# HOW PROPORTIONING MARKS AFFECTS THE PERFORMANCE OF ALLIED HEALTH STUDENTS IN A PHARMACOLOGY COURSE

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## ABSTRACT

Students have higher marks in programs with a higher, rather than lower, proportion of marks allocated to ongoing assessment. There has been little attention to how the allocation of marks affects the academic performance of students in courses. One study of students in a nursing program in a pharmacology course has shown that (i) marks were much higher for ongoing assessment than examinations, (ii) there were weak relationships between marks obtained in examination and ongoing assessment, and (iii) modelling increasing the marks allocated to examinations dramatically decreased the number of students who would have passed the course. The aim of this study was to determine whether these findings extended to other allied health (paramedicine, optometry) students in the same pharmacology course. Findings were similar for the students in the paramedicine and optometry programs. Although the general trends were similar between the students in the paramedicine/optometry programs and nursing students, there were quantitative differences. For the students in the paramedicine and optometry programs, the marks are higher, there are better correlations for the marks between exams and ongoing assessment, and increasing the marks allocated to exams has a lesser effect on the pass/fail rates than for the students in the nursing program.

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## INTRODUCTION

Historically, exams, where students have no prior access to the exam, were the most common way to determine academic performance for students. However, over the last 40 years, exams with prior access, and open book or semi open exams, have been introduced. Also, ongoing assessment (coursework) has been introduced into many degrees, and most courses have become a mixture of exams and ongoing assessment. Presently, in exams, multiple choice questions (MCQs) are often used to test the assimilation of knowledge and short answer questions (SAQs) may be used to test authentic learning (Vanderbilt, Feldman, & Wood, 2013). Exams ensure that the students complete the work themselves. However, when there are time pressures, exams may not allow academic excellence, whereas ongoing assessment can be used to teach as well as test (Richardson, 2012).

There is evidence that the marks for ongoing assessment are higher than for exams, and this has various consequences. Across UK universities, in the programs with higher proportions of ongoing assessment, students had higher overall marks, and consequently are awarded higher classes in degrees, than those with a lower proportion of ongoing assessment (Chansarkar & Raut-Roy, 1987; Gibbs & Lucas, 1997; Bridges, et al., 2002). This also applies to students in biology/molecular sciences having higher marks in courses with 100% ongoing assessment i.e., no exams, compared to courses with mixed assessment (Simonite, 2003).

There are no national rules applied to universities about the proportional allocation of marks for ongoing assessment and exams. For accredited programs, there may be rules about the allocation of marks, and within universities, there may be broad rules about the allocation of marks e.g., no more than 50% of marks to be allocated to exams. However, for individual courses, the detail of the allocation of marks is often left to the course coordinator and can be made on a seemingly arbitrary basis and not justified. In second-year pharmacology courses for allied health students at Australian universities, marks for exams/summative tests vary from 40-80% for students in nursing programs (Doggrell, 2020) and from 45-75% for students in paramedicine: 45% exams, 55% ongoing assessment (Australian Catholic University); 70% online quizzes and tests/exams (Central Queensland University, University of Southern Queensland) 75% summative test and exam 25% ongoing assessment (La Trobe University).

For optometry/vision science students, there is no information available on the web regarding proportional allocation of marks for ongoing assessment and exams from Australian universities, but the information is available for one UK university, and was 100% for exams (The University of Manchester).

There are few studies of the consequences of proportioning marks between exams and ongoing assessment in individual courses. A recent study of nursing students in a second-year pharmacology course showed (i) marks are higher for ongoing assessment than examinations, (ii) there are weak relationships between marks obtained in examination and ongoing assessment, and (iii) increasing the marks allocated to examinations dramatically decreased the number of students who would have passed the course, whereas decreasing the examination marks increased the number of students passing (Doggrell, 2020). It is not known whether these results are similar for other allied health students studying the same pharmacology course.

The second-year pharmacology course referred to in Doggrell (2020), was also studied by students in the paramedicine and vision science/optometry programs, and the following questions, hypotheses and objectives were addressed in the current study:

1. Do students have higher marks in ongoing assessment than exams? The hypothesis was that, as the nursing students in the course had higher marks in ongoing assessment, the paramedicine/optometry students would too. The objective was to compare the academic performance of students in ongoing assessment and the exams.
2. Do marks in ongoing assessment predict marks in the exams? As there was a weak relationship between the ongoing assessment and exam marks for nursing students, the hypothesis was that there would also be a relationship for the paramedicine/optometry students. The objective was to determine whether performance in ongoing assessment was a predictor of performance in the exams.
3. Does allocating higher proportions of marks to the exams decrease pass rates? The objective was to consider how proportioning marks, between ongoing assessment and the exam, affected the overall marks and pass rates for the completing students.

