Meeting challenges through innovation: Modelling as a way of assessment

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Abstract
Particular assessment practices can encourage certain ways of knowledge acquisition and processing. One challenge is to use assessment practices that foster creativity and encourage students to attain deep understanding through visualisation and integration of concepts.

To meet this challenge, the biological science lecturers at a New Zealand institute of technology started using modelling of dynamic processes as one way of summative assessment in 2012.

In 2014 surveys were done among lecturers and students to understand how these respective groups experienced this form of assessment.

Fair marking seemed to be one of the biggest challenges that the lecturers experienced since a number of lecturers were involved in assessing the models in the different classes.

Many students reported that they enjoyed the creative processes involved in this assignment. Using PowerPoint animation functions and presenting their models in front of other students made many students feel empowered. Most students were impressed with how much they have learnt about the particular topic through this assignment in comparison with what they have learnt during preparation for other assessments. The time spent on the modelling was however a concern raised by a number of students.

In this presentation the methods used in the modelling assignment and their evolution over time are explained. Some examples of student work are shown. More of the results of the above-mentioned surveys are shared. The changes implemented as result of the survey findings and the lecturer and student concerns and advice are described.

Introduction

Particular assessment practices can encourage certain ways of knowledge acquisition and processing of information. One challenge is to use assessment practices that foster creativity and encourage students to attain deep understanding through visualisation and integration of concepts.

In an attempt to meet this challenge, the Bioscience and Anatomy and Physiology bridging education lecturers at an institute of technology started using the modelling of dynamic processes as one way of summative assessment in 2012. Processes could be simulated using physical models with moving parts or any form of animation such as PowerPoint animations or photographed sequences of drawings or claymations. It was a requirement that the work may not include any copied material.

The envisaged advantages of this form of assessment were centred on the idea that it could encourage the acquisition of skills that are not necessarily encouraged by tests and exams including dealing with uncertainty, perseverance, creativity and problem-solving and sharing one's ideas with others.

In 2014 lecturers and students took part in surveys to understand how these respective groups experienced this form of assessment. This paper attempts to paint a picture of these experiences.

Background

It may be that lecturers often see measurement and testing as the main aim of summative assessment. Because validity, reliability and fairness of assessments are important, lecturers may sometimes be reluctant to venture into "different" assessments for summative purposes. Bridging courses aim to help students acquire the basic knowledge and understanding in subject areas like the sciences. Assessing in written form and mostly on lower cognitive levels in summative assessments may be tempting. From a quality control viewpoint written papers provide safety: the evidence is objective and hard to contest. Written tests and exams are convenient and lecturers use them confidently.

The problem with staying safe, is that according to research, summative assessment may have a strong influence on what is valued as important by the students and teachers and may direct teaching and learning. This is described as the *"washback"* effect that summative assessment (examinations) may have on teaching and learning (Crowe, Dirks and Wenderoth (2008:368, 379), Rajasekar (2008:12) and Spratt (2005:27).

Assessment should be about more than measurement and testing. It should also include evaluation and appreciation of creative products, processes, and performances (Coil 2014:49). Crowe, *et al.,* (2008:379) found that although most teachers in their study agreed that testing must include higher order cognitive levels, the analysis of this group's test and examination papers did not reflect this.

From the above-mentioned, one can assume that if summative assessment encourages operating on higher order cognitive levels by, for example, expecting integration of concepts and allowing for creative problem-solving, teachers will encourage these skills through their teaching and that students will prepare themselves in order to meet these demands.

The modelling assessment reported on in this paper asked the students to *visualize* and make *simplified dynamic representations* of processes. The topics for the models were mostly aimed at giving the students a chance to illustrate processes that they have learnt about (such as denaturation of proteins and formation of ions) in a dynamic way. Nine to twelve topics, all related to dynamic processes studied during the course, were given. Students were encouraged to work as pairs but individual work was allowed. Students had

to present the model in class in front of their class mates. The presentations were video-taped and saved on a shared drive for all lecturers to view.

Lecturers marked the models and presentations for comprehensiveness, correctness and understanding of the concepts using descriptive rubrics. Students used a different descriptive rubric to peer assess the model for quality. This peer mark accounted for 2.5 marks out of 10. Criteria were openly discussed with students beforehand.

The choice of a descriptive rubric to guide the marking was in line with Coil's (2014:52) advice that in the assessment of creative products, rubrics with descriptors for each of the criteria to be evaluated must be used. She advised that *"a scale of possible points should be assigned for varying degrees of mastery or quality."*

To ensure consistent marking, three samples of the assessment were pre-moderated by lecturers responsible for the marking. Afterwards post moderation was conducted by one of the lecturers. Marks were adjusted up or down if it seemed necessary.

