Restructuring the lecture/tutorial model for effective learning

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***Abstract**: In traditional engineering courses, lectures are delivered in hour blocks and tutorials follow up in other hour blocks with examples designed to illustrate the lectures. Often the tutorial is delivered by a different tutor to the lecturer. Student feedback on this type of teaching identified impediments to learning including poor class scheduling, inappropriate room type, and tutorial questions being too easy, hard or not relevant. Student feedback also indicated that a better model for tutorial teaching includes tutorials embedded in lectures. An example of a two hour lecture period with an embedded tutorial is given.*

***Keywords**: active learning, tutorial, student feedback*

Introduction

A typical engineering undergraduate spends many hours in tutorials. Most engineering programs invest a significant amount of resources in tutorials, including academic staff time, tutor time, and room occupancy. It is a widely held belief by teaching staff (and students) that the student "needs" tutorials. This is supported by our own experience – most of us learnt engineering in this way. However, the attendance rates at tutorials for RMIT Chemical Engineering students have been observed to be as variable as attendance rates at lectures, suggesting that many students do not believe that tutorials are as beneficial to them as we like to think. A study was undertaken with 2nd year Chemical Engineering students to elucidate why this might be and how tutorials could be made more effective.

The traditional model for lectures/ tutorials

The role of the traditional tutorial is to give students the opportunity, in the presence of a tutor, to tackle questions related to theoretical concepts outlined in a previous lecture. While there is variation in the model between programs and universities, there tends to be some common patterns. Rules such as "one hour lecture/one hour tutorial" may be used to set up class schedules. "Suitable" rooms are allocated for each, such as sloping floor for lectures, so

students have a good view of the front of the room, and flat floor for tutorials, so the tutor has close access to the students. A "large" class may be broken into "smaller" groups for tutorials, which must then be repeated for each group. This requires repeat performances by staff, which increases the burden on a limited resource. Furthermore, the size of the smaller group varies and tends to depend on staff workload rather than on what is a sensible size of group to teach.

This model was not designed to suit the learner and problems with it include:

- inflexibility due to scheduling and room type,
- discontinuity from lecture to tutorial because of change of venue/time,
- delays for some groups when multiple tutorials are scheduled,
- fatigue of staff teaching repeat classes, and
- the limited quality and quantity of one-on-one conversations possible in tutorial groups that are too large.

From a student's point of view, the traditional tutorial is often a poor quality learning experience.

Directions for restructuring

An unpublished paper by Hadgraft (2000) emphasised that good teaching requires a balanced approach across each subject. Hadgraft argued that focusing on only one aspect of teaching, whether it be the lecture, tutorial, or resources, will not yield satisfactory learning outcomes for students. Hadgraft presented "an overview of teaching practice" and identified that after a "wealth of material" has been made available to students in whatever way is appropriate, students must be able to engage with the material and have opportunities to link practice activities back to original concepts/ learning objectives. The size of the activity will lead to development of different outcomes. "Small" activities such as ten minute tutorial questions would lead to development of individual skill, while "large" ones such as an assignment completed over a number of weeks or a semester long project would lead to understanding of professional practice in a broader context. This clearly identifies the purpose of tutorials as a time when small activities should lead to development of individual skills.

Hadgraft (2000) also identified the importance of interaction to achieve student engagement. Inherent in the interactive exchange is the opportunity for the learner to receive valuable, immediate feedback (Peterson and Swing, 1985), which is when the learner is most receptive. Interaction fosters formulation and development of ideas (Johnson, 1971) and assists in the consolidation and strengthening of what is known (Johnson and Johnson, 1992). More educators are now recognising that interaction between peers is a particular useful learning strategy (Murray, 1999). The participants are more comfortable because the interaction is exchanged on a level that both participants understand (Damon, 1984). Whether with tutor or peer, in a participatory context, the student is in a position to learn, from one-on-one interaction, specifically what he or she needs, by requesting clarification or challenging the position taken and so on. This is when students feel most actively involved in their own learning. This also leads students towards self-evaluation their own level of understanding, which in turn leads to taking more responsibility for their learning.

What students think about different types of tutorials

How can we know what students consider an effective learning experience? Or what kind of environments and conditions support their learning? Collecting student feedback can be an

onerous, time-consuming affair, and undertaking too many surveys can lead to feedback-fatigue. Crisp interactions leading to immediate visible changes are most desirable from a student point of view. In this instance, students in the second year of Chemical Engineering at RMIT (a cohort of 50 students) were surveyed, as a group, about tutorials. Tutorials generally cater for 20 to 30 students. Initially the group brainstormed answers to particular questions that aimed to identify the range of tutorial experiences familiar to the students. Then "popularity" of the various categories and conditions were determined by asking the whole group to vote by a show of hands.

