



Faculty and Student Experiences of Curriculum Reform: A Case Study of the Chemical Engineering Program at the University of Cape Town

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Introduction

This research paper describes a study that investigates a recent process of curriculum reform in an undergraduate engineering program. Curriculum continues to hold a prominent space in discussions around engineering education, yet there are limited exemplars of full scale curriculum reform around the globe. At the University of Cape Town (UCT) in South Africa, the design of the new chemical engineering curriculum drew on contemporary shifts in thinking about the engineering profession [1, 2], as well as a focus on widening access to the degree and coupling this with success. Furthermore, engaging with current deliberations on the problem-based curriculum, this design took on a problem-centered focus [3]. This curriculum design demanded a far more integrated mode of course delivery than is typical in a traditional engineering curriculum. The overall process from initial deliberations through to implementation took place over nearly a decade, and the first graduating class is in 2017.

The study to be reported in this paper on took place during the year in which the final year of the new curriculum for the four-year program was implemented. Both instructional faculty and teaching assistants involved in delivering the new curriculum, and final year students who had been the first cohort through the curriculum were surveyed in an open-ended questionnaire. The study aimed to move beyond a simplistic assessment of the reform to take a close look at perceptions of the reformed curriculum, in order to offer critical insights to the field. We were particularly interested in exploring challenges experienced during the process of change, both for faculty and for students.

The present study

In this study, we wanted to get beyond typical methods of evaluation which result in relatively superficial assessments of whether the innovation was perceived to be successful in meeting its needs. Recognizing the complexity of the student experience in studying engineering, the challenges in teaching, and the potential for contradictory experiences, we needed a research design that would allow us to capture more detailed responses. At the same time we wanted to survey the class broadly, noting that there is significant diversity in student background and performance.

We therefore opted for a survey methodology, but chose a purely open-ended format with very limited questions, to prompt for expansive responses. Following a preamble detailing the person's role in the curriculum, respondents were asked three main questions:

1. In your view, what are the main features of the new curriculum?
2. What do you see as the main advantages of the new curriculum (from the perspective of students)?
3. What do you see as the main disadvantages of the new curriculum (from the perspective of students)?

Faculty and teaching assistants were also asked to respond to the second and third questions from their perspective. Finally, students were asked about the experience of being the first cohort in the new curriculum, and faculty and teaching assistants were asked about the way this experience had influenced them professionally.

Standard qualitative coding methodology was used to identify themes in the data. For the purposes of this paper reporting on the preliminary analysis, we started with the responses to the first question referring to what respondents saw as the main features of the new curriculum. From this analysis we noted the prominence of the block structure. In the analysis of responses about advantages and disadvantages, we were struck by prominent contrasting perceptions about the impact of the block structure on conceptual learning, and we thus chose to explore this somewhat for this paper, linking it also to perceptions on the overall assessment outcomes.

Findings of the study

As noted above, one of the key drivers for the new curriculum was an intention to improve the quality of learning. The block structure was implemented so that students would only be working in one conceptual area at a particular time. Instead of one class session per day on a topic and a weekly afternoon tutorial, from second year onwards students would spend at least two sessions in the morning and two full afternoons in the week on a particular topic.

There were many responses stating that students felt the block structure helped as they only had to focus on one topic at a time and that this could aid conceptual mastery. There were also many responses that the intensity of the block structure worked against conceptual mastery as there was not enough time to grapple with conceptual challenges. We have given these two categories of responses respectively the shorthand 'Better Learning' and 'Worse Learning'

Significantly, many students gave responses in both these categories, for example in this response from a student to questions 2 and 3:

Main advantages:

Taught one thing at a time instead of learning different material in different courses concurrently ['Better Learning']

Main disadvantages:

Not enough time to consolidate work taught (especially on long days with two morning periods and 3 afternoon periods) - was taught something in the morning and expected to understand before the afternoon lecture that teaches a new thing following from the morning lecture. ['Worse Learning']

[S07]

Figure 1 shows the proportion of respondents mentioning each of these points, and importantly shows those who gave both (apparently contradictory) responses.

