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ORAL ASSESSMENTS: ENCOURAGE STUDENTS' MATHEMATICAL AND STATISTICAL TALKING

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Abstract

Take a moment to recall assessments in mathematics and statistics, memories of written tests and final examinations may surface, particularly, those questions that you simply could not start or could not understand. Sometimes, the recollection may be the time you were astonished as you received full marks for a solution when you would readily admit to the absence of any "real knowledge" of the topic. A written solution may not fully reveal the true thoughts and reasoning behind its construction, thus masking whether a concept is fully understood or a solution is the result of a template. Conversations may reveal more evidence of mathematical knowledge than a written solution alone, and as such it may provide a valuable tool to enhance the learning and assessment process.

The promotion of "mathematical/statistical talk" requires students to be comfortable to suggest ideas and more, importantly, be less fearful of saying the "wrong thing". This can be achieved by working in groups of three or four standing at whiteboards and even if students are passive, initially, this is still preferable to staring at a blank sheet of paper totally alone.

The structure of the class is adapted to include inquiry-based learning activities with an emphasis on vocal explanations concurrent with a written solution on whiteboards. Emphasis will be on the ability to formulate questions effectively, to discover individual mathematical strategies, to be able to link mathematical and statistical ideas to produce well-constructed explanations and the capacity to start a solution. These implicit skills will hopefully aid the students during tertiary studies and beyond into employment.

The oral presentation assessment allows students to feel free to be creative mathematically/statistically whilst demonstrating concepts and skills which may not be experienced when writing an answer to a question in a test or examination.

This exploratory qualitative paper will show the constructive alignment process by referencing Structure of the Observed Learning Outcome (SOLO) taxonomy in two pathway courses leading to entry to first year Engineering and Information Technology degrees. In this style of class, educators ask for talking noise rather than the sound of silence.

Keywords: *SOLO taxonomy, oral presentation, constructive alignment.*

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1. Introduction

When teaching, at any education level, the spoken word is the primary conduit for conveying concepts, ideas and solutions. Assessments in mathematics and statistics consist of written format for the most part rather than employing the oldest form of skill evaluation, oral (or viva voce) (Huxham, Campbell, & Westward, 2012). Doctoral thesis, the legal moot court and many postgraduate medical programmes utilise oral examinations in their final assessment component (Joughin, 2007). This approach is to evaluate the reasoning and understanding behind the prose and as interpreted by the author.

Oral evaluations may reveal more knowledge than a written solution, allows for demonstration of a broader range of skills and placing an emphasis on oral communication at university encourages the development of this graduate attribute. Tertiary students will read the course outline concentrating on the assessment tasks with the expectation of written tests followed by a final examination. They will pay particular attention to what is involved, when it is due and how much it is worth and the focus will be an accumulation of marks rather than an accumulation of knowledge. The tutorials and assessment are conducted in the same style: students work in groups at whiteboards around the room, in the style of a "flipped tutorial" (Seaton, King, & Sandison, 2014). Weekly oral-based tutorials provide an opportunity for peer teaching and peer learning through teaching. It is essential that an assessment is aligned with the teaching style, so that students are being assessed in the same mode as they are being taught. Since, the students are accustomed to discussing problems in groups in tutorials each week, the assessment style is aligned. Please note that this not excluding written tests as assessments, but rather an accompaniment assessment.

2. Design of tutorial

The first impressions (or should that be fears?) when the phrase 'Oral Presentation' is mentioned in any situation not just an educational setting may include 'I will look like an idiot', 'I will say the wrong words', 'I will embarrass myself', 'I don't know the topic that well, what if I cannot answer a posed question' and many more. The emphasis firmly placed on 'I' and it is the 'solo aspect' of mathematics learning that requires addressing here. The mathematical and statistical learning environment experienced at most primary and lower secondary is a 'social group approach' at solving problems and collaborating on ideas and solutions. However, when high stake examinations approach at secondary level, the learning environment becomes more 'solo' than previously encountered. At tertiary level, this 'solo' aspect may be more pronounced and can be a little alienating for weaker students. This tutorial style has been around for over thirty years, originating from La Trobe University of Melbourne, Australia and hence is, often, referred to as the 'La Trobe Method' (Seaton et al, 2014). The tutorial has evolved to suit physical environments and specific topics, but the one constant element is the students actively drive the tutorial by participation in whatever manner or role each time. The ideal environment is to have a room where whiteboards are integrated into the walls, though portable whiteboards may be used just as effectively with a wobble or two! Different coloured whiteboard markers, magnets and board dusters together with the previously unseen question sheet are supplied by the tutor.

