Applying Educational Research to Improve Teaching and Learning in Information Systems

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Abstract

Universities need to respond to a change in student profile from the traditional academically committed student to a student who seeks a qualification for a job. This study reports on the application of educational research to the redesign of a single subject (or course). The aims were to engage students in deep learning; increase a learner's responsibility for learning; and encourage better study practices; improve teaching and subject objectives, and authenticate and validate the assessment method. Statistical results presented indicate that the aims were to some extent achieved. Several further improvements and research are identified.

Keywords: Information systems teaching and education, formative, summative and continuous assessment, assessment validity and reliability, course objectives.

Introduction

This is a study about improving teaching; the objectives of a subject, referred to as a course in some countries, and the method of assessing each student's achievement of the objectives. Mass education has meant a change in the type of student at university (Biggs, 1999). The students are, as described by Biggs, "…at university not out of a driving curiosity about a particular subject or a burning ambition to excel in a particular profession, but to obtain a qualification for a job…[have] a less developed background of relevant knowledge…[come] to the lecture with few questions…[want] only to put in sufficient effort to pass". This study is in response to the change in the type of student. From a student-centred view, the goals were to engage students in deep learning, rather than surface or strategic learning; increase the responsibility taken by each student in monitoring and judging his/her achievement of the objectives; and encourage the development of more constant study practices that emulate a work environment. The goals from a teacher-centred view were to improve the quality of the teaching, improve the clarity and explicitness of the objectives, and authenticate and validate the assessment method.

Research of educational assessment, though regarded as uneven and weak (Black, 2000) presents a consensus that subject objectives are achieved by the use of reliable and valid assessment (e.g. Biggs, 1999; Boyd, 2001; Chase, 1999; Crooks, 1994; Kanjee, 2000). Using such assessment and responsive teaching practices will therefore yield positive learning outcomes for the students. This paper examines the application of this principle to the teaching of information system development. The subject, its objectives and assessment are described and the outcomes are recorded. The discussion relates the outcomes to the goals of the study. In conclusion, several areas for further research are presented as well as suggestions for improvements to the objectives,

assessment, and consequently the method of instruction.

The Subject

In the subject, Business Information System Development 1 (BISD), chosen for study, students learn a limited set of modelling tools and techniques that are used in the development of business information systems (for details about the content of the subject see (Box & Ferguson, 2001). Information system development requires constant effort over time. Students are too frequently taught information system development, and many other subjects, by means of assessments that result in peaks and troughs of effort expended to meet assessment deadlines. By applying research on educational assessment to define objectives and assessments, students can be encouraged to change this spasmodic behaviour. Objectives and assessments for BISD were designed and implemented to facilitate such a change. The assessments require students to apply constant effort to their learning; and so meet objectives. The short-term bonus for the students was the effort they expended explicitly counted toward their grade. The expected medium- and long-term bonus will be that students are better prepared for follow-on subjects, especially those that are self-paced, and industry.

Continuous assessment was used as the means for students to acquire and demonstrate their knowledge and skill of object-oriented information system development modelling tools and techniques. The subject was conducted with two instructors delivering to 93 students. During the 12 weeks of teaching, there were 12, two-hour, weekly classes with all the students attending. Also, groups, of no more than 20 students attended one tutorial of one hour per week. The students also arranged individual and small group consultation with an instructor.

The specification of the subject was given in the subject outline. The subject outline is a document describing the aim(s), objectives, assessment, marking criteria, content, teaching and topic schedule of a single subject. The previous subject outline, BISD had been delivered once a year for the past four years, had been identified as needing improvement in a number of areas to bring it in line with leading educational research findings. The focus for improvement this time was the objectives and assessment.

