

## **Using case studies to promote meaningful engagement in complementary studies for Engineering students**

### **Herbert Wolfgang Bernhardt**

*Faculty of Engineering and the Built Environment, Durban University of Technology, Durban, South Africa.*

[herbert@dut.ac.za](mailto:herbert@dut.ac.za)

Complementary studies are an essential part of South African accredited engineering programmes. Pienaar (2001) maintains that the studies are “aimed at developing future engineers in a more holistic manner and preparing them to cope in a rapidly changing world”. Most students approach complementary studies as “learning” (more accurately “memorising”) subjects rather than “doing” subjects like design or the typical technical subjects of the engineering curriculum.

The problem for the educator is: how does he/she structure the course to assist the students to learn to “cope in a rapidly changing world”. The latter aim is unpacked in terms of the following competencies: to communicate effectively, to demonstrate social responsibility, to act ethically, to work in teams and to manage effectively. The author argues that these competencies cannot be acquired by rote learning.

In this paper the author explores using a problem theme, namely “corruption”, as a vehicle to promote engagement by students in situations encountered in the real world. He used media articles on corruption as case studies. Appropriate questions that encourage students to think critically and engage in higher-level learning (Ertmer, Sadaf, & Ertmer, 2011) were given as online tasks.

The methodology used to evaluate if the use of a theme like “corruption” did indeed succeed in promoting engagement by students was case study research (Yin, 2009). The research questions asked were: (i) How did the use of the theme “corruption” stimulate students’ engagement with the subject matter? and (ii) Was this technique effective in promoting engagement? The students were invited to fill out a questionnaire to assess the extent of engagement.

Analysis of the answers to the questionnaire, as well as the responses to tasks the students had to complete around the theme of “corruption” using an online course management system (Moodle) showed that significant engagement did indeed take place, and that this technique can be considered effective in promoting student-centred learning.

### **Introduction**

It is recognised worldwide that in any engineering field there is a need for undergraduate students to be exposed to courses in the knowledge area called complementary studies. This knowledge area is very broad and includes courses on sociology, psychology, the arts, economics, management, and the humanities. There are vast numbers of subjects that students from different universities can choose from, but little seems to be written about the challenges of teaching these courses.

Complementary studies are often considered by students and lecturers in the engineering field as less important than “main-stream” subjects such as design, or technical subjects like thermodynamics, heat transfer, and the like. The distinction between “soft skills” that are typically part of complementary studies versus “hard skills” that require preciseness, advanced calculation techniques and rigorous logical reasoning adds to that perception. Furthermore, the term “complementary” implies the notion of “completing”, “supplementing” or “adding-on” reinforces the perception of being less important. The author argues that this perception

influences both the delivery mode of the lecturer as well as the study methods used by the students. This perception of being “less important” is also reflected in the allocation of resources (or lack thereof) for subjects in the area of complementary studies. Typically classes in these subjects are large, because of the combination of a number of disciplines. No provision is made for small tutorial groups run by specially trained tutors and often there is only one lecturer designated to teach the whole course. It is generally accepted that multiple choice type questions are deemed adequate for assessment purposes, and they are used to make the marking load manageable.

### **The Place of Complementary Studies in the Engineering Curriculum**

The objectives for complementary studies in undergraduate engineering courses were elaborated by Pienaar (2001). They include the development of:

- “Wealth-creating and innovation skills
- Communication and interpersonal skills, and
- Ethical, social and environmental values and responsibilities”

The need for practicing engineers to appreciate the bigger picture, which students of complementary studies are supposed to learn, is undisputed. The importance placed on complementary studies in the training of future engineers is reflected in the criteria for accreditation. In South African professional engineering degrees at least 56 credits (out of the total 560 credits) must be devoted to this knowledge area, as elaborated in the *Whole Qualification Standard for Bachelor of Science in Engineering (BSc(Eng))/Bachelors of Engineering (BEng): NQF Level 7* issued by ECSA (2004). The trend to place similar significance to complementary studies is world-wide, as described by Prados (2005). The Accreditation Board for Engineering and Technology ((ABET), 2012-2013) stresses as important outcomes “the ability to function in multidisciplinary teams, a knowledge of contemporary issues and the ability to communicate effectively”. The need to appreciate the bigger picture is recognised in the achievement of the following Critical Cross Field Outcomes listed in the Qualification standard (ECSA, 2004):

- Working effectively with others as a member of a team, group, organization and community.
- Collecting, analyzing, organizing and critically evaluating information.
- Demonstrating an understanding of the world as a set of related systems by recognizing that problem contexts do not exist in isolation.
- Contributing to the full personal development of each learner and the social and economic development of society at large.

