Implementing new generation instructional information management systems: A Western Australian example

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In the context of planned change it is argued that information management for decision support is crucial to innovation and implementation success. A new generation of instructional information management systems (IIMs) is now becoming available at affordable prices and some of their characteristics are described in this paper. These computer systems seek to integrate the school community with the web of relationships between curriculum, teaching, assessment and school organisation. Following professional development activities an IIM User and Non-user Group of teachers and administrators, in a remote area school in Western Australia, were surveyed in order to discover some of the early implementation difficulties in employing this technology from a user perspective. It is concluded that IIMs have the potential to enable schools to monitor their performance more effectively, with subsequent benefits accruing to teaching, learning and professional collegiality.

It has become increasingly evident that, within a global information society, those who can access information, transform information and create information are substantially advantaged by all the indices of success in the post-industrialised state, while those who cannot create and transform information are increasingly dependent on those who can. New technologies construct a totally new environment, and this radically alters the way we use our senses and consequently the way we act and react to things. Thus, the restructuring that necessarily occurs as a consequence of introducing new technology enters practically every facet of our lives. Changes come, therefore, because of the application of new technologies and it does not matter so much about the details of the content. The medium is the message. The inevitable transition to a computer based classroom offers major challenges and new opportunities for teaching and learning, empowering us to break the lock of structures and the inertia of tradition that has tended to constrain change managers to accept these as givens in their efforts to reform schools and education systems (Carter and O’Neill, 1985).

Managing Information

In spite of the huge, and continuing, expenditure of resources in time, money and human endeavour recorded in an enormous body of literature on curriculum innovation and change, this effort has not been noteworthy to date in bringing about changes of the order and scale required to have a noticeable and durable effect on school systems and educational practice.

Traditional curriculum models, if they worked at all in guiding practice, did not take into account one of the major realities of life very obvious to those who administer and teach in schools. It is the generation, flow and management of information that in the past has substantially acted as a bottleneck to, rather than enhancing the implementation of, curriculum and innovation for school improvement, and the raising of school achievement in line with individual entitlements and societal expectations. The basis for conceptualising and integrating curricula with both their internal and external environments lies in, and increasingly must rely on, information management to guide and inform design and implementation decisions, made on behalf of an increasingly complex society and its stringent mandates for schooling.

Well constructed Information Management Systems (IIMs) are designed specifically to allow for the unobtrusive and automatic acquisition of data describing the key operations associated with the interlocking cycle of relationships between curriculum, instruction and assessment (Hextall, 1988). A variety of data are crucial to determining program effectiveness and can serve to guide school improvement processes. Accountability, in the sense of being able to define precisely and show relationships between system
variables and desired outcomes, proves to be an important but elusive task without recourse to technology to meet the increased societal expectations of schools and ‘value for money’ for the educational resources expended.

At the junction of instruction with learning the introduction of the microcomputer together with advances in communications technology provides us with the potential to revolutionise both, as well as the organisational structures in which they conventionally take place. In short the computer, when interacting with a professionally informed mind, acts as a magnifier of human capacities that allows us to perceive yet further possibilities previously beyond our comprehension. The intellectual tools to support instructional leadership through the management of information to guide and inform data-based decision making are already becoming available at affordable prices. Sophisticated IIMSs which combine those functions that lie at the heart of schooling, such as curriculum development, instruction, evaluation and assessment, allow for the formation of information rich environments with great transformative potential.

For example, the form a curriculum takes is not simply two dimensional in its scope and sequence, except perhaps in its documented form. The curriculum, as lived out by students in schools and classrooms is multi-dimensional, and thus two-dimensional models appearing in a range of curriculum documents do not, and cannot, adequately represent the dynamic nature of learning context, curriculum processes and associated knowledge structures which also have to be addressed in the process of curriculum decision making. To be responsive to these, the curriculum of each school has to be locally crafted in order to capitalise on local talents, with local insights in order to meet local needs. Sophisticated IIMSs enables instructional leaders to determine the curriculum scope and sequence they desire, while enabling each of their teaching staff to be actively engaged in curriculum development activities in an on-going way.

