A CASE STUDY OF TEACHER ENDORSEMENT OF AN INTEGRATED LEARNING SYSTEM

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Eight classes (Years 4 to 7) from a Queensland primary school trialed an integrated learning system (ILS) as a means of remediating students' mathematics learning problems. At the end of the trial, the teachers were asked whether they would recommend the system to other schools. Endorsement appeared to be related to the computer knowledge of the teachers and concomitant experiences of the students, the extent of integration of the ILS sessions in classroom teaching, and the pedagogical beliefs of the teachers.

Over the last two decades, Australian educational authorities have striven to ensure that schools are preparing their students for the challenges and demands of the modern computer age. Queensland aims to have, by 2001, at least four computers in every classroom, and teachers competent in the use of technology. However, the proliferation of computers in schools has not been accompanied by an integration of technology into classroom instruction (Bracey, 1994; Fuglestad, 1996; Hadfield, Maddux, & Love, 1997; Jones, 1998), a condition that appears to stem from teacher anxiety (Kristiansen, 1992; Turner, 1995), a clash in pedagogical beliefs (Chu & Spires, 1991), lack of adequate inservice (Castner, 1998), and problems associated with computers (Pacey, 1992; Yelland, 1997).

One of the by-products of the growth of information technology in education has been the computer-based integrated learning system (ILS) which includes extensive courseware plus management software. An ILS has three essential components, namely, *substantial course content*, *aggregated learner record system*, and a *management system* which "will update student records, interpret learner responses to the task in hand and provide performance feedback to the learner and teacher" (Underwood, Cavendish, Dowling, Fogelman, & Lawson, 1996, p. 33). This paper reports on a study to determine reactions of teachers at one school to the core numeracy courses in an ILS.

STRUCTURE OF THE ILS

The ILS trialed by the school was a comprehensive instructional system powerful enough for complex courses. According to the manufacturer, its courses were designed to foster the development of foundation skills and concepts and to promote the use of higher-order thinking skills. It should be noted that the manufacturers endorsed the system only as a tool for teachers to use to consolidate already introduced material and to diagnose student difficulties. They argued that it is the teachers' role to introduce the material to be practised on the ILS, and to remediate the difficulties identified by the ILS. Thus, they contended that the effectiveness of the ILS depends on the quality of teacher input and that any evaluation of the ILS should take into account the role of the teacher in relation to the program.

The ILS in this study is a closed system, that is, the curriculum content and the learning sequences were not designed to be changed or added to by either the tutor or the learner (Underwood et al., 1996). In the core numeracy component, basic mathematics material is categorised in *strands* (e.g., fractions, measurement) with each strand incorporating several hierarchical levels through which students need to progress. With each level, tasks are supplied via electronic worksheets (designed in America but appropriate for Australian schools) which are presented in random order to students. When students achieve high mastery (80%) at one level, the ILS automatically raises them to the next level. The random nature of the presentation is to ensure that task performance correctly represents level. The worksheets vary in quality, but many are reasonably attractive in their presentation and creative in the way they probe understanding, particularly with the use of 2-D representations of appropriate teaching materials in mathematics (e.g., Multi-base Arithmetic Blocks, Place Value Charts, fraction and decimal diagrams). There are some speed games to drill number facts. As well, there are on-line student resources in the form of a *Help* icon (provides answer), a *Tutorial* icon (provides information on how to do a task), a *Toolbox* Icon (provides calculators, rulers, tape measures, etc.), a *Reference* icon (provides definitions), and an *Audio* icon (reads text passages to the students through earphones). Worksheets can be printed to provide off-computer activity.

However, there are aspects of the ILS that cause some difficulties. For example, the use of the Help and Tutorial icons automatically grades performance as incorrect, insufficient task variety in some domains causes repetition of examples (a feature that often lead to student boredom and frustration), and novel presentation or solution formats of some tasks were difficult for students to interpret (e.g., the units digit must be typed first in solutions to number facts). Generally, questions are closed and performance is based on speed (with time delays leading to the ILS defaulting to incorrect).