The final objective was to discuss any differences between the results for the students in the paramedicine and optometry programs and those previously reported for the students in the nursing program in the same pharmacology course.

## METHODS

This study was of a second-year pharmacology course at Queensland University of Technology, taught between 2009 to 2016. The first part of the course was of principles of pharmacology and the second part was of systematic pharmacology. The allocation of marks is given in Table 1.

**Table 1. Allocation of marks**

| **60% Exams** with no prior access | | | **40% Ongoing assessment** | | |
|---|---|---|---|---|---|
| 25% Mid-semester exam | | 35% Final exam | 20% Tutorials | | 20% Assignment |
| 20% MCQs | 5% SAQs | 35% MCQs | 10% Worksheet | 10% Group | Case study |

The tutorials were both formative and summative and were held weekly in classes of 25 students divided into groups of 5. Prior to the tutorials, the students were given a worksheet, which related to the lecture content for the week before the tutorial. Half of the tutorial marks were given for the completed worksheet, marked at the tutorial. The worksheet preparation was unsupervised and could be undertaken alone or in groups. The other half of the tutorial marks was a group mark for performance at the tutorial, which included questioning by the tutor of individuals and the group about the content of the student preparation. The second part of the ongoing assessment was a summative written case-study assignment undertaken by individuals outside of class. This case study was of a subject with essential hypertension and either angina for the paramedicine program or ocular hypertension for the optometry program. The case study was a series of questions requiring short/essay answers.

From the paramedicine and optometry programs, there were 117 and 60 students enrolled, and 114 and 59 completed, respectively. One student in the paramedicine program did not complete the assignment or the exams, and two did not complete the final exam. Five students of paramedicine failed, including the three who did not complete, and two who completed but failed with marks of 44% and 47%. One student in the optometry program did not complete an assignment. The two students of optometry who failed the course included the student who did not complete, and another who completed but failed (47%). Data analysis is for the completing students.

The author was the coordinator of the course, and as such had access to the Microsoft Excel sheets and the marks associated with the course. The study was started after the completion of the course, including release of final marks to students. Ethical approval was obtained for this project from the Human Research Ethics Committee at Queensland University of Technology; Ethics Approval Number 1900000541.

*Data analysis for objective 1: comparing academic performance in ongoing assessment and for the exams.*
The marks for the ongoing assessment (tutorials, assignment, and combined) and for the exams (mid-semester, final, and combined) were totalled. The totals were expressed as a percentage, and then the percentages were averaged. The percentages for individuals in the exams and ongoing assessment were compared by Students paired t-test. Mean values ± SD were also determined. Students who received < 50% for a component were considered to have failed that component and failure rates for exams and laboratories were compared by Odds-ratio using the online Odds ratio calculator; https://www.medcalc.org/calc/odds_ratio.php.

*Data analysis for objective 2: regression analysis to determine whether performance in ongoing assessment was a predictor of performance in the exam.*
To determine Pearson's correlation and significance, regression analysis was undertaken using the data analysis function in Microsoft Excel. Coefficients of 0 - 0.19 were considered very weak, 0.2 – 0.39 weak, 0.4 – 0.59 moderate, 0.6 - 0.79 strong, 0.8 – 1.0 very strong: http://www.statstutor.ac.uk/resources/uploaded/pearsons.pdf . The marks for individual students in the exams were also plotted against their marks in ongoing assessment. The equation for the regression line ($y = ax + b$), where 'a' is the slope of the line, and the $R^2$ values are also given. In regression, the $R^2$ coefficient of determination is a statistical measure of how well the regression line approximates the real data points, with an $R^2$ of 1 indicating the regression line perfectly fits the data.

*Data analysis for objective 3: how proportioning marks, between ongoing assessment and the exam, affected the overall marks and pass rates for the passing and failing students.*
For all the students who completed the course (i.e., successful and failing students), modelling was undertaken to determine the effect of changing the marking proportions from 40% ongoing assessment/60% exams had on the pass/failure rates and overall grades. The proportions modelled were changed to (i) 60% for ongoing assessment and 40% for exam, (ii) 80% ongoing/20% exam, (iii) 80% ongoing/20% exam, (iv) 100% ongoing/0% examination (v) 20% ongoing /80% exam, and (v) 0% ongoing/100% examination. Thus, to change from mark out of 40% to mark out of 60%, the mark was divided by 40, and multiplied by 60. Mean values ± SD were determined. Students who achieved less than 50% in the ongoing assessment or the exam were considered to have failed that component for both the actual and modelled data.