New generation information technology can assist tremendously with the design, development, evolution and alignment of curricula across system to classroom levels of schooling. It provides, for example, the means for monitoring which curriculum elements are included in daily lesson plans, student grouping practices; ‘at-risk’ students; the development of teacher made learning materials; the management of material resources; the form of assessment programs across different time spans and subject areas, and curriculum alignment to external references, benchmarks and standards on a continuous, routine and substantially unobtrusive basis (Carter, 1993). The curricular structure for a particular IIMS for use in outcomes-based programs is shown in Figure 1.

Figure 1: An Hierarchal Arrangement of Curriculum Elements for Information Management

<table>
<thead>
<tr>
<th>CURRICULUM &amp; OUTCOMES HIERARCHY</th>
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<tbody>
<tr>
<td><strong>CURRICULUM</strong></td>
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<tr>
<td>The Instructional Vehicle</td>
</tr>
<tr>
<td>W hat learning opportunities and experiences should students have to assure outcomes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CROSS REFERENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Rationale for Instruction</td>
</tr>
<tr>
<td>W hat should the outcomes of instruction be?</td>
</tr>
<tr>
<td>W hat are we trying to accomplish?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I: Categories of Standards/Exit Outcomes</th>
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<tbody>
<tr>
<td>National, State, Local, Professional, Curricular, Assessment, Life Roles</td>
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</table>

<table>
<thead>
<tr>
<th>II: Broad Skill/Knowledge Outcomes</th>
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<tbody>
<tr>
<td>General Proficiency/skill areas: discipline or performance based</td>
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<thead>
<tr>
<th>III: Specific (vocational/societal) Outcomes</th>
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<tbody>
<tr>
<td>Skill knowledge by discipline or proficiency area</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>IV: Operational Statements</th>
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<tbody>
<tr>
<td>Specific statements describing behaviour/actions based on skill or knowledge demonstration</td>
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</tbody>
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<table>
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<tr>
<th>V: (Operational Statements - optional)</th>
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</table>

Because the IIMS automatically records detailed audit trails as staff members use it, supervisors can obtain profiles of how the performance of students and/or teachers are changing, by viewing sets of records accumulated unobtrusively through the daily operations of the school over selected periods of time.

There are two ways of using technology in information rich environments. One is for the purpose of automating: the other for informing. While there are some who clearly seek to use technology for the former purpose, it tends to become mechanistic and to isolate the human element from the process itself. Automating then is not a satisfactory means for supporting teachers and administrators and for educational problem solving. To ‘informate’, however,
is to empower educators as professionals. It is in this context that curriculum leaders can work with staff in order to resolve the question of what information has to be readily available and easily accessible for them to both understand and execute certain educational processes and curricular events.

Instructional Process

Research on schools and into teacher effectiveness has shown that instruction makes a difference. For the full potential of this to be realised, teachers must be able to capitalise on new knowledge, exercise data-based professional judgements, and acquire intimate knowledge of the changing needs of the learner in the exercise of their own creativity and spontaneity. While a well designed curriculum, aligned with appropriate instructional processes, is regarded as fundamental to helping each student achieve mastery of course objectives, slavish adherence to the textbook and detailed attention to every objective in the curriculum is not a means to achieving the desired outcomes. In effect, it is likely to work against the desired result of raising student achievement.

For the instructional context and learning environment to be rich, a process orientation in which a variety of instructional strategies must be present, with students afforded the opportunity to read and discuss much more widely than is directly required for the immediate achievement of the objectives, is required. It is also important to realise that it is not necessary and even ill advised to seek to control all the activities that take place under instructional processes. Rather teachers have to be able to ascertain their nature at will, and to direct them differentially to learners as needed, and in the full knowledge of the extent to which external agencies are also influencing and guiding instructional processes.

With the curriculum on-line, data accumulates unobtrusively through the normal operation of the school and the ongoing processes of education. Accumulated data that ‘captures’ the functions and operations of the school from, curriculum development, lesson planning, student, parent and teacher, and assessment points of view, and cross-referenced to external standards can now be managed with a pedagogically driven IMS.

Archived data, ordinarily lost to the school and the system but now unobtrusively and continuously accumulated through the normal operation of school routines, can be queried, probed and structured in ways that support research into the operation and functioning of the school, including its intellectual, social, economic and organisational aspects as a form of problem finding, and problem solving. Obvious uses here, for example, are for the management and utilisation of the schools’ material resources; the conduct of program evaluations and audit trails; supervision of beginning teachers and the induction of new staff; performance appraisal (where access to on-going data can readily support formative processes) and the tracking of ‘at risk’ students.

