

# Physics foundation program: Implications for second year mainstream physics module.

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**Abstract.** There has been much concern about the university physics pass rates over the years. The huge gap between school and post-school education has placed universities under considerable pressure to in particular adapt undergraduate physics curricula in order to provide adequate mathematics foundation required to navigate the physics curricula. As a consequence of this dilemma, the duration of the three-year undergraduate physics program at the University of Johannesburg (UJ) was elevated to four years in order to make provision for additional tuition. This study examines the impact of physics foundation program on students' academic performance on their first encounter with physics mainstream curriculum at UJ by providing a comparative analysis of the performance of students from foundation program and their counterparts in the mainstream curriculum.

## 1. Introduction

Universities and higher education institutions are increasingly becoming aware of the importance and significance of the transition from high school to first year undergraduate study. Literature on the transition from high school to university suggest that strong academic background, achievement of good grades, and academic motivation are needed for students to persist in their engineering and physics major [1]. Besterfield-Scare *et al*, [2] has seen the first year as critical for both academic and retention of Science, Engineering and Technology (SET) students. This trend has also been widely observed within South African universities.

An increasing number of students pursuing studies in SET and relatively low first semester completion rates by students entering first year university studies is widely observed in South Africa (SA). At UJ the first semester of the first year of study is one of the major factors for early drop-out from university, since a pass in this semester is the pre-requisite to enroll for second semester. After the transformation of the education system over the past few years there has been significant changes in the throughput of the students in their first year of university studies. A closer look into the investigation of the number of SET graduates produced by South African universities was undertaken with the intention of identifying problem areas experienced by students as they enter universities. Amongst the identified challenges it was observed that the huge gap between the school and post school education has placed universities under considerable pressure to in particular adapt undergraduate physics curricula in order to provide adequate mathematics foundation required to navigate the physics curricula. An introduction of Foundation Provision Program (FPP, as described in [3]) served to adequately develop the foundational competencies necessary for students to embark on successful first year

studies and beyond. It is important to note that the first year physics course (PHY1), at UJ is achieved by the successful completion of physics 1A and physics 1B modules. At UJ the mainstream (3 year program) students complete their PHY1A in a semester whilst the extended (four year program) complete their PHY1A in three semesters. It must be mentioned that these groups are chosen based on their NSC APS scores (four year  $\approx$  50-59% and three year  $\geq$  60%). It is known that strong academic background, achievement of good grade, and academic motivation are needed for students to persist in their science studies. It is realized that if physics educators are to respond to country's call for an increased number of SET graduates, a large portion of that increase is likely to come from a more diverse range of students, including women, as well as students with lower entry-level qualifications in mathematics and physical science. It is also realized that while these students may initially struggle academically, they may well have the potential and motivation to make a significant contribution to the SET profession, provided appropriate academic and social support systems, remedial and "catch-up" courses are provided. It was previously reported by Sondezi-Mhlongu *et al*, [3], that students show great improvement in their performance after the introduction of FFP. This has resulted in researchers now being interested in these students particularly in their second semester of second year mainstream performance. Some of these students proceed to join their counter parts in first year mainstream in second semester of their second year of their academic year. At this level of study, they are taught electricity, magnetism, light and optics topics in the same class with mainstream students. This study aims to reveal that this FPP group of students continues to perform and merge the expected capabilities of their counterparts in mainstream and beyond their first year level of university studies.

### 1.1. Definition of phrases and terms

- **Semester Mark:** Contribution of all the assessment marks obtained by a students in one semester. This mark is comprised 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 over 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 over the total number of students who enrolled for the course at the beginning of the year.