## RESULTS

*Comparison of marks for examinations and ongoing assessment for completing students.*
The overall mark for the completing students in the pharmacology course in 2015 in the paramedicine and optometry programs were similar: 70 ± 12 (114) and 69 ± 10 (59), mean ± SD (number of students) respectively. The marks were also similar for each component of the course except for the final exam, in which the students in the paramedicine program had higher marks than those in the optometry program (Table 2).

The marks for the students in both programs were higher for ongoing assessment than the combined exams (Table 2). Students in the paramedicine program had similar marks in both exams whereas the

students in the optometry program had higher marks in the mid-semester than final exam (Table 2). For the ongoing assessment, the tutorial marks were much higher than the assignment marks (Table 2).

**Table 2. Percentage marks for ongoing assessment and examinations**

| **Paramedicine, n = 114** | | | **Optometry, n = 59** | | **Paramedicine vs Optometry** |
|---|---|---|---|---|---|
| **Academic outcome** | **% Mark** | **Paired t-test** | **% Mark** | **Paired t-test** | **Unpaired t-test** |
| **Combined exams** | 68 ± 13 | P < 0.0001 | 64 ± 13 | P < 0.0001 | P = 0.058 |
| **Ongoing assessment** | 75 ± 11 | | 78 ± 10 | | P = 0.115 |
| **Mid-semester exam** | 69 ± 12 | P = 0.274 | 70 ± 11 | P < 0.0001 | P = 0.510 |
| **Final exam** | 67 ± 16 | | 59 ± 17 | | P = 0.002 |
| **Tutorials** | 85 ± 14 | P < 0.0001 | 89 ± 12 | P < 0.0001 | P = 0.141 |
| **Assignment** | 65 ± 15 | | 67 ± 17 | | P = 0.342 |

Each % Mark is the mean ± SD.
Unpaired t-test is between students in the paramedicine and optometry programs.

*Failure rates for completing students.*
For the completing students, the failure rates were similar for students in the paramedicine and optometry programs: 2.5% vs 1.7%, respectively. Some of the students failed the individual components by obtaining < 50% (Table 3). More optometry students failed the final exam than paramedicine students (Table 3). For both students in paramedicine and optometry, the failure rates were higher for the combined exams than ongoing assessment, final exam than mid-semester exam, and for the assignment than tutorials (Table 3).

**Table 3. Failure rates for examinations and ongoing assessment**

| | **Paramedicine, n = 114** | | **Optometry, n = 59** | | **Paramedic vs optometry** |
|---|---|---|---|---|---|
| **Academic outcome** | **Failure number (rate)** | **P value from Odds ratio** | **Failure number (rate)** | **P value from Odds ratio** | **P value from Odds ratio** |
| **Combined exams** | 9 (7.9%) | P = 0.090 | 9 (15.3%) | P = 0.029 | 0.126 |
| **Ongoing assessment** | 3 (2.6%) | | 1 (1.7%) | | 0.653 |
| **Mid-semester exam** | 7 (6.1%) | P = 0.024 | 2 (3.4%) | P = 0.042 | 0.519 |
| **Final exam** | 18 (15.7%) | | 18 (30.5%) | | 0.014 |
| **Tutorials** | 1 (0.9%) | P = 0.006 | 1 (1.7%) | P = 0.199 | 0.495 |
| **Assignment** | 15 (13.2%) | | 4 (6.8%) | | 0.163 |

*Regression analysis and Pearson's correlation coefficients for completing students*
Regression analysis was undertaken to determine whether performance in ongoing assessment was a good predictor of performance in the exams. A good correlation would be indicated by both a slope of ~1 and $R^2$ values of ~1. For the analysis of exam mark vs laboratory skills, slopes indicated a moderate fit, as the slope and $R^2$ value were 0.63 and 0.69 for students in paramedicine and optometry, respectively (Figure 1), presumably because the marks for the ongoing assessment were much higher than for the exams.

