ALIGNING LEARNING AND ASSESSMENT THROUGH ADAPTIVE STRATEGIES IN TUTORIALS IN PHYSICS AT THE UNIVERSITY OF AUCKLAND

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ABSTRACT

Continuous assessment in physics is important for students. It provides the development of mental models by revising and revisiting concepts. In Physics 120 "Physics of Energy" and Physics 150 "Physics of Technology" at the University of Auckland, we identified that during 2007 and 2008 there was a significant and increasing non-participation rate in assignments and tests. In 2009 strategies were implemented to improve participation by adapting tutorials to be more interactive and aligned to the on-line assignment assessments. There were four online OASIS assignment assessments spread through each course. One week prior to submitting the assignment assessment, six practice questions were given. These questions were similar to those questions in the interactive tutorials. Four OASIS questions were given with changed variables as the assignment assessment. After the third and fourth OASIS assignments there was a strong indication that alignment between tutorial questions and assignments encouraged more participation and completion of OASIS assignments.

INTRODUCTION

"Assessment is primarily concerned with providing teachers and/or students with feedback information which they need to interpret when answering the three feedback questions: 'where am I going?', 'how am I going?' and 'where to next?'" (Hattie, 2003). Physics tutorials need to provide students with these answers through a series of structured, timely questions that enable students to answer those three questions. Physics tutorials, therefore, should be high-quality, formative learning experiences that support students in their learning process.

Popham (2008) offers the definition of formative learning as "a planned process in which assessment-elicited evidence of students' status is used by teachers to adjust their ongoing instructional procedures or by students to adjust their current learning-tactics." Wren(2008) has indicated that if they use formative assessment to benefit all their students "teachers must be willing to confront a number of obstacles including the willingness to reject the transmission model, the need to accept that students have an untapped potential for learning rather than a fixed learning potential." Black and Wiliam (1998) mention other obstacles to learning related to assessment practices including two relevant to this paper:
- Grades are over-emphasised, while efforts to recognise student problems and provide useful advice to students are not emphasizes enough
- Assessment feedback often results in students being compared with each other, which sends them the message that they are in a competition

O'Byrne and Thompson (2005) investigated the tutorial benefits of on-line assignments. They considered a list of conditions believed to promote student learning (Brown, Gibbs & Glover, 2003). Their investigation used an electronic resource ***MasteringPhysics***, by Addison-Wesley. This resource was accessed by students through a web-page and was chosen because it offers advantages such as immediate feedback, immediate marking and personal login. These strategies reduced the chance of copying of assignments. Some gains were made over a paper-based assignment system. Staff ratings of the effectiveness of ***Mastering Physics*** assignments were complemented by comments, such as feedback was more 'tailored to student responses', 'provided when required', 'sample solution does provide a good guide' and 'used to help answer problems'. Losses included the loss of group-work caused by students working under their own login name,

since more students worked individually rather than in teams, and the alignment between questions in the paper-based assignments and those in the final examination.

MOTIVATIONS
At the University of Auckland there has been increasing non-participation in assignments and tests as the semester proceeded. Data collected from Physics 120 and Physics 150 from 2007, 2008 and 2009 shows that there has been very significant and increasing non-participation rates as the semesters developed, in both assignments and tests (see Figures 1 and 2) below.
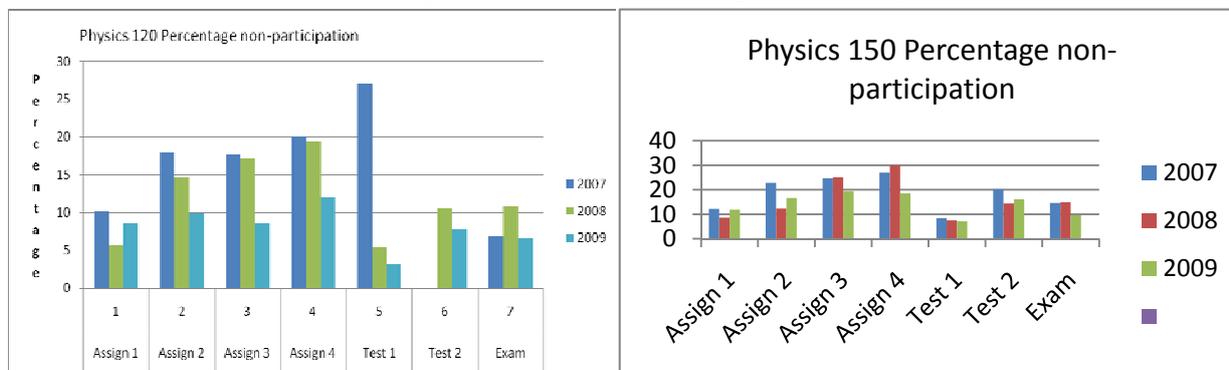

