Competency in units and measurement: Does it provide a good indicator of the performance of students in university first year Physics?

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Abstract. Units and measurements form an integral part of the Physics discipline. Competency in the conversion and manipulation of both fundamental and derived units is a key requirement to achieve success in both theoretical and practical components of Physics courses. In light of this imperative, an investigation into the performance of students in the handling of units in application-type questions and graphs as well as measurements in general, becomes relevant when considering the challenges facing the fit-for-purpose Physics modules in the Engineering and Health Sciences Faculties across the universities in South Africa. The results from this study point to the existence of a reliable correlation between the quality of the students entering the university, their competency with respect to units and measurements and their performance in theoretical and practical components of Physics courses.

1. Introduction

This inquiry primarily focused on the performance of students in Physics modules for the Diploma programmes in Chemical Engineering and Electrical Engineering in the Faculty of Engineering and Chiropractic and Homoeopathy in the Faculty of Health Sciences at the Doornfontein Campus of the University of Johannesburg. The admission criteria for these programmes are underpinned by the required academic point system (APS) scores as indicated in Table 1 below. The Physics modules for the programmes under consideration are more of an applied physics nature comprising tailor-made courses well-suited for the requirements of the programmes. The Physics modules make provision for both theory and practical components offered separately. The assessment for the theory part of the module is composed of semester tests and a summative semester examination. Continuous form of assessment is adopted for the practical module which requires a separate pass mark.

Table 1: Academic Point System (APS) scores for the three Faculties from which sample was drawn

Faculty	Qualification	Admission Point System Score
Health Sciences	Chiropractic Diploma	27
Health Sciences	Homoeopathy Diploma	27
Engineering	Chemical Engineering Diploma	24
Science	Analytical Chemistry Diploma	12

The competency of the students in units and measurements may be crucial for laying a solid foundation required to navigate other conceptual areas in Physics as a broad discipline. Students' competence in units and measurements was assessed by employing a designed diagnostic test covering specific relevant aspects depicted in Table 2 below.

Table 2: Aspects covered by the designed diagnostic test administered

Section A	Scientific notation
Section B	Elementary Conversions
Section C	Multiple conversions
Section D	Multiple conversions in dimensional formulae
Section E	Multiple conversions in graphical interpretations

As indicated earlier, the sample comprised students drawn from the Faculty of Engineering and the Faculty of Health Sciences and the breakdown is reflected in Table 3 below.

Table 3: Groups of students involved in this inquiry

Group 1	Electrical Engineering
Group 2	Chemical Engineering
Group 3	Chiropractic and Homoeopathy

The comparative performance of the three groups is provided in Figure 1 below. Students in Group 3 (Chiropractic and Homoeopathy) performed better than the Engineering Groups. The performance disparity seems to suggest that competence in the areas investigated appears to be a function of the set Faculty specific admission requirements. In terms of the required APS score, the admission criterion for the Faculty of Health Sciences is stringent as compared to the Faculty of Engineering and hence better quality students enrolling for Chiropractic and Homoeopathy. The nature of the students' performance based on the designed diagnostic test administered suggests the existence of the correlation between the APS scores and hence the quality of the students entering the qualification programme as well as their competence in units and measurements.

