Student Engagement: A Successful Approach to Teaching and Learning in a Third-level Engineering Module at the University of KwaZulu-Natal[1]

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Abstract

The range of outcomes evident in student learning often signals a variety of teaching and learning approaches. In an attempt to address the needs of a large and diverse student body in a high-risk module at the University of KwaZulu-Natal, a teaching and learning approach quite different from the traditional lecture-style approach was introduced. The study reported in this article focused on a third-year civil engineering module where the lecturer used a combination of weekly plenary sessions and interactive group sessions to encourage interaction among students and between students and staff. The research question for the study was, 'What effect do increased student-student and staff-student interaction and engagement have on student confidence, motivation and academic success?' Interviews, observations and final module marks were used to generate the data that were used to answer the research question. Findings from the qualitative study indicate improved student confidence and motivation. Analysis of the final module marks established that this approach supports academic success. The findings have implications for research and practice particularly at UKZN as they show that implementing and researching innovative practices has enabled the establishment of better teaching and learning environments that have the derived benefit of improved pass rates.

[1] Preliminary findings of this study were initially presented at the SEFI conference, Lisbon, September 2011.

Keywords: student engagement, academic success, interactive group sessions

Introduction

An issue of concern nationally is the progression and throughput rates of students in engineering (Nel 2010). In his report to the Engineering Council of South Africa (ECSA), Fisher (2011) reports that fewer than 33% of engineering students graduate within the set curricular time, and fewer than 67% graduate within six years.

This has grave significance in view of the critical shortage of engineers in South Africa (Case 2006; Fisher 2011; Nel 2010), which has repercussions at many levels. It seriously inhibits socioeconomic development (JIPSA 2010; Rasool & Botha 2011), it constrains infrastructural development and it also stifles development within the discipline, which impedes the country's ability to keep abreast with global trends in engineering (Fisher 2011). Fisher suggests in this regard that the issue of higher education teaching,

> should be a matter of serious national concern, not only on the grounds of the human and financial costs of poor throughputs and high student attrition, but from the perspective of social and economic development, and the skills requirements of an economy which needs to grow and which critically needs to create jobs (2011: 85).

One of the ways in which this concern has been addressed is by improving access to engineering courses, and at the University of KwaZulu-Natal (UKZN) this has resulted in greater student numbers than ever before, with a student body characterised by wide diversity in terms of socioeconomic, educational and language backgrounds, and with varying competencies and learning styles. But despite the increased student intake, retention and throughput in engineering are low and the university's response has been to give serious attention to their improvement, and a number of student-centred initiatives have been put in place in an attempt to boost progression and retention rates at the institution.

These initiatives include academic counselling, supplemental instruction[2] (SI) and workshops on topics such as time management and study skills. While these initiatives have been ongoing, very little has changed, however, in the way teaching and learning are approached by academics in engineering. Lectures are still commonly conducted in the traditional style.

The dominant perception this seems to convey is that there is something wrong with the students, perpetuating the notion that they need to be 'fixed' – hence the mélange of student-centred initiatives. It was therefore refreshing to find that in one high-risk[3] third-level module in the discipline of civil engineering at UKZN, the lecturer approached the module from a different teaching and learning perspective. This was achieved by increasing student engagement with both their peers and the academic staff with the object of improving student confidence, motivation and academic success. This article reports on the intervention that was conducted on the third-level civil engineering module as a contribution to the knowledge base in engineering education.

Among the many core modules that students take in the study of engineering, certain modules act as barriers to progression for students (Pocock, Bengesai & Moodley 2011). In recent years, this particular third-level civil engineering module has been identified as one such barrier. After several years of teaching this module, the lecturer decided to adopt a fresh approach based on his own experience of teaching the module together with ideas from the literature. To accommodate the volume of work that needed to be covered, and to improve interaction among students themselves and between students and staff in a large group, the lecturer used a two-pronged approach which combined plenary sessions and interactive group sessions. The four lectures per week allocated to the module were reorganised into two double periods: one plenary session where the lecturer adopted a traditional lecture style in presenting the content to the students, and one interactive group session that focused on problem-solving activities related to the content presented in the plenary each week.