The Subject Objectives

The objectives were formulated based on: previous subject outlines, teaching experiences with BISD and teaching experiences with follow on subjects, peer review, the desire to integrate generic attributes or transferable skills and course design literature (e.g. Biggs, 1999; Bloom & Krathowl, 1956; Boud, 1995; Boyd, 2001; Crooks, 1994). These influenced the choice of the breadth of content, the desired depth of understanding of the content and, upon reflection, assured the quality of the objectives. The phrasing of the objectives was based on Bloom’s taxonomy of cognitive abilities expressed in behavioural terms (Bloom & Krathowl, 1956). The objectives were expressed as demonstrable outcomes achieved under certain conditions to a particular standard. This ensured, according to the literature, the assessment could be brought into line with the objectives.

The objectives were different from previous deliveries of the subject. Formerly the objectives were teacher-centred, emphasising the delivery of content. The new objectives were student-centred, focusing on the learning that needed to be done. The new objectives, as they appeared in the subject outline, appear in Figure 1. The objectives narrowed the breadth of coverage by reducing the content. For example, the use of a CASE tool was eliminated and a smaller portion of the system development life cycle was covered. Reducing the content meant that it was possible to focus on a limited set of modelling tools and techniques. This meant increased time emphasising the content and depth of understanding. This limited set of models was used to perform the analysis and design of a system, without any loss of traceability

Aim:

For students to become adept with the knowledge and skills required to competently use a limited set of the tools and techniques within a given method of business information systems development.

Objectives/Learning Outcomes:

By the end of this subject, a student with at least a passing grade should be able to:

1. Recognise probable business requirements for a given scenario.
2. Accurately identify and specify manual and automated processes for a given scenario.
3. Write clear and unambiguous specifications at a business oriented high level and at business and system oriented expanded levels.
4. Identify members in a development team and their responsibilities while contributing to the processing and completion of the development tasks covered in this subject.
5. Recall and explain a software development process and the activities within the phases of the process covered in this subject.
6. Accurately represent a business information system as a set of models using common and well-established modelling tools and techniques.
7. Explain and repeat the process used to create a set of models that accurately represent a business information system.
8. Follow a self-evaluation process evidenced by a written product.

By the end of this subject, a student with at least a credit grade should be able to:

9. Do all the above objectives.
10. Independently improve on the set of models prescribed in class by responding appropriately to comments from others and his/her self-evaluation.

By the end of this subject, a student with at least a distinction grade should be able to:

11. Do all the above objectives.
12. Independently expand the set of models from those prescribed in class to represent a business information system for a larger scope of the given scenario.

By the end of this subject, a student with a high distinction grade should be able to:

13. Do all the above objectives.
14. Demonstrate professionalism in the completeness and accuracy of his/her work such that it would be pedantic to find fault with the work.

Figure 1: Aims and Objectives of BISD

from one model to another, and ended with a set of models that would be adequate to use as program specifications.

There was a shift from norm referenced to criteria referenced grading. The new objectives were grouped to indicate what a student would have to be able to do to achieve a particular grade. It was realised that the majority of the objectives had to be met for a student to pass. It was no longer workable to consider that 50% measured a passable level of mastery of the essential materials. This meant that the previous method of distributing portions of 100% to various tasks, awarding marks for each task and then aggregating the marks to determine a grade needed to change. The change meant a student's grade was determined explicitly by his/her demonstrable achievement of all of the objectives for a particular grade as judged by the instructor; the judgement being made against a set of criteria that took into consideration the conditions under which the task was done, and the standard to which the task was done.

The Assessment

The assessment tasks were described generically in the subject outline. Specific content of each task was set week by week based on the progress of the students. Progress was gauged by the instructors during class, at weekly meetings, by weekly marking of assessment tasks, from written student evaluation, and verbal and written unsolicited student feedback.

