An Exploratory Study of the ODL Course in Structural Engineering

Stella M. Mlasi[1] and R. Naidoo[2]

[1]*Department of Civil & Chemical Engineering, University of South Africa, c/o Christiaan de Wet & Pioneer Avenue, Florida, Johannesburg, South Africa*

[2]*Institute for Open & Distance Learning, University of South Africa, 1 Preller Street, Muckleneuk, Pretoria, South Africa*

Keywords: Module, Structural Steel, Open Distance Learning, Pass Rates, Interventions.

Abstract: The study was conducted on a structural steel design module taught via distance learning mode at the University of South Africa, UNISA. Structural steel design is part of structural engineering under the broad field of civil engineering. It is very challenging for students to learn or study structural steel design in an open distance learning (ODL) environment; because students struggle to put concepts in the correct perspective without any assistance. This lead to few but major challenges such as poor pass rates, graduates with low confidence and lack of quality skills and decision-making. In addressing these challenges, few interventions were introduced including improving communication and teaching methods, redesigning study materials and prescribing up to date books. The interventions were implemented progressively from the year 2013 up to date, and the outcomes measure was the examinations. The examination results showed that the pass rates has been improving annually after 2013, with the overall pass percentages increasing and the number of distinctions increasing from 0 to 6. This implies that the intervention that were implemented are effective but needs to be applied strategically.

1 INTRODUCTION

Engineers think from the abstract to the concrete and vice versa. The learning of concepts and strategies are essential in engineering teaching, learning and assessments. Engineering students frequently use strategies influenced by the instructional method and assessment procedures (Heywood, 2000). Engineering knowledge is changing hence lecturers should establish new approaches to engineering education. The approaches must encourage deep or surface approaches to learning. Assessments used can have a harmful or less than positive effect on learning because they cause surface learning. Engineers require a variety of learning styles when they are engaged in projects due to both convergent and divergent thinkers. Spatial ability is important in engineering design. Engineers need to be able to visualize**.** Learning style may be in conflict with the style of teaching to which we are exposed. Consequently teaching and learning styles should be matched. The nature of engineering learning suggest variety of styles. Consequently teachers may have to change their teaching styles.

In the United Kingdom another type of student approach to learning was identified (Entwishle, 1979). The *strategic* approach described the class of student who tried to manipulate the assessment procedures to her/his own advantage by combining her/his efforts to the reward system as they see it. It is extrinsic and achievement motivation. Kneale (1997) believed that there was an increase in strategically motivated students in British universities. Strategies adopted are indicative of the different perceptions of what students believe is wanted from them by their teachers in order to measure their performance. (Wilson, 1981). The preknowledge concept is important in students learning orientation. Teaching and assessment strategies used can influence the orientation that students take to *deep* and *surface* learning. Clearly, if students are to overcome the misconceptions they have about concepts, then a *deep* learning approach will have to be encouraged. In this situation a traditional lecture approach, however good the lecturer, may not be adequate.

Engineering is particularly suited to holistic assessment because of its desire to simulate the real world that students will meet when they exit from their courses. Project work has been introduced,

Mlasi, S. and Naidoo, R.
An Exploratory Study of the ODL Course in Structural Engineering.
DOI: 10.5220/0006751302460251
In *Proceedings of the 10th International Conference on Computer Supported Education (CSEDU 2018)*, pages 246-251
ISBN: 978-989-758-291-2

laboratory methods have changed and continue to change because of technological advances. These caused changes in curriculum content. The normal traditional tests does not connect to the real world.

This review article is written in order to present feedback from the interventions that were implemented in a module that was not yielding good results. The module is called Structural steel and timber design, facilitated both online and on print by the Civil Engineering Department at the University of South Africa, UNISA, which is an open distance learning institution. The module contents cover the application of all the concepts and theories learned in the earlier days of ones career in civil engineering. In South Africa, the design decisions are guided by the South African National Standards (SANS) published codes and the engineering and environmental sciences and as well as social needs. This full year module is on the exit level of a three year Civil Engineering Diploma and it is actually a two in one module, which comprise two components: Structural steel design & Structural Timber design.

The basic knowledge for structural steel and timber design is defined by:

- Memorizing and understanding definitions, equations, etc.
- Applying equations and procedures;
- An understanding of the concepts and procedures involved;
- A more complete understanding of the phenomena involved.

Vuc, Baloi and Litcanu (2015), Olds, Moskal and Miller (2005) explain two assessment methods in engineering education as 1) descriptive studies and 2) experimental studies. The assessment or examination results used in this paper can be classified as experimental data and the techniques were quantitative.

In 2001, the authors Anderson & Krathwohl (2001) published a revised Bloom's taxonomy that covers six levels of educational objectives. The module structural steel and timber design educational objectives are covered by two of the six, that is analysing and applying. For the module under consideration, analysing involves examining the structure (of steel or timber) or its components to determine their capacity and then organising the design steps logically. On the other hand, applying involves using the acquired knowledge from other modules such as theory of structures and structural analysis.