The first question was: "what types of tutorials are there?" The students identified the following tutorial "types". The "popularity" of each is shown as the % of the class that voted for each category.

Tutorial Type	*Most popular*	*No opinion*	*Least popular*
Embedded in lectures	50%	25%	25%
Tutorials held in a flat floor room	50%	50%	0%
Tutorials held on a different day to the lecture	5%	80%	15%
Tutorials that work through set problems	25%	60%	15%
Tutorials that work through problems of your own choice	0%	75%	25%

Table 1: Popularity of different types of tutorials with 2nd year students

An attempt was made to elaborate on the popularity of the various types by asking the students what was good, or not good, about them.

"What's good about that tutorial type?" yielded the following responses:

- If the tutorial is straight after the lecture and in the same room, it's no effort to attend.
- You get to attempt set practice questions.
- It helps you to solve assignment questions.
- If the tutorial is in a flat floor room it's then possible to have a one-on-one discussion.
- You use the knowledge that you learned in lectures. They help to clarify the learning from lectures.
- If the tutorial is the same day it helps to use the knowledge straightaway, it's easier to remember.
- Having a post grad tutor is good – they explain it in language we understand.

"What's *not* good about that tutorial type?" yielded the following responses:

- If the tutorial is on another day or after a free period, it's too easy not to attend.
- If the tutorial is straight after the lecture, its too much if its more than 2 hours.
- If you work on a set problem that is the same as on the assignment, if you can do the assignment already, it's not worth attending.
- If set problems are given prior to the tutorial, it's frustrating if you can't solve them on your own.
- If there are no set problems, there is insufficient structure for you to get a benefit
- If there are set problems, don't spend a whole hour on one question!
- It the tutorial is at the end of a day, you are too tired to focus on the subject.
- If the tutorial is on another day, you forget a lot, there seems to be discontinuity.

The issues identified by the students fell into the following broad categories:

- motivation to attend tutorials
- development of skills during tutorials
- linking the tutorial experience with the lecture content.

Clearly these issues are also causally related. Lack of motivation to attend was exacerbated by poor class scheduling, room type not conducive to interactive contact, and being tired. Development of skills was hampered by questions being too easy or too hard, too unstructured or too drawn out. Poor class scheduling diminished effective linking of the tutorial experience with the lecture content.

On the other hand, motivation to attend was increased by good class scheduling, development of skills was augmented by engaging with relevant questions and getting one-on-one help, while linking learning to material from lectures was seen to increase with the 'doing' of examples ("using the knowledge"), good class scheduling and opportunities to access peer/postgraduate tutoring support.

The last question was: "what's the ideal tutorial?" Responses included:

- a mix of lecture and tutorial with max 30 minutes of lecture,
- having a choice of set questions to attempt,
- availability of postgraduate (other) tutors.

To return to Table 1, there was a significant minority of students [25%] who indicated that they disliked the "tutorial embedded in a lecture model". This view was at the opposite extreme to the majority of the class [50%] who preferred this model and to most of the views expressed during the discussion. It was unclear what type of tutorials this minority preferred. Due to time constraints and the dynamics of the group survey this was not fully explored during the survey session. Possible reasons for this difference include:

- some students have never had a good learning experience at a tutorial
- some students lack skills needed to recognise effective learning environments
- some students wish to avoid developing a relationship with their lecturers
- some students do not feel confident about discussing their work in a group

This remains an interesting point for further discussion with the students.

The ideal model for a tutorial as perceived by the 2nd year students was developed as a mindmap as shown in Figure 1.