The assessment regime during the teaching session, Figure 2, was designed to “enhance learning by structuring the study effort” (Boud, 1995). Assessment was a repetitive, ongoing process, using multiple simple assessments to evaluate student learning (Boyd, 2001). A topic was covered over three weeks, weeks A, B & C in Figure 2. In class in week A, the topic was set. A student had from the end of class in week A until the beginning of class in week B to write a two paragraph summary of the set topic: “lecture preparation”. During class in week B, the topic was discussed and one or more exercises were completed: “lecture exercises”. Between classes in weeks B and C the student attempted the exercise again: “tutorial preparation”. During the tutorial in week C a student made notes on his/her tutorial preparation; tutorial preparation plus these notes was the “tutorial participation”. A student could then attempt the work again, “resubmission”, after reflecting on his/her tutorial notes, grade and feedback. Grades and feedback were provided online by the instructor, usually within 24 hours after class in weeks B and C. This assessment regime meant, once the students were fully engaged with the subject, that they would be studying a number of topics a week and that they would encounter a topic at least five times over a number of weeks. The consequent, required, study effort was very structured with multiple simple assessments in a week, namely: one lecture preparation; one or more lecture exercises in class, tutorial preparation, and tutorial participation in class.

A pass/fail grade was awarded, for each task, based on what content had been covered at the time the student was doing the task and the quality of the task. Responses from the instructors were varied, including corrections of errors, suggestions for alternatives, directions to consider previous discussions and the knowledge gained since the work was submitted.

The assessment regime varied when a topic spanned more than one week. In these instances, the lecture preparation was not repeated, though some students did this voluntarily, and resubmissions were not done as the second attempt at the tutorial preparation fulfilled the purpose.

Lecture preparation required a two-paragraph summary of a topic based on a few pages of reading. The preparation was similar to the “One-Sentence Summary” exercise- who does what to whom, when, where, how and why (WDWWWWHW) (Huba & Freed, 2000).

Lecture exercises were usually a student’s first attempt at a model. Tutorial preparation was a second attempt at the same model with a slightly larger problem scope. Tutorial participation was an opportunity to perform self- and peer- evaluations on the prepared model. A resubmission was the third attempt at the same modelling exercise.

A learning portfolio was the only final and major assessment. A final examination was not part of the assessment. The learning portfolio contained all attempts at a model, that is, all set tasks plus any more attempts a student wished to do. Each new attempt was made after evaluating the preceding attempt. The portfolio was a record of the student's change in knowledge and skills. The portfolio was a "purposeful collection of a learners work… [documenting] achievements, efforts, progress… [and] self-assessment (MacIsaac & Jackson, 1994).

The content, the topic to be summarised or the model to be attempted, were specified in the subject outline. The specification was modified as the weeks progressed in response to the learning and understanding shown in the submitted assessments. For instance, weeks 8 and 9 were a review to consolidate and clarify all preceding topics and clear up misunderstandings about the requirements of the system being designed, rather than the delivery of more content.