The research question which was posed in relation to an investigation of this innovative teaching module was: What effect does increased student-

[2] Supplemental instruction (SI) is a collaborative, peer-group study session

[3] *High-risk* signifies a module that has a historically high failure rate.

student and staff-student interaction and engagement have on student confidence, motivation and academic success? Answers to this question were sought from data derived from interviews, observations and final module marks.

Literature on Student Engagement

There is extensive theoretical literature on the importance of student engagement for successful learning experiences and personal development (Astin 1984; Chickering & Gamson 1987; Goodsell Maher & Tinto 1992; Kuh, Kinzie, Schuh & Whitt 2005; Pascarella & Terenzini 2005), confirming a strong correlation between student engagement in educational activities that encourage student interaction, and positive outcomes with regard to student success. Additional outcomes indicated in the literature are student development, academic achievement, perseverance and satisfaction (Astin 1984; Chickering & Gamson 1987; Goodsell *et al*. 1992; Kuh *et al.* 2005; Pascarella & Terenzini 2005; Strydom & Mentz 2010; Trowler 2010).

Trowler (2010) characterises student engagement as an investment of effort and time in educational activities by both student and the institution. Harper and Quaye (2009) argue that student engagement includes more than student participation and involvement and suggest that activity, feelings and sense-making are further important components. Kuh, Kinzie, Buckley, Bridges and Hayek (2007) see student engagement as participation in activities that are effective educationally and have results that can be measured. For Krause and Coates (2008), student engagement refers to the educational activities within a class that lead to the achievement of learning outcomes. Strydom and Mentz (2010) describe student engagement as the extent to which students participate in educationally purposive activities. Taking these various perspectives into account, *student engagement* for the purpose of this study applies to the effort made by students to participate (collaborate, question, explain and describe) in educational activities designed by the lecturer. Included in this perspective is the notion that both students and staff are responsible for effective student engagement (Chickering & Gamson 1987).

Noting that the concept of student engagement derives from the educational philosophy historically of John Dewey, Graham, Tripp,

Seawright and Joeckel (2007) indicate confirmation from subsequent research that active participation in lessons does indeed have a positive influence on academic achievement. A large-scale study of first-year university students by Kuh, Cruce, Shoup, Kinzie and Gonyea (2008) found that student engagement in purposefully designed educational activities correlated positively with academic outcomes. Their study focused more specifically on the effect of interaction among students and students and staff and found that, regardless of social and educational background, student engagement seems to increase the probability of achieving academic goals and attaining the skills and competencies required in the present-day world. In a separate study of undergraduate students, Kuh (2008) also found that the competencies of students entering university were not as crucial to their academic success as was their involvement in educational activities as students. This finding is especially relevant in the current context, marked by notable student diversity with regard to language, culture, educational competencies and socioeconomic background.

Tinto (1993) argues that increased interaction between students and staff results in students becoming more comfortable in their academic environment. This, he says, leads to increased feelings of 'belonging' or 'fit' with the institution, that are in turn positively correlated with retention and academic success. Rush and Balamoutsou (cited in Trowler 2010) claim that one of the benefits of student engagement is the resulting ability to work confidently with peers. Pascarella and Terenzini (2005) showed that environments that encouraged close relationships between faculty and students promoted intellectual development. Gibbs (2010: 17) suggests that 'close contact is more easily possible when there are not too many students for each teacher to make close contact with'.

Kuh *et al.* (2008), report that students who interact with peers and staff, and who use their knowledge in practical situations, gain from their studies. More interaction with peers and staff enhances the sense of legitimation and also creates opportunities for richer learning experiences (Bensimon 2009). The South African Survey of Student Engagement (SASSE), a study commissioned by the Council for Higher Education (CHE) and conducted by Strydom and Mentz (2010), used five benchmarks to measure effective educational practice: level of academic challenge, active and collaborative learning, student and staff interaction, enriching educational experiences, and supportive campus environment. This is relevant to the

current South African context, as the engineering student cohort is representative of diverse socioeconomic, educational and language backgrounds, with varying competencies and learning styles.

The theoretical framing of the study (below) draws on the benchmarks of effective educational practice identified by Kuh (2003) and is shaped to capture significant points of issue emerging from the literature review.