### **Teaching/Learning strategy**

The perception by students about the relative unimportance of the knowledge area, combined with the environment (large classes) in which these courses are delivered, presents a major challenge to the lecturer. The need to be creative and innovative demands more from the student than to engage in rote learning of facts and information available in textbooks and lecture notes. Pienaar (2001) suggests that “application of unique instructional learning methods and activities” is required for effective teaching of complementary studies. From a theoretical perspective, a teaching strategy must be devised which promotes student-centred learning, as opposed to content-centred learning. Pienaar (2001) highlights the need for student-centred learning activities.

To be creative and innovative requires critical thinking. This implies that students reflect on their proposed solutions to problems in terms of these being realisable. Student-centred learning

also suggests that assessment should be formative, allowing for improvement and development of students' skills and understanding, rather than simply providing evidence of meeting requirements of the course (pass marks). It is argued that effectual learning in complementary studies can only be achieved by meaningful engagement in the knowledge area as well as the environment in which it applies. Engagement for the purpose of this paper involves students analysing the information presented, trying to understand the situation, thinking and drawing conclusions about consequences of actions described and making predictions of how they would act if placed in similar situations. Engaging students in the learning process remains a challenge, particularly if the body of knowledge in the course is extensive and if students have not had significant exposure to the type of reasoning that is required in the subject. It is argued that one way for students to learn this is to engage with real problems that affect society.

In this paper the author explores using a "problem" theme as a vehicle to promote engagement by students in a course called Engineering Management and Labour Relations. The problem theme chosen was "corruption". The reason for choosing this theme was that in South Africa numerous articles on alleged corrupt actions by prominent leaders in government and business currently appear in the newspaper. A selection of such articles was used as case studies with which the students had to engage. The intention was to focus on a widespread social problem and use it to illustrate a number of aspects of management practice. For example, when dealing with decision-making, a newspaper report of bad decision-making in a particular situation (see comments related to the article Ethekeeni Councillors and the Manase Report lateron) was used. The students had to read the article and answer questions which stimulated them to reflect on the consequences of poor decision-making and suggest ways in which better decisions could have been taken in the given situation. During the course the students had to tackle issues such as the origins of corruption, its consequences, as well as studying ways of rehabilitating an organisation that has been guilty of major corrupt activities.

### **Student engagement**

A blended learning approach was adopted by which the theory covered in the lectures and course notes was applied to case studies of corruption. The rationale was to attempt to create a "learning community" (Zhao & Kuh, 2004),(Cross, 1998) within the class which consisted of engineering students from five different engineering disciplines. The subject is studied by all engineering students in the Faculty of Engineering at the university, and student numbers in the class are more than 350. Research has shown that learning is far more effective when students are actively involved – when they have to do something (Felder & Brent, 2009). In the learning strategy outlined above the students had to read a particular article, analyse the information presented, engage with the situation in terms of making value judgements on appropriate/inappropriate actions and suggest better ways of dealing with problematic situations. The learning community was the whole class that was required to do certain online tasks which involved answering questions and posting their answers in the form of forum comments. These comments could be read, and responded to by other class mates as well as the lecturer. The lecturer read the comments and then highlighted some of the more insightful ones during subsequent lectures. Thus the students felt engaged in that their input was being evaluated and feedback was given during lecture time or in the form of online postings by the lecturer. The students were told that their postings would receive marks (up to a maximum of 5% of the overall mark for the module), but not all postings were graded. Care was taken in designing the questions. The aim was for the students not merely to show that they understood the particular situation dealt with in a particular case, but that their engagement required higher level thinking (Ertmer et al., 2011).