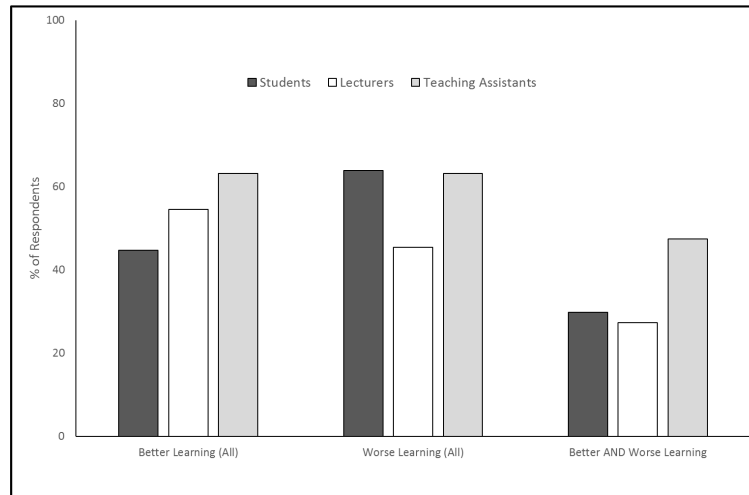


Figure 1 - Frequency of Comments on Learning Outcomes for Different Groups of Respondents

The responses coded as those indicating that the block structure helped their learning ('Better Learning') were defined as those with references to 'understanding', 'conceptual understanding', 'concepts' etc. It is interesting that so many students in this program use these terms to talk about their learning. In terms of how the curriculum structure had aided this kind of learning, many made reference to focus, attention and concentration, for example:

focusing on one material at a time is helpful in keeping the attention and focus on it [S43]

focus on one concept at a time more intensely [S36]

However, as noted at the outset of this section, there were also many responses that felt that while it was good to focus on one conceptual area at a time, that the curriculum structure did not have enough time for this to take place, and that overall this compromised on the possibilities for conceptual understanding, what we termed above with the category 'Worse Learning'.

One aspect is the inevitable trade-off when moving to a more modular structure, which is that students have to move through a whole new topic in a relatively short space of days. Many students made comments that not only was this exhausting, but that it worked against their mastery of the concepts:

Having a whole day of lectures, theoretically, allows students to focus on the work and ask questions in a ordered, consecutive manner. Unfortunately, owing to the long days [specifically in CHE3005W] this was not achieved practically as the long hours is exhausting for the student and the lecturers. Additionally, it was difficult to not really know anything about the topic at 10h00 and then by 18h00 essentially finishing two weeks worth of information. If one did not understand a concept or if one needs time to reflect on the work to fully understand it, meridian was the only time to do so to ensure that one understood everything. [S47]

Thus, in contradiction to the intention and the perception that the block structure allowed for better conceptual understanding because of handling one topic at a time, the view was also put forward by many that the fast pacing of individual blocks mitigated against

understanding, and while students might have passed the overall assessments that their understanding was poor. A number of students expressed personal regret over this.

This leads into a broader debate also reflected in the survey responses on the overall assessment outcomes achieved by the first cohort of students in the new curriculum. As noted above, the overall throughputs to graduation were higher than with previous cohorts, and students offered many comment on this even though the survey did not explicitly prompt them to do so.

Overall assessment outcomes

As shown above, early indications are that the new curriculum meets its intentions of better facilitating student progression through the curriculum. Although a fear was still stated by a fair number of staff and students that failing a full year course would be consequential, most students especially recognized that progression was more likely in this curriculum.

There were thus many comments from students specifically (18/47 students) around a perception that it was 'easier to pass' in the new curriculum. For many students, this was not necessarily that the assessments were 'easier' but that the whole structure with multiple assessment points, clear organization, and a holistic assessment decisions allowed for more students to achieve passing results.

There was also a group of [9] students who also felt it was 'easier to pass' in the new curriculum, but felt strongly that some students who were passing who should not be passing. Some of these comments referred to the system just noted that one weaker block could be mitigated by performance in others, but mostly comments centered especially on the assessment of groupwork in the course.

Discussion and Conclusion

The study points to the complexity of actually implementing curriculum reform, rather than just talking about it as is the more common practice. Beyond any simplistic statements around the difficulty of change, what this study shows is the very real challenge of changing structures to support learning. With limited time in the academic year, a move to a blocked structure, while theoretically good, does result in an intensity which can work counter to its intentions. And changing an assessment structure which gives more opportunities for assessment, and a holistic progression decision, while desirable for even intrinsic reasons of removing unnecessary hurdles to progression, will have varying perceptions in the student body, especially those who typically achieve well.

References

- [1] IChemE, "A Roadmap for 21st Century Chemical Engineering," 2007, Available: www.icheme.org/roadmap2007.pdf.
- [2] V. Gomes *et al.*, "Chemical engineering curriculum renewal," *Education for Chemical Engineers*, vol. 1, no. 1, pp. 116-125, 2006.
- [3] C. Crosthwaite, I. Cameron, P. Lant, and J. Litster, "Balancing Curriculum Processes and Content in a Project Centred Curriculum In Pursuit of Graduate Attributes," *Education for Chemical Engineers*, vol. 1, no. 1, pp. 39-48, 2006.