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Research Article

The Use of Pre-Lectures in a University Biology Course — Eliminating the Need for Prerequisites

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Abstract

First year biology students at Flinders University with no prior biology background knowledge fail at almost twice the rate as those with a background. To remedy this discrepancy we enabled students to attend a weekly series of pre-lectures aimed at providing basic biological concepts, thereby removing the need for students to complete a prerequisite course. The overall failure rate of first year biology students was lowered and the gap between students with and without the background knowledge was significantly reduced. The overall effect of the implementation of pre-lectures was a more appropriate level of teaching for the first year students, neither too difficult for students without a prior biology background and no longer too easy (or repetitive) for students with high school level biology.

Keywords: Pre-lecture, prerequisite biology, student success, background knowledge

Introduction

Prerequisites have been found important in ensuring that students enrolled in a particular course are well equipped with the prior knowledge and skills for successful completion (Tai *et al.*, 2006; McCoy and Pierce, 2004; Buschena and Watts, 2001; Plutsky and Wilson, 2000). The most conclusive evidence for this comes from comparisons of success rates of students with and without prerequisites in higher-level courses. For example, Buschena and Watts (2001) compared the results of economics students with different backgrounds and found that students with the prerequisite achieved significantly higher grades than students without the prerequisite. McCoy and Pierce (2004) found that not only did students with prerequisites achieve higher grades but they were also less likely to withdraw from their courses. In addition, Dochy *et al.* (1992) found that up to 42% of the variation seen in student testing is directly due to variation in students' prior knowledge. It would then logically follow that universities would have set in place some form of prerequisite or way of standardising background knowledge to ensure that all students are given a more equal and consequently greater chance of academic success. It would also imply that teaching should be aimed at a more appropriate level without the need for repeating high school level material.

Science in particular is an area where context dependent learning is critical for understanding difficult conceptual material. Science learning and teaching tends to be organised in a hierarchical way and students need to have a reasonable understanding of background information to be able to progress to the next level of understanding. Without this step-wise learning, knowledge and skills learnt by abstraction or in other contexts may be used incorrectly in new contexts (Cobb and Bower, 1999). Students who lack experience are more likely to be left under-prepared for the academic activities they will be expected to complete. This is especially true for biology courses where understanding of the curriculum relies heavily on past learning. If all students have the same academic background, i.e., if everyone is 'on the same page' the instructor is able to progress at a desirable pace and cover more material at a more advanced level, thereby raising the calibre of the course, and maintaining a higher level of student engagement. A study from York University in Canada (2007), found that when

students have not completed the necessary prerequisites were in a class with those who had, it slowed down class progress and was found to be detrimental to group learning.

Before demanding the implementation of prerequisites on all university courses, however, it is necessary to consider the effects that might ensue, including limiting student access which could result in financial loss for universities. In order to attract students into the sciences and to ensure they finish their degrees in an appropriate time period, most Australian universities have done away with biology prerequisites for first year students. Many students, especially those attempting perfect university entrance scores (i.e. potential medical students) do not have the biology background they need at the start of their university courses. Therefore, a need exists to create and implement pedagogical initiatives to correct the gap in students' knowledge, without demanding a prerequisite background or bringing down the level of instruction. A programme that will bring students without a background up to the appropriate level will also ensure that students with a background in the subject area are not bored by a rehashing of known material. In this way, both groups of students will benefit. In addition, confidence levels should increase in the group of students without the background, thereby increasing the probability that they will pass the course and be retained within the degree program.

However valuable a background in high school biology might be to university science students, we must also bear in mind that not all prerequisite courses are created equal. For example, Tai *et al.* (2006) found that classroom practices between different high schools can greatly influence student outcomes. In addition, many students now arrive at university having a gap of one, two or many years since attending high school, which means that, regardless of their background, all students should be entitled to attend programmes that will have an equalising potential. In this way the programme will not be seen as remedial so will not have those associated negative connotations. Interestingly, Born *et al.* (2002) have shown that remedial programmes do not necessarily have the desired effect of building student knowledge and confidence.

To correct this knowledge deficiency we have designed a programme with the potential to benefit all students and yet not be an excessive burden on lecturing staff. In addition, by fitting this programme within the teaching schedule of the course, students would be more likely to attend the sessions and to retain the knowledge gained. The programme aimed to provide for an easier transition for students without appropriate backgrounds and to even out any disparity that exists between students, as well as to elevate the level of teaching and learning in a first year biology course.

