</td>
<td>ICP 3.2</td>
</tr>
<tr>
<td>With guidance, plans an investigation for a topic, by devising questions, identifying and using information from more than one source; and makes inferences from the information collected in order to justify personal decisions.</td>
<td>Gathers information from more than one source and records useful information using a variety of techniques.</td>
</tr>
</tbody>
</table>
## Processing and translating

<table>
<thead>
<tr>
<th>ICP F.3</th>
<th>ICP 1.3</th>
<th>ICP 2.3</th>
<th>ICP 3.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responds to information from the investigation in practical ways.</td>
<td>Sorts information into simple categories and talks about ways of organising information.</td>
<td>Selects, categorises and compares relevant information.</td>
<td>Recognises key ideas and patterns, discards irrelevant information and transforms information into structured forms for display.</td>
</tr>
</tbody>
</table>

## Applying and communicating findings

<table>
<thead>
<tr>
<th>ICP F.4</th>
<th>ICP 1.4</th>
<th>ICP 2.4</th>
<th>ICP 3.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uses information from the investigation in practical ways.</td>
<td>Expresses a personal view of the information when communicating findings.</td>
<td>Presents findings and makes comparisons between own interpretation and those of others when communicating findings.</td>
<td>Justifies decisions from a personal perspective using some evidence and begins to review original understandings when communicating findings.</td>
</tr>
</tbody>
</table>

### LEVEL 4

**ICP 4**

The student:

- Identifies appropriate sources and data-gathering techniques for an investigation; records information from these sources accurately; considers various perspectives and begins to generalise beyond the immediate context when presenting findings.

### LEVEL 5

**ICP 5**

The student:

- Analyses and clarifies the purpose of an investigation to formulate questions; selects from a range of appropriate data sources and methods of recording; and uses supporting evidence to explain patterns and draw conclusions that generalise beyond the immediate context and present a particular viewpoint.

### LEVEL 6

**ICP 6**

The student:

- Formulates own hypothesis for an investigation; identifies the main aspects to be considered and decides on the most appropriate data sources and recording techniques; and justifies own conclusions by examining logically the viewpoints and the evidence presented by others for accuracy, bias and omission.

### LEVEL 7

**ICP 7**

The student:

- Investigates an issue or event by devising hypotheses and modifying and adapting the conduct of the investigation according to the resources and nature of the evidence available; and analyses the validity and consistency of conclusions drawn by self and others according to the sufficiency of the evidence gathered and avowed values positions.

### LEVEL 8

**ICP 8**

The student:

- Presents a research proposal and designs and conducts a balanced investigation in the field of society and environment; forms conclusions that are not overgeneralised; and judges decisions in terms of conflicting and inconsistent information and values.
| ICP 4.1 | Identifies the types of observations, data and sources appropriate to a topic and negotiates how they will be used to gain information. |
| ICP 5.1 | Analyses a social/environmental issue, formulates questions and plans ways of investigating it. |
| ICP 6.1 | Analyses a problem, formulates own hypothesis, uses social and environmental conceptual understandings to identify the main aspects to be considered, and makes predictions. |
| ICP 7.1 | Devises independently one or more research tasks or hypotheses to guide the investigation of an issue or event. |
| ICP 8.1 | Presents a research proposal and designs a research plan using the methodologies of social and environmental inquiry. |
| ICP 4.2 | Applies social science data-gathering techniques to collect and record accurate information from a variety of perspectives. |
| ICP 5.2 | Selects from a range of appropriate data sources and methods of recording that enhance the specific purposes of an investigation. |
| ICP 6.2 | Selects and decides on the most appropriate data sources and recording techniques for an argument or viewpoint. |
| ICP 7.2 |Modifies and adapts an investigation in response to resources available and the nature of the evidence. |
| ICP 8.2 | Conducts a balanced investigation in the field of society and environment. |
| ICP 4.3 | Identifies, selects and combines information from a variety of sources and perspectives, connecting similar ideas and making generalisations. |
| ICP 5.3 | Collects evidence from a variety of sources and explains patterns in the evidence to draw conclusions that present a particular viewpoint. |
| ICP 6.3 | Develops an argument by analysing viewpoints for accuracy, bias and omission. |
| ICP 7.3 | Draws valid conclusions consistent with the evidence gathered, but questions whether the data are sufficient to support the conclusions drawn. |
| ICP 8.3 | Demonstrates awareness that conclusions show uncertainty in data and does not over-generalise. |
| ICP 4.4 | Develops an informed opinion and communicates this with a particular purpose or audience in mind. |
| ICP 5.4 | Communicates findings in ways that show consideration of the facts, opinions and motives for a particular viewpoint when justifying generalisations made. |
| ICP 6.4 | When communicating findings develops conclusions, justifies personal stances by discussing logically and considering viewpoints and evidence presented by others. |
| ICP 7.4 | Communicates findings based on evidence gathered, according to the purpose of the investigation and can justify own values stance and the validity and conclusions drawn by others. |
| ICP 8.4 | Communicates findings in ways that show an awareness of the uncertainty of data and have taken into account any conflicting information and values to form conclusions that are not over-generalised. |