Method

In 2014 questionnaires with open-ended questions were used to get a picture of how students and lecturers experienced the modelling assessment. Ninety-six students and their lecturers completed the questionnaires.

The student questionnaire simply asked students what they enjoyed, what frustrated them and what suggestions they had for the improvement of this assessment.

The lecturers gave their opinions on the pros and cons of the assessment. They suggested alternatives and possible modifications to the assessment. Some informal discussions were also conducted with lecturers to gain further insight into their experience.

Results

The student responses to the three questions are grouped under themes and tabulated. The lecturer responses are described and compared with the student responses.

Table 1 gives a summary of the aspects that the students enjoyed in this assessment.

Table 1: Student responses: Aspects that were experienced as enjoyable

THEMES	ENJOYABLE ASPECTS
1. Personal and social gains and experience	Working in pairs-interacting with others Discussing the topic, good communication Seeing other groups knowing and understanding the topic Gaining confidence Work ethics Having fun It was an amazing experience
2. In-depth learning	Learning in depth Learning more about the topic Researching and reading about the topic Giving me a visual perspective Remembering it so well and will never forget Understanding the topic better
3. Opportunity for creativity and creative problem-solving	Able to work independently on how to present Opportunity to use own ideas Finding creative ways to teach the topic Brainstorming: coming up with ideas for model Seeing idea come to life Different: taking you out of your comfort zone
4. Presenting in front of others	Explain in own words Presenting the model in front of class Sharing knowledge with others in class
5. Watching others present	Listening to the presentations of others Looking at the models of others Listening to different interpretations Some preparations were done very well Some presentations were easy to understand Giving marks to class mates
6. Technical empowerment	Learning about PowerPoint animations Finding the materials to make the model Making the model
7. Time management	We planned well

Seven sources of frustration were identified. Students found working as pairs frustrating as well as accessing, analysing and understanding the information. Their responses regarding aspects that they found frustrating are summarised in table 2 below:

Table 2: Student responses: Aspects that were experienced as frustrating

SOURCE OF FRUSTRATION	SPECIFIC EXAMPLES OF FRUSTRATION
1. Problems associated with working in pairs	Getting together when living far apart Partner not doing part Absenteeism / illness of partner/ self
2. Frustrations related to accessing, analysing and understanding and remembering information	Harder to find information on the topic than in other assignments Figuring out the topic Remembering the information Learning only about small part of the work Trying to make it concise Topic was broad making it hard to select the most important and relevant ideas
3. Presenting in front of others	Pronouncing "big" words Shyness, anxiety, stress and nervousness to present in front of class
4. Watching and listening to others present	Lecturer can explain better Some presenters were not enthusiastic Some presenters gave wrong information Pronunciation made understanding hard Some presentations were hard to follow
5. Technical challenges	Did not know how to use PowerPoint properly Did not know how to make PowerPoint animations Struggled to follow written instructions Was uncertain on how to do the model Had to remake model
6. Time management issues and timing of assessment	Time management No organized practice- finding time to rehearse No class time for preparation At end of semester –it should be done earlier Waste of time: could rather do revision, study bigger topics, write test
7. Financial issues	Physical model costs a lot of money

The question asking for suggestions for improvement (table 3) was misinterpreted by some students who gave suggestions on how they would approach the assessment differently if they had to repeat it. Many students saw no need for improvement. A number of students suggested improvements related to time and timing, marking and working in pairs.

Table 3: Student responses: suggestions for improvement

	SUGGESTIONS FOR IMPROVEMENT
Personal and social	Would rather want to work as an individual Would rather not be marked by other students Would like to mark my partner
Accessing information	Need more provided information Need better topics
Presenting	Class discussion after presentations
Time and timing	Topics should be given sooner More preparation time needed More time in class for preparation More time for presentation Assessment should count 15% of total instead of just 10% because it is time consuming

Lecturer responses

Lecturers reported that they could see many positive aspects in this assessment. They were of the opinion that students gained better and deeper understanding of the topic which was, according to two lecturers, also evident when students did their examinations later in the semester. It was reported that especially creative students enjoyed the differentness of the type of assessment and that it challenged students to integrate loose standing concepts.

Lecturers commented that the pre moderation session helped to ensure consistent marking.