Case Study Setting

The case study high school is located in a mining town in a remote area of Western Australia. An evident feature of rural schools is that they are characterised by a relatively higher staff turn-over, when compared with metropolitan schools, and consequently they tend to have a relatively larger proportion of inexperienced staff then city schools. The 1994 report ‘Schooling in Rural Western Australia’ raised public concerns about the inexperience of rural teachers in the following terms:

In the ... District ... more than half have less than five years’ experience, and only one in seven has more than fifteen years’ experience and one in ten more than twenty years’ experience. (Tomlinson, 1994; p. 70)

From a costs and benefits point of view, these statistics are important to change managers considering the wholesale adoption and implementation of IMS technology. Mainly, this is because of the requirement for a high initial investment in system software and hardware for most schools, and also for a continuing investment in staff development in IT use. Without the latter the potential benefits to students are likely to remain unrealised, and, having made the initial capital investment, the retention of trained staff becomes an important issue in all schools - but remote area schools in particular.

These considerations were germane to the decision to upgrade staff computer literacy skills in the context of moving towards the full implementation of new information management technology across the case study school. Prior to the adoption of IMS technology and its subsequent implementation in the school, a considerable amount of groundwork was done by the Principal who had had previous experience with information management technology. He determined to ‘unfreeze’ the school’s organisational climate by using advocacy as a change tactic in order to engender staff receptivity for IMS use in supporting school improvement processes.

While IMSs are capable of integrating the administrative aspects of schooling with curriculum, teaching/learning and assessment, student monitoring and review, senior staff considered that there was an initial priority to narrow the IT focus, build staff confidence in the area, and give people tools and skills to become more effective in curriculum planning. It was reasoned that this would assist the adoption of student outcome statements which had recently been trialed on behalf of the State Department of Education in a single learning area. The planning focus would also orientate staff to computer managed learning in order to assist students achieve desired learning outcomes.

Participating Heads of Department shared the view that, while teachers tended to write term length teaching programmes and to submit them for validation; many did not interpolate specific lesson plans directly from their teaching programmes. Consequently, classroom level planning seemed to be both ad hoc and short term and did not appear to articulate well with other levels of planning. A further concern was that assessment items tended to be developed at the last minute, suggesting both the

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lack of a medium term curriculum view and insufficient attention being paid to the alignment of purpose (ie. Intended Learning Outcomes (ILOs)) with assessment during teaching programme development. Given these supervisory concerns, the area of teacher planning and IIMS use became the focus for data collection. It also supported a longer term implementation strategy leading to full IIMS 'take up' and use.

Principles of Procedure

As a precursor to implementing IIMS technology in the school, a group of high school teachers and administrators, together with two primary school teachers from nearby feeder schools, participated in a series of seminars on curriculum and information technology professional development workshops. The workshops focused on curriculum planning using an integrated Instructional Information Management System. The acquisition of new understandings and the mastery of IT skills took place sequentially and developmentally over the course of a whole semester. Professional development activities, aligned with the school development plan, afforded the participants an opportunity to use the IIMS as a planning tool, and enabled them to evaluate the implications of this technology for professional practice and school organisation.

Workshop participants who were trained to use the IIMS comprised eight teachers and administrators - six of whom came from the high school and two from feeder primary schools. They are referred to as the IIMS User Group in the survey data presented below. A second group of teachers and administrators within the school, but who had not undergone IIMS training, were also surveyed to ascertain the extent to which they already used computers to assist them with curriculum and instructional planning. This group is referred to subsequently as the IIMS Non-user Group.

Of the IIMS User Group, five staff members were Heads of Department, one was a subject teacher, and two were primary teachers (one a Deputy Principal and the other a Key Teacher). The age of those returning a short questionnaire eliciting self perceptions of their current and projected use of computers, was reasonably spread, and consisted of one aged between 20 - 29 years; three between 30 - 39 years; three between 40 - 49 years and one between 50 - 59 years. Three had taught for five years or less, two for between ten and fifteen years, and three for more than twenty years. The IIMS Non-user group consisted of six subject teachers and two Heads of Department also with a wide range of experience. Both groups represented a broad range of teaching areas.

