



## A Review of Foundation Chemistry Teaching and Learning Material in a Four Year Engineering Programme

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### Abstract

*The Foundation Chemistry teaching and learning material, which consists of both learner materials and facilitator guides, was developed as a result of the re-curriculation of bridging programmes into foundation programmes and, subsequently, into extended national diploma programmes at the University of Johannesburg (UJ). Learner and facilitator guides, comprising of eleven teaching and learning sequences, were developed for each module in the four year engineering diploma programme (extended diplomas), including the Foundation Chemistry module. Between 2009 and 2012 these materials were updated annually based on lecturer feedback during materials review meetings and on student feedback. This process serves as one of the quality assurance mechanisms of the Academic Development Centre (ADC). This study discusses a review of the material that was carried out after the three year period that was informed by a student evaluation conducted by the UJ's teaching and module evaluation experts, the Centre for Professional Staff Development (CPASD) and feedback garnered from an interview with the Foundation Chemistry lecturers. During the evaluation, a questionnaire was administered to ascertain the Extended Mechanical Engineering Diploma students' perceptions of the Foundation Chemistry module and for the purposes of this study those questions that focused on the learner material were analysed to identify trends that emerged from in the students' experiences. The findings indicated that most students believed that the learner material supported and facilitated learning, encouraged critical thinking and assisted their understanding of content. Furthermore, they were of the opinion that the assessment tasks in the materials improved their problem-solving skills. Students also requested that additional examples be included in the exercises and activities as well as the more challenging and exam-type questions in the assessment tasks. During the interview, lecturers highlighted the need to align the outcomes in the teaching and learning sequences with the learning guide outcomes and suggested that the content be rearranged accordingly and that where relevant, activities either be replaced or be contextualised in some of the teaching and learning sequences. Both lecturers and students requested that aids such as graphs, diagrams and tables be included in the teaching and learning sequences as well. Finally, the study concludes with a discussion on how these changes have been implemented.*

### 1. Introduction / (Theoretical) Background / Framework and problem / Aims / Research questions

With the massification of education in South Africa, there was an influx of underprepared students into higher education institutions which necessitated the development of Access Programmes. These Access Programmes take the form of bridging, foundation and extended programmes. The Academic Development Centre: Access (ADCA) at the University of Johannesburg offers extended programmes in Management, Engineering and Humanities faculties. The modules in the extended programmes take on a different form to the modules in the mainstream programmes. They have academic development principles and foundational provisioning interweaved into the mainstream content in order to provide students with a solid foundation in their discipline. This interweaving of the academic development and foundational provisioning into the content has necessitated the development of teaching and learning materials in all modules. This materials development process in all modules in the Access Programmes



began in 2004 with the re-curriculation of bridging programmes into foundation programmes and, subsequently, into extended programmes. All the teaching and learning materials are developed according to a specific ADCA template. Foundation Chemistry is one such module where materials which consist of both learner materials and facilitator guides were developed. Faculty lecturers who taught in the programme were contracted to develop these materials in each of the relevant modules, while a senior subject specialist (who is also an academic development specialist), who coordinates and manages all aspects of the module which is being developed, took on a mentoring role due to their teaching background. The lecturers who were developing materials were given specific criteria and guidelines to follow during a materials development workshop. The mentor had to ensure that the content was appropriate and that the ADCA teaching and learning methodology was adhered to while acknowledging that there is no one approach to the teaching and learning of specific content to maximize students' understanding [2]. The ADCA prides itself on integrating its teaching methodology into the teaching and learning materials. The materials are therefore context-specific in order to enhance the quality of the teaching and learning. The facilitator guide is designed in such a way as to provide lecturers with a possible teaching strategy based on academic development principles being built into the teaching and learning sequences. The learner guide, on the other hand, supports and promotes students' learning, facilitates student engagement and provides opportunities for the clarification of meaning while teaching as espoused by [2]. It also enables students to prepare for lectures beforehand. In addition the students are encouraged to use textbooks to supplement the learner material.

