



IMPROVING FIRST YEAR MATHEMATICS WITH FIRST YEAR SEMINAR INTERVENTION

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ABSTRACT-The massification of South African Higher Education over the past 20 years has shown that 70% of the student population entering the sector are first-generation (or first-in-family) students. First year students arrive with high expectations and their school results adhere to the admission requirements. Within the first few weeks these students realise that they have not been empowered to pass mathematics at university level. This paper reports on the influence of a two week mathematics intervention programme in the beginning of the academic year on the performance of first year mathematics students in Science and Engineering. The paper explores the relationship between mathematics at Grade 12 level; mathematical skills developed during the First Year Seminar (FYS) and the mathematics results obtained after the first semester. A purposive sample participated in the pre- and post-FYS test in mathematics. The comparative analysis of students who passed mathematics (first semester) and those who failed mathematics, indicated that the students who attended the FYS have a fair chance of passing university mathematics. The purpose of the inquiry was to determine whether students did benefit from additional post-matric educational support programmes. Furthermore, it was attained that the FYS could be regarded as one of the possible predictors of profiling at-risk students.

Keywords: Mathematics, First Year Seminar, Intervention programme.

1. INTRODUCTION

In 2009, Stellenbosch University hosted the first national First Year Experience (FYE) conference, after which the South African Higher Education (SAHE) sector started placing more emphasis on institutional FYE programmes (Leibowitz, Van der Merwe and Van Schalkwyk, 2009, p.3). This opened the door for more focused research and discussions on the first year programmes and created better understanding for student transition from the secondary schooling system (Jacobs, 2010). Based on the Council of Higher Education's report (2013), only 25% Science students and 12,5% Engineering students complete their degree in the minimum time (CHE, 2013, p.37). Such rates have a strong influence on the SA economy and are a national concern in the HE sector.

From 1994, HE enrolments have escalated by nearly 90%, from 495 356 to 937 455, (CHE, 2013, p.37) in South Africa. Regrettably, high attrition and low participation rates still exist. Many students from varied academic backgrounds, who would have been rejected in the previous dispensation, are now enrolling in higher education institutions (HEI) in search of qualifications (Tait and Godfrey, 2001). It is significant in the Science and Engineering fields where students study to better their opportunities to find good work (Giancola, Munz and Trares, 2008). Unfortunately, students from the SA public schools system are not adequately prepared to meet the expectations of Science fields in HE (Jacobs, 2010). Factors such as the absence of academic literacy and inflated school marks (Nel and Kistner, 2009) have a serious negative impact on success rate. Approximately 70% of first year students are first-generation (first-in-family) students (CHE, 2013, p.45), creating tremendous challenges for these students, lecturers and ultimately institutions (Olive and Russ, 2010).



The responsibility now exists for HE institutions to develop initiatives to combat student failure and drop-outs. The Orientation (O-week) or First Year Seminar (FYS) programmes (Kift, 2008) originated as a strategy to facilitate underprepared students into practices and challenges of the complexities of transition into HE. Programmes like these are focused on building students' confidence by introducing them to a *milieu* that will help them improve their skills. This paper explores the impact of the FYS constructed by the Faculty of Science at the University of Johannesburg (UJ) and specifically the problem solving component of the programme.

The research question proposed in this paper is: what is the influence of the problem solving component of the FYS on the mathematics performance of first year students? The aim is to establish whether the performance of students in the problem solving section of the FYS is related to their first semester marks in their mathematics module.

2. LITERATURE REVIEW

2.1. Theoretical framework

This paper discusses student transition, specifically in Science disciplines where university curriculum and lectures continue with content knowledge embedded at school level. The lens is placed on the FYE and the important role of First Year Seminars (Orientation) to induct students into HE (Pretorius and Jacobs, 2014). Furthermore, the development and transition of lecturers teaching first year students (Jacobs and Jacobs, 2014) will be explored as they contribute as a key component in guiding success in first year students.

2.2. Science student transition

Institutions assume that the entering first year students have the appropriate level of background knowledge in the respective Science subject fields as the students adhere to admission requirements. Sappa and Bonica (2008) emphasise the fact that these Science (and most of the other) students are caught in an educational gap between school and university. The gap has been created by the new environment, socio-economic expectations, poor schooling, insecurity and lack of confidence to mention a few (Jacobs, 2010). Lecturers should acknowledge that students enter with some accumulated educational skills (and cultural capital) and must then try to support them to develop these skills in order for them to reach the level expected at university.