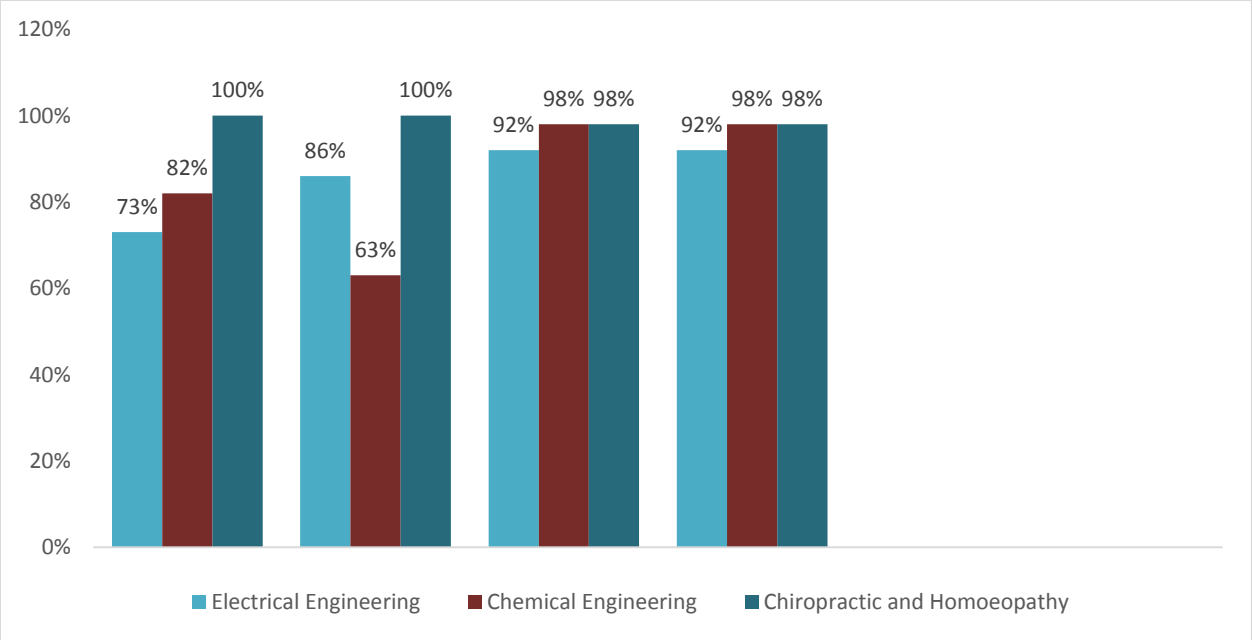

Figure 1: Comparative performance of the three groups

The overall academic performance seems to suggest that students benefited from the learning opportunities provided (Figure 2).

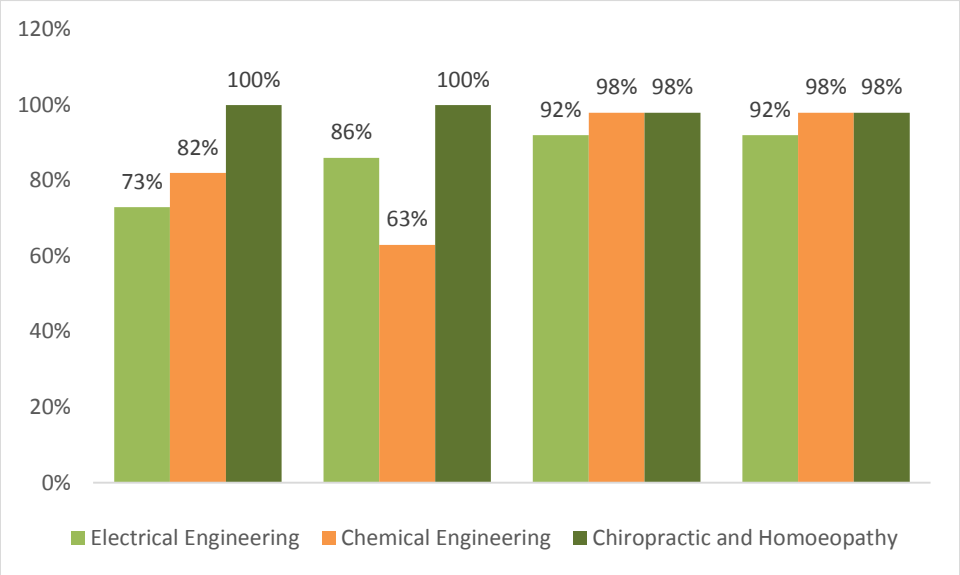

Figure 2: Comparison of academic performance

Comparative analysis in terms of the pass rates and throughput rates [Figure 3] appears to reaffirm the fact that students enrolled for Chiropractic and Homoeopathy programmes demonstrated satisfactory performance.