Learning communities were also created within the class by multidisciplinary teams (of 4 to 6 students from 3 different engineering disciplines) that had to do the course assignment which

carried 15% of the overall mark of the course. The students were given opportunities to form their own groups. This in itself promoted engagement with each other. The assignment addressed the outcome: working effectively with others as a member of a team. It was also designed around the theme “corruption”.

Some brief details of the assignment are given here.

*One month ago an investigation by independent auditors has revealed that two of your fellow executives have been guilty of using bribes (which were paid from company funds) to secure lucrative contracts with major clients.*

Each group of students had to formulate a strategic plan to limit the damage that had been caused by the corrupt action of former colleagues, and put the company on track within 12 months as one of the leading suppliers of sophisticated control hardware.

Students were given the following guidance as to what should be included in the strategic plan:

- “Assessment of the impact on the profitability and reputation of the local and international operation as a result of the corrupt activity. Try and give a monetary value of the likely impact.
- Assessment of the impact on the morale of people working in the company that this corrupt activity must have had.
- Outline the structures that you will put in place that all company employees are aware of the consequences of unethical actions, and that everyone in the company knows what is expected of him/her as far as ensuring that the name of the company is not adversely affected by his/her actions.
- Your proposal should also include steps to ensure that people are not operating out of fear of trying new things or that they will be subjected to a witch hunt.
- Outline the steps that ensure that employees actively engage in understanding what values are beneficial for sustained business success and competitive advantage.
- Describe how you propose to develop a culture of commitment to “doing things right”.”

To successfully complete the assignment clearly required higher level thinking.

The aims of using a topical theme like “corruption” in stimulating engagement include:

- Making the subject interesting by exposing the students to complex situations
- Getting students to think critically in terms of causes and consequences of poor management practice rather than being passive recipients of pre-selected knowledge
- Giving students opportunities to express their thoughts clearly in writing

Care was taken that when students had to do certain tasks, these tasks were not beyond their capabilities. In other words, the intellectual challenge for the students was gradually increased to ensure that the students’ motivation was not destroyed. The lecturer deems it important that students do not generate fear about their ability to master a subject because of tasks that are perceived too difficult.

The case studies were used so that the students could envisage what they would do if they were managers that had to deal with the specific issues presented. Some of the engagement expected was on an individual level – students had to rely on their own ingenuity or creativity to perform the task. Other tasks required interaction with other students, such as the course assignment referred to above.

## **Research Method**

The case study research method was used to determine if this particular way of promoting

student engagement was effective (Yin, 2009). The research questions asked were:

1. How did the use of a theme such as “corruption” promote engagement with the subject?  
and
2. Was this an effective pedagogical strategy?

The students were informed in the first lecture of the lecturer’s intention to conduct some research on the effectiveness of using a theme like “corruption” to promote engagement with the subject material, and what kind of tasks they were expected to do. Reasons were given why the lecturer chose to use this method. They were also told that their responses to the tasks would count 5% of the overall final mark. A brief description of the type of tasks expected was given. Furthermore, as part of the research methodology, an anonymous survey would be conducted to try and establish the effectiveness of this intervention.

### **Data Collection**

Student engagement was tracked by counting and analysing the written comments to questions posed in tasks given to the students in an online course management system called Moodle. Some examples of student responses to online tasks are given below. In conducting the course the lecturer endeavoured to ensure that feedback was given in lectures every time the students had to complete a task. Written feedback on tasks, tutorials and tests was also provided via Moodle.

Finally, the students were requested to fill out an online survey which sought to establish the usefulness of this teaching/learning strategy to promote student-centred learning. In formulating the questions for this survey the author took care that questions were phrased in a way that would not influence the students’ responses (Krosnick, 1999). Some questions were repeated in a different format to establish reliability of responses.

The questions asked were in four categories.

Category I: Usefulness of the theme “corruption”

Category II: Level of questions/tasks

Category III: Promote Learning

Category IV: Open-ended

The complete list of questions is given in the Appendix. To most of the questions (except where indicated otherwise in brackets – see Appendix) the possible responses were:

- Strongly agree
- Agree
- Not sure
- Disagree
- Strongly disagree

### **Results**

The following brief example illustrates the way in which the students were encouraged to engage with instances of corruption that were used as case studies.