LEARNING AND THE ILS

ILS's tend not to meet many of the characteristics of effective software and this is true of the particular ILS reported on in this paper. In its core numeracy course, the ILS operates as a tutor, with the students passive and the computer in control. This is contrary to modern views about learning with computers (Sivin-Kachala, Bialo, & Langford, 1997) and learning of mathematics (Kennedy & Tipps, 1997), particularly with respect to higher cognitive functioning (Carnine, 1993; Riel, 1994), investigations, and the construction of knowledge links (Wiburg, 1995). The random nature of the worksheet delivery means that the ILS does not provide sequences of activities that can change misconceptions (as argued by Sivin-Kachala et al., 1997). The ILS is used by one student at a time so there is no place for groups (an important component of effective use of technology according to Sivin-Kachala et al., 1997).

The ILS does not meet any of the five criteria put forward by National Council of Teachers of Mathematics (Kennedy & Tipps, 1997) for the effective teaching of mathematics. For example, the ILS: (a) requires students to work individually and thus does not build mathematical communities; (b) is the sole authority for correct answers and therefore does not encourage logic and mathematical evidence as verification; (c) encourages memorisation of facts and procedures rather than mathematical reasoning; (d) emphasises mechanistic answer-finding (precise answers in a precise order) rather than conjecturing, inventing, and problems solving; and (e) treats mathematics as a body of isolated concepts and procedures rather than as a connected schema.

Furthermore, the ILS generates and presents tasks at random, thus giving no continuity or logic between questions. Whilst it does provide students with feedback on the correctness of their responses, a process that is desirable for effective learning (Sivin-Kachala et al., 1997), its worksheet nature makes it susceptible to the same pedagogical flaws that were identified by Erlwanger (1975) in the Individually Prescribed Instructional (IPI) packages that proliferated in the US in the 1970s (Baturo, Cooper, & McRobbie, 1998). Whilst there is very little evidence of the ILS's improving student learning (e.g., Becker, 1992), they are nevertheless reasonably popular in many schools in Queensland. The exploration of the reasons for this is the focus of the study described in this paper.

METHOD

There were four cases in the study, with each case consisting of the two teachers and two classes from each of Years 4, 5, 6 and 7 in a large primary school. In Years 4, 5 and 7, the two classes were combined in one large room (with the two 2 teachers team teaching); the year 6 classes were in different buildings. Each class had approximately 30 students, and had been provided with 3 computers, 3 ILS systems, and a printer. The students were generally from low socioeconomic backgrounds and few students had computers at home. The Years 4, 6 and 7 teachers had placed the computers on one side of their classrooms whilst the Year 5 teachers had placed them in a withdrawal room adjacent to the classroom. Initially, all computers were stand-alone systems which meant that students had to use the same computer for each of their allocated sessions and teachers had to access all computers to print reports. Because of these restrictions, a peer-to-peer network system was set up to replace the stand-alone system. This meant that any student could use any available computer, and reports for any student could be obtained from any computer. All classes were using the ILS for the first time.

Data were gathered by interviews and observations. Two semi-structured interviews were developed for school administrators, computer coordinators, teachers, teacher-aides and technical staff (where available). The first interview (beginning of the study) focused on logistics and management of the ILS, beliefs about teaching and learning mathematics and the role of the ILS, existing use of computers by students, and perceptions of students' likes, dislikes and preferences with respect to the activities within the ILS's core mathematics course. The second interview (end of the study) focused on changes in logistics, management, perceptions of students' attitudes and performance, and teachers' recommendations for the ILS. Observations were made of classrooms and students on the ILS system. Where convenient, teachers and students were questioned as to the reasons for any actions that attracted interest.

Each classroom was visited for six days - two days at the start of the study (in which the first interview was administered), two days in the middle of the study, and two days at the end of the study (in which the second interview was administered). The teachers were interviewed outside of their class using audiotapes; field notes were kept of observations.