Lecturers also found this assessment very challenging. Their fears centred on the perception that the presentations were very stressful to students and that the marking could not be carried out fairly by different lecturers. The difference in expectations that lecturers had of their students' performance was given as a reason for the fear of unfairness. This created discomfort and fear of being the one that is not *"judging like the others.*"

For this reason lecturers suggested that the judgement criteria should be scrutinized, clarified and simplified and every judgement criterion should focus on one aspect only. Other suggestions included that a panel or single person should mark all the models or that every lecturer could mark a certain topic for the whole class rather than a whole class with different topics.

It was also mentioned that the timing of this assessment should be carefully planned so as not to compete with too many other assessments.

Lecturers also suggested some alternatives to how the assessment was conducted. Students could create models with provided materials in class in a limited time. There was also suggestions that there should be less emphasis on the presentation of the model, that the students should present the model only to their lecturer to avoid exposure of other students to misinformation and that the weighting of the modelling assessment should be reduced to 5% instead of 10% of the total mark.

Discussion

Student experience
Analysis of the descriptions of their journeys in preparing and doing this assessment showed that valuable gains were made by many students. Higher order cognitive skills like analysis, visualisation and creative problem-solving were perceived to be encouraged. Personal attributes like perseverance and confidence were tested and built. Technical skills (such as research and making animations, using PowerPoint and other software) and social skills (like team work and presenting in front of others) were encouraged. These gains were not necessarily measured and/or credited, but were evident from student descriptions. Some of these gains are discussed in more detail below:

*Analysis***:** Even though the topics given were only given as single sentences, some students found that it was hard to figure out the topic. Some found it a struggle to follow the given guidelines since the instructions were quite wordy. Analysing the sourced information regarding the topic to identify relevant information was also a challenge. They had to be able to identify the steps in the process and place them in sequence in order to be able to make the model. Some students did not go to much depth with their analysis of the available information. This was evident in some clearly superficial and incorrect interpretations in some models.

Creativity and problem-solving: Using available resources to create an attention attracting correct model, even for well-known processes, was a challenge. Students had to use creative problem-solving skills to create the model. Divergent thinking enabled student to come up with many ideas. Convergent thinking brought them to selecting the most usable optimum idea(s). Some students reported that they struggled to decide about what to do and how to present the model. Ideas and opinions competed and even if they started with one idea, it sometimes turned out to be unworkable.

Visualisation: In developing this optimum idea, every step in the process had to be converted to an image and tested for correctness against the information available on the topic. These images had to be integrated to form a coherent whole. Students reported that the model gave them a *"visual perspective.*"

Perseverance: Some students reported that they had to start over because the first plan did not work out as expected. It sometimes led to a waste of physical materials, money and time. A minority saw it as frustrating and a waste of "learning" time and resources. One saw it as time that was wasted on one single topic during which the teacher could have taught them many things. For most, however, the model contributed to joy and fun when they finally found their workable idea and saw their idea come to life. One described the assessment as "*an amazing experience*."

Working as a pair: Both members of the pair had to participate equally and sensibly in all stages of the preparation and presentation. It took planning to ensure that each member of the pair had a fair share of the process to present. Most frustration centred on getting together as a pair, however many found the sharing of ideas and support invaluable.

*Presenting in front of people***:** For some students this was the hardest part of all. Some students reported that they were shy, anxious or nervous, but many also listed the presentation as an aspect that they enjoyed the most, even among those that saw it as daunting at first. Some reported that they gained confidence in the process.

*Technical skills***:** Students who opted for PowerPoint or other animations, were often unfamiliar with the techniques. They experimented, consulted video clips and asked for help from lecturers and peers in order to upskill themselves.

Research: The research for this assessment provided enjoyment to some and caused frustration in others. For some students it was frustrating at first but changed to enjoyment once they had sorted out what the expectations were and found relevant information. The process needed to be well understood and steps that could be modelled had to be selected and simplified. Once students started reading wider about the process they often found out that it was not as simple as sometimes given in course books. Steps often needed to be chosen and filtered from a variety of alternatives because even scientists may not agree on what the truth is. The contested nature of science became clear in some cases. In the topic: "*the formation and functioning of peroxisomes*", it was, for example, easy to memorise that peroxisomes are filled with detoxifying enzymes. However, to figure out where and how peroxisomes are formed, how they are filled with enzymes and what they do with those enzymes, took a bit more searching and thinking.

Lecturer experience compared with student experience

Lecturers and students in this study agreed with one another on the most important issues such as the opportunity for problem-solving and creative work and gaining a deeper understanding on the topics that they studied in this way. Hamilton (2013:113) had a similar experience when he used a video-making collaborative task in assessing Mathematics. He said that problem-solving and group creativity were enhanced by this kind of assessment and that making the video added "*a critical dynamic of repetition while structuring conceptual connections.*"

This assessment created a number of uncertainties for lecturers. This resonates with Hamilton's (2013:110) observation that teachers must realise that in a cyberlearning age, "*they will grow, learn and change with their students*" as they learn together.