In one online task the students had to read a short report of a corruption scandal involving the international company Siemens. The students had to respond to the following question:

*The people involved in the Siemens corruption scandal were all highly paid competent professionals. Why do you think they would be tempted to corrupt activities such as paying*

*bribes to get tenders.*

Here are some of the responses. The responses have been edited to correct spelling and grammar mistakes.

“Money, power and greed go hand in hand. The more money you have, the more power you have in the world, so the temptation to have more money will always be there as long as we live.” This student tried to find causes that gave rise to the stated actions. In other words, he analysed a situation in terms of what prompted a certain response.

“Despite high and competitive salaries they were earning, the desire to amass wealth, power and prestige drove the workers to explore corrupt means. The higher up a person goes in the social ladder the more anxious he or she is to maintain and safeguard perpetual wealth.” This student highlighted the power that values (wealth) have on decisions (to use bribes to secure more contracts).

“When working for a multinational company like Siemens an employee's level of performance is judged more by their accomplishments than their deeds. This may have forced some of the employees to feel the need to go to the extreme in order to get the numbers that were expected of them. It may have been less about personal gain and more about trying to keep their job in the cut throat world that is business.” This student focused on the immense pressures that people in high positions experience to keep delivering what is expected from them.

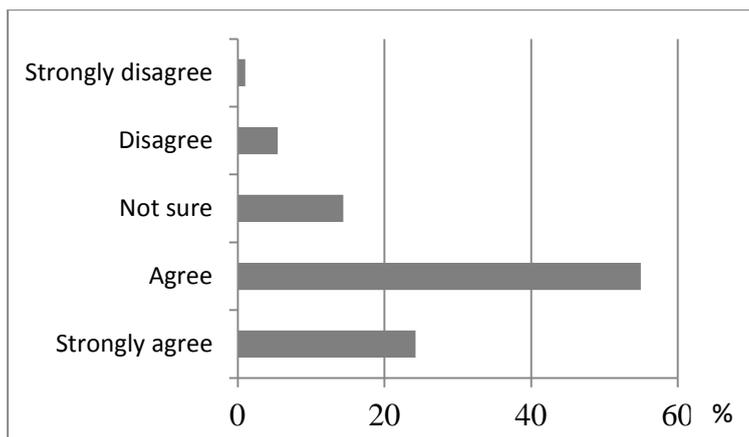
“Despite the high salaries and booming business that Siemens enjoys, the people at the centre of this debacle are probably the "keeping up appearances" type who have holiday homes in expensive locations and children who attend expensive private schools.” This response refers to the common situation where people live beyond their means, and have to generate more money to try and maintain their status in society.

Numerous other examples could be given of responses which illustrate that students did engage with the situation presented, in terms of collecting, analyzing, organizing and critically evaluating information.

While an analysis of the number and intellectual quality of the responses to tasks given in the form of Moodle forum submissions gives a fairly good indication of the effectiveness of this technique in promoting student-centred learning, the results of the survey gives a more comprehensive summary. Out of a student population of 353 for this course, 203 students filled in the survey. Filling in the survey was anonymous and voluntary.

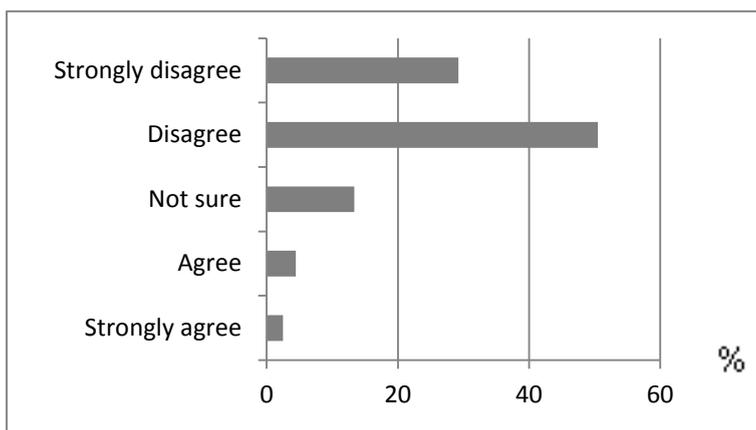
Responses in category I (usefulness of the theme) are indicated in the following graphs (figures 1 -4):

Figure 1 indicates that 79% of the respondents stated that they enjoyed doing the tasks on corruption. This shows that using the theme “corruption” did help to make the subject interesting to the students.