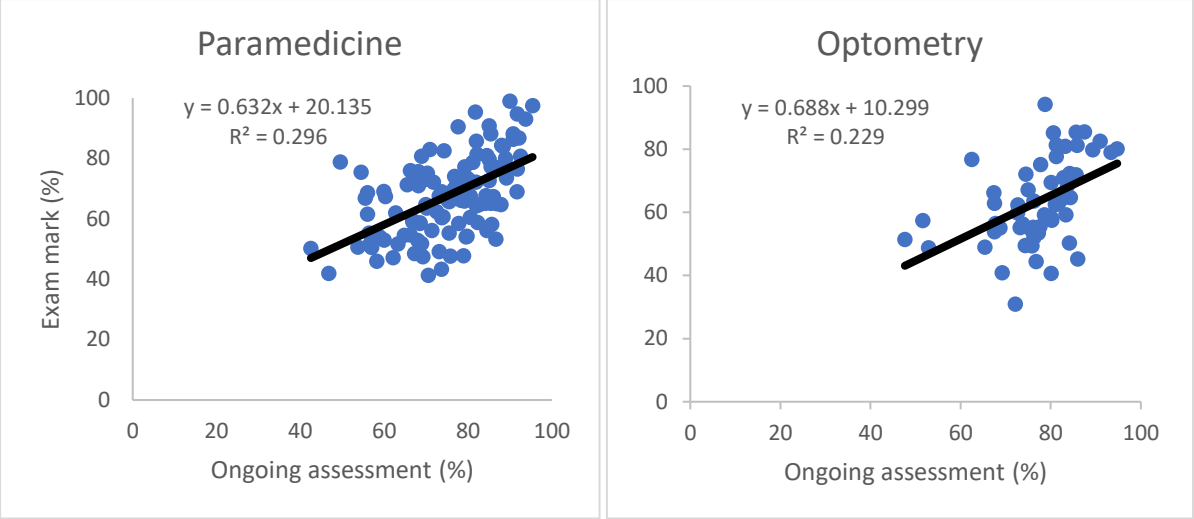


**Figure 1. Regression analysis of combined examination marks vs ongoing assessment marks for completing students of paramedicine (left) and optometry (right) in a pharmacology course.**

Regression analysis showed a moderate correlation between the marks for the examinations and the ongoing assessment, and a weak-to-moderate correlation between exams and the tutorials or the assignment for both students of paramedicine and optometry (Table 4).

**Table 4. Linear regression analysis of exams vs ongoing assessment**

| | **Exams vs ongoing assessment** | | **Exams vs tutorials** | | **Exams vs assignment** | |
|---|---|---|---|---|---|---|
| | Paramedicine | Optometry | Paramedicine | Optometry | Paramedicine | Optometry |
| **Slopes** | 0.632 | 0.688 | 0.327 | 0.327 | 0.488 | 0.325 |
| **$R^2$ values** | 0.296 | 0.229 | 0.124 | 0.083 | 0.249 | 0.134 |
| **Pearson's coefficient** | 0.544 | 0.478 | 0.399 | 0.423 | 0.363 | 0.387 |
| **P values** | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.003 |

*Modelling changing the proportional allocation of marks between ongoing assessment and exams.*
The passing rate for both the students in paramedicine and optometry was high (98%), and modelling increasing the marks allocated to ongoing assessment did not affect the passing rate (Table 5). Conversely, modelling increasing the marks allocated to exams increased the failing rate to maxima of 9% and 15% for students in the paramedicine and optometry programs, respectively (Table 5).

**Table 5. Actual and modelled data of overall marks, grades, and passing/failing percentages**

| **% Assessment /% exams** | **Data type** | **Overall mark** | **Grade** | **Additional students** | | **Overall mark** | **Grade** | **Additional students** | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Passing (%)** | **Failing (%)** | | | **Passing (%)** | **Failing (%)** |
| | | **Paramedicine, number of students = 114** | | | | **Optometry, number of students = 59** | | | |
| 100%/0% | Modelled | 75 ± 11 | 5.6 ± 1.0 | 0 (98%) | | 77 ± 11 | 5.8 ± 1.0 | 0 (98%) | |
| 80%/20% | Modelled | 74 ± 11 | 5.4 ± 1.0 | 0 (98%) | | 75 ± 9 | 5.5 ± 0.9 | 0 (98%) | |
| 60%/40% | Modelled | 72 ± 11 | 5.3 ± 1.0 | 0 (98%) | | 72 ± 9 | 5.3 ± 1.0 | 0 (98%) | |
| 40%/60% | Actual | 70 ± 13 | 5.1 ± 1.0 | (98%) | (2%) | 69 ± 10 | 5.0 ± 1.0 | (98%) | (2%) |
| 20%/80% | Modelled | 69 ± 12 | 5.0 ± 1.0 | | 3 (4%) | 66 ± 12 | 4.7 ± 1.0 | | 4 (9%) |
| 0%/100% | Modelled | 68 ± 13 | 4.9 ± 1.1 | | 5 (9%) | 63 ± 13 | 4.6 ± 1.1 | | 9 (15%) |

Each value is the mean ± SD.

