RESOURCE USE AND STUDY HABITS IN A FIRST-YEAR MATHEMATICS SERVICE UNIT

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ABSTRACT

We analysed students' actual and intended use of a variety of study resources in a first year mathematics service course. We combined online tracking with self-report via survey and interviews. Our major finding was that students desire and intend to use a variety of resources but in actuality focus on traditional modes of engagement. We also found evidence that these students adopted different study habits and a different learning approach in their service maths units as compared to their discipline units.

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INTRODUCTION

Learning and teaching environments in higher education are gradually becoming more flexible and as a consequence students expect to be able to learn in a flexible manner and desire to have access to a greater array of resources. In addition to traditional modes of engagement (lectures, tutorials, the reading of textbooks) students might have access to drop-in centres, lecture recordings, online quizzes and other study resources, discussion boards and various forms of social media. Gaining an understanding of why a student decides which resources to utilise, and when and how they use them, is crucial to both improving the student learning experience and making informed decisions about where to invest energy in providing, maintaining or improving such resources.

Self-regulated learning (SRL) is the degree to which students are metacognitively, motivationally and behaviourally active participants in their own learning process (Zimmerman, 2008). A proactive learner is someone who is aware of their strengths and weakness and can self-evaluate their own progress (Zimmerman, 2002). Various instruments (surveys, questionnaires, structured interviews) have been used to establish the validity of the SRL concept. The Motivated Strategies for Learning Questionnaire (MSLQ) is an 81-item instrument assessing rehearsal, elaboration, organization, critical thinking, time and effort management, study environment, peer learning, seeking help, valuing expectancy and affect (Pintrich, Smith, Garcia, & McKachie, 1991). The Self-Regulated Learning Interview Scale (SRLIS) presents each student with six scenarios (e.g. preparing for a test or writing an essay) and then analyses the answers to open-ended questions covering various categories of learning strategies (Zimmerman & Pons, 1986). The Inventory of Learning Styles (ILS) has 120 questions of which one quarter address "regulation strategies" (Vermunt, 1998; Vermunt & Verloop, 1999). Vermunt (1998) has validated the ILS on samples of over a thousand students and linked self-regulation to the student's approach to learning (Saljo, 1979; Ramsden, 2003) and verified that a student with well-developed self-regulation is more likely to employ a deep approach to learning. A high degree of metacognitive self-regulation has also been found to be positively correlated with final grade (Pintrich et al., 1991). Finally, Pintrich et al., (1991) also found that self-efficacy for learning and performance was strongly correlated with expectation of an excellent grade.

These instruments were used to inform the design of our own interviews and surveys. In this pilot study, we used a mixed method approach to combine quantitative data (from website statistics and Likert questions on surveys) and qualitative information (from interviews and open-ended survey questions).

CONTEXT

MATH1013 is a 3 credit point first year subject. The course is regularly taken by approximately 600 students, the majority of whom major in Biology, Psychology or Medical Science. It is compulsory for these students to do four different 3 credit points units of maths or stats and this is one of the units usually chosen. They are expected to have done 2-unit Mathematics for the HSC but approximately 1 in 5 have not done any senior maths at high school.

Face-to-face teaching consists of 2 lectures per week and 1 tutorial. Tutorials have between 20 and 30 students each. Additional face-to-face opportunities include a lunchtime consultation hour with each lecturer; duty tutors to answer any questions two lunchtimes per week; or the mathematics learning centre. Traditional document resources include weekly tutorial questions and solutions (available on the school website) and a 100 page set of printed lecture notes (costing about $15). All lectures were given using a document viewer and the hand-written material was scanned and made available as PDF files; Lectopia recordings of all lectures were also available. Finally, online randomly generated weekly practice quizzes (using MapleTA) were available.

METHODOLOGY

Online data collection occurred throughout the entire semester. Usage patterns for the lecture recordings (Lectopia) and online practice quizzes (MapleTA) were automatically provided by the software packages used and a hit counter was used to monitor downloads of various PDF documents (tutorial solutions, scans of lectures, etc.). The tutors also recorded tutorial attendance each week, but only visual estimates of lecture attendances were made. About halfway through semester (Week 7), student volunteers were requested for structured interviews (about an hour long) which were conducted by the authors not involved in lecturing. The interview topics and questions were derived from the SRLIS (Zimmerman & Pons, 1986). Four students were interviewed in-depth and the issues raised by these students were used to design an online survey that was offered to the entire cohort in Week 9 of semester. The online survey ran for a further 4 weeks until the end of semester.

Students were asked about the level of maths studied in high school, the degree they were currently enrolled in, their intended major and any other maths subjects they had or were currently studying. In addition the survey had questions about the frequency of usage of 14 different resources; Likert-response questions about student attitudes towards resources, study habits, and self-evaluation; and 4 open response questions. The relationship between these questions and the categories of learning strategies identified by Zimmerman and Pons (1986) is in Table 1. The questions are in Table 2.