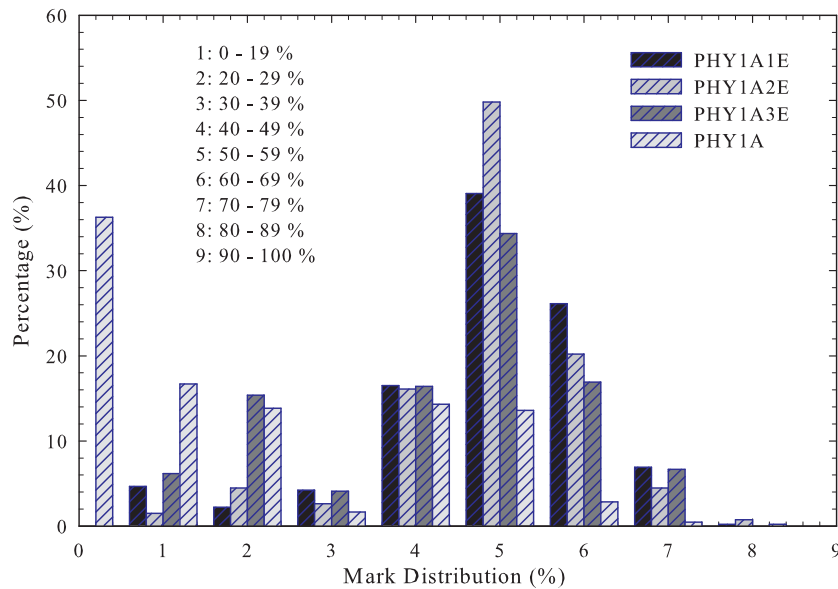
## 2. Methodology

The performance of mainstream students was looked at against the performance of extended degree program students by looking at two different sets of data which was taken over two years (from 2011 to 2012 academic year). The data collected in 2012 for mainstream students were the data of the students who registered in the same academic year whereby they undertook physics 1A in the first semester and proceeded to physics 1B in their second semester of their first year university experience. The data collected from physics 1A extended in 2011 and 2012 were taken from the students that registered for physics 1E, 2E 3E, after completing physics 1A extended in their first semester of their second year university experience. The data collected in the 2012 academic year were the data for the students that came from first year extended program (which lasted for three semesters) and those that came from the first year mainstream degree program. It is important to mention that these students were taught in the same class in

the second semester of 2012. The final results (average of the semester and examination marks, the pass rate and the throughput) of the respective groups were analysed and reported.

### 3. Results and Discussion

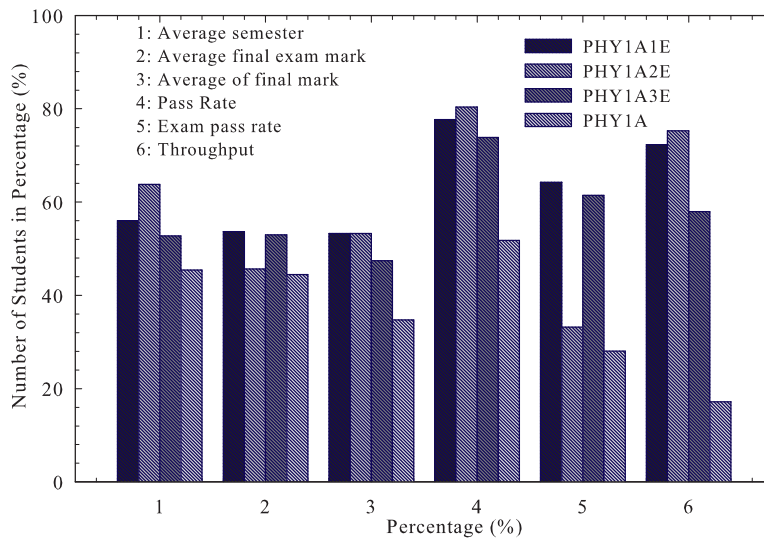
Figure 1 shows the histogram of the final marks performances of physics 1A1E, 2E, 3E and 1A for academic year 2011 and 2012, respectively. The histograms show both the results obtained from students belonging to extended as well as those from mainstream degree program. The observed feature of these histograms is the high percentage of the students passing the extended module(s) (obtaining  $> 50\%$ ).



**Figure 1.** : A histograms of percentages (number of students) vs mark distribution (%) of PHY1A1E, 2E in 2011 and PHY3E, PHY1A mainstream in 2012 final marks performance.