Figure 1: Physics 120 Percentage non-participation rates 2007 to 2009
(2007 Test 2 data not available)

Figure 2: Physics 150 Percentage non-participation rates 2007 to 2009

This project was seeking to determine if increasing the quality of tutorials by increasing engagement and aligning tutorial questions to future assignment questions might improve the number of students completing assignments.

THE OASIS ASSIGNMENT AND ASSESSMENT TOOL
OASIS is a web-based learning and assessment tool. The Faculties of Science and Engineering at the University of Auckland use OASIS predominantly with first-year Physics and Engineering students for skills practice and summative assessment. The tool delivers individual tasks, marks student responses, supplies students with prompt feed-back by providing a response that indicates if the student's response is correct or incorrect within a limit of accuracy (usually 1% to 2 %), provides the accepted answer together with a mark value (1/2, 1 or 2 marks per question) and logs student activity.

The Physics 120 "Physics of Energy", Physics 150 "Physics of Technology" and Physics 160 "Physics for Life Science" papers all have over 200 students per semester. Physics 160 attracts nearly 600 students in semester 2 each year as they compete towards entry into medical school. These large student numbers would result in a large marking load after each of the four assignments relevant to each paper. If paper assignments with hand-written answers were used then a large time commitment would be required for marking. OASIS relieves this marking load and provides better workload management for lecturers, together with instant feedback to students.

In each of the above courses the four online OASIS assignment assessments are spread through each course. One week prior to submitting the assignment assessment, six on-line OASIS practice questions are given. The assessments include four of these questions given with different values of the same variables. Each student receives different values from other students.
Smaill (2005) reports that first-year engineering students found the OASIS software easy to use as it provides all the data, requires no steps or reasoning to be given and clearly shows where the answers need to be entered. Smaill (2005) reports that OASIS helps them improve their skills and learning. This conclusion was based on extensive observation and analysis of assessment results. He concluded that the OASIS assessment system supported improved student achievement. The OASIS system presented no significant difficulties that would hinder achievement.

DEVELOPMENTS
At the University of Auckland students from a diverse range of backgrounds study within Physics 120 and 150, although very few are able to progress to Stage 2. In recent years to support first-year students, non-compulsory support tutorials have been provided for four hours daily. These are very

well attended in the few days before each OASIS assignment assessment occurs, but there is no focus to each tutorial. There are two tutors per hour and these change hourly. In addition, as part of the course work, there have been two-hour compulsory 'laboratory tutorials' alternating with three-hour laboratory experiments each fortnight.

The assessments include assignments, tests, laboratory reports and examinations. In laboratory tutorials students are provided with questions from past examinations but there seems to be no relationship between the purpose of tutorials and the OASIS assignments.

THE LABORATORY TUTORIALS

The tutorials are two hours each and it is intended that they should support learning and prepare students for assessments. In 2007 and 2008 students were provided with past paper questions from either tests or examinations in a study situation where tutor support is provided by post-graduate student tutors. These tutorials tended to become a very passive learning situation in which students would not always seek or receive the support they needed. In 2009 the structure for each tutorial in Physics 150 was changed to include two or three types of engagement. One initiative was to activate tutors to be pro-active helpers. Another initiative was to increase the level of student interaction so that more group work (using groups of 5 to 6 students) is implemented, thus increasing peer support and reducing the emphasis on competition for grades. A one hour training session for tutors was provided before the semester started. It was intended that this tutor development programme should enable tutors to guide the whole range of students towards problem solving more effectively than in previous years. A 'Tutor Reply' sheet was designed to provide feedback from tutors and students to the lecturers about difficulties students were having and the effectiveness of the tutorials.