The survey was optional and 67 students participated (of whom 59 also provided their names). After the survey was closed and all exams completed, we compared the distribution of final marks of the 59 named survey participants to the entire cohort. The distributions were remarkably similar (see Fig. 1). The mean mark of the survey participants was 3 marks higher than the entire cohort. An unpaired t-test confirmed that this difference was not statistically significant (two-sided p=0.12). Thus, although the participation rate was low, based on the similar distributions, we treat the survey participants as representative. However, other confounding factors that need to be considered while interpreting our findings include the possibility that voluntary survey participants might be more self-confident and more inclined to engage with online activities.

Table 1: Relationship between Zimmerman's categorisation of learning strategies and some of our survey questions.

Categories of strategies (and definition)	Survey question(s)
Self-evaluation (student-initiated evaluations of quality or progress of their work)	A1-7
Organising and transforming (rearrangement of instructional materials)	S3, S4
Goal-setting and planning (students set goals and plan activities to achieve goals	S1
Seeking information (secure further information from non-social sources	F12-14, S5
Rehearsing and memorising	F4-5, F11, S2
Seeking social assistance (from peers, teachers and adults)	F6-8
Reviewing records (re-reading tests, notes, textbooks	F3, F9-10

Table 2: List of survey questions

Frequency of Resource Use	How often do you ... F1: attend lectures, F2: attend tutorials, F3: use pre-printed lecture notes F4: download tutorial questions, F5: download tutorial solutions F6: use consultations, F7: see duty tutors, F8 use Maths Learning Centre F9: view Lectopia recordings, F10: download scans of lectures F11: attempt the online quizzes, F12: consult Wikipedia, F13: use Wolfram Alpha, F14: use online resources from other universities.
Resource usage/access	R1. I am happy with the resources available R2. It's confusing to have so many resources R3. I would prefer more face-to-face resources R4. I prefer working online in my own time R5. I like the flexibility of many different resources R6. There are too many tutorial questions R7. There are too many students in my tutorial R8. I get the attention I need from my tutor
Self-regulation	S1. I do the tutorial preparatory questions before going to the tutorial S2. I work through the examples in the lecture notes S3. I make up my own examples S4. I create my own summary of each topic S5. I look for additional resources
Attitude and self-evaluation	A1. I have learnt some useful things A2. My quiz mark was higher than I expected A3. My quiz mark was lower than I expected A4. It is difficult for me to determine whether I have mastered each topic sufficiently A5. I expect to do well in the exam for this unit A6. I need to study harder than I have so far A7.My study habits are adequate
Open comments	O1. Does the way you study MATH1013 differ from the way you study other maths or stats units? Please explain how. O2. Does the way you study mathematics and statistics differ from the way you study other subjects? Please explain how. O3. Which of the resources available did you find most useful? O4. Which of the resources available did you find least useful?

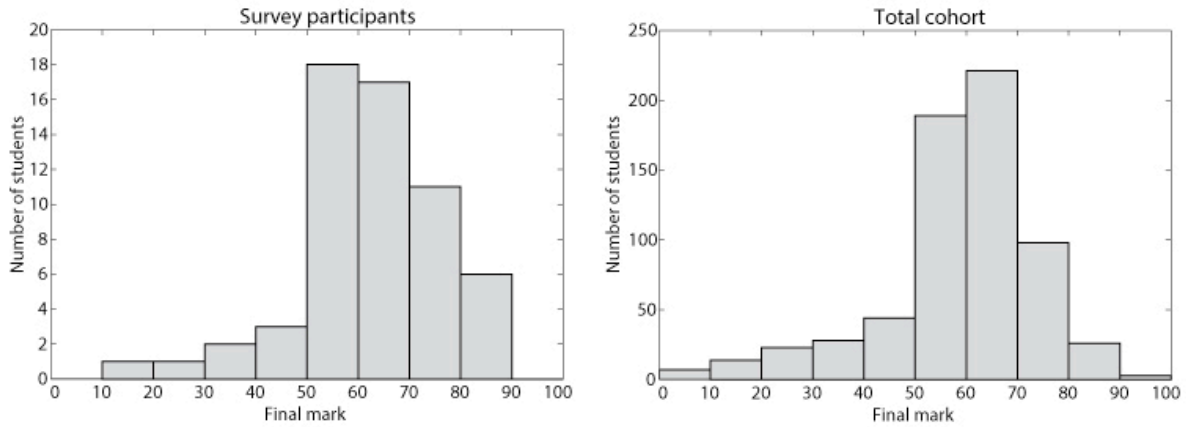

Figure 1: Comparison of distribution of final marks for survey participants and entire cohort.