1.1 Theoretical Framework

1.1.1 Connectivism

Connectivism is a learning theory that describes complex learning in a complex changing social digital world. Learning occurs through connections within networks. The theory uses the concept of a network with nodes and connections to define learning. Learners recognize and interpret patterns. Learners are integrated by the diversity of networks, strength of ties and their context. Learning is a process that occurs within wide environments of shifting core elements – not entirely under the control of the individual. Learning is focused on connecting specialized knowledge states and creates a community of practice. Connectivism is driven by the cognition that decisions are based on rapidly altering foundations. New information is frequently being acquired. Discrimination between important and unimportant information is vital. The ability to recognize when new information alters the cognition based on decisions made yesterday is also critical.

Siemen's Principles of connectivism: (Siemens, 2015)

- Learning and knowledge rests in diversity of opinions.
- Learning is a process of connecting specialized nodes or information sources.
- Learning may reside in non-human appliances.
- Capacity to know more is more critical than what is currently known.
- Nurturing and maintaining connections is needed to facilitate continual learning.
- Ability to see connections between fields, ideas, and concepts is a core skill.
- Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities.

Decision-making is itself a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decision.

1.2 Syllabus

The syllabus comprises structural loading (load patterns, load factors, limit state designs and analysis), design of structural elements such as beams, compression and tension members, connections and base plates.

The assessment comprises of one multiple choice questions assignment, one or two written assignments in the same format as the examination; and this is done in order to give the students a fair opportunity to show how much they know the subject.

This paper focuses only on the results from the examination and not the assignments. The examinations are venue based and students adhere to the set rules. However, the assignments are conducted at a distance and at the convenience of the students; therefore the results will not necessarily indicate that the students showed their sole potential without any help from other people or resources. Although the module has been facilitated over the previous years, the results presented in this paper date back from the year 2013 to 2016; because this is the period during which different interventions were introduced. The interventions were introduced in order to improve the quality of knowledge and skills students acquire, the confidence of graduates thereafter, pass rates, design concepts based on what the industry needs as well as promoting the course itself to make it interesting and fulfilling to the students. The interventions were teaching and communications in which concepts were introduced and explained one at a time, summarized teaching notes and introducing new up to date textbooks:

The nature of the structural steel and timber design module is that, the science is derived from structural analysis, theory of structures and materials; and then followed by uncountable complex design steps. The theory of structures and materials covers topics such as the sectional properties, stress and strain calculation, computing reaction forces and member forces in pin-jointed trusses. The structural analysis involves analysing determinate and indeterminate structures with regard to the applied bending, axial and shear forces, which cause the structure to deform within the limits or fail by yield or collapse. Structural steel and timber design module involves the design of flexural or bending members likes beams, slabs and beam-columns, compression members such as columns and struts, trusses and connections; and all these can be made from either steel or timber.

In the ODL environment for almost all the modules, there could be or not at all the learning and teaching arrangement. Felder and Silverman (1988) describe learning as a two-step process that involves the reception of information and processing of information. This is true, and for engineering students it might be a prolonged process especially in the ODL environment; because most of the concepts in engineering are hard to conceive and interpret. ODL students are self-taught and follow different styles or methods within the time constraints that they choose themselves. It is therefore easier for the lecturer, assessor or the module coordinator to interpret the effectiveness of the learning styles and methods from the results of the assessments, in this case examination results.

2 METHODOLOGY

The module outcomes are: that the students should have a thorough understanding of structural loading, be able to design structural steel and timber elements such as beam, columns, connections and trusses and tension members at the end of the academic year.

The sketch in Figure 1 summarises the stages that students go through when studying the structural steel and timber design. All the three stages are equally important and lead to the outcomes of the module.

The assignments results contribute towards the students' final mark in the range of 20 to 30% and the examination covers 70 to 80%; and this is done to encourage them to keep up with the studies through to the examination stage. The students who failed to pass are given the opportunity to write supplementary examination, provided they satisfy the given criteria. The graphs plotted under the results and discussion sections below include both actual and supplementary examinations.