The interviews were transcribed into protocols and the field notes were restructured and summarised. The data for each of the cases were combined, restructured, and studied for commonalities; characteristics of the cases which related to the possible impact of the ILS were identified, and responses for each case were summarised into tables. Finally, data on categories were related to teachers' evaluations (endorsements) of the ILS to identify factors that appeared to influence the effectiveness of the ILS (as perceived by the teachers).

RESULTS

The cases were similar in some aspects. For example, each case had 6 computer (stand alone, then peer-to-peer), 6 ILS programs, a roster system that enabled each student to have three 15-minute sessions per week, the prior computing experience of the students was either minimal (e.g., restricted to game playing) or nonexistent, and close supervision in terms of teaching advice was difficult to provide because of the teaching commitments with the remainder of the class. Therefore, supervision in all cases tended to be limited to providing superficial help (e.g., how to enter/exit the ILS; what key or icon to press; how to interpret a particular task). This section focuses on the differences between the cases.

Year 4 Case

The two Year 4 teachers had virtually no prior computing knowledge but were committed to providing mathematics computer experiences for their students. However, there were no other computers in the classroom to provide other computer activity (and the 6 computers were fully used for the ILS). These teachers were also committed to providing remediation for students with mathematics learning difficulties but were able to provide superficial remediation only. Furthermore, although they had received ILS inservice before beginning to use the ILS in their classroom, they initially found it difficult and time consuming to print reports and to decipher the reports in terms of students' progress and consequently were unable to utilise this aspect of the ILS to inform their mathematics teaching with respect to remediation. However, with the support of the Year 5 teacher who coordinated the ILS program in the school, they were eventually able to make use of the reports and integrate the ILS activity and feedback from the reports into their mathematics teaching. These teachers did not set up a reward system possibly because their students were enthusiastic users of the ILS and did not require enticement to persevere ("they riot if they don't get a turn"). The teachers liked the way the ILS presented mathematics, they thought that their students were benefiting by using it, cognitively and affectively, and were happy to endorse it as an effective teaching resource for primary schools.

Year 5 Case

One of the Year 5 teachers was the school's ILS coordinator and she ran the program in the double Year 5 class. She had used the system in other primary schools for three years and her prior experience had alerted her to potential problems (e.g., students' waning enthusiasm over time, and technical procedures) with respect to using the ILS. To offset the former problem, she instituted a system of rewards to ensure that the students remained on task. Moreover, she was facile with the reporting system (particularly those that described common student errors) and was aware of, and used, the extra worksheets designed to reinforce the tasks encountered in the sessions. As well as this means of keeping track of students' progress, the students were taught to record their overall result at the end of their ILS session and to note their errors. These records and notes were then given to the teachers who arranged individual remediation when required. Thus, this case provided substantial off-computer class and individual mathematics follow-up for their students, even although, unlike the other classes, the Year 5 computers were located in a withdrawal room adjacent to the classroom.

The other computing knowledge of both Year 5 teachers was limited to word processing and spreadsheet programs and, whilst they would have liked to provide these computer experiences to their students, they had no other computers with which to do so. The Year 5 teachers approved of the way the ILS interacted with the students. They believed that their students liked the ILS and were benefiting from working on it and consequently strongly endorsed it.

Year 6 Case

Unlike the other cases, the two Year 6 teachers were in different rooms. Teacher A had considerable knowledge and experience of how to use computers in classrooms whilst Teacher B had knowledge of the ILS from a previous school he'd taught at. Each had another computer with which to do other mathematics computing (games, spreadsheets, problem solving) with their students. They disliked the way in which the ILS presented mathematics and interacted with the students - Teacher A firmly ("wouldn't be doing it if I had the choice") and Teacher B strongly ("really appalled by the 1970s concept ... thought we got rid of this years ago"). They felt that the ILS was not value for money because it was not interactive enough, it was demeaning ("another way to show failure"), and could be replaced by much better software. They felt that they had not been adequately inserviced to enable optimal use of the ILS, and were pedagogically opposed to what they *could* use. Neither integrated the ILS activities into their other mathematics teaching; they saw it as "extra" revision for their students and felt there was little transfer from the ILS to other mathematics.