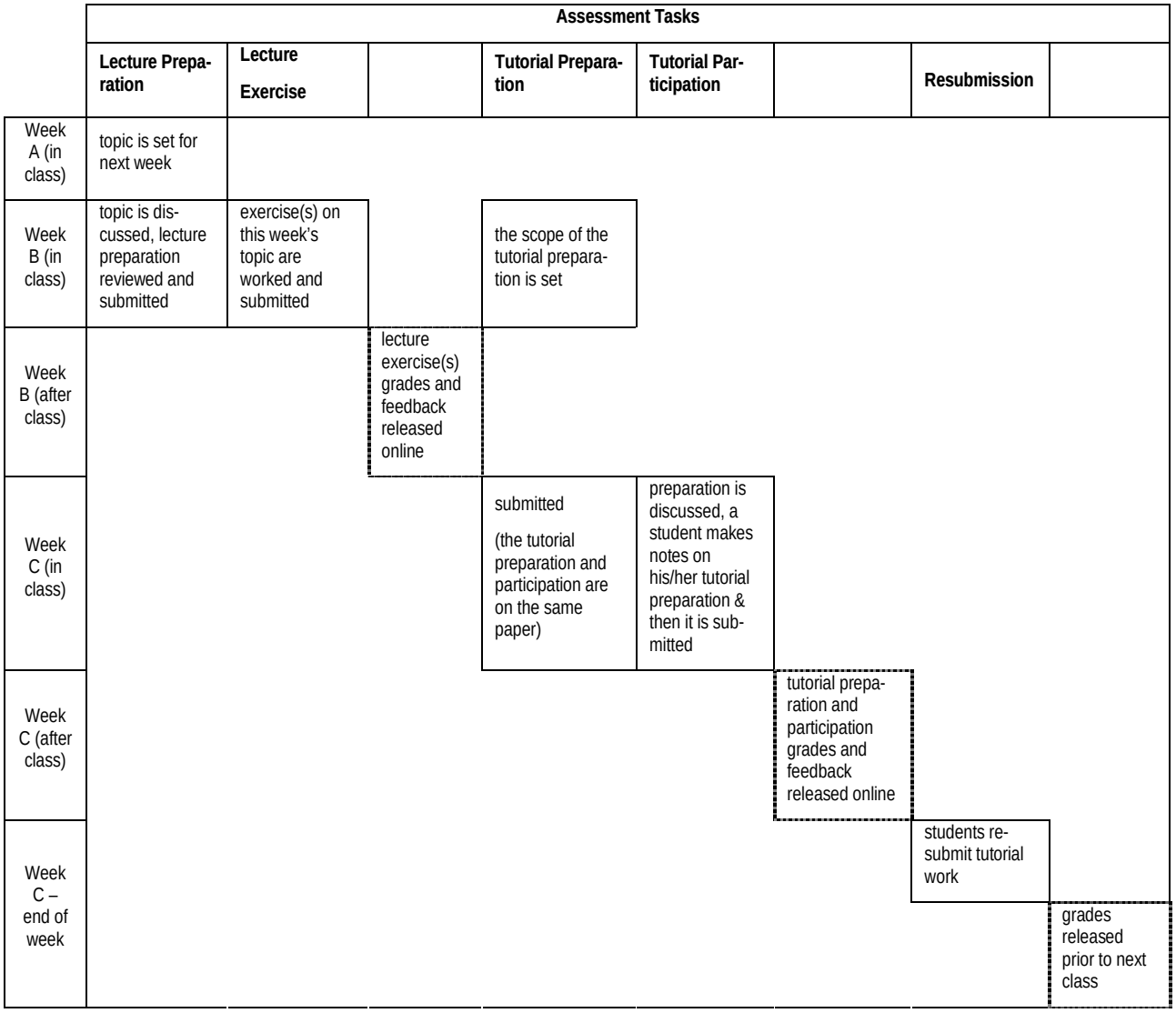

Figure 2: Typical Assessment Regime for a Topic

Marking Criteria

As well as the grouping of objectives into grades, more detailed marking criteria were provided. The criteria that applied in general to lecture preparation and exercises, tutorial preparation and participation, and resubmission were written in the subject outline. The specific criteria for a model were discussed and recorded in class. The possible grades for any one continuous assessment task were pass or fail. The students were encouraged to build a profile of mostly passing marks. The same specific criteria for a model and the objectives were used as the criteria when grading the portfolios. Criteria referencing was used rather than norm referencing (Biggs, 1999) for all assessment tasks.

Method of Instruction

The unit was presented as a guided experiential learning environment. A role-played case (Cope & Horan, 1996) of a genuine system was used. One of the instructors was the real user and client for the system. The students were supplied with a written case, several client briefings incorporating actual artefacts and photographs, and detailed responses to questions asked of the client. Students were able to question the client in class, via e-mail and by out-of-class interview.

In keeping with educational research findings, the students were encouraged to adopt appropriate study strategies to avoided severe workload problems from the outset (Crooks, 1994). For instance, the lecture preparation required the reading and summarising of a few pages directly related to the topic rather than one or two chapters. The WDWWWWHW technique was explained and emphasised during classes to help students keep to the two-paragraph limit.