The senior subject specialist and the subject lecturers review the teaching and learning materials annually and provides verbal and written feedback to the lecturer that writes the material. However, in 2012, the review of materials differed in that it included students' feedback (the student voice) which was missing previously. There are very few studies which focus on the review of teaching and learning materials which includes the student voice. Most studies on materials development focus on e-learning and distance learning material. The focus of this study was the review process of the Foundation Chemistry learner materials and facilitator guides, in the Extended Mechanical and Industrial extended Engineering programmes in the ADCA at the University of Johannesburg. [4] suggests that reviews of materials are part of internal quality management processes. Therefore in order to ensure quality, student-friendly and well-developed material which supports good teaching and learning, the ADCA annual materials review is necessary. Each lecturer who was developing materials had to sign a contract which stipulated that they had to update the material annually over a period of three years based on the feedback provided by the lecturers who were lecturing the module. Few reviews and evaluations of teaching and learning materials that have been developed for students have been reported in the literature. Even those which have been reported, lack the student voice. This could be due to the students not being given the opportunity to evaluate the materials or due to their lack of skills to meaningfully appraise the materials [4].

In this study the review process of the Foundation Chemistry materials after a three year period is discussed. The changes were based on lecturers' feedback during materials review meetings and students' feedback derived from a module evaluation done by The Centre for Professional Staff Development (CPASD) at the University of Johannesburg. The aim of the study is to explain how the Foundation Chemistry materials were reviewed and the findings of the review. In particular the following research questions were explored:

1. How was the Foundation Chemistry material reviewed?
2. What were the findings of the Foundation Chemistry material review process?

## **2. Methods and Sample / Mode of inquiry**

This is a qualitative case study carried out in an access programme at a comprehensive university in Johannesburg where the researcher is employed as a chemistry subject specialist. The feedback from the



senior subject specialist, two lecturers (Miss D and Mr N) and the first year students in an extended Mechanical Engineering diploma was analysed. The senior subject specialist coordinates, teaches and manages the Foundation Chemistry module in the extended Mechanical Engineering class and both lecturers teach the module in the extended Industrial Engineering classes.

Data were gathered primarily through feedback provided by:

- The senior subject specialist during mentoring meetings;
- The lecturers during subject meetings;
- The senior subject specialist's one-on-one meetings with the lecturers;
- The students in the extended Mechanical Engineering class.

The feedback was in both written and verbal format but was also communicated to the writer of the materials verbally during the mentoring sessions. The student feedback was communicated in writing by staff from CPASD to the senior subject specialist. According to the analysis report, 30 of the 35 students in this class responded to the questionnaire. Eight of the twenty five questions in the questionnaire elicited feedback on the learning materials. Most of the questions were in the form of a statement and required students to respond using the following Likert scale: 0 - not applicable, 1- strongly disagree, 2 – disagree, 3 – agree, 4 - strongly agree [1]. Two of the questions elicited open-ended responses. Most of the students were from disadvantaged backgrounds and all of them were second-language English speakers.

### 3. Data analysis and Results / Findings

#### 3.1 Subject meetings, mentoring sessions and one-on-one meetings

The data elicited from the feedback of the senior subject coordinator and the two lecturers were analysed and the themes which emerged included learning outcomes, didactical structure and relevance of content, teaching and learning aids, activities and assessment tasks. The findings which have been listed below are arranged according to these themes. The findings from this feedback highlighted:

1. The need to align the outcomes in the teaching and learning sequences (units) to the outcomes in the learning guide issued to the students at the beginning of each year. Once this is done, the relevant content must be re-arranged accordingly;
2. Where relevant, activities in some of the teaching and learning sequences should either be replaced or be contextualised;
3. Some of the activities should be made optional for students;
4. The need for a variety of assignments to be included in the unit as the assignments had become monotonous;
5. The need for additional supplementary exercises to be included to give students the opportunity to practise;
6. The need to re-examine the order in which the teaching and learning sequences were presented.

#### 3.2 Students in the Extended Mechanical Engineering class

For the purpose of this review, those questions that focused on the learner material were identified and analysed to establish trends from the students' experiences, as shown in figure 1 below. Each of the responses to the eight questions was marked out of a score of 4. According to the Likert scale 4 is strongly agree and 0 is not applicable. The range of scores for the eight question was between 3.0 and 3.7 as shown in the graph in figure 1 below, with the first question being the highest score, and the last being the lowest score. Most of the students' responses indicated that the learner material supported and facilitated learning and promoted the understanding of the content. They were also of the opinion that it encouraged them to think critically. Furthermore, they believed that the assessment tasks in the material improved their problem-solving skills.