Tutorial 1: Questions similar to those used in the OASIS questions, taken from a variety of texts, were provided to the lecturers to confirm they were suitably focused. When answers were attached they were provided to laboratory tutors for the tutorials.

Tutorial 2: Before the second tutorial the laboratory tutors were sent an email again reminding tutors of the strategies they might use to guide students towards problem solving using several steps. The tutorial was divided into three parts during which tutors could practice these steps with students:
Part 1: Questions to determine individual student understanding and identify students who need support.
Part 2: Team questions – taken from the Serway text "Questions to Improve Thinking" that structured the questions which were provided to tutors. Students worked in teams of three to four in all the tutorials for this second part.
Part 3: Past examination questions.

After the second OASIS assignment the percentage of non-participation rates in OASIS 1 and 2 for 2009 (11.9% and 16.6% respectively) were higher than in 2008 (8.6% and 12.3 % respectively) but comparable to 2007 non-participation rates. It was decided to re-develop the tutorial resources. The intention was to align the questions provided to students to those used in OASIS questions.

The two lecturers were consulted about the OASIS questions to be used and questions from the text book that were similar in context to the OASIS questions were chosen. They were chosen to determine student understanding using the 'Quick Quiz' questions from the text as the Part 1 questions. The 'Tutor Reply' sheet was developed further to provide more detailed feedback about student responses to the tutorial questions.

Tutorials 3 & 4 were both given a similar format, with a brief time for feedback about lecture style, then Part 2 provided some of the 'Quick Quiz' questions from the text and Part 3 provided selected text book questions that were aligned to the upcoming OASIS assignment questions.

DATA COLLECTION

The data for this project used the Mixed-Method approach (NSF Handbook, 2002) and provided information from interviews, focus groups, laboratory tutors, lab-tutorial tutors and surveys. All reporting of indicators is in terms of 'positive-outcome' strategies. Only those features revealed in the feedback are included in the remainder of this paper.

RESULTS

THE TEACHING AND LEARNING PROGRAMME - FEEDBACK FROM TUTORIAL EXPERIENCES

Tutorial 1 feedback shows that:

- tutors need time to become active
- tutors may prefer students to learn from text
- tutors need to prepare for each tutorial; hence material must be provided several days before.
- problems should be "easy to follow"
- laboratory-tutors need detailed answers
- some students can be reluctant to be involved in groups of 3 to 4 when they are in competition
- active tutors help students to learn using interactive reporting on white-board

Tutorial 2 feedback identified several ideas and concepts that students did not understand. Feedback suggests fewer questions are required for tutorials than provided and that formula sheets would be useful. Tutors requested they be provided with answers to all questions before the tutorial by the course coordinator.

Tutorial 3 feedback indicated:

- the need for several tutorial opportunities before students understand the dynamics and value of their engagement
- that tutors become more active with experience as they "were active, revolving around the room to provide assistance and check on student progress. After some time the room became much quieter and students settled to the work."- report from observer
- some students take at least two tutorial experiences before they become aware that the tutorial questions are from their textbook. Most had not read their text and had not attempted the 'quick quiz' or problem solving
- additional tutorials were held before lectures and not in the usual tutorial time to review some topics – the Kirchhoff's Loop laws tutorial was attended by 19 students.

Tutorial 4 focussed on several topics that needed emphasis and was used as the opportunity to survey student opinions about OASIS as an assessment tool. Students were equally divided about their preference and non-preference for OASIS as an assignment and assessment system. They liked OASIS since they can practice many times, at home or at university; it is more quantitative rather than qualitative so does not rely on writing skills. They disliked OASIS since it was possible to 'fluke' the answer rather than simply understand the Physics.