Theoretical Framing of the Study

Student engagement is based on the premise that the more time students invest in learning, the better they are able to grasp the content; more practice, coupled with constructive feedback enhances student learning. As part of the National Survey of Student Engagement (NSSE), Kuh (2003) identified five clusters of practices which may be used to benchmark the extent of students' engagement and which will promote effective learning. Similar to those selected by the CHE in the SASSE study (2010), these five clusters are student–faculty interaction, active and collaborative learning, enriching educational experiences, academic level of challenge and supportive campus environment. Of these, the three which I found most pertinent to the study reported on in this article, and which I refined to suit the purpose of the study, were student–lecturer interaction, active and collaborative learning, and enriching educational experiences. Student-lecturer interaction involved the educational opportunities created for communication between lecturer and students during class; these included questioning, clarification and feedback from the lecturer. The active and collaborative learning focus related to students' active engagement in solving problems and how they worked together to solve problems. The third benchmark took into account students' overall experiences in the lessons and focused on enhanced learning (academic success), motivation and confidence. This three-part framework also picks up the theme of *Education at the Crossroads* in as much as the discipline of civil engineering and more especially this third-level module have hitherto adhered to a traditional approach to teaching and learning in which lectures have been strongly teacher-centred activities, and where the challenge now is how best to inculcate new thinking that will foster new educational possibilities, practices and optimisms. Taking note, then, of

avenues that scholarship might suggest for educational reform, this paper reports on a study of one such new venture which shows a paradigmatic change from a traditional teacher-centred approach to a student-centred approach much more closely aligned with student engagement and with active and collaborative learning (see Astin 1984; Chickering & Gamson 1987; Goodsell *et al.* 1992; Kuh, Kinzie, Schuh & Whitt 2005; Pascarella & Terenzini 2005; Strydom & Mentz 2010; Trowler 2010).

Methodology

A mixed methods approach was adopted in generating data for this study, following the position taken by Johnson and Onwuegbuzie (2004) that a combination of qualitative and quantitative paradigms allows the researcher to draw from the strengths of each approach while minimising their separate weaknesses.

Primary data were generated through lesson observations, interviews with students and staff, and secondary data and final module marks were accessed from the Student Management System (SMS). The primary interview and observation data were analysed using interpretive qualitative analysis, and were compared with statistical analyses of the final module marks on SMS including the central measures and the maximum and minimum marks to determine whether the intervention influenced academic success.

Observations of plenary and interactive group sessions and interviews with students and staff were conducted in 2011. With the intervention having been piloted in 2010 data over the period 2009 to 2011 were used in the analysis and the 2009 final module marks were used as a benchmark against which to compare the 2010 and 2011 results. Observation of the interactive group sessions made it possible to measure aspects of student engagement such as interaction among students and between students and staff. Random sampling was used to identify those students who would be interviewed about their experiences in the module, yielding a sample of seven students, the lecturer and a facilitator as interviewees. Written consent was obtained from all the study participants. The student interviews yielded data for analysis directly related to answering the research question, while interviews with the lecturer and facilitator provided insight into the module

and understanding of the context. For example, the lecturer was able to provide insight into attendance. He observed that whereas prior to implementation of the innovative approach the first lesson of the day was generally sparsely attended, after the intervention was instituted attendance during the same time slots improved significantly – although it must be acknowledged that pedagogical strategy is just one of many possible factors to which the increased attendance could be attributed.

The nine respondents were interviewed independently. Academic staff interviews, seeking to ascertain effectiveness of and challenges in implementing the innovative approaches, were conducted between lectures and during the lunch breaks, as this was often the only time available to both researcher and staff. Students were interviewed predominantly in the afternoons once their lectures were completed for the day as this provided sufficient uninterrupted time to probe and clarify their responses. These interviews sought to ascertain the students' experiences of the innovative approach. The responses of the seven students were coded and, as nuances in the data arose, they were recorded. Salient points that emerged were categorised into themes. Supporting evidence from interviews and rich descriptions of lesson observations were documented. The final module marks were analysed to determine overall pass rates, and measures of central tendency were computed to determine the effect on the quality of performance and to compare them with those for the period 2009 to 2011.