Initially, a common questionnaire was to have been administered to all staff in the IIMS User and Non-user groups alike. During its development, however, it became readily apparent that there was a difference in the nature of the professional discourse between the two groups. Generic terminology, for example, such as ‘going on-line’, ‘curriculum alignment’ and even ‘Intended Learning Outcomes (ILOs)’ were unfamiliar to participants in the IIMS Non-user Group. Not surprisingly, curriculum concepts related to the IIMS were specific to the IIMS User Group. Because of this emergent realisation, the questions were modified to accommodate a broader range of curriculum terminology than that used in the first instance. Accordingly, a section was added to the questionnaire specifically for IIMS users, under the theme of ‘computers as an aid to planning’.

Discussion occurred between the Deputy Principal and two other senior members of staff concerned with the IT aspects of the school’s five year development plan, and the need to acquire information supporting prospective IIMS implementation referenced to student and teacher needs. Information was required for the implementation plan that would differentiate between staff who had undertaken IIMS professional development training and those who had not.

Teachers who had participated in the IIMS workshops were given a questionnaire asking them to reflect on their subsequent practice in using the IIMS as a planning tool. Samples of the open ended items are presented in Figure 2.

Figure 2: Sample Questionnaire Items

CURRENT PLANNING PRACTICES

Programming
Do you write programmes for the courses that you teach?

If your answer is no:
What do you use as an alternative for planning your course?
• When do you do your programme planning?
• Why do you write programmes?
• What format do you use for programming?
• How do you use your programmes to link intended learning outcomes (or objectives) to instructional activities?

If your answer is yes:
1 2 3 4 5
I consider myself to be computer literate.

1 2 3 4 5
I would be interested in using computers to make my planning more effective.

1 2 3 4 5
I have reservations about using computers in planning/preparation.

1 2 3 4 5
I am not confident in using computers.

1 2 3 4 5
I would be interested in using computers to make my planning more effective.

1 2 3 4 5

IIMS USERS
In what ways do you consider that an IIMS can assist you in your planning in the following areas:
• Aligning ILO’s with content and teaching/learning processes?
• Assessing effectively and validly?
• If you were to use the IIMS for planning, what other ‘on-line’ information would you like to see?
The IIMS Non-user Group was given a parallel questionnaire asking members to reflect on their current planning practices - including their use of computers in planning. Responses to that section of the questionnaire eliciting self-perceived ratings, regarding computer use when planning, are shown in Figure 3. Sixteen questionnaires were returned, equally divided between each of the two groups of teachers. Fourteen of the total of sixteen participants, included in both User and Non-user Groups, were from the high school. The survey took place six weeks after the conclusion of the staff development seminar and workshop series.

**Results and Discussion**

While the survey was relatively modest in size and scope, fourteen out of a whole school staff of twenty eight afforded a reasonable representation of the situation concerning IT use at the school. Fourteen members of the whole group of Project participants used teaching programmes. Of these, only two did the majority of their planning at school. These participants made planning decisions involving the contemplation of curriculum elements such as time, content and assessments, although there were variously incorporated in their teaching programmes. Six of members included objective/course outlines and curriculum guidelines. One commented that, "...he used to have a column for strategies, but didn't any more." Variability in participants made planning decisions variedly incorporated into their teaching programmes. In the IIMS User Group three respondents linked learning activities to objectives in their lesson plans. Four linked content to the item probing in drawing up lesson programmes. In the IIMS User Group there was an evident lack concerning the linking and alignment of objectives with other curriculum elements. A number of respondents verified that they had already adopted this practice through the use of 'cut and paste' facilities currently available in standard word processing packages.

Once they had completed the initial training workshops members of the IIMS User Group commented they had changed their assessment strategies. They practically reviewed objectives/course outlines, and constructed clearly aligned assessment items, rather than relying on judgements based on their tacit knowledge of course structures and outcomes. Three respondents verified that they had changed their assessment strategies. They had changed their assessment strategies. They had changed their assessment strategies.