Classes were conducted using a number of group activities interspersed with short disseminations of content and instructions. Questioning and interaction during classes was encouraged. Each class had a tangible outcome, a lecture exercise of one or more full or partial models, or evidence of tutorial participation by notes made on the tutorial preparation brought to class.

To facilitate student-teacher communication out of class a web-based course management tool, Blackboard 5, was used to 1) release grade sheets and feedback on submissions in a timely manner; 2) broadcast answers to students' e-mailed questions; 3) make announcements about administrative issues, and 4) provide materials such as sample source case documents, readings and class notes.

Results

Data collection for the study occurred by participant observation, i.e. by an instructor, conversations with the other instructor and students, grading assessments, a formative evaluation, and in-class polls.

The retention of students followed a typical pattern experienced in similar subjects at the same institution. At week one there were 93 students enrolled in BISD, by week six fewer than 50 were regularly attending, in week 12 only 34 students remained. In-class polls disclosed that the students who stopped attending and/or submitting had essentially given up and were resigned to failing. The following results relating to grades consider only the 34 students that completed, that is, only those that submitted a portfolio.

The percentage of passes the students received each week tended to increase over time, Figure 3. The correlation of passing continuous tasks and passing the portfolio is shown in Figure 4 and Tables 1 and 2. The distribution of grades for the portfolio, Table 3, shows 38% of students failed and 62% received a pass or higher. Of the 93 students that commenced only 23% passed, of the 77 enrolled in week six 27% passed.

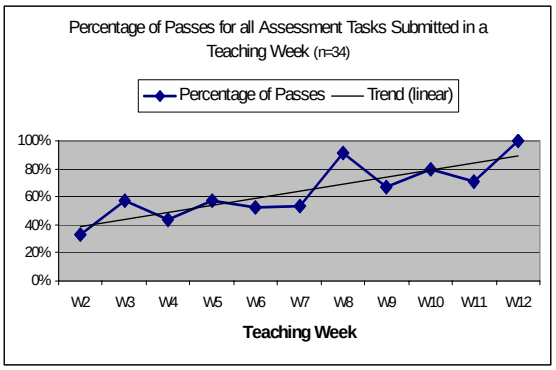

Figure 3: Percentage of Passes for Continuous Assessment Tasks on a Week by Week Basis

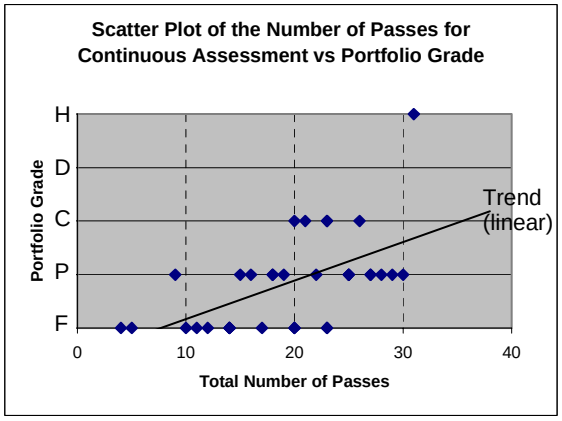

Figure 4: Number of Passes for Continuous Assessment vs Portfolio Grade

	Lecture Preparation	*Lecture Exercise*	*Tutorial Preparation*	*Tutorial Participation*	*All Continuous*
Lecture Exercise	0.56	1.00			
Tutorial Preparation	0.40	0.44	1.00		
Tutorial Participation	0.38	0.43	0.72	1.00	
Portfolio	0.26	0.32	0.60	0.55	0.59

Table 1: Correlation Coefficients. Numerical variables are: mean number of passes for continuous assessment, and pass (1) or fail (0) for the portfolio

	Lecture Preparation	*Lecture Exercise*	*Tutorial Preparation*	*Tutorial Participation*	*All Continuous*
Lecture Exercise	3.52				
Tutorial Preparation	2.36	2.63			
Tutorial Participation	2.23	2.56	5.06		
Portfolio	1.48	1.85	3.86	3.44	3.77