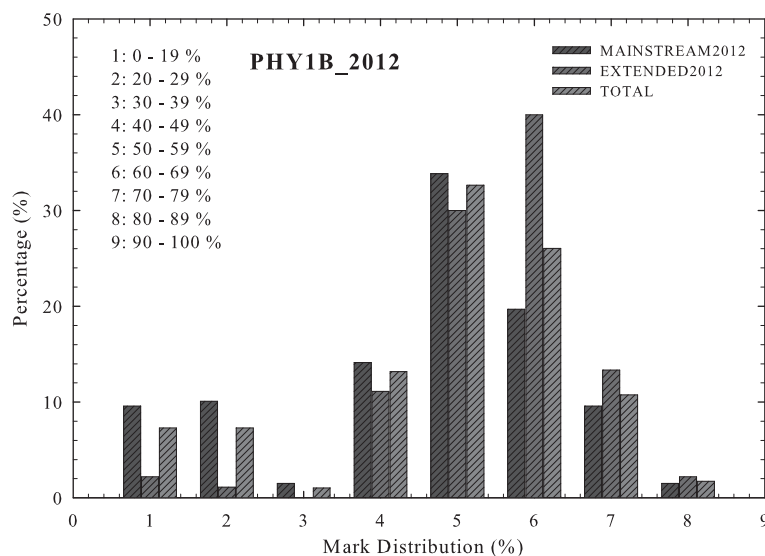
It must be mentioned that these modules were taught in different classes over different time periods (mainstream taught over a semester and extended program taught over three semesters). It is evident from the graphs that a number of extended students obtained a subminimum pass mark over their three semesters in all modules. These are evidenced by the overall performance of more than 70% final mark results as observed from the accumulative percentage frequencies of the student numbers. The encouraging feature is the less percentage ( $< 25\%$ , as observed from the histogram) of students who could not achieve the minimum requirement (50%) to pass the module. It is observed that the bulk of PHY1A students failed to obtain the minimum requirement (50%) to pass the module; this is despite their high APS score from NSC.

Similar analysis for the same categories of students for the 2011 and 2012 final marks performances are presented in figure 2. The meaning of the terms indicated in insert carry the same meaning as defined in our work [4]. The focus of this analysis will be on average of final mark and the throughput of the respective groups. It is observed that the average of final mark of PHY1A1E, PHY1A2E and PHY1A3E are 53%, 53% and 47%, respectively whilst the final mark of PHY1A is 30%. The respective throughputs of the groups are 72%, 75% and 58% for PHY1A1E, PHY1A2E and PHY1A3E, respectively, whilst the throughput of PHY1A is 17%. The results seem very different but the total or overall extended throughput is calculated to be 25%. This was calculated from the total students that wrote the extended degree program



**Figure 2.** A figure representing students' marks distribution in percentages of the total contribution towards students' promotion, for 2010, 2011 and 2012, respectively.

over the total registered students at the beginning of the extended degree program. We need to indicate that low overall throughput of extended program result from many factors, e.g. students not qualifying to obtain the prerequisite to continue in the extended degree program. We observed a student enrolment decline in each extended module which reflected this overall reduced throughput. The difference in the throughputs of these results can be ascribed to the time spent on teaching physics content which improved the understanding of the content better which translated into the enhanced pass rate and throughput result for the extended group.



**Figure 3.** A histograms of both mainstream and extended students groups (in same class of PHY1B mainstream and extended 2012 final marks performance).

Figure 3 represents the histogram of the PHY1B group. This group is comprised of the students that did their first year PHY1A over three semesters (as outlined in the method above) and those that did their PHY1A in the first semester of 2012. The histograms of final marks performances of individual groups are compared to the total obtained from combined groups. The percentage of students who passed the module ( $>50\%$ ) for mainstream students is 65%; whilst the percentage of students who passed the module from extended program is 86%. However, the combined results yield a drop in the average marks of the class. In overall, the bulk of the students are passing the module.

#### 4. Conclusion

The results of the investigation in this regard seem to suggest that students from the extended degree program appeared to have gained a somewhat adequate knowledge, understanding and confidence. This was shown by the 21% performance difference observed above their counterparts from mainstream in PHY1B module. This undisputed performance is attributed to the time spent on the physics foundations that help students to simulate concepts thoroughly. In addition, the observed impact of the extended degree program on the confidence of students in coping with the mainstream module has also been acknowledged by the academic personnel. The results obtained from this study are an indication that the extended degree program has contributed immensely in producing competent students who would perform well in their physics 2 studies. We recommend that the students with APS scores of 6 be enrolled in a four year degree program as this can enhance the overall first throughput and increase the number of third year and honours students.

#### 5. Acknowledgements

The authors acknowledge the assistance from the department of physics at UJ.

#### References

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