Although they used different strategies, the IIMS User Group had a fairly clear idea about the ‘what’ and ‘how’ of linking Intended Learning Outcomes to assessment items. The Non-user Group participants were less clear about this, although all asserted that they constructed items based on objectives. The same pattern of responses occurred with respect to the linking of assessment items to specific Intended Learning Outcomes. This suggested that IIMS training in the area of curriculum and assessment greatly assisted in establishing curriculum alignment. When this occurs assessment articulates clearly with purpose and both can be referenced to student outcomes. Three of the IIMS User Group commented that, since completing the IIMS workshops, they had changed their assessment strategies. This was most evident when formalising links to student outcomes, and served to highlight the potential benefit to be gained in professional development activities, integrated with IT use, when following Outcomes-based or Criterion Referenced educational philosophies.

Within the IIMS User Group, seven respondents owned a computer and one was in the process of buying hardware. Only one did not use a computer when engaged in course planning. Five used computers for developing teaching programmes and writing up lesson notes; four for lesson plans and six for assessment items. Computers were also used as electronic markbooks, for student worksheet development and subsequent archiving. Six of the IIMS Non-user Group owned a computer. Two did not. Thus, while ownership of computers in this group was almost as high as in the IIMS User Group, actual use of a computer as a planning tool was much lower.

In the Non-user Group, one used the computer for course planning including lesson plans and notes.
used the computer for lesson plans, and
three did not use the computer at all for
these purposes. A comparison of
responses between the two groups
concerning attitudes towards computer
use for planning purposes, is summarised
in Figure 3.

Given the ordinal nature of the data
and the small size of each group, no
attempt has been made to test for
statistical significance. For the sample
studied, there is a marked interest in
developing more advanced skills in
computer use generally, and in their
application to planning using new
information technology in particular. This
proclivity is evidently more pronounced
within the IIMS User Group. Several
respondents are not at all confident
that they are computer literate, and two
participants are clearly not confident in
using computers per se. Six respondents,
however, are confident to very confident
in using computers. This attribute may
be used to advantage to support
teacher workplace learning as IIMS
implementation proceeds across the
school.

There is a varied pattern of
responses to the item regarding access to
computers which needs to be investigated
further because open access to computing
facilities, including home use, is a basic
requirement for encouraging widespread
use of the IIMS across the school
community. Generally, the results show
that, while there is a cadre of people who
are confident and competent in computer
use within the school, there still needs to be
a lot of preliminary work undertaken in
order to develop generic skills and
competence in computer literacy
supporting IIMS implementation.

The final section of the question-
naire elicited information specific to the
IIMS User Group. All respondents agreed
that the IIMS was instrumental in enabling
ILOs to be linked directly with instruction;
in aligning contextualised internal
relationships that occur between
curriculum, instruction and assessment
(Hextall,1988), and in aligning all of these
with external standards and benchmarks.
Representative comments included:

"It has the potential to show exactly what
objectives have been met and which haven’t. It
could keep track of what to teach", and,
"... being able to link folders and flick back
and forth when planning lessons ensures that
strategies link to and follow from intentions".

Six respondents agreed that IIMS
technology had great potential in assisting
teachers to assess student abilities more
effectively than hitherto, and that it was
easier to keep in view all relevant
information and to keep track of the
alignment. One teacher thought that, in
theory, the technology had great potential
in this area, but had doubts about its
application in practice due to the ever
present reality of time constraints.

Five agreed that future IIMS use
would become very efficient. However, all
also expressed concern about the need for
large amounts of professional
development time in the early implemen-
tation stages. Four noted the need for a
lot of ‘on-line’ material to be stored if the
process was to be justified as ‘time-
efficient’. One commented that initially
there would more work but little benefit to
be gained in the short term. Further, he
didn’t believe there would be any time-
saving benefits in the long-run, noting that,
"... computers do not save time, they shift
focus." One commented that there would
be no time-saving benefits because of the
requirement to manipulate large
quantities of data.