Table 2: Significance of Correlation Coefficients. (*z* scores)

Grade	**No.**	**%**
High Distinction	1	3%
Distinction	0	0%
Credit	5	15%
Pass	15	44%
Fail	13	38%
Total	34	100%

Table 3: Distribution of Grades for the Portfolio

A formative evaluation was done in week 5, using the instrument included in the "Formative Evaluation of Teaching Strategy" in Hogan (1999). Table 4 shows the compilation of the responses into positives, areas of difficulty and suggested improvements. The total number of evaluations was 39. However, the five constructs in the instrument gave a student the opportunity to express his/her concerns more than once. All instances of a response by a student were included, hence the number of responses to “Explanation” under "Suggested Improvements" is greater than 39.

Formative Evaluation at Week 5 Results as Number of Responses (n=39)

Category	**Exemplars of Responses**	**Positive**	**Area of Difficulty**	**Suggested Improvement**
Environment	availability of consultations, access to the online materials, the client being readily available, the tutorial instructor and instruction, the administration setup	16		
Explanation	explanations of the assessment and topics, provide more diagrams, examples and answers to tasks, provide more system requirements, understanding what is expected, quantity of materials		27	52
Feedback	comments and response to each task	2		11
Group Work	collaboration with students during class, interaction with the client and instructors	18		
People	student whining, humour, jokes and banter in class, stupid questions		10	
Relevance	attending class is worthwhile, applying what is being taught/learnt	17		
Structure	repetitive structure of assessment, improving time management, having to do lecture preparation, practicing skills, strict policy of having to do tasks	27	35	
Technical	computer/printer failure		1	
Workload	the amount of preparation and reading required, sacrificing other subjects, not having enough time		14	

Table 4: Compiled Week 5 Formative Evaluation Results.

Another in-class poll, taken in the last class, collected data on the number of hours per week devoted to the subject. Early in semester, the instructors explained that about five hours out of class plus three hours in class would be needed to be applied to BISD to earn a passing grade. Only one student admitted spending eight or more hours per week, for every week of teaching. Approximately half admitted spending

eight hours per week from week seven to the end of the teaching weeks. All of the students admitted spending more than eight hours per week on BISD in the last two teaching weeks.

During the 36 hours of individual or small group consultation, student comments were often volunteered or solicited. Typically, students brought work to the consultation. Students stated that their poor work was a result of not attending, not reading the class handouts, and/or not reading the online materials. Students also offered the comment that the structure of the assessment method gave them more opportunity to improve.

An instructor observed that the higher the grade for the portfolio the more likely the student had engaged in deep learning from early in the semester. Indicators of deep learning were that tasks were done correctly and met the requirements of the client. Surface learners tended to do the task without demonstrating an understanding of the correct way to do the task or of the client's requirements. Surface learners used the notation for the models with little indication they had thought about the task. Some took a deep approach to learning the correct way to do the task, but a surface approach to understanding the purpose of the model, and so incorrectly represented the client's requirements. Many started out by taking a strategic approach, often querying their status, the number of passes and fails they had received, and how many more passes were needed. There were two or three asking these questions late in the subject.

Discussion

The results show that the goals: to improve teaching, objectives, and the assessment method; encourage deep learning; increase the learner's responsibility for his/her learning; and develop better study practices have to some extent been achieved.

The drop in retention from 93 students to 77 and then 34, while concerning, is in accord with other subjects with mostly the same cohort, and with previous BISD cohorts. Since other, more traditionally delivered and assessed subjects, with mostly the same cohort, experienced similar attrition it cannot be concluded that the changes implemented for this subject are attributable to the attrition. The distribution of grades for the portfolio, Table 3, is much as expected based on observed and recorded student participation. Though more than half the students that submitted portfolios received a pass or higher it is disturbing that less than a quarter of the student persisted and achieved the objectives. For those that persisted, the results suggest some degree of achievement of the goals.

