**Is Foundation Provision the solution to the first year students’ performance?**

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**Abstract:** An introduction of Foundation Provision Programme (FPP) in the physics content of first year physics at the University of Johannesburg (UJ) has shown an observable improvement in the performance of the students. It was observed that one of the major sources of difficulty experienced by students in understanding physics concepts were due to the lack of mathematical skills which are not fully developed as they exit Further Education and Training (FET) level. An introduction of the mathematical concepts within the physics content at the beginning of main physics syllabus at UJ for a four-year programme was observed to produce improved results. However, at the beginning of 2012 the content of the first section of FPP was introduced within the physics content as compared to what was done and reported in the previous year. This simultaneous assimilation of both physics and mathematical basic concepts was observed and analyzed and the recommendation of the better method is suggested based on the students’ performances in the first term of 2011 and 2012, respectively.

1. Introduction

Science, Engineering and Technology (SET) have become essential in the development of the country in all its facets. It has been observed over the past few years that students entering university for degree studies in their respective fields experience considerable level of difficulty. Inadequate understanding of basic mathematics and physics concepts has been identified as a critical deficiency characterizing the performance of SET first year university students. In an endeavour to bring a necessary intervention to the understanding of the basic concepts related to mathematics and physical science, a four year program at the UJ introduced topics that focus on the fundamentals of these courses. As it was identified in the previous years that in understanding physics, students lack basic mathematics, therefore the Foundation Provision Programme (FPP) was established in the year 2010 (Sondezi-Mhlungu, 2011). FPP tried to bridge the gaps between the high school basic concepts and those expected to be well understood when entering first year of university. In 2010, the first three months (term) of the first semester (first half of the year) was dedicated towards bringing about these necessary basic mathematical concepts and techniques needed in solving physics related problems. In 2011, the duration was increased from a term to a semester with an aim of increasing the performance of the students and the understanding of the physics concepts thereof. It was observed that the results did not show any significant difference, as they showed comparable averages of students' performances at the end of the semester. It was then decided that for the year 2012, FPP would be offered in a manner that the focus will be more on the physics topics. Basic mathematics was still offered in the context of physics. The pace was retained to be as slow as possible to allow simultaneous assimilation of both mathematics and physics concepts.

*Definition of phrases and terms*

***Semester Mark***: Contribution of all the assessment marks obtained by a students in one semester. This mark comprises of all assessments undertaken in a semester, that is, the combination of class tests, tutorial tests, homeworks and practical mark.

***Average Module Mark***: Final mark obtained after the contribution of the semester mark and the exam mark.

***Module Pass Rate***: This is the percentage obtained by considering the number of students who participated in a given examination. The total number of students passing the exam divided by the number of students allowed to write the exam, gives a pass rate of that particular group.

***Throughput***: This is the percentage of the number of students who passed the module divided by the total number of students who initially registered for the course.

1. Methodology

The four year degree program at UJ sees the enrolment of various groupings of students; ranging from pure BSc. students, BEng. students and BOptom. students. The physics FPP for 2012 covered basic mathematics concepts in physics contexts, that is, straight line graphs whereby these were taught in the context of graphs of motion, position versus time graphs, velocity versus time graphs and other associated concepts. Basic trigonometry was used in the context of understanding vectors and forces. Students were taught the technique of resolving vectors from the understanding of trigonometric ratios. Continuous assessment was monitored to establish their understanding and the build up towards the exam. Other topics covered in this module were motion in two dimension (building up from the understanding of one dimension, linear graphs and related concepts); Newton's laws; including the proper drawing of free-body diagrams; work and energy and impulse and momentum, waves and sound. After the implementation of these interventions in the four year degree program, a closer look at the performance of the students with the aim of assessing the program was undertaken. These observations of the students' performance in their first semester from 2010 to 2012 was looked at and the findings are listed in tables 1, 2 and 3.

1. Results and discussion

Table 1 contains the information regarding the overall picture of the students, from the students' intake into the module, the students allowed to write the exam, the module pass rate and throughput numbers of the module. The information in this table show that 90%, 89% and 95% of the students qualified to write the exam in the year 2010, 2011 and 2012, respectively. It is important to mention that a student at UJ, requires only 40% of the theory mark and 50% of the practical mark to be allowed into the exam. Table 2 lists the outcomes of the students' marks outputs as analysed from the students’ progress from the time of enrolment to the final exam written. Despite the fact that almost equal percentage of students qualified to write an exam in 2010 and 2011 (≈ 90%); we observe the difference in the exam pass rate (59% and 64% obtained in 2010 and 2011, respectively). This difference can be attributed to both the content and duration of FPP (one term in 2010 and a semester in 2011). This therefore suggests that, time for simulating the content learnt is of utmost importance for the proper learning of the content. Although the exam pass rate of students in 2012 is even much lower as compared to those obtained from two previous years, we still observe exactly the same throughput (67%) as obtained in 2011. This is an indication that, incorporating mathematics suitable for the understanding of Physics concepts was more relevant than to teach pure mathematical concepts away from Physics.