Findings

In the restructured module, the plenary session was dedicated to the introduction and explanation of the concepts in a traditional lecture-style teaching approach. In this 90-minute session, the lecturer explained and discussed concepts in a series of (approximately) 15-minute sessions separated by 5-minute breaks, structured on the assumption, drawn from his extended experience of lecturing the module, that 15 minutes was about the maximum attention span of students in his class. In addition, printed handouts of the lecture material were also provided to the students. Prior to the commencement of the research, the lecturer indicated that the purpose of the handouts was to make it easier for students to pay full attention during the lecture and take additional notes as and when necessary. It also gave students

the opportunity to familiarise themselves with the content ahead of the plenary and group sessions and to revise prerequisite knowledge if necessary.
The plenary session was conducted at a fast pace with few opportunities for students to ask questions. The lecturer did not encourage questioning during this session and there seemed to be an unspoken rule that this was not allowed. I noted during observation of the plenary session that some students focused on writing down as much as they could of what the lecturer was saying (despite having the handout), some simply listened to the lecture, and others were preoccupied with their cell phones or chatted with their peers.
The interactive group session was very different from the plenary session in both approach and environment. Students were divided into four groups of 20 (it was explained by the lecturer that no negotiations by students were entertained for placement in any group as it was envisaged that many students would want to be in his group). The venues used were single-level rooms with desks arranged in rows. Although it somewhat restricted movement, this arrangement did allow for more student/instructor interaction than in the regular lecture theatre with tiered seats. The group sessions were conducted concurrently, one by the lecturer and the other three by trained facilitators who acted in place of the lecturer. In an interactive group session conducted by the lecturer, I observed the lecturer introduce a problem on the board, following which, after some prompting, the students were encouraged to make input to a solution with the assistance of step-by-step explanations by the lecturer. Students were given problems that they had to attempt to solve within specified time frames, and communicated with lecturers on issues such as clarification of the problem and the methods that they were using to solve the problem. Some students worked collaboratively with each other and made reference to their handbooks and notes to solve the problem. The lecturer interacted with students independently as well as in groups. Once the lecturer was satisfied that the students had had sufficient time and had made sufficient attempt to solve the problem, students were then asked to explain and discuss their particular solutions. The researcher also noted that activities as they have been set out in the handbook lent themselves to group interaction and discussion.

In summary, students were clearly engaged in active learning and collaborative activities (student-centred activities associated with student engagement) orchestrated by the lecturer in a shift from traditional classroom practice.

Analysis and Discussion

The intervention stands as an instructive instance of *Education at the Crossroads* in its encouragement of student engagement with content and student interaction with peers and staff.

Analysis of the data collected from observation of the interactive sessions and interviews with students is discussed under the following themes: *academic success*, *motivation and confidence*, *feelings of legitimation* and *interaction with peers and staff*. The second of these themes, *feelings of legitimation* was not initially included but subsequently emerged as being strongly indicated in the data. During student interviews, students acknowledged that they understood very little of what was presented in the plenary, expressing the view that they expected it all to become clear during the interactive group sessions. I probed into this further and queried why they did not question the lecturer or ask for clarification during the plenary. Many students responded that they did not feel it was the correct forum to raise questions and that the lecturer did not encourage them to question or to seek clarification during the plenary. They understood that questioning and clarifying were objectives of the interactive group session that would follow on a subsequent day.

Academic Success

Academic success was measured in terms of passing the module. The final module marks were statistically analysed to determine the pass rates, central measures and mark range in the specific module over the period 2009–2011. An analysis of the 2009 final module marks was included as it provided a basis for comparison of academic success pre-intervention and post-intervention. A pilot study of the innovative approach was conducted in 2010 and followed up in 2011 to determine whether the data were indicative only of a particular cohort of students. For the purpose of consistency and validity, statistical analysis results were used of final module marks from 2010 and 2011, the years in which the intervention was implemented. The data in Table 1 (sourced from the Student Management System, UKZN) establishes that academic gains were consistent during the period when the innovative approach was used.