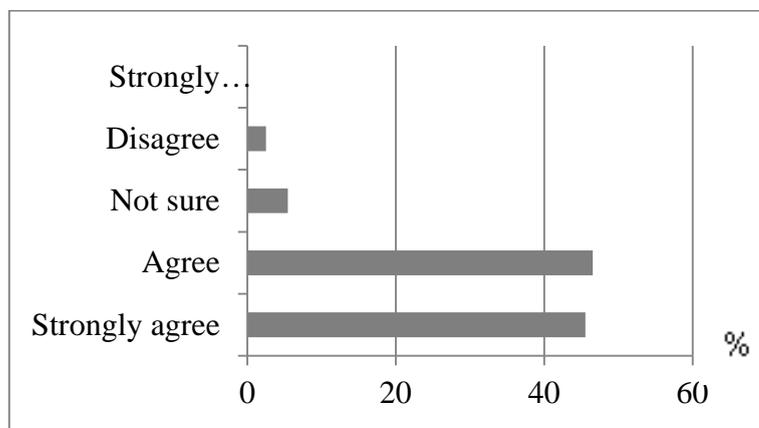


**Figure 1.** Responses to the question: I enjoyed doing the tasks on "corruption" on Moodle

In order to test the reliability of the data the same question was asked in two different ways. The questions that addressed this were: "I enjoyed doing the tasks on "corruption" on Moodle" [responses summarised in Figure 1] and "I did NOT see any benefit in doing the tasks on corruption set on Moodle" [responses in Figure 2]. These questions were given as questions 1 and 4 in the survey. The results show that the almost inverse response rate indicates a very high degree of reliability.



**Figure 2.** Responses to the question: I did NOT see any benefit in doing the tasks on corruption set on Moodle



**Figure 3.** Responses to the question: The theme "corruption" made the study material relevant to the real world

More than 90% (represented by options “agree” and “strongly agree”) of students indicated that the corruption theme helped to make the subject relevant (see Figure 3) to the real world.

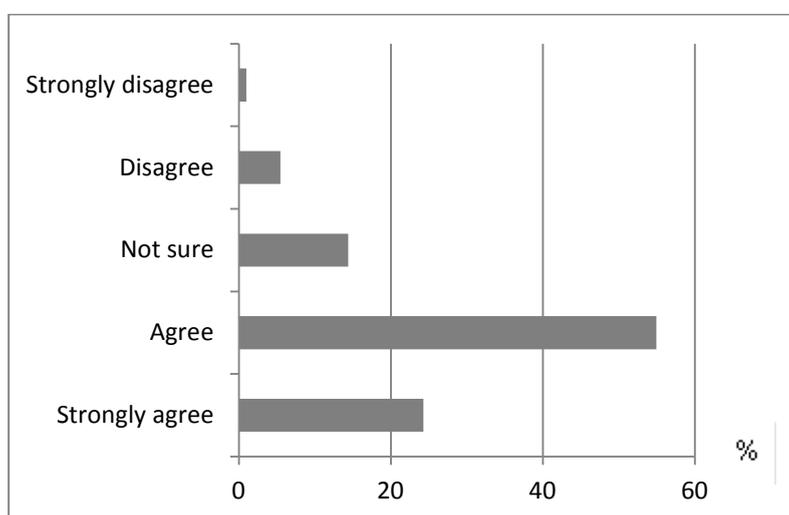
Figure 4 indicates that the theme helped students to get a more comprehensive understanding of the multidimensional nature of the functions managers have to perform. In other words, the theme helped students to broaden their understanding of the complex environments in which managers work.