When asked

- "Would OASIS assignments be better if they used more shorter questions and you were given some questions that were similar, but not exactly the same, as the practice questions" students indicated they would rather stay with the current format and that they would be concerned about carry-on mistakes if the first part was incorrect. They preferred to have more questions on the same concepts instead of the same question with different values.
- "If a different type of assignment was used what type might be best?" some students expressed a preference for OASIS, since it was able to be accessed from any computer, whilst others preferred a hard-copy take-home assignment that included many questions covering the whole of the course

Most students seemed to prefer the current format but had significant criticisms. The survey shows that:

- most students did not start OASIS 2 immediately if assessment items in other subjects take precedence
- most students are using their text book to solve the questions
- most students do not use the Help Room since Help Room tutors need to be more supportive
- while 22 students out of 41 indicated there is little impact of other work and assessments, 19 students express that there is a significant impact of other assessment work that prevents them doing the OASIS 2 assignment. 21 students of the 41 indicate that other assessments they had at this time prevent them doing as well as they would like to do
- only 8 students indicated that personal aspects in their lives prevented effective involvement with this assessment
- 23 students; 18 students and 17 students indicated that the difficulty of the ideas in the lectures prevented them achieving as well as they would have liked to

- 26 students expressed that the lab tutorials had little or very little impact to support them solving OASIS problems. 21 students; 16 students and 11 students indicated that lab tutorials did have a significant impact to support them to answer OASIS 2 questions. Further alignment between tutorial activities and OASIS questions is required.

Of the 8 students who did not complete OASIS 2 and responded to the questionnaire, 5 indicated that they did not start the assignment. None of these 8 students used Help Room tutor support at any time during the course. Four students indicated they simultaneously had other assignments with two indicating at least four assignments at this time. Their inability to manage workload prevented them from completing OASIS 2. There were other personal aspects in their life also prevented them completing the assignment. They experienced difficulty engaging with ideas in lectures and this prevented them achieving as well as they would like. The students indicated the tutorials did not significantly help them to solve the OASIS questions.

THE TEACHING AND LEARNING PROGRAMME – FEEDBACK FROM THE FINAL INTERVIEW
Of the informants, three were females and eight males. Ten were in their first year of university study, while one was second year. All had come directly to university from secondary school.

Nine students indicated OASIS assignments improved their understanding of Physics, or gave some better understanding; eight students indicated that study for tutorial-aligned OASIS provided at least some improvement of achievement in tests; and six students indicated that study of tutorial-aligned OASIS provided at least some improvement in exam results.

When asked what aspects might be improved, students had a range of suggestions from the need for tutorials to provide more explanation of concepts and be more useful to their learning, rather than contributing just an attendance mark to assessment. They suggested that laboratories need to be more aligned with course work and lectures. Finally they requested change from multiple – choice tests as they do not provide feed-back about how to improve understanding, and the need to provide reviews.

EFFECTIVE, OR NOT? STUDENT ACHIEVEMENT IN PHYSICS 150 PHYSICS OF TECHNOLOGY OASIS ASSIGNMENTS
The percentage non-participation in assignments 3 & 4 (See Figure 2) decreased relative to the continuing increases in 2007 and 2008. There may have been a positive effect of alignment of tutorials with assignments. The most dramatic effect is the reduction in non-participation in the final examination, from around 14% to just below 10%. Failed students whose result was DNS/DNC ('did not sit/did not complete') the courses also reduced from 15.7% in 2007 and 17.6% in 2008 to 11.5% in 2009.

CONCLUSIONS

The positive response to aligning tutorials to the on-line OASIS assignments seems to indicate that students felt supported and encouraged to make more effort to attempt the on-line OASIS assignments. The tutorial methodology provided more engagement and group-work opportunities in a learning situation in which they knew that the work they were doing was coordinated and meaningful relative to impending assessments. The tutorials provided guidance, re-engagement and stimulated student cognitive development of ideas and concepts directly relevant to assessment. They encouraged group work, allowed tutors to identify student difficulties and provide opportunities to remediate student understanding. Student-student and tutor-student feed-back opportunities were enabled and these reduced the emphasis on competition. The tutorials sought to recognise the potential of each student and enable improved achievement by each student.

This project was part of a wider project seeking to identify barriers to student learning, and find specific strategies that are
- "innovative, challenging, responsive to the needs of diverse learners, and under-pinned by sound disciplinary and pedagogical expertise.
- Founded on an in-depth understanding of a wide ranges of teaching, learning and assessment methods, of practices which support student learning, and the ability to select and apply different teaching methods in appropriate contexts." (University of Auckland, 2009).

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