Table 1: Mark groupings of students' performances in the years 2010, 2011 and 2012.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **2010** | **2011** | **2012** |
| Students in module | 174 | 481 | 306 |
| Students admitted to the exam | 156 (90%) | 428 (89%) | 290 (95%) |
| Students refused admission to the exam | 18 (10%) | 53 (11%) | 16 (5%) |
| Students who attended exam | 155 (89%) | 418 (87%) | 269 (88%) |
| Number of absentees from exam | 1 (0.6%) | 10 (2.1%) | 21 (7%) |
| Students who passed exam | 92 (53%) | 268 (56 %) | 139 (5%) |
| Students who passed the module | 108 (62%) | 324 (67%) | 205 (67%) |

Table 2: Mark groupings of students' performances in the years 2010, 2011 and 2012; data represented in percentage.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **2010 (%)** | **2011 (%)** | **2012 (%)** |
| 1 | Average semester mark | 57 | 54 | 59 |
| 2 | Average final exam mark | 52 | 54 | 50 |
| 3 | Exam pass rate | 59 | 64 | 52 |
| 4 | Average module mark | 52 | 50 | 52 |
| 5 | Module pass rate | 70 | 78 | 76 |
| 6 | Throughput | 62 | 67 | 67 |

This consistency in the throughput (in 2011 and 2012) is as a result of the average semester mark of the year 2012 is 59%; which is a bit higher than those obtained from the other two years whilst keeping the exam mark comparable with those in the previous years. It is rather important to note that the module pass rate obtained from the years 2011 and 2012 is ≥ 70% (obtained in 2010) which is a good indication of the success of the program. The minimum of 70% obtained in 2010 as opposed to 78% and 76% obtained in 2011 and 2012, respectively, is achieved due to time spent in the program (term (2010) and semester (2011 and 2012)). The histogram in Figure 1, graphically represents these data and it is clear that there is a correlation between the duration of FPP (three months) and the performance of the students. The introduction of mathematical concepts within the physics context are presumed to be beneficial towards the understanding of the physics at this level. This is an indication that pure basic mathematics concepts (which initially involved pure algebra and basic trigonometry) are not a direct necessity in bringing the understanding of the physics concepts, but a strategy of incorporating necessary mathematics within the physics content are a necessary tools to tackle physics related problems. Despite the difference in the throughput and the module pass rate obtained in respective years, it is observed that the average final exam mark (≈ 52%) and average module mark (≈ 50%) are constant throughout this three year duration.



**Figure 1**: A histogram representing students’ marks distribution in percentages of the

total contribution towards students’ promotion, for 2010, 2011 and 2012, respectively.



**Figure 2**: A histogram representing students’ marks distribution for 2010, 2011 and 2012, respectively.

Table 3: Distribution of students' performance in the final examinations during the years 2010, 2011 and 2012; data represented in percentage.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **2010 (%)** | **2011 (%)** | **2012 (%)** |
| 1 | 0-19 | 9 | 11 | 5 |
| 2 | 20-29 | 2 | 2 | 7 |
| 3 | 30-39 | 10 | 4 | 2 |
| 4 | 40-49 | 17 | 16 | 20 |
| 5 | 50-59 | 21 | 36 | 37 |
| 6 | 60-69 | 25 | 24 | 24 |
| 7 | 70-79 | 14 | 6 | 7 |
| 8 | 80-89 | 2 | 0 | 0 |
| 9 | 90-100 | 0 | 0 | 0 |

It is of ultimate importance to determine the distribution of the final performance of the students in these years. A mark distribution of the performance of students at the end of the module; is listed in Table 3 and graphically represented in the form of a histogram in Figure 2.

The distribution of 2010 performance is seen to be more towards lower percentages as compared to the other two following years (2011 and 2012). Almost 38% of the students in 2010 obtained less than a pass mark (50%), 33% of these in 2011 and 34% of students got less than a pass mark in 2012. Although there is a significant difference in these percentages of the students passing the module, between the 2010 and (2011/2012) percentages, the average marks obtained in these years are almost similar (50%). This suggests that the average marks cannot be an accurate indicator of the performance of the students in terms of the module pass rate and the throughput.

1. Conclusion and Recommendations

The results across the two groups (2011 and 2012 groups) were very similar. These observations lead to the conclusion that students enrolling for Physics as part of their courses, need some basic mathematical skills. For Physics module(s), these skills must be incorporated within the course itself. This was established from the comparison of the 2011 and 2012 results. It was revealed that teaching mathematics outside the context of Physics does not give better results, instead the results are similar to the results where these concepts were learnt within the Physics concepts. This programme has revealed that students get a chance to assimilate necessary concepts over some time and they gain confidence in solving Physics related problems. The results obtained in 2010 indicates that the students’ performance is a bit lower due to the lack of the treatment of basic concepts which incorporate mathematical skills and Physics related problem solving skills. The time spent in making sure that students grasp these concepts is very important.

This study recommends that, some intervention be made early in the year and the amount of time allocated to understanding of basic mechanics concepts be increased because the mechanics concepts are the core in introductory first year physics. We hope that the recommendations will enhance maximum pass rate and throughput and hence more students will enrol for physics in the second semester of their first year.

1. Acknowledgements

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References

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