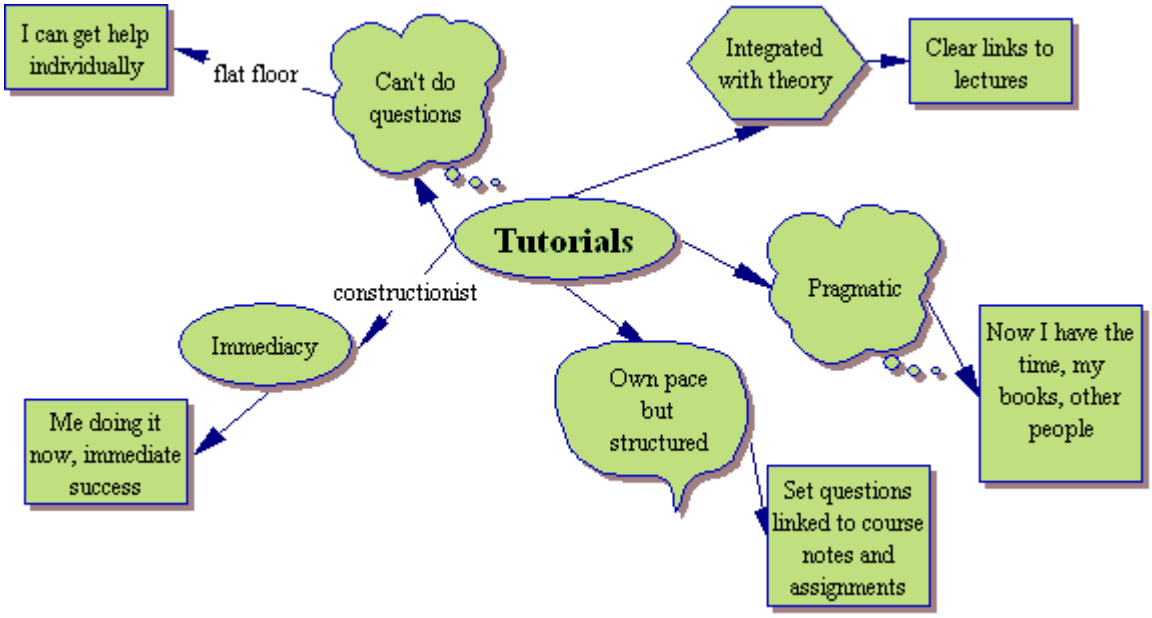

Figure 1: Mindmap of the ideal tutorial as perceived by 2nd year students

Discussion

The response to this group session suggests that these students were adopting a very pragmatic approach to their study experience. This is consistent with the findings of a study by McInnis et al (2000) that showed increasing numbers of full time students are employed in part-time work and that attendance at university is no longer perceived as a place where students go and stay for the whole day – every day of the week. Whatever the academic opinion, students are making judicious decisions on a day-to-day basis regarding their attendance at tutorials and lectures. The students' decision to attend/not attend and engage/not engage is based on expected value gain for the time/effort invested. An unpublished PhD thesis by Anderson documented at a later stage (Anderson, 1997) identified that an informal group atmosphere is important in fostering active participation and listening. That is, if students felt comfortable in asking questions, particularly in regard to difficulties in understanding the work, then more learning would take place. This correlates well with the popularity of postgraduate or peer tutors who are perceived to be more approachable than the lecturer because of their ability to explain things in a way that students understand.

The popularity of the "embedded tutorial model" (Table 1) suggests that some students are having good quality learning experiences in some tutorials. However, there was a sizeable minority who did not like this model. There was also no general consensus on what students would like to do at tutorials – work through set questions or problems of your own choice were only voted for by 25% of the students. This suggests that there are other options students would like, that were not identified in our survey.

So what else would they like?

Hadgraft's (2000) study suggests it is ineffective to tinker with tutorials without considering the course as a whole. Anderson (1997) suggests that comfort level in asking for help is the key issue, rather the content of the set questions/problems. Clearly this particular study has not addressed all the issues.

An alternative model for teaching tutorials

A number of students identified a good example of the 'best tutorial type' as that offered in a Mineral Processing class. This lecture/tutorial is outlined in more detail below.

A model class plan is illustrated in Figure 2, where each block represents 5 minutes of a total 2 hour class. This particular class is an introduction to the principles and technology of reducing the size of ore pieces during mineral processing.