Other reservations and concerns
from the IIMS User Group included:

• No time to input large volumes of data.
• Need to up-grade to more powerful
computer architecture.
• Need to network computers.
• More IIMS specific professional

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**Figure 3: Summary of Computer Use between IIMS User and
Non-user Groups**

<table>
<thead>
<tr>
<th>USE OF A COMPUTER WHEN PLANNING</th>
</tr>
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<tbody>
<tr>
<td>(Please circle - 1 = Strongly agree: 5 = Strongly disagree)</td>
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<table>
<thead>
<tr>
<th></th>
<th>USERS</th>
<th>NON-USERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 *</td>
<td>1 2 3 4 5 *</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>-------</td>
<td>----------</td>
</tr>
<tr>
<td>I have adequate access to computers at school for preparation/planning purposes</td>
<td>2 1 1 1 3</td>
<td>2 1 1 2 2</td>
</tr>
<tr>
<td>I consider myself to be computer literate</td>
<td>6 2 1 3 1</td>
<td>3 1 3 2</td>
</tr>
<tr>
<td>I am interested in further developing my skills on the computer</td>
<td>8 5 1 2</td>
<td>5 1 2</td>
</tr>
<tr>
<td>I have reservations about using computers in preparation/planning</td>
<td>1 2 1 4 1</td>
<td>1 1 1 5</td>
</tr>
<tr>
<td>I am concerned that using computers in preparation/planning will take too much time</td>
<td>5 2 1 1 3</td>
<td>2 1 3 2</td>
</tr>
<tr>
<td>I am not confident in using computers</td>
<td>2 2 2 2 2</td>
<td>2 1 5</td>
</tr>
<tr>
<td>I would be interested in using computers to make my planning more effective</td>
<td>5 3 4 3 1</td>
<td>4 3 1</td>
</tr>
<tr>
<td>I would be interested in using computers to become more time-efficient in my planning</td>
<td>5 2 1 4 1</td>
<td>4 3 1</td>
</tr>
</tbody>
</table>
development needed beyond current levels.

- Security of information.
- Access to hardware and software.
- Having the hardware and software compatibility for systems to integrate effectively.
- Need for permanent technical support person on staff.

In sum, these comments relate directly to difficulties associated with developing computer rich environments per se. These are viewed by the workshop participants in terms of costs associated with acquiring and setting up equipment and systems, the fundamental requirement for technical support, data management and protection and the need for staff development and training. All of these problems extend beyond the case study school, and are well known to change managers seeking to capitalise on the benefits of technology transfer, yet recognising the inherent difficulties this brings (Hall and Carter, 1995).

School staff who have been introduced to and experimented with an IIMS have had the opportunity to use this new information technology to enhance their current planning practices as well as decision-support for computer managed learning (CML). They are now in a position to reflect on how this has changed their behaviour and thinking with regard to planning and cognate professional activity. A number of participants in the IIMS User Group have reported that they've revised their ideas on planning, and as a result have changed their approach to teaching and learning.

There has been observable changes in language, discourse and social groupings in the school since the IIMS workshops concluded. The IIMS User Group continues to use the language of IT and curriculum, and, while it hasn’t become a distinct social group within the school, members share an informal and common professional identity. User Group members recognise that they have become a collegial source for sharing ideas with other staff concerning IIMS technology, its ‘take up’ and use as the early phases of implementation proceed.

**Conclusion**

In this paper it has been argued that IIMS software is an essential element to be integrated into the conceptualisation, adoption and maintenance of any curricular and instructional processes that we care to design and implement, allowing for stringent accountability criteria to be met in the provision of a general education for all students that can be justified in its own terms. Good responsive software design allows for the establishment of relationships between curriculum elements, instructional process and assessment and evaluation thereby facilitating alignment between each of them and with external standards. Moving toward outcomes-based education will help schools monitor their performance more effectively and thereby improve the quality of teaching and learning.

The use of a new generation of software tools with great transformative potential, such as those described above, may help us break the log of at least some of the constraints that have previously inhibited us in bringing about classroom change and school improvements. Ultimately, implementation success has to be judged in terms of the achievement of student learning outcomes, as well as in improved management practices and restructured environments supportive of the notion that all students can learn, and that it is the responsibility of schools to ensure that in fact they do.

Realising this vision is likely to place heavy demands on curriculum management and require the exercise of high quality leadership (Carter, Glass and Hord, 1993). As already asserted in this paper, and developed as one of its main themes, we now have a new generation of information technology available, which, when allied to human capacities and a vision of the future that we hold, can assist the transformation of schools. The caveat is, however, that if we do not at the same time attend to the deepening of vision and ensure that instructional systems are well understood, the transformative potential of new information technology, where it counts most in schools and classrooms, is unlikely to be fully realised.

**REFERENCES**