2.3. First year programmes

Internationally, issues related to the transition of first year students have received a fair amount of attention since the 1970s (Akerlind, 2005, p.1). Formal programmes and dedicated structures are part of the well-established support systems in the USA, UK, European, Australian and Asian HE institutions (Meyers and Ryan, 2008). First year lecturers and staff intervening with the entering students, in local universities, are still trying to convince governance structures that formal Orientation programmes, which assist in accommodating these students and according to Kift (2008) are crucial, to retain first year students in the system. Vincent Tinto (2008, p.14) points out that certain factors will improve the academic success of first year students:

- integrate the social and academic platforms;
- build relationships with peer groups;
- form part of the institutional culture; and,
- be involved in many aspects of university life.

Ng, Shirley, Willis, Lewis and Lincoln (2015, p.37) published their work on first years from low SES backgrounds and debate whether the student or the institution should be responsible for bridging the gap. The above markers for academic success indicate that a collaborative approach will place the onus on students as well as institutional resources to provide mechanisms to ease the transition. It is evident that students with financial difficulty often regard these programmes as expensive and



even just to travel to the campus is costly. However, it could be argued that students from less privileged communities often have a greater need for transition programmes and support.

South African universities are actively developing some form of first year programme given the diverse background of students entering the sector. This paper reports on a programme designed within a faculty of Science and focusses on the enhancement of mathematics as a core component of the programme.

2.4. The FYE programme in Science at UJ

UJ (Faculty of Science) has been designing and implementing support systems for first years since 2004. The increasing drop-out rate and more diverse student population guided development of a structured FYE which was launched in 2005 and an improved FYE programme was approved four years later. The First Year Seminar (FYS), previously a day of Orientation, and First Year Academy (FYA) were also established during the last decade. The FYS focuses on entering students and the FYA serves as a platform for lecturers and senior students to engage and assist these students in their transition from school into the university.

2.5. The First Year Seminar in Science

The FYS is a formal programme, scheduled during the two weeks before formal lectures commence at the beginning of the year. The programme facilitates the transition process of all students enrolled for Science modules (Chemistry, Physics and Mathematics). The FYS concentrates improving laboratory skills, academic literacy and mathematical problem solving. More than a 1000 students are placed in smaller groups (12-14 groups of 80 students) and they rotate between different sessions and are actively occupied on campus from 08:00 to 15:00 for nine days.

The FYS commences with an official opening and welcoming by the Executive Dean and heads of Departments in the university Auditorium. All the first year students and parents or care givers are present as the academic procession celebrate the start of their university lifecycle. After the official introductions and some entertainment, the parents remain in the Auditorium when the students leave to start with the programme. The parents are then introduced to what is expected from them in support of the students, they also get a briefing on finances and other policies and usually have many questions to pose to staff assisting with the session.

The FYS programme have different elements and the main components are:

- Five x 2 hour sessions aimed at improving academic literacy, in other words the discourse employed in the field of Science. First-generation students may find it difficult to write scientific essays and reports (Bowl, 2001) and more than 70% of the entering students are non-English mother tongue speakers (Jacobs and Jacobs, 2014).
- Five x 2 hour sessions aimed at developing mathematical problem solving skills in order to decrease the gap in their educational background and to cope with first year mathematics.
- Three x 2 hour sessions focusing on acquiring laboratory skills that will be needed for first year Biology, Physics and Chemistry practical sessions.

Additional sessions presented during the FYS are directed at developing time management and study skills. Students attend a “first lecture” and are assisted with note-taking and activities to get acquainted to the lecturing environment. They are introduced to the computer laboratories and assessed to determine computer competence. Students are also made aware of the different support services, the library, health and psychological centres and co-curricular activities available on campus. First year students take part in a game, dubbed the “amazing race”, facilitated by senior “mentor” students to get acquainted with the campus as soon as possible. Research by Pascarella and Terenzini (2005) and Keup and Barefoot (2005), proved that active participation of students in

formal programmes have a remarkable positive effect on first year students to make the relevant adjustments in order for them to cope with the demands of HE.