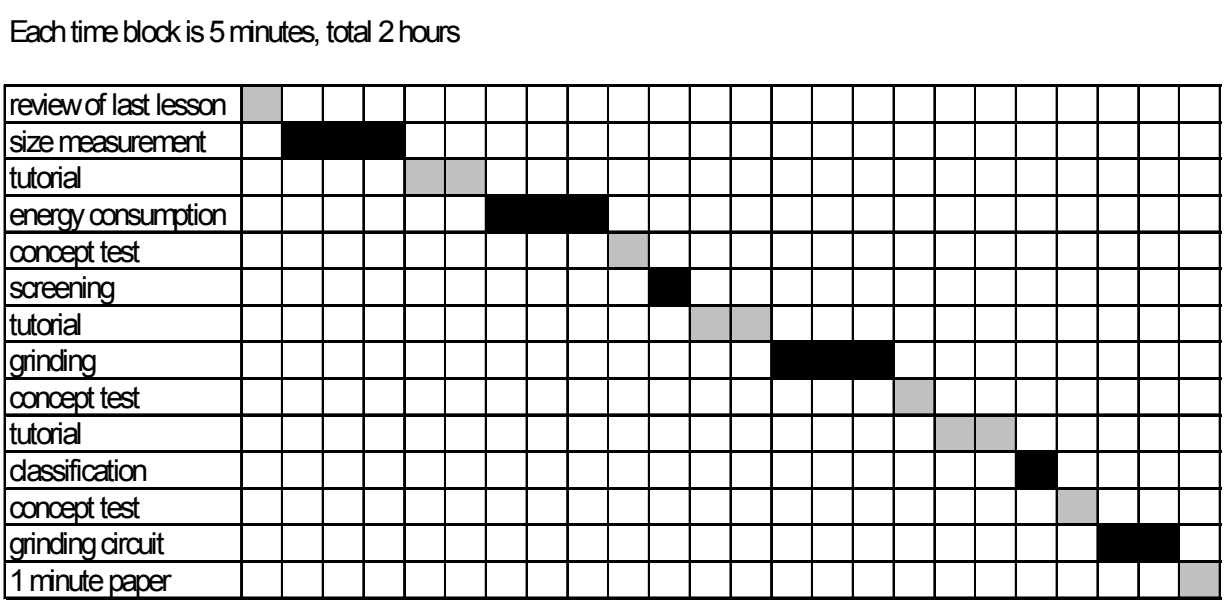

Figure 2: Structure of class on size reduction in mineral processing

There are six periods of "mini-lectures" which utilise Powerpoint presentations. This has the benefit of limiting how much can be written on each slide and enabling colour photographs of equipment in operation to be easily be shown. Each mini-lecture lasts no more than 15 minutes, and preferably less. The students are provided with printed copies of the slides to avoid the necessity of trying to write and listen simultaneously. The mini-lectures are not monologues but are studded with short questions eliciting student responses.

The tutorial sessions last for only about 10 minutes, but are extended if it seems necessary. Students work on simple calculations that emphasise and expand the previous mini-lecture. The calculations are especially designed to increase the familiarity of the students with industrial operations and with their scale. The lecturer, and tutor if available, walks amongst the students during the tutorial to check progress with the calculations and to both ask and answer individual questions on the mini-lecture content. Model answers are shown on the screen and discussed at the end of the short tutorial block. Students are told that after each major section of work (3-4 weeks) they will be given a hard copy of all tutorial answers.

"ConcepTests" (as developed by Mazur (1997)) are used to test whether a key concept is understood. They also serve to signal to the students which are the key concepts. They are conducted in the usual way in that students are first asked to think and answer a set question individually. Their answers are then checked by voting by a show of hands, or by hidden signals (fingers against the chest to show their choice of answer). If there are many wrong

answers then the students are asked to discuss their answers with a classmate, followed by an second answer check. Finally the correct answer is given together with a brief explanation, and can be made more full if there still seems to be uncertainty. Often the ConcepTest questions are not in the context of the class, in this case size reduction, but are made more lateral to create interest and reinforce the idea that key concepts are of a more generic value. Finally, there is the occasional use of the 1-minute paper at the end of the class to see if students can link some of the key concepts and to provide feedback to the lecturer.

The perceived benefits to the students of using this embedded tutorial model for classes are;

- only relatively short periods of attention and concentration are required,
- they become impatient to relax and talk, and this is utilised for productive work,
- they can ask the lecturer questions about content in "real time" and don't have to wait until the end of the class or during the week,
- shy students are not deterred from asking for help because they can do so individually rather than publicly,
- signals are given as to what are the key concepts which need to be grappled with,
- signals are given as to what type of calculations are important, and at what level of detail or mathematical complexity.

There are also significant benefits to the lecturer that outweigh the increased level of preparation and thought required before the class;

- shorter lecture sections are less tiring and stressful to deliver,
- concept tests provide real-time feedback on the level of depth understanding,
- tutorial time is an opportunity to get to know the students,
- individual learning styles and needs can be assessed, as well as individual levels of understanding and motivation,

The lecturer found lecturing in this way particularly enjoyable thanks to the informality of the class and had a much more relaxed and confident experience. Quiet and attention was required during the mini-lectures, and it was generally found that the students respected this need of the lecturer when their need to relax and talk together was also recognised. The opportunity to get to know students personally was probably the most rewarding outcome, and as a result they showed little reluctance to come and talk frankly about their problems with the lecturer. Despite the informality, the lecturer actually felt far more in control of the class and student learning because of the high level of immediate feedback. This led to a great deal of personal satisfaction from the perceived achievement of a much deeper level of understanding by the students.

Conclusions

There is widespread dissatisfaction among students with their experiences in traditional tutorials. A class of second year chemical engineering students was asked to describe different types of tutorials and what was good or bad about them. Their feedback on those types reflected major issues of motivation to attend, development of skills at the tutorial and linking the tutorial experience with the lecture content. Motivation was increased by good timetabling, being asked relevant questions and getting one-on-one help. Linking the tutorial experience to the lecture content was enhanced by good timetabling, and peer/postgrad tutoring. Some students could not identify what they would like in a tutorial, and this remains

an outstanding question. The most popular tutorial type was the "embedded in lectures" model. This model combines lecture and tutorial, limiting time spent on each to 10 to 15 minutes. Level of understanding is tested with ConcepTests and 1-minute tests. This model is popular with 2nd year students and the lecturer alike. More work is needed to establish a model that meets the needs of all students.

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