Pre-Lecture Preparations

Various programmes have been trialled and implemented within introductory biology courses in an attempt to improve students' academic performance and to bridge the gap between those with different background knowledge. Methods such as supplemental instruction (Shaya *et al.*, 1993), resource seminars (Minchella *et al.*, 2002), compulsory class attendance (Moore 2003), intensive orientation programmes (Wischusen and Wischusen, 2007) and bridging courses (University of Sydney, Australia, personal observation) all have had varying success. Interestingly, these programmes are seen to be remedial in nature and have not been effective at increasing participation in the sciences or encouraging persistence (Born *et al.*, 2002). Steele (1997) found that interventions designed to be more academically challenging rather than remedial were more likely to improve student performance. We found that students at Flinders University when given opportunity to complete non-graded remedial activities were unlikely to take advantage of the learning opportunity and typically, only the most highly motivated students, who were generally the high academic achievers, took advantage of the additional material. Under these conditions withdrawal and failure rate remained high.

In an attempt to allure all students into gaining useful knowledge the pre-lecture concept was introduced. We designed an extra lecture to be given at the beginning of each week to be aimed at filling the knowledge gaps and to prepare students with the essentials for understanding subsequent lectures which would be delivered at the first year level. All students were encouraged to attend these lectures, particularly those without a background in biology or if they were unable to define a list of terms given to them in advance of the week's lectures. For those students without the prerequisite knowledge the pre-lecture series prepares them for subsequent lectures, while allowing them to complete the more challenging sections of the course. For students with the prerequisite, the pre-lecture series served as a refresher to revise material they had previously covered but may not have understood fully. For all students the prelecture was seen as a confidence builder and allowed students to attend the standard lectures with more ease. Refer to Appendix 1 for an outline of a pre-lecture. In this way students could use a constructivist approach to actively build new ideas or concepts based upon current and past knowledge (Huitt, 2003). Through this initiative, a transition programme was developed to reduce the effect of background knowledge, to give students the support and confidence they required to fully engage in a first year science course and to consequently achieve a higher level of understanding in the course.

Results

Between 2000-2007, the first year biology topic BIOL1102: *The Molecular Basis of Life*, at Flinders University, had approximately 500 students enrolled each year from 36 different degree programs. International students were not included in the analysis as background experience could not be ascertained. BIOL1102 was selected to trial pre-lectures due to the large class size. On average during each year 48.3% of students enrolled did not have the relevant background knowledge, SACE (South Australian Certificate of Education) biology. Analysis of data from 2000-2005 found that student backgrounds do effect their results in BIOL1102. Students without the prior background knowledge (a total of 1287 students) failed the course at almost twice the rate as those students who completed SACE biology (a total of 1376 students), on average 19.05% compared to 11.99% respectively (t=-5.33, p<0.001, n=2166, Figure 1). In particular, first year students failed the final exam at an alarming rate of 35% and withdrew from the course at a rate of 21.9%.