2.6. The First Year Academy (FYA) of Science

The FYA was established in 2007 with the main purpose of creating a community of practice where first year lecturers meet. These meetings serve as discussions on research strategies, inform policies as well as sharing creative techniques to improve lecturers teaching styles to accommodate these students (Jacobs and Jacobs, 2014). The FYA orientates all the participating lecturers in the FYS and prepares the staff compliment with current trends, feedback on previous programmes and student experiences from mentors and successful first year students.

In a recent study by Fleischman and Imaz-Marial (2015, p.82) in Australia they found that the entering tertiary student experience emotions such fear, stress and excitement. Educators need to be aware and make a conscious effort to comfort students and reduce attrition rates. Caring and empathy have not been a priority in the science fields and generate new challenges for the colleagues involved with transition practices especially in mathematics. Selected lecturers (interacting with first year students) are required to have an ability to communicate and interact with students and create relationships built on trust, confidence and comfort. Fleischman and Imaz-Marial (2015, p.84) suggest that academics follow the four “B’s” concept derived from medical training: “...be thorough, be clear, be honest and be firm...” and encourage students to ask good questions.

3. EMPIRICAL RESEARCH COMPONENT

3.1. Methodology: participants and sampling

In 2014, 1060 first year students registered for the FYS and 86% of them attended the whole programme (all nine days). Of these students 34% (n=360) completed a multiple choice test (25 items), before and after completion of the FYS and participated in this specific research. This paper analyses results from a purposive sample of 360 students, of whom Grade 12 results, pre- and post-FYS test and who were all enrolled for the first year mathematics (MAT1A) module. Other students did either another mathematics module or did not complete the pre- and post-FYS test in problem solving or their school mathematics results were not available.

A demographic analysis of the participants indicates that:

- 80% are Science students, the remainder being enrolled for Engineering;
- just less than 25% is female;
- slightly more than 20% had English as the primary home language.

3.2. Data collection

Data was collected via a 25 item multiple choice FYS ‘test’ aimed at determining their content knowledge in respect of laboratory (6 items), language (8 items) and problem solving skills (11 items). Respondents were requested to complete the test upon arrival on the first day of a nine day programme and the same test on the last day. Their final school results (Grade 12) and final first semester results in mathematics were also captured.

3.3. Data analysis

Descriptive statistics, cross-tabulations and frequency distributions were conducted via the Statistical Package for the Social Sciences (SPSS), version 22 to determine relationships between the different results.

3.4. Reliability and validity measures

In 2014, the pre- and post-tests on the three abovementioned constructs were administered for the first time. The 2014 investigation thus served as a pilot study and its reliability will be determined in 2015 again. Specialist lecturers in respect of the three test components designed the test items. This ensured the sight and content validity of each item.

3.5. Findings

The sample of 360 first year students presented the following scores (all percentages) in pre-FYS problem solving ($M = 45.44$, $SD = 19.444$); post-FYS problem solving ($M = 62.86$, $SD = 18.188$), school (Gr 12) Mathematics ($M = 73.18$, $SD = 10.173$) and first year (MAT1A) Mathematics ($M = 48.74$, $SD = 11.663$). These scores are further analysed in the three successive tables below.

Table 1: Cross-tabulation: Math Gr 12 versus Math1A marks

MAT1A	Mathematics in Gr 12					Total
	59% or lower	60 - 69%	70 - 79%	80 - 89%	90% or higher	
49% or lower	6	76	69	19	3	173 (48.1%)
50 - 59%	1	44	50	27	4	126 (35.0%)
60 - 69%	1	4	15	20	4	44 (12.2%)
70 - 79%	0	1	1	8	1	11 (3.0%)
80% or higher	0	0	0	2	3	5 (1.4%)
Total	8 (2.2%)	125 (37.4%)	136 (37.8%)	77 (21.3%)	15 (4.2%)	360

Table 1 indicates that 46.4% (167) of the students, who scored 60% or more at school, scored less than 50% (a 'fail') for mathematics 1A at the end of the first year's first semester at university level. It is more noteworthy that three students, who scored 90% or more for mathematics in Gr 12, failed the subject at university. As already mentioned, the predictive value of school mathematics results is not necessarily credible.

Table 2: Cross-tabulation: Post-FYS Problem solving versus Math1A marks

MAT1A scores	Post-FYS Problem solving scores						Total
	0%	20%	40%	60%	80%	100%	
49% or lower	2	11	43	66	50	1	163 (45.3%)
50 - 59%	1	2	16	53	52	3	127 (35.3%)
60 - 69%	0	0	6	10	28	1	45 (12.5%)
70 - 79%	0	0	1	6	5	0	12 (3.3%)
80% or higher	0	0	0	3	4	0	7 (1.9%)
Total	3 (0.8%)	13 (3.6%)	66 (18.3%)	136 (37.8%)	139 (38.6%)	5 (1.4%)	360

Table 2 presents a cross-tabulation of post-FYS problem solving and first year Mathematics (MAT1A) scores in various intervals. This table reveals that 32.5% (117) of the students, who scored more than 60% in the post-FYS test obtained less than 50% (i.e. a 'fail') for university Mathematics. It seems as if students who scored less than 60% for the post-FYS problem solving test, have a greater probability not to pass MAT1A.

A comparison of pre-FYS versus post-FYS problem solving marks, in accordance with students' results in MAT1A is finally presented in table 3. In this table the increase of pre-FYS to post-FYS scores in all five intervals are indicative. The mean pre-FYS problem solving score of the group below 50% (i.e. students who failed MAT1A) improved by 18.61% in the post-FYS test, indicating that the FYS contribute to the results obtained in mathematics IA. The deduction can be made that students with



higher post-FYS problem solving results have a fair chance of passing MAT1A. The increase in the mean post-FYS problem solving results from the pre-FYS problem solving test results also contribute to prediction of the success or risk of failing MAT1A. Lecturers are thus able to determine very early in the semester which students could be identified as **STudent At-Risk (STAR)** students and suggest early-intervention strategies to support these students.

Table 3: Pre-and Post-FYS Problem Solving scores in accordance with Math1A marks

MAT1A marks	N	Mean (%)	
		(Pre-FYS Problem solving)	(Post-FYS Problem solving)
49% or lower	172 (47.8%)	39.31	57.92
50 - 59%	125 (34.7%)	48.73	65.71
60 - 69%	43 (11.9%)	57.73	71.36
70 - 79%	10 (2.8%)	50.91	67.27
80% or higher	15 (4.2%)	53.33	73.33

The analysis indicates that students with higher post-problem solving results had a greater probability of passing MAT1A, although many other factors could possibly influence the success in MAT1A. The problem solving module exposed students very early to the expected level and complexity that success at HE requires. The lecturing staff have access to a benchmark profile before the start of the semester and could immediately suggest additional tutorials and support.

4. DISCUSSION AND IMPLICATIONS

This investigation attempted to determine whether there is a relationship between the FYS Problem Solving module and performance in mathematics of first year students. It was found that there is a definite connection between students' scores on the problem solving component of the FYS and their achievement in mathematics in the first semester. Although no causality is implied or can be deduced, first year students' problem solving capabilities (as detected during the annual FYS, before the academic year commences) seem to have substantial predictability in respect of their performance in mathematics. This finding elevates the contribution and pertinence of the Faculty's FYS, related to its potential to add value to, and support academic success.

The purpose of the inquiry was thus attained and the FYS could increasingly be regarded as one of the possible predictors of profiling at-risk students. The timing of the FYS (at the beginning of the academic year) has the additional benefit of making available vital information about first year students in mathematics, six weeks before the first official assessments are conducted. Participation in the FYS has the potential to influence students' ability to make a successful transition to university positively. The FYS, especially in respect of mathematics students, enable them to get acquainted with the HE context and first year level expectations.

The modules of the FYS, which focus on mathematical problem solving, academic language and laboratory skills assist in bridging the current gap between school and university education. Further research could enable the institution, the Science Faculty and first year students to address envisaged transitional challenges much sooner (within the first three weeks), by providing appropriate support where needed. This inquiry might ultimately assist staff involved in the Faculty's FYS to review and fine-tune the programme. This programme can be described as an exceedingly positive educational outcome and a pointer towards first year academic success.

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