Teacher A kept the trial going to the end although he felt that students were ambivalent towards it ("some kids enjoy the speed games") and not greatly benefiting from it. He wanted to use the three ILS computers for other computing activity. Teacher B did not complete the trial. He stopped rostering students onto the ILS and began to use the computers for what he saw as more creative endeavours (e.g., problem-solving games and simulations, multi-media based projects). He felt that the ILS was conflicting with the way he wanted to set up his classroom (which he saw as student-centred and creative). He believed that it was not useful for the students and reported that his students were bored with it. Neither teacher endorsed the system.

Year 7 Case

Apart from the six computers dedicated to the ILS, these teachers had six other high powered computers in their classroom. With these they ran an extensive and creative program of computing activities including spreadsheet and data bases, playing problem-solving games and simulations, and conducting Internet research and multi-media projects (and publishing a class newspaper). Thus, they had reasonably extensive knowledge and experience of how to use computers in classrooms for mathematics, including the use of the ILS. Their other computer work was designed to fit in with their teaching program but the ILS program could not be modified to do so. Consequently, they did not like the roster system because they felt that it interfered too much with their program of teaching ("lost students at important times"). They saw the ILS as an "extra to classwork" and thus did not follow up on the ILS reports of students' learning difficulties. Whilst they were reasonably satisfied with the ILS in terms of its presentation of mathematics, they did not like the way it interacted with the students ("it directs them too much ... kids like to be in control of the computers"). They believed that their students were not benefiting from it and did not like it, although a student survey showed that many of the students did, in fact, like it and thought that the ILS was helping them learn mathematics. This phenomenon appeared to be a pedagogical clash between relational (Skemp, 1987) teachers and instrumental students. Neither teacher finished the trial and neither endorsed the system.

CASE CHARACTERISTICS

From an analysis of the data, categories of characteristics common to the cases emerged and were classified as *operational*, *user*, and *teacher belief* characteristics. Operational characteristics incorporated the number, location, and set-up of the computers and the way in which the students were supervised. User characteristics included the teachers' prior general computing knowledge, the students' prior computer experiences, follow-up off-computer activities (i.e., the extent to which the ILS activities and reports were utilised in everyday classroom mathematics teaching), and the organisation of any rewards to support student effort on the ILS. The students' prior computer experiences were classified as *nil* if restricted to games, *limited* if included the use of wider mathematics software, *creative* if used for problem-solving activities and/or spreadsheets/data bases, or *extensive* if involved multi-media. The teacher-belief characteristics included the teachers' attitude to the pedagogy underlying the ILS, satisfaction with the delivery of ILS instruction, satisfaction with ILS inservice, and perception of the benefit students were receiving from the ILS.

Looking across the four cases, it appears that teachers' pedagogical beliefs, teachers' prior computing knowledge, and students' prior computer experiences were the factors that most affected endorsement of the ILS. The Years 4 and 5 teachers (who endorsed the ILS) had limited computer knowledge, provided their students with limited computer experiences, tried to provide follow-up off computer activities to reinforce ILS activities or to re-teach mathematics problems reported by the ILS, were compatible with the mathematics pedagogy inherent in the ILS, were satisfied with the ILS's delivery of mathematics activities and with the inservice provided, and believed the ILS was of positive

Table 1 provides a summary of the characteristics in relation to endorsement.

Table 1
Characteristics That Influenced Endorsement With Respect to the Cases.