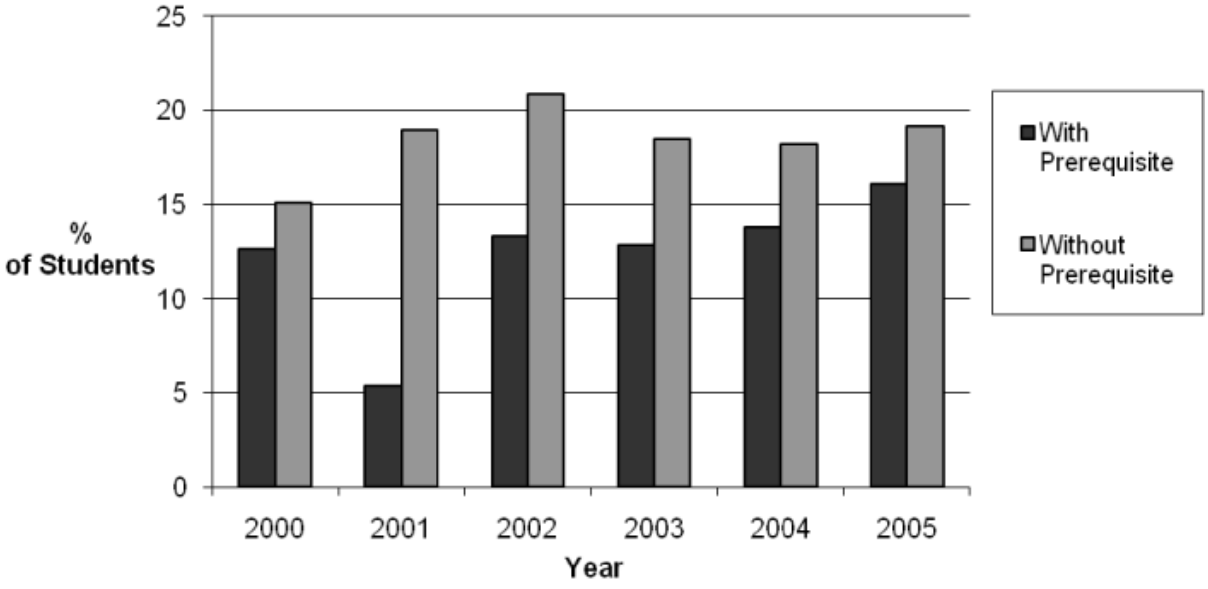

Figure 1 *Rate of failure for students with and without prerequisite, 2000-2005 at Flinders University of South Australia*

Students were surveyed in 2005 (n = 345), prior to the implementation of changes to the course, and found that 67% of students who had completed SACE biology found the topic either too easy or at the appropriate level while 63% of students who had not completed SACE biology found the topic too difficult. At the same time students who had completed SACE biology consistently complained that they found the topic boring and repetitive, indicating that the level of instruction was hitting the middle ground and neither group of students were satisfied. Refer to Appendix 2 for the survey questions.

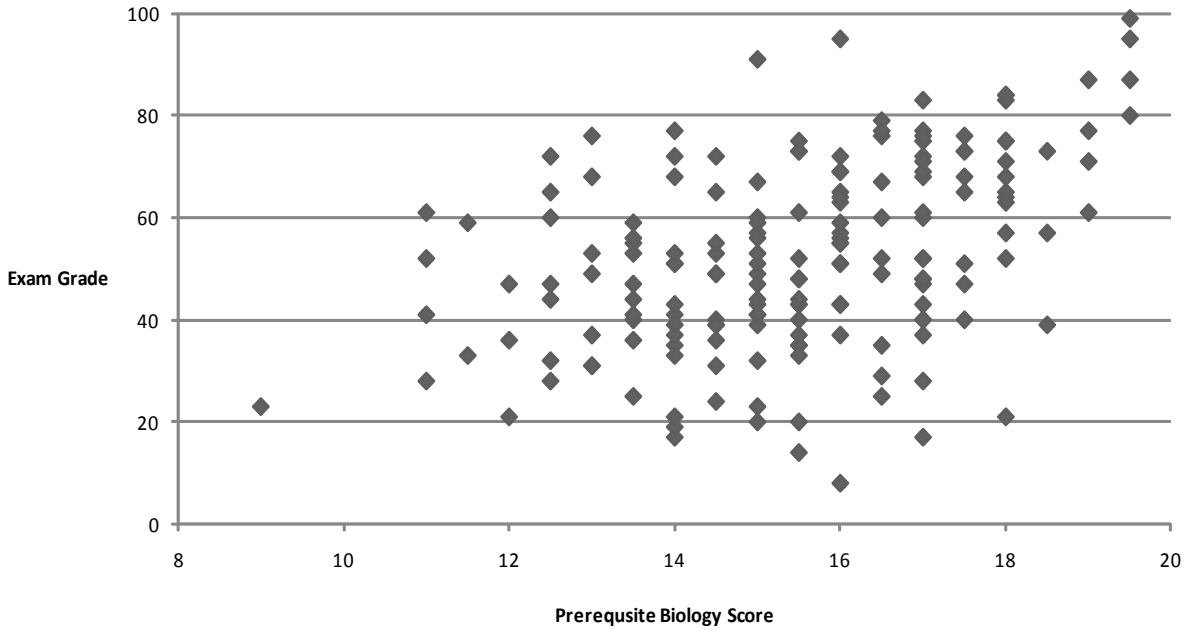

Figure 2 *Prerequisite biology score versus BIOL1102 final exam grade*

In addition, students with a background in SACE biology and who had achieved high grades were found to do better in their first year biology university course than students who achieved lower grades in SACE biology. However, the correlation between the grade students received for their SACE biology course and their university biology exam grade was weak (r^2 = 0.18, p<0.01, Figure 2), indicating that having a biology background can help at university but does not equally prepare students for first year.

After the Change

After the introduction of pre-lectures into BIOL1102 in 2006 we found a pronounced effect on students without a background in biology. Data for 2006 and 2007 were combined. No significant difference was found in the failure rates of students with or without a biology background (t = 12.71, p > 0.05) after the change was introduced. Additionally the failure rates were reduced across both groups of students and withdrawal rate dropped to only 7% in 2008.