RESULTS

FREQUENCY OF ENGAGEMENT AND RESOURCE USE

The self-reported rates of engagement with various activities or resource use are shown in Fig. 2. The items are displayed in the rank order based on the totals for the three highest categories of usage (less than once/week; once/week; more than once/week). The order of popularity changes for several items if the category of usage "only before a quiz" is added to that total.

The four most popular items are also the most traditional (lectures, tutorials and the associated tutorial resources). Resources provided online that require only passive engagement are next in popularity. The online quizzes and websites such as Wolfram Alpha (where students can practice mathematical calculations) require active engagement; they were next in order of popularity. The activities that represented one-on-one interactions with staff (duty tutors, lecturer consultations, Maths Learning Centre) were reported as used the least frequently. However, the online practice quizzes, Wikipedia and the duty tutors were also used by quite a few students only before a quiz.

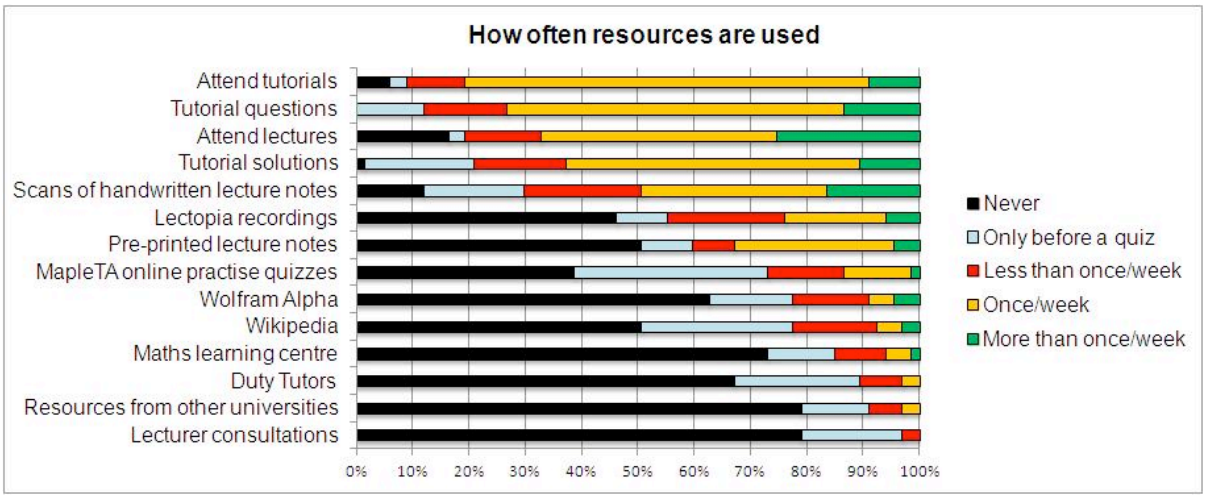

Figure 2: Self-reported frequency of engagement and resource use

The download data from the website supports the popularity of the traditional resources. Lectures occur on Thursdays and Fridays, with the corresponding tutorials held on the following Mondays and Tuesdays. Thus, not surprisingly, the highest rates of document downloads occur over the weekend, averaging 120 hits each day. Furthermore, this number increases by a factor of 10 on the weekends prior to a quiz. The most popular documents are the tutorial questions (400-500 downloads each over the semester), the corresponding solutions (300-400 downloads) and the two practice quizzes (350-400 downloads). The number of downloads of scans of handwritten lecture notes were extremely variable (ranging from as few as 28 to as many as 235 depending on the lecture). There was also a peak in usage at the start of a new topic in Week 6. The use of the Lectopia recordings reached almost 200 views for a single lecture near the very beginning of semester; but showed a gradual and systematic decline to as few as 30 views by the end of semester.

The use of the online quizzes showed a similar pattern of engagement. During semester 129 students attempted at least one online practice quiz using MapleTA, but only 4 students attempted every available activity. Usage declined during semester from a peak of 102 for the first activity to only 12 for the last activity. There was also a peak (of 63) in usage just before the first quiz.

ATTITUDES TOWARDS RESOURCES

The survey responses for questions R1-R5 are shown in Table 3. The vast majority of respondents were happy with the range of resources provided and liked the flexibility of having different resources. There was a greater preference for working online (R4) as compared to more face-to-face resources (R3) which is consistent with the frequency of engagement seen in the previous section. However, this should be viewed with great caution, since this survey was voluntary and also conducted online.

Table 3: Survey responses to questions regarding attitude to resource availability.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
R1: I am happy with the resources available	1	1	7	40	18
R2: It's confusing to have so many resources	12	39	8	7	1
R3: I would prefer more face-to-face resources	5	17	21	19	5
R4: I prefer working online in my own time	0	6	15	28	18
R5: I like the flexibility of many different resources	1	1	9	36	20

The open-ended comments from students were also generally supportive of the range of resources. This desire for variety is also consistent with feedback during student-liaison meetings. When asked which three resources were the *most useful* (as opposed to which resources were used *most frequently*) the selections now covered the entire spectrum of resources: traditional tutorial questions and solutions were indicated the most (39%); Lectopia recordings, scanned and printed notes were somewhat less popular (25-27%); and the online quizzes were chosen by some students (17%). The online Lectopia lecture recordings were explicitly mentioned by 12 respondents: two said it was the least useful resource (and preferred to read printed notes) but 10 categorized it as the most useful resource: mostly for time-management reasons as shown by these comments.

- *I find the Lectopia recordings most useful. As my class is at 8am and I have other classes at 11am and it takes me 1hr 1/2 to get to uni, I have not been to one lecture this semester. However, I have watched all lectures and taken notes and done all the tutorial questions.*
- *Lectopia - I work on Fridays and use this to catch up on the lecture.*
- *I find it easiest to dedicate a whole weekend to watching all lectures, taking notes and then completing all tutorial questions in one go.*

When asked which resource was the *least useful*, 25 students responded by stating that all the resources they had used so far *were* useful. Commonly occurring complaints were the need to queue for duty tutors or the Maths Learning Centre; and that the on-line quizzes were difficult to use.

STUDY HABITS

The vast majority (48/67) of survey participants said they study for all maths units in the same way, usually indicating that this involves “working through example problems” and doing all the tutorial questions. However, only 9 said that they studied maths the same way as their *other science* subjects. There was a very consistent recurring theme about why studying maths is different to studying the other science subjects. The term most often mentioned in association with studying maths was “practice” (19 respondents). On the other hand, the terms most often used to describe study-habits in their other science units were “memorisation” (13 respondents) and “rote-learning” (3 respondents). None of the survey respondents used either of these two latter terms when discussing maths study habits. The comments below are very typical of this distinction.

- *My study for this unit is entirely problem-based: learning through doing tutorial questions and examples in the text. Other units tend to involve heavy memorisation without a lot of worked examples.*
- *Maths requires a different style of learning, as learning the theory is not nearly enough. A lot of practise is also required.*
- *Maths is a lot about doing lots of practice etc. instead of memorising notes.*

DISCUSSION

Although lectures and tutorials are only available at fixed times, students made an effort to attend and engage with these traditional activities. However, they were critical of a lack of flexibility in other resources: some were unwilling to engage with the online quizzes because they did not want to invest the time to learn the syntax rules needed to answer maths questions online. Likewise, many avoided or disliked queuing to see the duty tutors or the Maths Learning Centre. The comments and the observed pattern of engagement with online resources suggests that many students try most of the online resources near the beginning of semester but only a small subset continue to use them as the semester progresses.

The distinctions drawn between mathematics and other science subjects were the most interesting observation. Memorisation and rote-learning are associated with a surface approach to learning (Ramsden 2003). Although practising a skill by doing many example problems can also be argued to be a form of rote-learning, none of the survey respondents used the terms memorisation or rote-learning when talking about mathematics. In Bloom's taxonomy (Krathwohl, 2002), memorisation is associated with the lowest levels of the cognitive hierarchy (Knowledge and Comprehension) whereas "practise" leads to procedural fluency. It encompasses the next two cognitive levels (Application and Analysis) in that procedures need to be interpreted and applied successfully to varied examples. Evidence of a deeper approach comes from comments such as

- *MATH1013 is different as there isn't much in the way of formulas to remember (or they are too complex to try to remember) and learning ways of approaching questions seems more helpful.*

There was some evidence of the higher cognitive levels of Synthesis and Evaluation but it was rare: only three students indicated that they regularly "make up their own examples" (S3) and only half the students "create their own summaries" (S4). Although the lectures and notes emphasize the connection between methods and concepts from different parts of the unit, none of the students mentioned looking for connections or making their own links between ideas in their approach to learning.

CONCLUSIONS

Zimmerman (2002) argues that, "self-regulated learning is not a single personal trait that individual students either possess or lack. Instead, it involves the selective use of specific processes that must be personally adapted to each learning task". We likewise found that:

1. Students desire and request a variety of resources but focus on traditional modes of engagement.
2. Some students are proactive learners with highly individualised ways of using resources, and every resource was used by some students, depending on personal needs and preferences.
3. Students regard studying for maths to be a form of "practising" as opposed to "memorisation" which is more common in their study habits for their other science units.

This suggests that a variety of resources must be maintained for inclusive teaching, because it is difficult to predict which ones will be used. Pro-active students will find creative and productive ways to use whatever resources they need; less confident students may briefly engage with a resource and then disengage if it requires too much planning or effort.

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