An example of this is where students had to comment on the correctness or otherwise of the decision made by executive members of the Ethekewini Municipality according to which all councillors of Ethekewinin Municipality had to “swear to maintain confidentiality before they could read the (Manase) report”. The subject of the report was an investigation into irregular spending by the municipality of R532million, and the allegation that 10 councillors had done business with the municipality from which they had benefited.

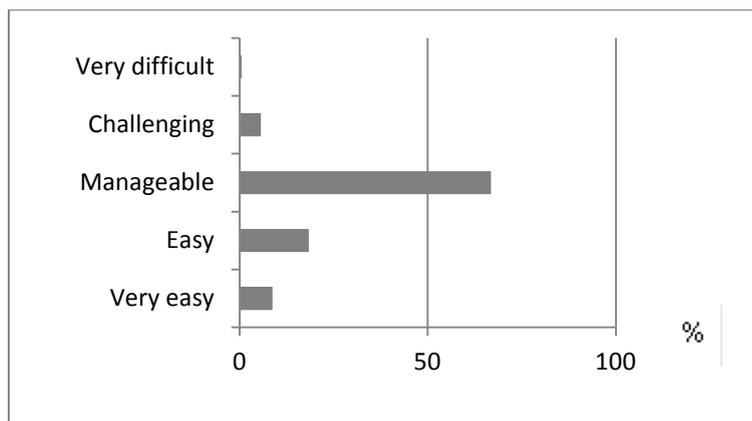
The following response by one student on this matter indicates that the student appreciates the complex environment in which managers have to make decisions:

“This is not confidential information. The information in the Manase report affects the public and the public has a right to know how their money is being spent. It is understandable that there is ongoing investigation but the right thing to do here is keep the public in the loop.”

Responses reflecting the intellectual challenge (Category II) associated with the tasks required to be performed by students under this theme are shown in Figures 5 and 6. Figure 5 shows that most of the students found that the tasks were not beyond their ability (manageable – 67%). 18.4% said they found the tasks “easy” and 8.7% rated them “very easy”. 5.6% rated them “challenging” and 0.5% as “very difficult”. It is probably fair to assert that the tasks given were not trivial, but within the capability of most students.



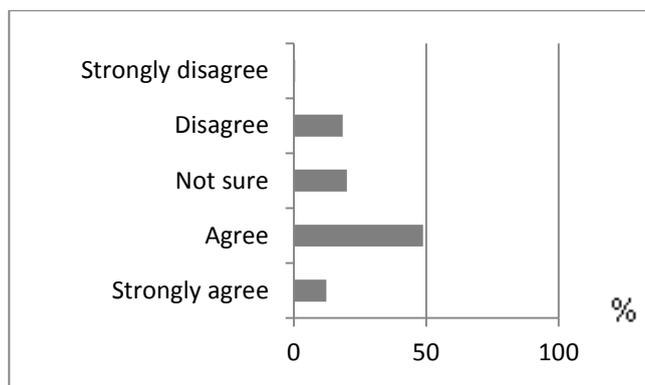
**Figure 4.** Responses to the question: Using a theme such as "corruption" helped me to appreciate the multidimensional character of the functions of managers



**Figure 5.** Responses to the question: I found the tasks to be completed on Moodle

Perception of the intellectual challenge posed by tasks that students had to complete is reflected in the verbal feedback by a number of students who were asked about whether doing the group assignment was easy or otherwise (after they had received the marks for their assignments, and had had an opportunity to look at their marked submissions). Not one of them said that they found it easy, and most of them described the task as challenging or “very” challenging.

Figure 6 indicates that 61% of students (“agree: 48.7% and “strongly agree”: 12.3%) found that the answers to the questions required advanced language skills. Thus the theme helped to give the students practice in communication tasks.