As students came to grips with the requirements of the assessments their results improved, Figure 3. Though the correlation coefficients, Tables 1 and 2, are low, all but two correlations, portfolio versus lecture preparation and exercise, are significant. The significance of the correlations is not surprising. It shows what most teachers already believe, that the more a student does during a semester the better the students final result will be. These results are more encouraging and support the statement that there was a degree of achievement of the goals.

The formative evaluation, Table 4, revealed a number of issues. The greatest number of responses was in the "Explanation" category. Though students found it difficult that there were no "right" answers, it was evident that more examples were required. This might be an indication that further improvement is required of the teaching by "provide concrete examples of … abstract aims" (Black, 2000).

The structure of the assessment, Table 4 "Structure", was well received by the students although many were experiencing difficulty. Also, there was a positive response to the relevance of attending class and what was taught, "Relevance". This indicates that better study practices were encouraged.

The "Environment" and "Group Work", Table 4, received positive responses. The students were benefiting from interacting with the instructors and other students, and were engaged in learning.

There is a difficulty with explaining the data for workload when juxtaposed with the poll results of time spent on the subject. The one student that had applied eight or more hours throughout the session was astute and realised she required such an effort to learn. Others, perhaps not as astute, account for the contradiction.

There was not sufficient constant reinforcement of the connections among the continuous assessment tasks, the portfolio and achievement of objectives. The evidence being: the early strategic approach taken by many that persisted for a few; the failing portfolios did not address all of the objectives; the increased number of study hours in the final weeks.

The reasons for poor work as stated by the students show that some were taking on the responsibility for their learning and were monitoring and judging their work correctly.

The observation that the deep learners were the 62% of passes for the portfolio compares favourably with 53% from a similar study (Cope & Horan, 1996).

The learning approach taken by students is possibly a function of the feed back they received. Comments accompanied by marks do not lead to learning gains (Butler, 1988). The continuous assessment that was designed to encourage learning and student development would be considered as formative (Black & William, 1998; Cowie & Bell, 1999; Kanjee, 2000). However, most students commenced the semester with the position that the assessment regime was "a multiple set of summative assessments… with a considerable direct influence on the final outcome" (Bligh, 2000). For some, this position persisted for the semester. Though the assessment was continuous, perhaps it was not formative, that is, providing a non-judgmental, non-threatening atmosphere (Rolfe & McPherson, 1995).

Conclusion

This study has been beneficial. The application of educational research to the objectives and assessment method yielded positive results. The successful students did engage in deep learning, increased the responsibility for their learning, and improved their study practices. The instructors did improve their teaching by responding to the students' progress demonstrated in the assessment tasks.

A purpose of the evaluation of BISD was to generate ideas for further improvement. Some ideas are: 1) the objectives will be changed to include improving the ability to follow instructions and questioning ability; 2) in the future, each student will decide when they would like feedback only or feedback and a grade for a task and so make the atmosphere less threatening and judgemental; 3) the portfolio will receive a number of formative evaluations during the semester; 4) the work the students do to complete a task will be collected and reviewed a well as the final outcome of a task; 5) the connections among the objectives, each task and the portfolio will be emphasised; 6) increase the provision of self assessment techniques.

Further application of research that addresses the tension between teaching, assessing, classroom management and the impact on learning will be pursued. The instructional strategy will be adjusted to help identify students who are not grasping the ideas or concepts to improve the retention of students.

Further studies shall include: time studies of the students and instructors workloads; research to understand students' learning context perspective and their applied learning approach; discovery of obstacles that students encounter; collection of data on factors that influence achievement as well as achievement data; measures of pre- and post knowledge and skills; theories of cognition appropriate to the subject domain; links between theories of learning and theories of psychological measurement; the validity of assessment based on the needs of employers. In this way the instructors can change and build their expertise slowly, rebuilding theories that support and give coherence to practice.

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Biography

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