In a number of ways the lecturer experiences contradicted student experiences. Some students suggested that the weight of the model should be increased to 15% whereas there was a suggestion from lecturers that it should be decreased to 5%. Students may have felt that the weighting of the marks did not adequately reward the time and effort that they had to put in and/or did not reflect the learning gains that they have made. Lecturers may have tried to minimize the effect of the possibility of inconsistent marking on the overall course mark.

Students generally found doing the presentation enjoyable and worthwhile even though some reported their shyness and anxiety especially before the presentation. Lecturers, in contrast, were very aware of the stress that presenting in front of the class created for the students, as is evident from the suggestion that presentations should be done only in front of the lecturers.

Another reason for this suggestion was that some lecturers were understandably concerned about the exposure of students to misinformation which might confuse them and/or might become entrenched. Some students were critical and noticed that some presentations contained errors. Most students reported that there were good presentations that contributed to their understanding.

Another source of anxiety amongst lecturers was that there was often a wide variation between the lecturer and peer marks. The students were free to make the model in any way they wanted as long as the model met certain criteria. The model assessment reported on here could therefore be seen as an "*ill-structured problem*" to which there is "*no right answer*". According to Coil (2014:50) this is what is needed to encourage creativity. The model as creative product was assessed by peers as "quality". Lecturers did not assess the model as a creative product. They assessed the correctness of the model in portraying the process and mastery, familiarity and understanding of the relevant knowledge. The exact factual knowledge was not stipulated per topic. The rubrics required of the lecturer to judge

the degree of correctness and comprehensiveness of the model and the understanding and familiarity with the topic as demonstrated during the presentation.

Discussions with lecturers showed that lecturer expectations were varied. Some saw the inclusion of a comprehensive number of correct, and relevant facts as the most important aspect to be assessed. It was suggested that a checklist of the facts to be included in each model and presentation should be compiled for every topic. This list could be ticked off during the presentation. Other lecturers were intrigued by the overall impression that the model created by using movement, colour and shapes and in giving an integrated picture of the process to be modelled. Some missing information was not seen as so important by these lecturers.

Recommendations

The results of the questionnaires, as discussed above, clearly show that both lecturers and students could see benefits in this assessment that made it superior to other assessment methods in a number of respects. To improve on the weak points the following are recommended:

To enable students to start working long before the due date, topics could be given as soon as the students start the course. Careful planning should avoid clashes with assignments / assessments in other courses. The last two weeks before the examination should be avoided. Time should be set aside to assess the models formatively. A period (such as the week before presentation) could be agreed upon during which students show their models to the lecturer to check for misrepresentations of concepts. Students can then correct their models without penalties before finally presenting it to the class and for the final assessment.

To make the experience less stressful and more empowering, special effort could be made to develop skills such as PowerPoint animation skills of students (and lecturers if required), presentation skills (by giving formative class presentation tasks from early on in the course) and evaluation skills (by using rubrics to assess these peer presentations from early on in the course).

The introduction of more complex topics such as "*how bacteria digest proteins*", requiring integration of two or more concepts and forcing students to integrate extracellular digestion and protein hydrolysis*,* should be more challenging and interesting to students than simple topics like *"protein hydrolysis*".

A rubric may perhaps not be the best assessment tool for assessing factual knowledge. A checklist stipulating the necessary knowledge per topic may be a more precise tool. Although such checklists may make it easier for lecturers to mark and for students to figure out what to do, it will take away some of the positive aspects of the assessment such as the need for analysis.

Conclusion

The modelling assignment seems to be worthwhile assessment tool. It sends the message to students and lecturers that higher order cognitive skills like analysis, visualisation, integration, creativity and problem-solving skills are valued. It provides an opportunity for students to develop a range of life-skills while deepening their understanding of specific concepts and their connections with other concepts. Many students enjoyed sharing their new-found understanding with their peers.

Many of the learning gains of the modelling assessment cannot be quantified nor directly measured. Lecturer and student experience mostly tells a story of engagement with a challenging, enjoyable confidence-building task.

Lecturer discomfort may be partially due to lecturers growing, learning and changing with their students (Hamilton, 2013:110). Lecturer concerns should however be addressed in an open way and by putting measures in place to alleviate sources of possible inconsistency and fear. This could come in the form of clearer rubrics or checklists, more preparation time for the students and more class time where lecturers can help students with misconceptions and technical challenges prior to the presentations.

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