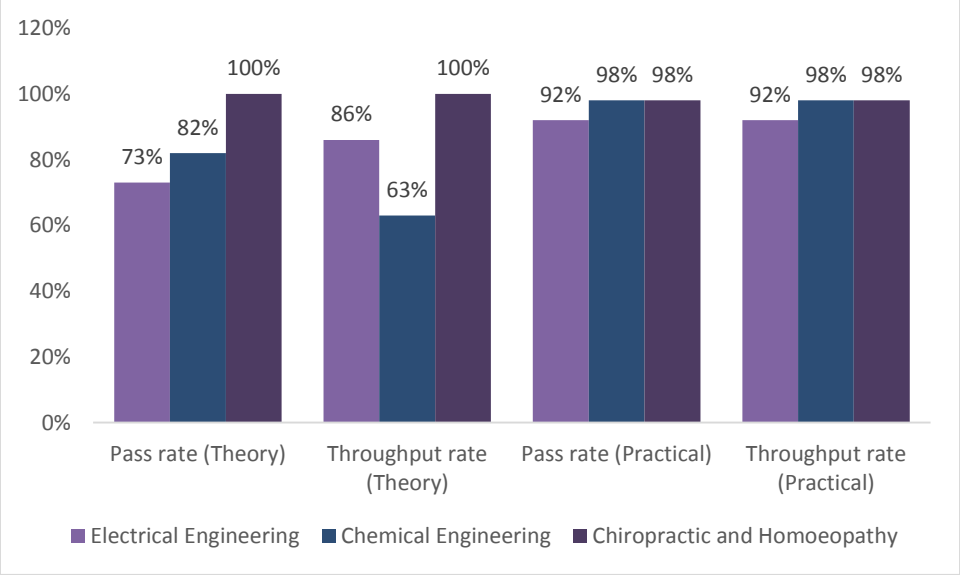

Figure 3: Comparison of pass rates and throughput rates

The pass rate is determined on the basis of the number of students undertaking the assessment while the throughput rate is based on the number of students initially enrolled for the specific module. The pass rate and the throughput rate for the practical component were evidently higher as compared to the theory component.

2. Discussion

Students in the three groups largely experienced difficulties when plotting graphs related to the experiments performed during their laboratory sessions. This inadequacy became evident when their experimental reports were evaluated. Yet, graphs play a highly significant role in providing visual means of presenting information that may be held in a functional relationship or a data set [1]. In addition, being too rigid with the prescription of graphical conventions for statistical data across the school years might stifle students' creativity in thinking of ways to tell the stories in their data sets [1]. The use of software applications to generate graphs is also accompanied by inherent difficulties for students although software applications are designed to enable students to visualize data to promote sense-making from the arrangement of information in space [1]. As an additional consideration, students have a tendency to use a spread of data and the measures of centre to compare data sets in later years of schooling but do not incorporate explicitly these notions with graph interpretation [2].

Within the context of this inquiry, other areas of difficulty for the students appeared to be multiple conversions and multiple conversions in dimensional formulae. These areas of difficulty require adequate attention for the sake of developing meaningful students' conceptual understanding as a key ingredient necessary for grappling with conceptual areas in Physics as well as solving application-type problems.

3. Conclusion

The overall academic performance in semester tests as well as the final examination projects a reasonable correlation with competency levels in units and measurements as the conceptual area under consideration. Competency levels in units and measurements is a crucial skill necessary to study Physics and its ramifications as a fundamental science and this skill also forms an integral part of the technical expertise required for the performance of key tasks such as the calibration of many instruments and equipments used in various scientific fields. In essence, this inquiry has endeavored to provide valuable insights into some of the essential students' competency levels which are critical to becoming rounded professionals in a scientific sense.

4. References

[1] Watson, J & Fitzallen, N. (2010). The Development of Graph Understanding in the Mathematics Curriculum: Report for the NSW Department of Education and Training. NSW Government.

[2] Australian Curriculum, Assessment and Reporting Authority. (2010). Draft Consultation 1.0 Mathematics. Canberra.