Table 1 *Mean exam grade achieved by students attending pre-lectures*

	Pre-Lecture attendance			
	1-3 times	4-6 times	7-9 times	10-12 times
n	74	30	32	10
Mean	63.6	67.5	68.2	72.5
Std. Deviation	16.9	13.9	14.9	14.3
1-3 times	-	3.9	4.6	8.9
4-6 times	-	-	0.7	5.0
7-9 times	-	-	-	4.3

Pre-lecture attendance was found to have a strong influence on the grade students obtained in their final exam. We allocated the data into four groups, attendance at 1-3 pre-lectures, 4-6, 7-9 and 10-13 pre-lectures and as seen in Table 1, the more pre-lectures students attended the greater on average the higher their exam grade.

What do the Students Think?

Compared with students in 2005 (*n* = 345), students surveyed in 2006 (*n* = 360) using a likert-type scale (appendix 2) had changed their perception of the level of difficulty of BIOL1102. There was an decrease in the proportion of students without SACE biology (62.8% vs 53.9%) responding that the difficulty level was 'too hard' and a decrease in the number of students with SACE biology (13.4% vs. 5.17%) that responded that the difficulty level of the course was 'too easy'.

An analysis of the responses from students attending the pre-lectures indicates that students ranked pre-lectures as highly important to contributing to their success in passing the course, second only to the normal lecture series.

What did academic staff think?

Six lecturers were involved in teaching of the course in 2006, all of which were involved in the course previously. All lecturers were required to prepare a weekly pre-lecture, which covered SACE biology material, and to update lecture material which would not focus on, nor repeat SACE biology material. We found that the introduction of pre-lectures did not substantially increase lecturer work load, but helped them define the level of instruction.

Discussion

The opportunity to introduce or review material prior to a series of lectures allows students to prepare for, engage with and feel more confident when attending standard lectures delivered at the first year level. Providing students with this opportunity enables them to be more receptive to new information, to build onto and relate new concepts to established knowledge. Through the introduction of pre-lectures student learning and understanding of difficult material has increased and students are more likely to stay enrolled in and pass difficult science topics, especially those without prerequisites. This method not only allows for a greater understanding of course concepts but also allows the course to be taught at a level appropriate for both groups of students. It also ensures that students will be more prepared for understanding second year material. The combined effect allowed for more students to be engaged with course material, with fewer students commenting that they were bored and fewer students withdrawing from and failing the course.

A pre-lecture programme similar to the one we implemented was introduced to general chemistry students, made up of first year students who lacked previous chemistry background (Sirhan *et al.*, 1999; Sirhan and Reid, 2001). Here the pre-lecture is described as '*an activity carried out before a block of lectures, designed to ensure that the essential background knowledge is established and is accessible so that new learning can be built up on a sound foundation*' (Sirhan and Reid, 2001). By using this type of intervention students who lack the prior knowledge are brought up to speed by introducing them to the essential information and understanding required for new learning to take place. By providing this type of background information it is less likely that the course material will be 'dumbed down' for students to understand it. In this course, as in others, prior to the intervention, there was a significant difference in the grades received between students with established prior knowledge in the course and those without (McCoy and Pierce, 2004; Sirhan *et al.*, 1999; Sirhan and Reid, 2001).

The results presented in this current study provide a potential alternative to implementing compulsory prerequisites to enable students from all backgrounds to achieve well in their course and to proceed through their degree at the same rate as their contemporaries. In the past many researchers have attempted to correct such discrepancies in the success rate of students with and without background knowledge (Shaya *et al.*, 1993; Minchella *et al.*, 2002; Moore, 2003; Wischusen and Wischusen, 2007; McCoy and Pierce, 2004; Sirhan *et al.*, 1999; Sirhan and Reid, 2001) with varying levels of success. The ability of the pre-lecture to be easily incorporated into most curricula makes it an attractive and inexpensive option for lecturers hoping to improve academic performance amongst students with various backgrounds.

The pre-lecture also enables students from a variety of backgrounds to be brought together and to be taught at the same level where otherwise students may be on an unequal footing. By allowing students to be taught at an appropriate first year level, rather than attempting to cater for all students and ultimately catering for very few, the pre-lecture can increase the overall level of instruction. This inexpensive and effective addition to a first year course enables more students to successfully complete the course and importantly, to continue their education in science. With fewer students enrolling in science based degree programs, implementing a small change in first year can lead to an increase in enrolment of students in subsequent year levels, with the overall result of higher completion of science degrees.

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