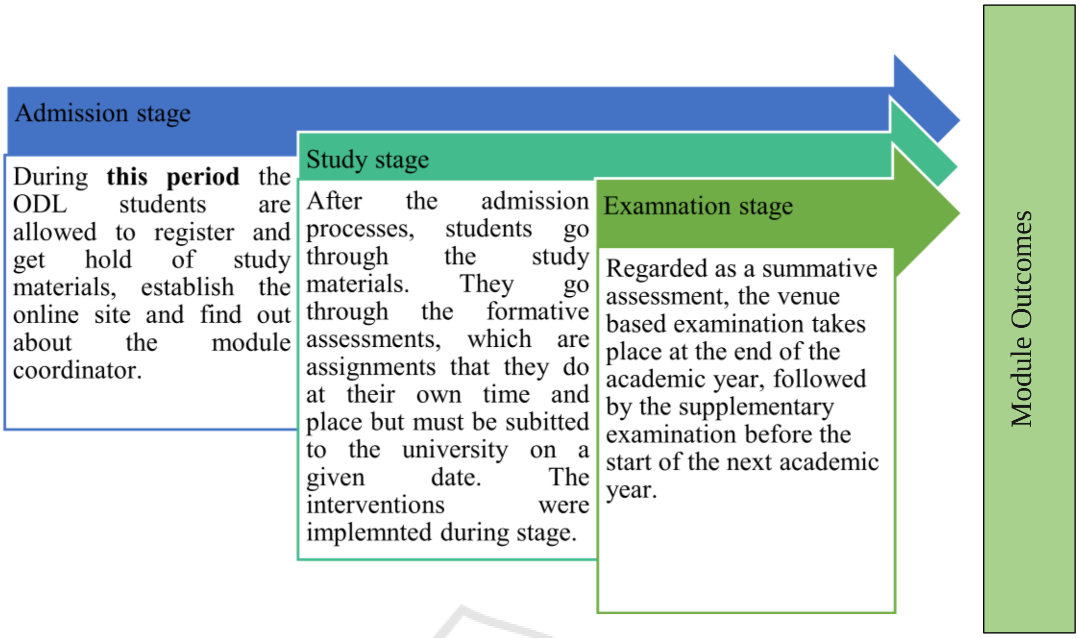

Figure 1: Learning stages.

3 RESULTS

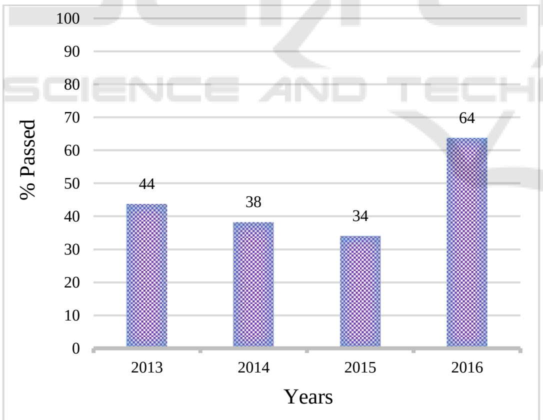

Figure 2: Annual pass rate.

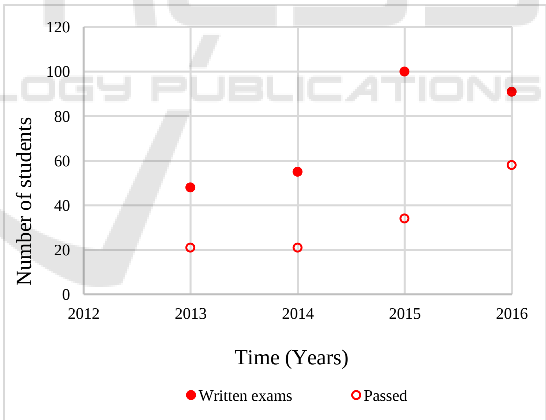

Figure 3: Annual intakes and pass rates.

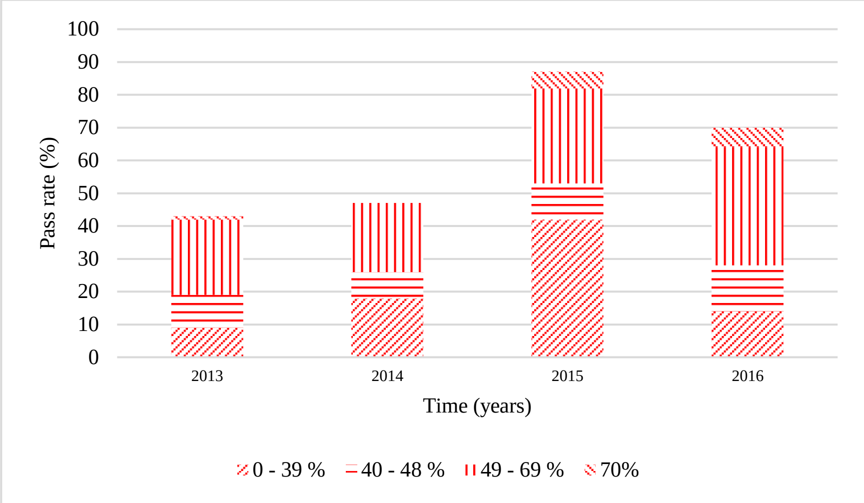

Figure 4: Breakdown of pass percentages.