	Cases			
	Year 4	Year 5	Year 6	Year 7
Characteristics	Endorsed		Not endorsed	
Operational				
Number of computers	6 (all ILS)	6 (all ILS)	8 (6 ILS)	12 (6 ILS)
Computer location	Classroom	Withdrawal room	Classroom	Classroom
Supervision	Superficial	Superficial	Superficial	Superficial
User				
Teacher computer knowledge	Nil	Limited	Extensive	Extensive
Student computer experience	Nil	Limited	Creative	Creative
Follow-up of results	Partial	Extensive	None	None
Rewards	None	Some	None	None
Teacher belief				
Pedagogy	Compatible	Compatible	Incompatible	Incompatible
Delivery	Satisfied	Satisfied	Unsatisfied	Unsatisfied
Inservice	Satisfied	Satisfied	Unsatisfied	Unsatisfied
Benefit	Positive	Positive	Negative	Negative

benefit to their students. On the other hand, the Years 6 and 7 teachers, who did not endorse the ILS, had provided (or wanted to provide) their students with creative computing experiences, were opposed to the pedagogy inherent in the ILS, were not satisfied with the ILS's delivery of activities nor with the inservice provided, and could not perceive any improved mathematical performance in their students.

DISCUSSION AND CONCLUSIONS

The four cases show a relationship between endorsement, student computer knowledge, teacher computer experience, and teachers' beliefs (pedagogy, delivery, inservice and benefit) about the ILS. Differences in teachers' beliefs about the pedagogy of the ILS appeared to be very significant. The Years 4 and 5 teachers (who endorsed the ILS) approved of how the ILS operated in relation to their students. The Years 6 and 7 teachers (who did not endorse the ILS) had concerns with the ILS even at the start of the trial. As the Year 5 coordinating teacher stated, commenting on what was happening in the school, "The first thing is, it won't work if teachers do not believe in it!"

Teachers' beliefs in relation to the benefit of the ILS to their students appeared to be related to their knowledge of the educational uses of computers in classrooms, and not necessarily to knowledge of what their students believed. The Years 6 and 7 teachers had more extensive computer knowledge than the Years 4 and 5 teachers had. The Years 6 and 7 teachers believed that students should not be passive with respect to computers and mathematics teaching, and they wanted to provide their students with more creative, active and problem-solving computer experiences than that provided by the ILS. They believed that their students were not happy with the ILS and were not benefiting from it. However, teachers' perceptions of their students' feelings about the ILS were not always in harmony with their students' responses to a survey with respect to their likes and dislikes about the ILS. However, this error in perception did not stop the Year 7 teachers deciding not to use the ILS in the future. On the other hand, the Years 4 and 5 teachers, with more limited computer knowledge, liked the ILS because it required little from them in terms of organising what to do with the software. For students in Years 4 and 5, whose computer experience had been limited, the ILS appeared to be an exciting experience with its varied displays and use of mouse and earphones.

Teachers' beliefs about the appropriateness of the ILS's interactions with their students appeared to be related to their beliefs about how mathematics should be effectively taught. The ILS in this study places students in a passive role in the learning process, providing practice worksheets in random order. As Baturo, Cooper and McRobbie (1998) argued, this tended to result in learning that is limited to syntactic knowledge. Thus, the ILS does not place students in an environment which the literature argues should be effective in teaching students mathematics (e.g., Kennedy & Tipps, 1997). The Years 6 and 7 teachers agreed with this, but the Years 4 and 5 did not. In fact, the Years 4 and 5 teachers argued in support of mathematics teaching approaches that reflected the ILS; that is, approaches based on instrumental learning (Skemp, 1977) and transmission models of teaching. As well, their attitude to computing, through preference or lack of knowledge, also appeared to reflect the approach embedded in the ILS, that is, a tutor-tutee relationship where students are passive and the computer is in control. The impression was that the mathematics classroom practices of the Years 4 and 5 teachers reflected the ILS; that is, involved repetitive practice on exercises with the teacher in control and the students in a passive role.

Policy within Queensland schools aims to increase teachers' knowledge of classroom uses of computing. This may have an effect on the Years 4 and 5 teachers' continued endorsement of the ILS. However, if their beliefs about teaching mathematics stay the same, they are likely to continue to use the ILS. As many Queensland teachers share the Years 4 and 5 teachers' practices with respect to teaching mathematics, this could explain the continued popularity of the ILS in Queensland schools.

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