2.1. The ambiance of first tutorial

It is essential that the initial tutorial creates an atmosphere of community and sets the tempo for the rest of the semester. Often, students are unaware that they will be gathering around whiteboards discussing problems rather than sitting at tables individually completing questions. Tutors have to adjust and may need guidance since questions and queries may not be as predictable as before and the relinquishing of control of the class flow to groups is not always easy. Simple gestures can frequently be overlooked in the schemata of learning. A welcoming smile with words of encouragement can quickly change a cold tutorial room into an amenable learning environment where nerves and apprehension are traded for introductions and chatter about questions. (Sadeghi, Ofoghi, Hamidi, Niayfar, & Babaei, 2016)

Just as that first day at kindergarten, where to sit after entering the room or choosing the colour of the whiteboard marker are the first major decisions that students confront. It appears to be an unwritten rule in life (in many different situations) that if other seats are available at an empty table then this seat is preferable to joining a table with a stranger. My first active role is to guide students to creating tables of four as they enter the class and encourage conversation. As the students approach the whiteboards, where the questions have been placed, they will be apprehensive in initiating conversations about suggestions, but the audience is now smaller (just three other people).

2.2. The question

Discussion of mathematical ideas, concepts and strategies are usually the domain of the educator not that of the student so anxiety levels may increase concerning revealing lack of knowledge and mathematical communication abilities. The following quote is useful in providing the students with an insight to the pathway the semester will follow; 'We learn more by looking for the answer to a question and not finding it than we do from learning the answer itself ' (Alexander, 1964). Students have access to any online material or lecture notes as the questions are modelled to promote discussion rather than a quick solution.

With the magnets holding the questions in position, students can approach the question in whichever manner they feel appropriate. Sometimes, a student may decide to choose to work on one solution with the individual commentating on a specific method, and then another student may repeat using another method. Students may discuss the merits of each solution and even discover another approach. Students may suggest an approach and proceed to produce a solution, others may interject to add or amend at various points in the solution on the whiteboard. Thus, within one main solution many alternatives are entwined so students have the opportunity to see mathematical and statistical strategies without extra effort. It is surprising how quickly all inhibitions disappear as the semester progresses and friendships with a community spirit emerge. The groups are not homogeneous in terms of mathematical or statistical ability and this creates a symbiotic relationship within the group where knowledge is exchanged through queries and explanations.

3. Structure of the observed learning outcome (SOLO) taxonomy

Students believe and quote learning mathematics and statistics as a mixture of recapitulating lecture materials, rote memory of facts and methods with never-ending repetition of examination-type examples regardless of their chosen major (Sheryn & Ell, 2014). The following quote from Barton (2011) is an indication that this cycle is endemic at all levels of mathematics education:

> The tyranny of examples is at the heart of the interaction between mathematics as a subject and pedagogical pressures. Many lectures focus on doing exercises rather than teasing out problems, asking open questions, or exploring deep understanding. The dominance of exercise mode, and the perception (enhanced by assessment practices) that successful mathematics means solutions to exercises, is an enduring phenomenon in schools and universities. (Barton, 2011).

Students can be reluctant in appreciating and acknowledging the level of their own knowledge and understanding of a topic. This, often, produces the dichotomy of 'I know how to answer questions on this topic or I don't know how to answer questions on this topic'. Standing around the whiteboards, even if only observing rather than contributing, has a prospect of illuminating a possible strategy in an easier fashion than with individual work. Weaker students may feel less self-conscious as ideas can be captured seamlessly rather than visibly interrupting an individual who is working.

Structure of the Observed Learning Outcome taxonomy (SOLO) helps students to grasp the fact that progress in understanding is happening, no matter how small, while aiding educators to discover the scope and growth of the comprehension of a particular topic. The act of reviewing students' solutions as a group is less intimidating and frequently the nature of the question is one to obtain more topic information rather than the correctness of the answer. The complete worked solution, correct or incorrect, reveals the depth of understanding of how they have inter-related and organised the individual parts.

There are five levels starting at the lowest level, Pre-structural, Unistructural, Multistructural, and Relational through to Extended Abstract (Biggs & Collis,1982).

3.1. Pre-structural level

This is an important stage since every journey starts with a small essential step in order to find the final destination. Recognition and collection of information from question in order to solve the problem is important and students need to be made aware that this is progress! Usually this will consist of unconnected information snippets with no overall pattern of organisation. Students will transcribe symbols and formulae from lecture notes or web sources onto the whiteboard, but no particular direction to a solution is involved.

For example, a contextual question concerning basic differentiation, students will have written numbers, expressions and/or equations that have been explicitly stated in the question. No obvious links are noticeable from the workings on the whiteboard.