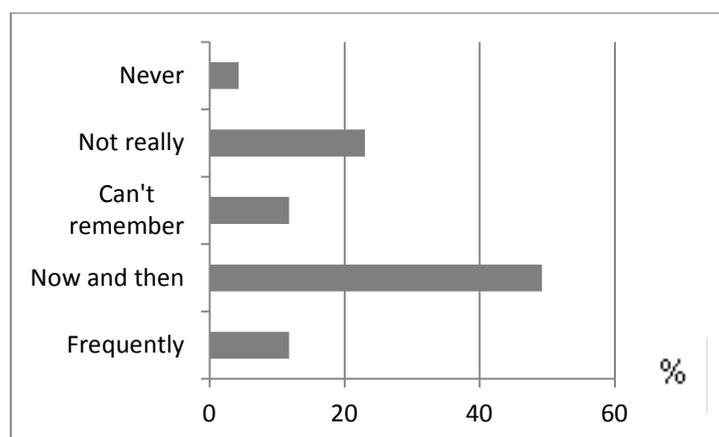


**Figure 6.** Responses to the question: I felt that the tasks set required a high level of language skill

The fact that many students did find it difficult to clearly express their thoughts in writing, as is illustrated by the following unedited response to one of the tasks, testifies that good communication skills were necessary to successfully do the tasks set. In answer to the question: Describe two consequences of forcing councillors to keep the information confidential, one student wrote the following unedited response:

“A major consequence of the confidentiality of this report for any Councillors that read this report , is that there is a rising doubt of their commitment to his best to serve the Public of Ethekwini, jeopardizing there credibility, and there is also a rising suspicion of Corruption within this report among the public.”

Under category III (promote learning) figure 7 shows that a significant number (61%: 11.8% “frequently” and 49.2% “now and then”) of students did engage in discussions with fellow-students on the examples presented under the theme corruption.



**Figure 7.** Responses to the question: I talked to my class mates about some of the problems of corruption presented in the course

Some of the unsolicited comments written by students in the survey under category IV (open-ended) are shown in Table 1 below:

**Table 1.** A selection of (unedited) comments

I like the current structure of the course. To truly understand the role of a manager and the importance and difficulty of this role, the students would have to read up on articles and cases on their own. Students should be encouraged to research further so that the relevance of this subject can be clearly seen.
More corruption examples and its impact.
Anything that is relevant to the south african business world
More real life examples to help us relate to the real applications

### Discussion of Results

From the description of students' written responses to tasks set on Moodle and the graphs presented in Figures 1 – 7 there is little doubt that the majority of students were stimulated to engage in an intellectually challenging way with the subject material through the use of case study examples presented in the form of newspaper articles on corruption. These case studies assisted them to relate management theory presented in lectures to real world examples. The examples also facilitated dialogue between students and the lecturer both by online discussions as well as in lectures through which real world issues were put under the spotlight.

### Challenges in making this Teaching/learning Strategy Work

The challenges to the lecturer to promote engagement by students using a topical theme include:

- Finding a balance between the amount of time spent investigating the actual problem/s, and dealing with the required knowledge content that the students are expected to master on completion of the course.
- Finding suitable examples that illustrate specific aspects of management practice. Here it is often necessary to make a choice of which aspects of a situation need to be highlighted, so that the relevance of the issue to the theoretical content becomes clear to the students.
- Posing appropriate questions that encourage students to think critically and engage in higher-level learning (Ertmer et al., 2011)

- Providing meaningful feedback to students so that they can make a value judgement on the appropriateness of their own responses, as well as identify the link between theory and practice.

## Conclusion

The author believes that the research question of how a theme like “corruption” promoted student engagement is answered by using carefully selected real-world examples that required the students to diligently analyse the facts presented. The issue of whether or not this method appears to have achieved its objective lies in the fact that students were challenged to think critically in order to answer the questions posed. Utilising this strategy does require extensive planning and careful integration between the knowledge material to be covered in the course and the case studies to be analysed, but the survey results and brief selection of student responses seem to indicate that the effort is worthwhile.