3.1 Admission, Dropout and Success Rate

During the year 2013, there were 48 admitted students, and the number went up to 55 in 2014, a 100 in 2015 and dropped back to 91 in 2016. Two students dropped out in 2013, none in 2014, two in 2015 and only one in 2016. So generally, the module has a very low dropout rate, which is not often the case for difficult subjects such as this at many universities. The success rates of the modules will be presented and discussed under the results and discussion later in this paper.

4 DISCUSSION

Figure 2 shows a graph of an annual pass rate for the module structural steel and timber design. The percentage incorporate the number of students who wrote the examination and passed, those who failed and were granted supplementary examination and passed. The 2013 average results resemble more or less the results from the previous years, before the above mentioned interventions were introduced. The written lecture notes were introduced first in the year 2013, and the prescribed books of the previous years were changed to be a recommended (which means any student was not forced to possess them). Since the prescribed books have been for longer, students still adhered to it when preparing for the 2014 and 2015 examinations, which were rather based on the written notes. The contents and the standard were still the same as the book, but the approach and style of asking questions were improved. Hence, it took about two to three years to get students used to the style and approach in the notes. The average results for the years 2014 and 2015 were therefore not impressive.

Presented in Figure 3 is the number of students admitted annually for and passed the examination. In 2013, there were 48 students and 21 of them passed; the number increased to 55 in 2014 and 21 of them passed; a 100 students in 2015 and 34 of them passed and of 91 students in 2016 about 58 passed. The lower numbers in 2013 and 2014 led to the accumulation of students as most of those who did not pass will re-register for the following year.

However, it can been seen from Figure 3 that the number of students passing the examination is increasing annually but not with the same percentage. The gap or difference between the number of students who got admitted and those who passed the examination is those who failed or chose not to write. The number of students who passed the examination was further broken in four groups in order to see the actuality and worth of the results. The groups were 0 – 39%, 40 – 48%, 49 – 69% and 70% or above. From Figure 4, it is particularly encouraging that in 2016 the 0 – 39% group was the least compared to the previous years. In the same year, the both the 40 – 48% and 49 – 69% groups has increased in numbers; and that shows that the understanding of course material has improved, quality of ideas and decision making when writing the examination has increased. The number of distinctions has been increasing yearly from 0 to 6 in 2016.

Due to the complexity of the module, the students need to be aware of certain things that are not included in the syllabus (such as analysing the structure and deducing necessary information to help in the design process, calculating forces and stresses, as well as having a substantial knowledge of steel properties). The results presented in Figure 4 was therefore not taken for granted as they prove that the effort was extraordinary.

5 CONCLUSIONS

The intervention that were introduced made the module delivery to be effective and efficient. The average results improved annually and it was also found that the number of average performing students whose results falls in the 49 to 69% increased by 15%. The number of distinctions increased from 0 to 6 in a space of four years. In conclusion, it is convincing that the interventions must be kept and improved for the better, as the next goal is to reduce the number of students whose results falls between 0 and 39%.

ACKNOWLEDGEMENTS

The authors would like to thank the University of South Africa for the data used in this paper and funding they have provided for the work to proceed.

REFERENCES

Anderson, L.W. & Krathwohl, D.R., 2001. A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives, Longman. New York

Entwistle, N. J., Hanley, M., and G. Ratcliffe (1979). Approaches to learning and levels of understanding. British Educational Research Journal, 5,99-114.

Felder, R.M. & Silverman, L.K., 1988. Learning and teaching styles in engineering education, Engineering Education, 78 (7), pg 674 – 681

Howell, D.C., 2004. Fundamental statistics for the behavioural sciences, Brooks/Cole – Thomson Learning Inc. Belmont, USA, 5th edition

Heywood, J (2000). Assessment in Higher Education Student Learning, Teaching, Programmes and Institutions. Jessica Kingsley, London

Kneale, P (1997). The rise of the 'strategic student'. How can we adapt to cope? In S. Armstrong, G. Thompson and S. Brown (eds.). Facing Up to Radical Change in Universities and Colleges. Kogan Page, London.

Olds, B.M, Moskal, B.M & Miller, R.L., 2005. Assessment in engineering education: Evolution, approaches and future collaborations, Journal of Engineering education, Vol (11) pg 13 – 25

Siemens, G. (2015). Connectivism: A learning theory for the digital age, Https://members.educause.edu (Accessed: October 2017)

University of South Africa (UNISA), 2015. My Modules @ Unisa: Information, codes and purposes, University of South Africa, Pretoria

Vuc, G, Baloi, F, Litcanu, M, (2015) Adapting Methods of Student Evaluation and Grading in Electrical Power Engineering. Procedia - Social and Behavioral Sciences 191, 147 – 151.

Wilson,(1981). Wilson, J. D (1981). Student Learning in Higher Education. Croom Helm, Beckenham