3.2. Unistructural level

This stage is similar to the previous stage so students may not comprehend that improvement in understanding is occurring so recognition, at this point. can improve confidence in their ability. Hopefully, this will lift the thinking from 'not knowing what to do' to 'an idea of where to go but not sure of the path to take'. Modest links are made between the question and required information essential to proceed to the solution. The relevant information is recognised, but not clearly understood to how to use it to progress further in the solution.

For example, students recognise that differentiation will play some role in the solution, but how and why still eludes students. The whiteboard will show y = expression with a mention of dy/dx but no workings.

3.3. Multistructural level

Now, connections are made, but their significance to each other and the pathway to the solution is overlooked. The layers are visible, but how and why the aspect of the understanding to continue has still to be developed.

For example, students understand that y = expression needs to be differentiated and has basic mechanisms to proceed to a certain point in the workings, but fails to recognise that another rule or strategy is necessary to get to the final answer. The whiteboard will show y = expression with correct placement of dy/dx with the basic correct derivatives though, did not use product or chain rule which is required to progress to the correct solution.

3.4. Relational level

This stage is where all the pieces are understood and are now accompanied with an appreciation of all the inter-relationships. The question is read, comprehended, and a plan of action decided as to a pathway to the correct solution.

For example, students will holistically view in the context of question the differentiation aspects in relation to the given expression and possess all the algebra competencies to complete the correct pathway. The whiteboard will show y = expression with dy/dx (and all rules) used contextually correctly within the question rather than just algebraically correct. A logical progression and understanding is witnessed in written and verbal form.

3.5. Extended abstract level

This is the final stage where students will desire to go beyond the aura of the solution and transfer the information and knowledge to other areas and conditions. Here, students will understand the rules, strategies and algebra necessary to differentiate the given expression and how to interpret the result as a practical application.

For example, students will have the whiteboard as described above in Relational level, but will go one step beyond. The optimisation question may have not specifically asked for optimal dimensions of a cuboid, but students deduce the next steps without being explicitly asked in question or by tutor. The mathematical journey involved, crafting the given situation into algebraic formulae, followed by an appropriate differentiation manoeuvring through to the practical realm and ultimately to the numerical dimensions required.

4. Discussion

It is very easy to jump to conclusions that this tutorial style would not suit the shy student, individually motivated, or overall weaker students. Students are practical and often without explicit guidance quickly pool resources, facilitating elevation or extension of their insight of the concept or topic. Students use the whiteboards in whichever manner suits them and the question, often little departures from the solution lead to the cementing of concepts. Azmitia, Fawcett & Garton, and Schwartz & Okita found that learning occur when observing how others solve problems, explaining one's thought processes as you proceed through a problem and the act of teaching your peers (Azmitia, 1988, Fawcett & Garton, 2005, and Schwartz & Okita, 2013) These practices occur each tutorial whenever the group tackles a problem even though, students' contributions may differ. The experience described through this paper has been at the tertiary level whilst practitioners of this style of tutorial in earlier education levels have introduced some rules for students. Pairs of students have to take turns in writing and explaining the solutions and the reason may be associated with age and maturity of students rather than tutorial design fault (Forrester, Sandison, & Denny (2017).

At the tertiary level, classes usually involve a mixture of students differing in age, life and job experiences, stage of degree courses, and of course, mathematical ability. The initial weaker student, who may have failed a written test, can now demonstrate the ability to construct and write a solution with a clear verbal explanation (Taylor, & McDonald, 2007).

The benefits of this style of tutorial beyond just the mathematical content, skills such as a team player, co-operative, good communication skills, ability to learn, adapt and use initiative may be the key to keeping your position and attaining promotion in a company. The conversations flow from the theory to methods and calculations through to practical applications, thus mathematics becomes more than just numbers. Any oral assessment usually fills students with panic as just writing with no understanding will no longer be sufficient. Students appreciate that the tutorials each week have been a preparation and this assessment, although still nerve-wracking, is not unknown territory. Presenting in front of the class is not as daunting as impromptu rehearsals are performed each week in one sense.

5. Conclusion

The interactions of writing and talking amongst students each tutorial create opportunities for adaptations of strategies to be personalised by individual students. Some of the immeasurable, at least on a written test, graduate attributes which employers find desirable students can improve by using this style of tutorial. The overall ambiance of the tutorial is learning via activity, conversation, idea construction, consolidation of concepts and enjoyment. Students can give a fuller account of their solution with more scope than just the stroke of a pen on paper thus allowing tutors to appreciate, understand and assess their solutions more clearly. The oral assessment encapsulates not only knowledge needed for a particular solution but additional requests can reveal more understanding which would have been hidden if only in a written context. This paper has concentrated on the journey and preparation of students towards the oral assessment and not the marking rubric or skills needed on the day.

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