## DISCUSSION

The findings were similar for the students in the paramedicine and vision science/optometry programs and were that (i) marks are higher for ongoing assessment than examinations and (ii) there are moderate relationships between marks obtained in examination and ongoing assessment in the course evaluated, and (iii) modelling increasing the marks allocated to examinations decreased the number of students who passed the course.

*Marks*

The overall marks for the students in the paramedicine and optometry programs were similar (this study) and higher than in the nursing program. The examination failure rates were also lower for the paramedicine and optometry than nursing programs (Doggrell, 2020). The most likely explanation for this is that the entrance requirements for the paramedicine and optometry programs are higher than for the nursing programs. If this is the case, it is surprising that the overall marks for paramedicine and optometry programs were similar, as the optometry program has a higher entrance requirement than the paramedicine program. The optometry students had lower marks in the final than mid-semester exam, and their marks in the final exam were also lower than those of the paramedicine students. One possible explanation for this may be that the optometry students had exam timetabling issues, giving them less time to prepare for the final exam than the paramedicine students had.

*Marks are higher for ongoing assessment than exams.*

This is the first study to show that marks for ongoing assessment are higher than for examinations for students of paramedicine and optometry in a pharmacology course. Similar findings have been made for nursing students in this pharmacology course (Doggrell, 2020), for science students in a bioscience course (Downs, 2006), and in programs (see Introduction). As discussed previously, the most likely reason for this disparity between marks in examinations and ongoing assessment is that the exam results represent those of the individual student, whereas the ongoing assessment marks may represent that of individuals or groups of students (Doggrell, 2020). In the present study, the tutorial mark of 20% is partly a group mark and is composed of 10% for unsupervised preparation/homework, which can be individual or group, and 10% for participation, which is a group mark. This makes it possible for the performance of weak students, and their marks in tutorials, to be artificially enhanced by better students in the group. The assignment component of the ongoing assessment (20%) should represent work undertaken by the individual student, but as this was unsupervised, there was nothing preventing students colluding, especially as text matching software was not used to detect this. Thus, the marking rigour and quality for individual students is lower in ongoing assessment than in exams, and this may have contributed to the higher marks for ongoing assessment.

*Marks in ongoing assessment are moderate predictors of marks in exams.*

This is the first study to show that marks in ongoing assessment are moderate predictors of marks in exams for students of paramedicine and optometry in a pharmacology course. This contrasts with the nursing students in this course, where ongoing assessment marks are only a weak predictor of marks in exams (Doggrell, 2020), and of marks in a research project assessment and the exam in a pharmacy course (Murdan, 2005). As the course being studied by the nursing, paramedicine and optometry students was the same, the difference cannot be related to the course, and must relate to the students. One possibility is that the students with the lowest entry requirements (nursing students) find exams challenging and rely more on obtaining good marks in ongoing assessment, and this needs to be assessed.

*Modelling altering the marks allocated to examinations changed the number of students who failed.*

The major finding of the modelling part of our study was to show that increasing the marks allocated to examinations would have decreased the number of students who passed the course in pharmacology, with 9-15% failing overall if all the marks had been allocated to the examination. In Australia, the allocation of marks for examination in pharmacology or pharmacology-related courses from paramedicine programs ranges in variable (45-75%). Thus, if the standard trend of there being higher marks in ongoing assessment than examination occurs in these courses, for the same marks in ongoing assessment and examinations, a smaller percentage of students enrolled at some of the universities (Central Queensland University, University of Southern Queensland, La Trobe University) where examination marks predominate, would have been successful.

A limitation to the modelling is that it does not necessarily reflect what would have happened in the course if the allocation of marks had been changed. Thus, if the marks for exams had been increased, the students may have changed their behaviour e.g., by allocating more time to these, and possibly increasing their exam marks.

*Implications of these results*

We have previously shown that first year nursing students rapidly lose their recall of bioscience, and less than half consider they have enough recall to handle further bioscience or pharmacology courses (Doggrell & Schaffer, 2016). This situation may have partly arisen from the allocation of marks. Thus, the concern is that the students in the pharmacology course, who pass the course based on marks from ongoing assessment, but not the examination components, may not have assimilated the necessary knowledge to continue their studies. Thus, the disparity between marks in examinations and ongoing assessment needs to be considered, and methods introduced to overcome this. One possible practical solution to this dilemma of whether students who pass ongoing assessment but fail examinations, should be allowed to pass courses and progress in their studies, would be to make it compulsory for the students to pass the examination component of the course. Another possible solution would be to limit how many marks could be proportioned to ongoing assessment to 20-30%, to limit the impact of the allocation of marks to ongoing assessment. This measure may improve the underlying knowledge of students, but even this would not guarantee that students have the recall of introductory courses necessary for higher-level courses later in their program.

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