Table 1: Module statistics for the period 2009–2011

Year	No. of students	% Pass	Min %	Max %	Mean %	Median %	Mode	Variance	Std Dev
2009	104	75.00	30	80	54.12	52	50.00	125.56	11.21
2010	80	91.25	45	85	63.53	63	68.00	136.15	11.67
2011	66	92.42	43	92	67.59	68	66.75	131.78	11.48

There is a strong likelihood that the pass rate increase from 75% to 92% between 2009 and 2011 can legitimately be attributed to the new approach to teaching and learning since a rise of 16.25% was already apparent in results from the initial pilot for the new course in 2010, although one additional factor could also be that the smaller enrolment than in previous years[4] may have made it possible for teachers to get to know their students better and for students to be less anonymous than in a large class (see Astin 1984; Kuh 1991; Pascarella & Terenzini 1981; Tinto 1993). The sustained improvement in 2011 suggests however that the innovative teaching and learning approach in the redesigned module had a significantly positive effect. Also noteworthy was the decisive overall rise in the range of marks as reflected in the minimum and maximum marks achieved by module students from year to year (Table 1, columns 4 and 5), and especially by the smaller 2011 cohort. All three of the important central measures (columns 6,7 and 8) reflected improvement over the three years: not only did more students pass, but the quality of pass also improved.

[4] According to the staff member lecturing in the module, the 23% drop in the number of students registered for this module between 2009 and 2010, and the further 20% drop from 2010 to 2011, was ascribed to attrition and high failure rate in the prerequisite module.

Confidence and Motivation

Evidence from the data shows that the innovative teaching and learning approach used in the module provided an enriching educational experience for students, who displayed enhanced motivation and greater confidence in their own ability. Student attendance at the interactive sessions was high despite the fact that it was scheduled for the first period in the day, which, according to the lecturer, generally attracts significantly fewer students. The high attendance could be attributed to students perceiving the interactive session as beneficial. The environment created during the group session stimulated discussion and interaction with peers and staff; communication is often easier in a small, informal group setting. This is indicated in the following response from a student:

> *I don't mind missing the plenary as I am able to understand in the interactive session…. I was also able to show my peers how to work out certain problems ... it made me understand my work better and now I feel confident about what I know. I don't feel afraid to ask questions (Student A, Interview, 2011).*

This confirms the point made by Rush and Balamoutsou (2006) that students who are effectively engaged will have a positive disposition about themselves and their role in the class and will be encouraged to question and to contribute to the group. Additionally, and as evidenced in my observation of the sessions, they are also apt to demonstrate confidence in working with peers.

However, some challenges did arise in that students who were not in the lecturer's group, harboured the concern that they would be disadvantaged. On further probing, it became apparent that the basis of this concern was that students thought that only the lecturer himself was privy to class tests and the final examination. Students in the facilitators' groups felt less confident, 'as we do not know whether we are being adequately prepared for the exams' (Student B, Interview, 2011).

Many of the respondents felt that the interactive group sessions were beneficial while the plenary sessions were unproductive. One of the respondents indicated that 'I don't even attend the plenary, as I understand well from reading my notes and attending the group session' (Student C, Interview, 2011). This statement was further supported by an attempt from a group of students who made a formal request via the class representative to

have all of the lectures converted to interactive group sessions, a request that was denied on the grounds that, according to the module requirements, a certain percentage of the lectures had to be formal. While the data indicated enhanced learning and improved confidence, it did not necessarily speak to the impact on motivation.

Interaction with Peers and Staff

Increased student interaction with peers and academic staff leads to the development of better academic environments linked to improved academic achievement (Tinto 1993; Kuh 2003). The lecturer–student interaction mentioned in the framework was realised during the interactive group sessions. This was indicated by one of the student interviewed, who commented that he had

> *benefited from the interactive sessions by working with other students and the lecturers and [facilitators]. I learnt how what we learn is applicable in practice…and it is informal so you don't feel afraid to ask questions or to say that you don't understand. They [staff] allow us to see how the problem is relevant to us in engineering (Student E, Interview, 2011).*

From my observation it was evident that students were actively participating in the group discussions and communicating with their peers as well as with the staff. The informal environment seemed to lend itself to easy discussion and questioning. Students noticeably wanted their explanations to be heard and they also showed interest in other perspectives; the class format also afforded students the opportunity to observe academic staff engage in problem solving while they explained what they were doing and why. These findings are further confirmation of the link between student engagement and richer learning experiences (Kuh 2009).

Feelings of Legitimation

Interaction with staff and peers seemed to foster a sense of belonging among students giving them further encouragement to participate in the session. In

the words of one of the interviewed student, 'You know you feel like you are a part of the group, that you belong and they ask you to explain as though your answers are important' (Student B, Interview, 2011). Students' responses seemed to indicate feelings of 'belonging' in the sense of being part of the discipline, and whereas continuing student apathy was observed in the plenary sessions, growing participation was apparent in the group sessions. In the group sessions, students made reference to the application of concepts and problems in the 'real world'. This indicated that students were beginning to see this module not just as a means to passing the degree, but also as an opportunity for them to be engineers-in-the-making. During observation, it was noted that students were actively engaged with the tasks that were set by the lecturer and interacted with their peers in discussing the task or asking for explanations. Interaction with the lecturer and facilitators included clarifying the task, asking 'how' and 'why' questions, explaining their solutions and contributing to class discussions. These observations are in line with a range of findings in the literature that report a positive sense of 'belonging' or 'fit' experienced by students in a conducive academic environment which allows for constructive student engagement (Tinto 1993; Trowler 2010; Bensimon 2009).

Challenges of the Innovative Approach

The lecturer reported in conversation that in the more cognitively demanding aspects of the final examination paper for 2011 questions were not answered well, and that despite the higher pass rate and improved quality of pass he regarded the new module initiative as still a work in progress, needing ongoing development and enhancement of its approaches to raise the level of achievement in higher-order thinking skills.

The lecturer also pointed out that the sustainability of this innovative teaching and learning approach is in question because accommodating the group sessions in the engineering timetable requires significantly more suitably qualified staff members to be available, simultaneously, as facilitators, which is not always possible. In the two semesters during which the innovative approach was piloted, the module coordinator used postgraduate students who were trained as facilitators to conduct the group sessions, but because most graduate engineers take up positions in industry

immediately – often because they need to fulfil their commitments to bursary providers – the annual postgraduate intake in civil engineering is normally low and few are available for facilitating the interactive group sessions. In addition, development in the discipline is, in part, reliant on research activity carried out by postgraduate students, which further cuts down on their availability as facilitators. Hence, finding adequate staff to sustain the intervention is problematic because it is time-consuming and requires ongoing training and funding for module personnel.

Conclusion

The innovative third-level civil engineering module investigated in this study sought to promote mutual engagement among student peers and between students and staff with the intention of improving student motivation, confidence and academic success. Data gathered for the study through interviews with students and staff, observations of plenary and group sessions, information gained through informal conversation with staff, and final module marks showed that the increased collaborative interaction brought about in the module enhanced the learning experience, boosted student motivation and confidence and promoted academic success – thereby transcending some of the challenges presented by large classes with high diversity in the student enrolment. While the disciplinary focus was teaching and learning in a specific engineering module, it is anticipated that the benefits of the new approach can be extended to other engineering courses as well which have hitherto centred principally on traditional lecture-style teaching.

Although the innovation had a positive influence on emotive commitment from students, it needs nonetheless to be noted that performance at higher levels of cognitive demand was less responsive to the intervention. Development of higher-order thinking skills was not an issue that the study set out to investigate but the reservations expressed in this regard by the lecturer would clearly support further consideration in any potential extension of this research through closer analysis of students' performance in the various aspects of the tests and examinations. Such an investigation would need to take account of the level of cognitive demand as well as diagnostic

analysis of student performance per question to determine students' level of development in specific aspects of this module.

With the university continuously beset by issues of retention and throughput, it is evident that the innovation is a shift in a positive direction but also that ongoing development and research of the innovation is necessary for further enhancement of teaching and learning. Where this initiative stands at an all too familiar educational 'crossroad' is its inescapable reliance on personnel resources and on intensive, continuing development and monitoring – sustainable only if adequate financial resources are found.

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