## References

- (ABET), Accreditation Board for Engineering and Technology. (2012-2013). Criteria for accrediting engineering programs. from [http://www.abet.org/uploadedFiles/Accreditation/Accreditation\\_Process/Accreditation\\_Documents/Current/eac-criteria-2012-2013.pdf](http://www.abet.org/uploadedFiles/Accreditation/Accreditation_Process/Accreditation_Documents/Current/eac-criteria-2012-2013.pdf)
- Cross, K.P. (1998). Why Learning Communities? Why now? *About Campus*, 4-11.
- ECSA. (2004). Whole Qualification Standard for Bachelor of Science in Engineering (BSc (Eng))/ Bachelors of Engineering (BEng): NQF Level 7 *Standards and Procedures System* (pp. 11): Engineering Council of South Africa.
- Ertmer, P.A., Sadaf, A., & Ertmer, D.J. (2011). Student-content interactions in online courses: the role of question prompts in facilitating higher-level engagements with course content. *J Comput High Educ*, 23, 157-186.
- Felder, R.M., & Brent, R. (2009). Active Learning: An Introduction. *ASQ Higher Education Brief*, 2(4), 1 - 5.
- Krosnick, J. A. (1999). Survey research. *Annual review of psychology*, 50(1), 537.
- Pienaar, G. (2001). The integration of complementary studies into the university education of engineers. *South African journal of higher education*, 15(3), 162-167.
- Prados, John W. (2005). Quality Assurance of Engineering Education through Accreditation: The Impact of Engineering Criteria 2000 and Its Global Influence. *Journal of engineering education (Washington, D.C.)*, 94(1), 165-184.
- Yin, R. K. (2009). *Case Study Research: Design and Methods* (4th ed. Vol. 5). Los Angeles: SAGE.
- Zhao, C-N., & Kuh, G.D. (2004). Adding Value: Learning communities and student engagement. *Research in Higher Education*, 45(2), 115-138.

## Appendix

Complete set of questions asked in the survey:

### Category I: Usefulness of the theme “corruption”

1. I enjoyed doing the tasks on "corruption" on Moodle
2. I would have preferred NOT to have the extra tasks on the theme "corruption"
3. The theme "corruption" made the study material relevant to the real world
4. I did NOT see any benefit in doing the tasks on corruption set on Moodle
5. Using a theme such as "corruption" helped me to appreciate the multidimensional

character of the functions of managers

6. Using the theme "corruption" to engage with the subject matter was: (*Extremely helpful, Useful, Of no benefit, A waste of time*)

7. If there had NOT been a theme such as "corruption" used to illustrate the concepts in the subject

- (*I would have battled to understand how one applies what is covered in the subject in the real world*)
- *The subject would have been less useful*
- *The subject matter would have been somewhat irrelevant*
- *I would have understood the subject matter well enough anyway*)

### Category II: Level of questions/tasks

8. I found the tasks to be completed on Moodle (*Very easy, Easy, Manageable, Challenging, Very difficult*)

9. I felt that the tasks set required a high level of language skill

10. From the examples on corruption presented in the course, I got an understanding of how complex it can be to be a manager

11. The reading material on corruption

- (*Was very informative*)
- *Was useful*
- *Was not very interesting*
- *Was irrelevant*)

12. The reading matter and questions that needed to be answered in the tutorial:

- (*Challenged me to think*)
- *Were interesting*
- *Did not require careful thought*
- *Were not useful*)

13. The use of the theme "corruption" stimulated me to read further articles on management

14. The examples used to illustrate "corruption" stimulated me to think deeply about causes and consequences of corruption

15. The questions asked in the test were challenging and required me to think

16. I have started implementing some of the suggestions I made in the test question on improving my time management. (*No, Yes*)

17. The theme "corruption" assisted me in APPLYING what I had learnt in the subject

### Category III: Promote Learning

18. The feedback given on tasks, tutorials and tests in written form, and verbally during lectures, helped me to evaluate if I was on the right track regarding my answers

19. The examples used in the theme "corruption" gave me practice in analysing situations in terms of causes, consequences and possible solutions

20. I talked to my class mates about some of the problems of corruption presented in the course (*Frequently, Now and then, Can't remember, Not really, Never*)

21. When answering questions on corruption I had to be careful to express my thoughts clearly and logically

22. As a result of our lecturer using of the theme "corruption" I definitely know more about management practice

23. The use of the theme "corruption" has helped me to reflect on my understanding of the concepts of effective management practice

Category IV: Open-ended

24. To promote deep learning in this subject, I would like to suggest the following: