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Curriculum and beyond: Mathematics support for first year life science students

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Curriculum and Beyond: Mathematics support for first year life science students.

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1 INTRODUCTION

1.1 CHALLENGES

The transition to higher education is a challenge for students in all areas of academia. New students, often from a range of educational backgrounds, are asked to adjust to very different teaching and assessment styles and to a more challenging curriculum (Hart & Baxter, 2003). In the life sciences students often adjust rapidly to the biology elements of the curriculum but struggle with the chemistry and mathematical aspects.

Formative exercises are a well-recognized method of supporting areas of the curriculum in which students report struggling (Yorke, 2003) and are influential in the retention of students (Yorke, 2001). There is a broad discussion on the definition of formative, and the importance of divorcing the formative and summative activities within a unit of learning (Rust, 2002; Nicol & Macfarlane-Dick, 2006).

Broadly speaking a well-structured formative program will: clarify and explain the performance criteria; engage the students in self-assessment and encourage reflection; provide signposts to the students about performance; encourage discussion between students and staff; provide a positive experience and deliver effective feedback to both staff and students (Nicol & Macfarlane-Dick, 2006). The major challenge is to build a series of opportunities which enable students to self-differentiate and engage at different points, while not being disadvantaged for doing so.

1.2 SUPPORTING LEARNING

Biochemistry and Molecular Biology is a first year module with 450-500 students per year. Within this module there is a particular emphasis on enzyme kinetics as there are a number of experimental, mathematic and conceptual skills associated with this topic which are fundamental to many other areas of study. The focus of this work is a lab report assessment based around the enzyme kinetics experiment undertaken by the students, with a large number of marks for mathematical processing and graphical skills. The diversity of student intake means that we needed to develop a flexible support structure for students struggling with mathematical ability. We achieved this through a structured and interleaved system of curricular and extracurricular formative activities highlighted in figure 1.1.

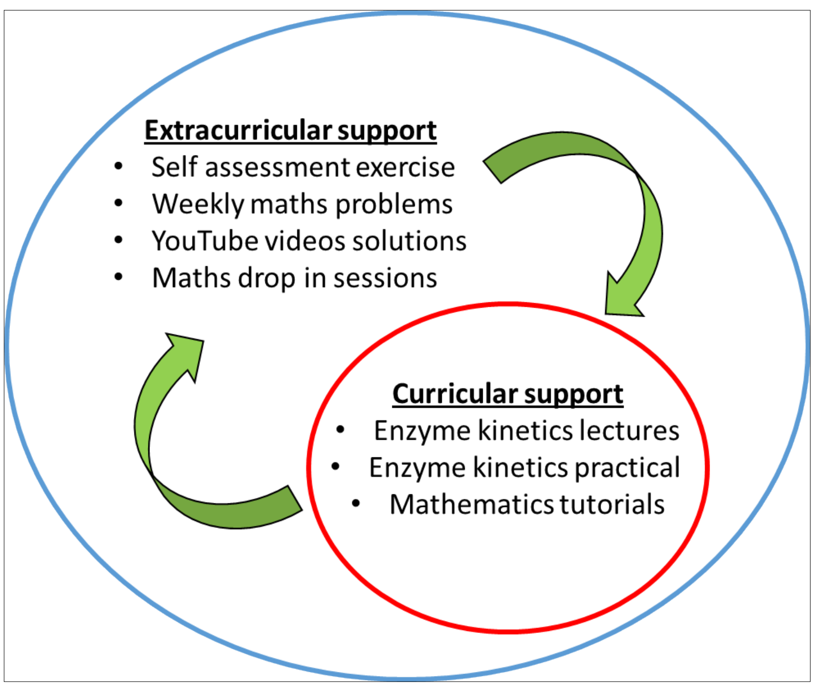

Figure 1.1: Diagrammatic representation of the curricular and extracurricular activities available to students to support development and confidence in mathematical skills for the Biochemistry and Molecular Biology module. The activities were designed to be flexible and interwoven, giving support across the piece.

1.2.1 In-module support

The curricular support begins with a series of tutorials containing materials designed to challenge students of all levels. These were run in a student centered manner with students encouraged to work together on the problems. This problem based, student led approach is often more successful with this skills based and practically focused learning (Hmelo-Silver, 2004). Following on from these the students were provided with some lecture based reinforcement of the concepts and mathematical processes involved, much of which was also provided in the guidance materials for the enzyme kinetics practical.

1.2.2 Out of module support

Extracurricular support needs to feed directly into the curricular element. In part this was achieved with a series of online mathematical problems written to feed directly into the taught elements. YouTube videos were made in which the solutions to these problems were explained, delivering a mock face-to-face experience which the students were free to review multiple times.

Finally, a series of drop in sessions were provided with the intention of supporting students across all modules; however experience suggests that the greatest impact of these in semester 1 is in the Biochemistry and Molecular Biology module. A self-diagnostic assessment exercise was provided to students at the start of semester 1 to help students identify their support needs.

1.3 AIMS

In this report we aim to evaluate the impact of the work done to support students in developing numeracy skills in the first year Biochemistry and Molecular Biology module.

2 METHODS

2.1 PROGRAM OF WORK

458 level 4 (first year) undergraduate students on the Biochemistry and Molecular Biology module were given a formative mathematics assignment related to enzyme kinetics. Students either self- or peer- marked the assessment in tutorial classes. Approximately two thirds of the tutorial classes were provided with paper surveys to complete; these anonymous surveys captured the pre-University qualifications of the students, and 6 Likert-type responses to the statements:

“I feel that this formative exercise has increased my understanding of the subject”

“I would like to undertake more formative assessment in the future”

Ethical approval was given by the University of Westminster Ethics committee VRE1415-0839.

2.2 STATISTICAL ANALYSIS

The student results on the module were taken from the Student Record System and are means ± s.d. where 2012/13 n=446, 2013/14 n= 478 and 2014/15 n=458. The cohorts were compared by one-way Anova, where $p<0.05$ was considered to be a significant change.

3 RESULTS

3.1 EDUCATIONAL BACKGROUND OF THE STUDENTS

The range of entry qualifications in the student intake is an important factor in considering the areas of support required. Fig 3.1.1 shows the entry qualifications of the students in the 2014/15 cohort.

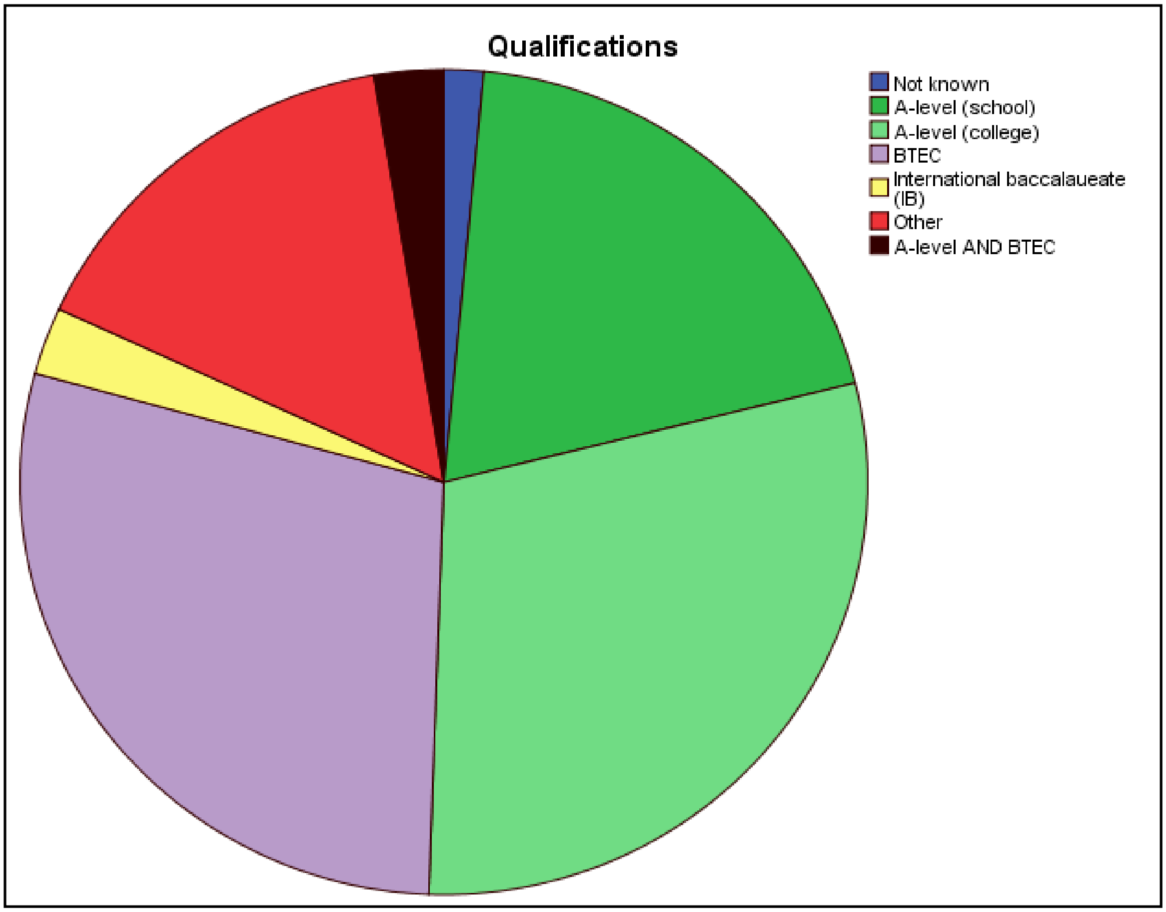

Figure 3.1.1: Entry qualifications of students taking part in the formative maths tutorials. n=52 A-level school; 78 A-level college, 73 BTEC, 7 International baccalaureate, 40 other and 7 BTEC and A-level.

3.2 NUMERACY SELF-ASSESSMENT – EXTRACURRICULAR SUPPORT

The numeracy self-assessment (appendix 1) is a short online question set designed to evaluate a student's current level of confidence. In 2014/15 106 of the 407 Blackboard registered students (26%) attempted the self-assessment test.

3.3 Numeracy drop in sessions - Extracurricular support

In the 2014/15 academic year 15 numeracy drop in sessions were held in the first semester. These drop in session had a curriculum of their own, although they were used by students for support in module assessments. The attendance at these varied from week to week, but were consistently attended by 18-36 students per week, with a peak of 42 coinciding with with the enzyme kinetics coursework submission.

3.4 YouTube interaction – Module linked extracurricular support

In total 12 videos were made to support students in tackling the formative problems, and were uploaded to YouTube. The mean number of views for each video was 116 with a range of 66-320. The videos worked through the problem from first principals and each problem corresponded with a skill required in the enzyme kinetics practical. Each problem also addressed skills which were further developed in the timetabled tutorial.

3.5 Maths Tutorial and Kinetics Practical – Curricular support and development

The maths tutorials are timetabled sessions in which student work through a series of problems based around amount of substance (moles), concentrations and dilutions. The problems were tackled by the students in working groups, and solutions presented at timed intervals throughout. Turnout at tutorial session was between 75-85%.

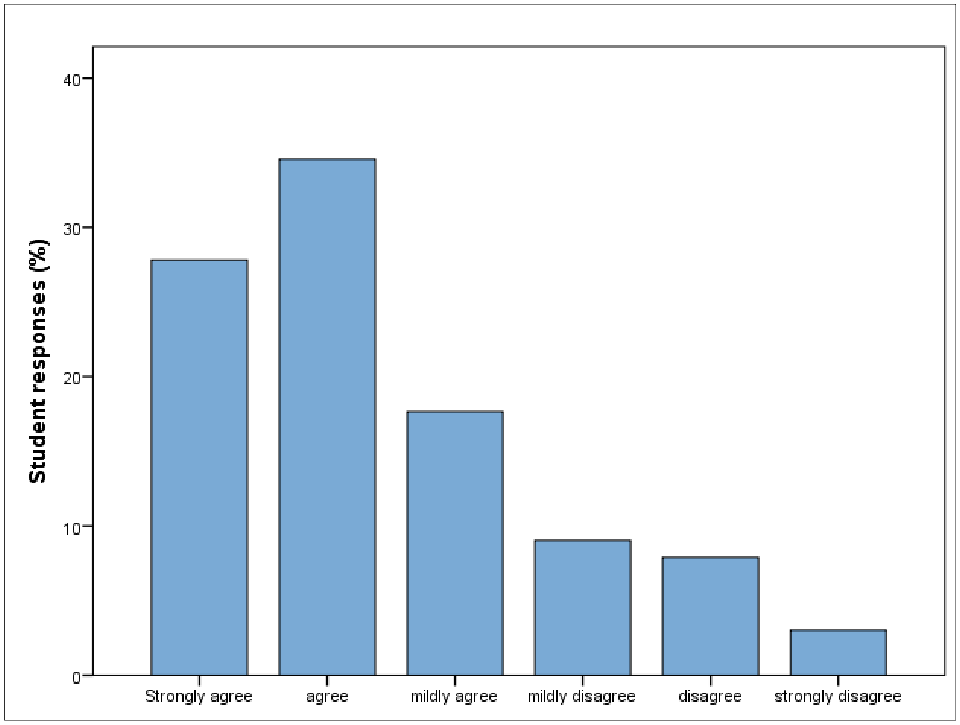

Figure 3.5.1: Likert-type responses to the statement “I feel that this formative exercise has increased my understanding of the subject” amongst the FSLS400 Biochemistry and Molecular Biology class (n=266).

The students responses to a questionnaire designed to assess the impact of the tutorial activities were measured by Likert response and are shown in fig 3.5.1. Over 70% of students felt that the formative exercises had helped them to understand the subject and gain confidence with the mathematics.

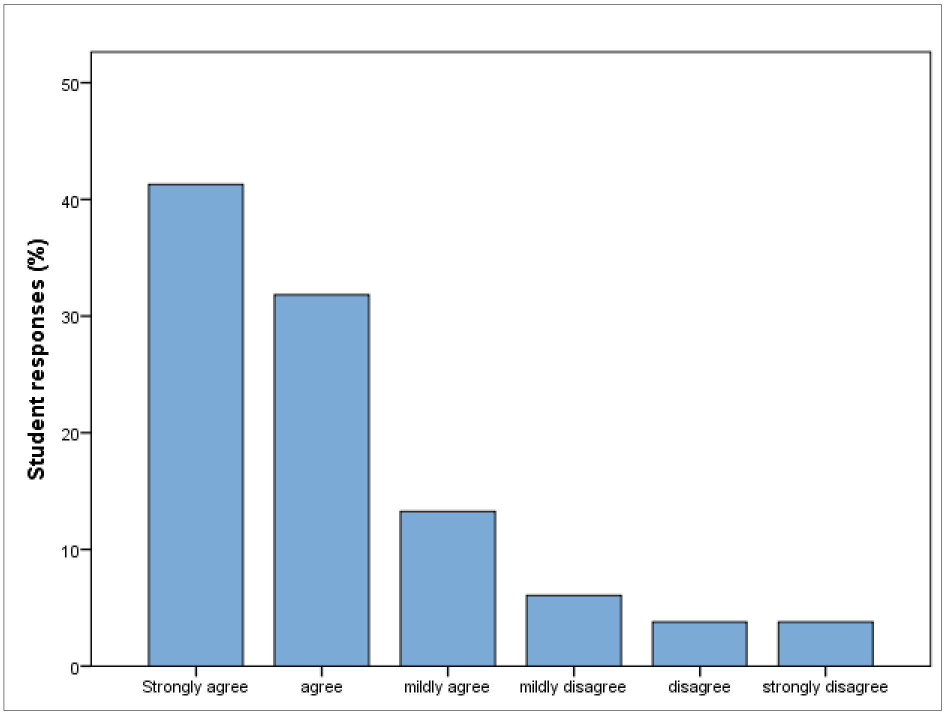

Figure 3.5.2: Responses to the statement “I would like to undertake more formative assessment in the future” amongst the FSLS400 Biochemistry and Molecular Biology class (n=264).

Student willingness to participate in further formative assessment of this type were assessed by Likert scale response and are shown in fig.3.5.2. This suggests that more than 85% of students would like more formative assessment to help support their studies and can therefore see the value of undertaking such tasks.

3.6 Student success

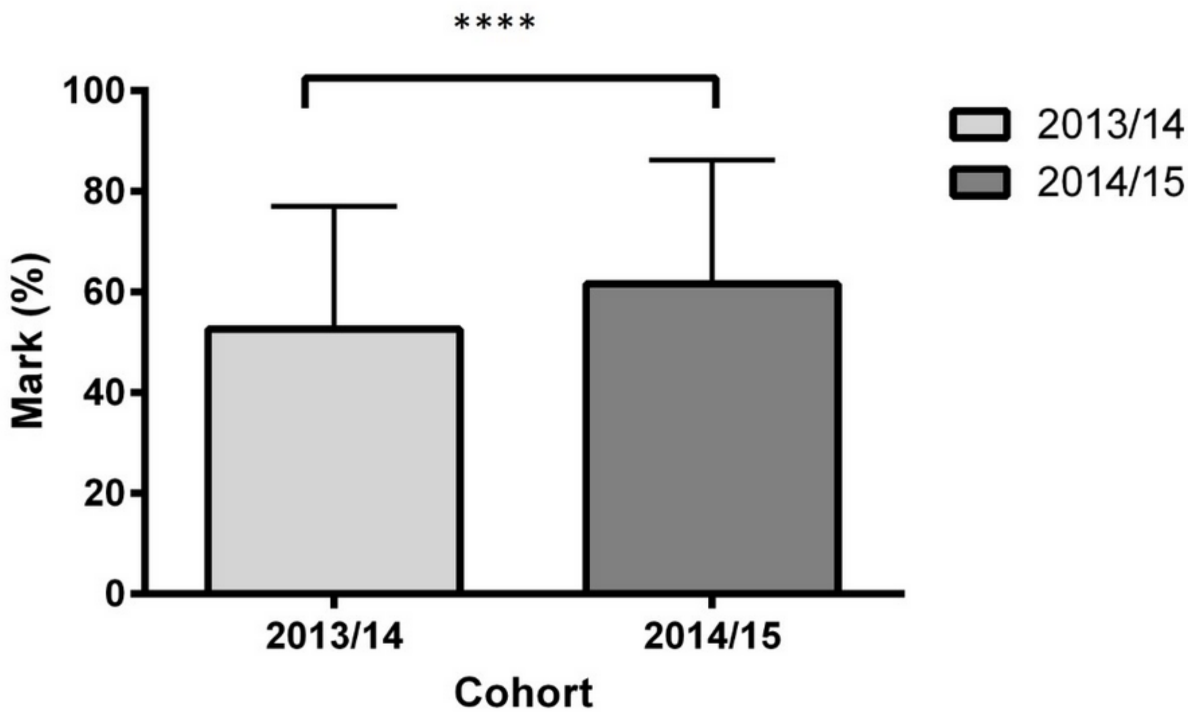

Figure 3.6.1: FSLS400 Level 4 Biochemistry and Molecular Biology; mean ± SD mark for the kinetics practical assessment (20% of the module). **** $P<0.0001$ when 2013/14 (n=478) is compared to 2014/15 (n=458) by unpaired students T-test.

Over a period of years a number of interventions have been made to support students in the development of their mathematical ability. This has had a significant ($p<0.001$) positive effect on the overall marks for the enzyme kinetics practical as can be seen in fig.3.6.1.

4 DISCUSSION

4.1 BENEFITS OF FORMATIVE SUPPORT

It is widely accepted that formative assessment is generally thought to have positive effects on learning (Yorke 2003), although there does seem to be considerable debate amongst teaching academics as to what formative assessment is and what it does. Formative assessments are, however, found by evaluation to be effective in developing all areas of the curriculum, including content to skills (Sadler, 1998; Black and Williams, 1988).

In this study we have utilized a formative program of activities to develop some of the numeracy skills essential for life sciences. Through a series of curricular and extracurricular activities we sought to engage the students and encourage the development of self-regulated learning practices through a structured series of curricular and extracurricular activities (Nicol, Macfarlane-Dick; 2006).

The very first requirement was that students displayed some insight into their strengths and weaknesses and undertook a self-assessment exercise to evaluate their numeracy skills. Student scoring below the threshold were recommended to attend the numeracy drop in sessions, which had a separate curriculum of their own. 26% of the students in this cohort took this test, which is disappointing. Attendance at the drop in sessions was also lower than anticipated, but as predicted, peaked around the time of the kinetics practical assessment in Biochemistry and Molecular Biology.

In addition to the drop in sessions, a series of online problems were provided and engagement with the online formative problems was measured through views of the YouTube videos. The average view number is 116 for each for the 12 videos, while for some the number was as high as 320. Unlike the self-assessment test and numeracy drop in it is difficult to estimate the number of students, who used this resource as the system records all views not only unique views. However, this resource sparked the most conversation between staff and students, who reported that the videos were of a great help. It is possible to tentatively suggest that this is an effective method of communicating with students, if not necessarily concluding that the student have learned effectively.

The material presented online fed directly into the timetabled, curricular tutorial session, in which the numeracy skills directly required for assessment were introduced. Attendance at these sessions was mixed, but was no less than 75%. Students reported mixed feelings about the tutorials, with some wanting more and some wanting fewer. The high attendance may be attributable to the direct linkage with assessment, or it may have been because they are held early in semester 1.

4.2 STUDENT SUCCESS

Over the course of three consecutive academic years, there has been a step wise improvement in the average score for the enzyme kinetics practical component of the Biochemistry and Molecular Biology module at level 4 ($p<0.001$). This would suggest that there has been an overall improvement in the learning achieved by the students on this module.

It is difficult, however, to pinpoint the causal factor, as two major variables are altered each year; the first and most obvious is the cohort of students taking the module, and the second is the teaching team, which varies slightly from year to year. In addition, alterations made in assessment briefing material and marking schemes may have contributed to this improvement. Despite this, it is clear from our work that the students found this work of help, and felt that it contributed positively to their learning.

5 CONCLUSION

It is a feature of formative material that a number of students will not engage, or engage late in the process, unless there is a mark attached (Rust, 2002). Indeed, our own assessment is that almost 90% of students reported that they were more likely to complete a piece of work if there are marks attached (data not shown).

The combination of curricular and extracurricular activities ensures that all students, regardless of their level of engagement, have an opportunity to undertake some formative training in the desired area. This does mean that the impact of the learning will be varied from student to student, but that students who are insightful and more aware of their weaknesses are provided a structured approach to work through their challenges. In addition, the mixture of online and classroom based activities ensures a level of equality between students who find it more difficult to attend drop in session due to outside commitments and those who are available. Teaching staff and students alike felt that this approach provided a positive learning experience for students and did not add excessively to the teaching burden of module staff.

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