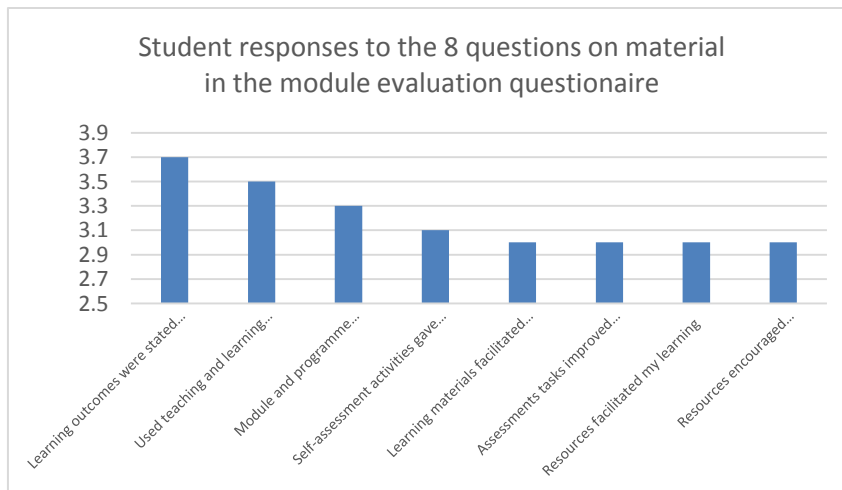


Fig.1. Graph representing student responses to the 8 questions on module material.

The analysis of the responses to the eight questions on the teaching and learning material in the questionnaire indicated that the strongest aspects of the module were:

- Learning outcomes were stated in the learning guides;
- Teaching and learning materials were used to support learning;
- Self-assessment activities gave students an understanding of their progress;
- Learning materials used facilitated learning;
- Assessment tasks improved thinking skills;
- Resources facilitated students' learning ;
- Resources encouraged students to think.

The findings from the open ended responses of the students highlighted:

1. The need for teaching resources such as graphs, slides and more practical work to be included;
2. The need for more tasks to be included in the materials;
3. Units 1 to 10 should be handed out to students once as a book rather than one by one;
4. The units need to have more examples for students to work through;
5. The need for more challenging and exam-type questions to be included in the assessment tasks;
6. Teaching and learning aids such as graphs, diagrams and tables should also be included in the teaching and learning sequences.
7. More illustrations should be added to these learning materials.

There were some mixed responses especially when students were asked about whether the learner material supported learning and thinking. Some students claimed that the materials did support learning but contradicted this when they said that it was not challenging.

#### 4. Conclusions and Implications

In conclusion, the findings of the analyses of the data showed that the materials needed to be reviewed by all stakeholders involved in the teaching and learning of Foundation Chemistry. Furthermore, the findings





from the materials review show that the feedback from both the students (student voice) and lecturers provides a broader perspective on the revisions that need to be implemented and also add value to the materials review process. [3] suggests ,

*“The systematic study of design and evaluation of educational interventions - such as teaching and learning sequences - not only aims to provide solutions to complex problems in educational practice, but also to advance our knowledge about the characteristics of these interventions and the process of designing, implementing and evaluating them”.*

However, future materials reviews of the foundation chemistry materials could involve a more diverse group of students and not only students in the Extended Mechanical Engineering class. Currently the researcher as the subject specialist has summarised the findings from the stakeholders’ feedback and communicated it to the writer of the material. The writer is in the process of updating the material unit by unit. The learner material is therefore a document in progress.

## References

- [1] Centre for Professional Staff Development (2012) Report on Students’ Perception of Module Foundation Chemistry FSPC11A, 2012. University of Johannesburg.
- [2] LEACH, John, AMETLLER, Jaume and SCOTT, Phil (2010). Establishing and communicating knowledge about teaching and learning scientific content: the role of design briefs. In: KORTLAND, Koos and KLAASEN, Kees, (eds.) Designing theory-based teaching-learning sequences for science education: proceedings of the symposium in honour of Piet Lijnse at the time of his retirement as professor of physics didactics at Utrecht University. Flsme series on Research in Science Education (64). Utrecht, NL, CDBeta Press, 7-36.
- [3] Lijnse, P. (1995).”Developmental research” as a way to an empirically based ”didactical structure” science. *Science Education*, 79(2), 189-199.
- [4] Stellenbosch University (2011) Policy on Teaching and Learning materials. 2011.