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Case study 3

In-class feedback: a flipped teaching model in first-year physics

To watch educator in charge Paul Lasky and education manager Theo Hughes provide an overview of the feedback in this subject, visit https://youtu.be/LAt_84LgLyg

Summary

The use of a flipped classroom approach promotes the idea that learners learn key concepts or skills prior to class, so that they can then engage meaningfully during class time in activities that are designed to extend their understanding and ability. Class time is less about educators 'doing' (e.g., speaking) and more about learners actively learning – problem-solving, engaging in dialogue, creating, constructing, demonstrating, debating, etc.

The role of feedback cycles in this active learning context is pivotal. Educators need feedback so that they can support and effectively challenge learners in their learning. Learners need feedback so that they can judge their performance and, where necessary, adapt their learning approaches.

Key features of this case study include:

- A flipped (or inverted) teaching model: teaching theoretical concepts via online resources such as readings and videos, which then allows increasing learner-educator interaction during face-to-face classes;
- Using quizzes, polls and peer assessment at the beginning of each lesson as a means of reinforcing learners' learning prior to class and indicating areas that need further work during class to the teaching team;
- A team of one educator and two tutors facilitating large classes of 100 learners as they work in groups to solve problems; and
- A developmental approach to assessment/feedback cycles: the assessment/feedback within class, as well as larger out-of-class assignments, build on each other and are aligned with the final exam.

Keywords

flipped teaching; inverted teaching; in-class response systems; clickers; peer feedback; automated feedback; dialogic feedback; constructive alignment; developmental assessment

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The case

The design of this subject came about after senior and educational design staff within the School of Physics and Astronomy took note of educational research from the field of physics. This literature suggested that traditional lecture formats were not the most effective means of teaching physics to learners. Instead, it was thought that learners would gain more from thinking about and solving problems in class, where skilled educators could provide the most timely and effective support. As a result, a flipped (or inverted) classroom model was adopted. In essence, the flipped classroom model recommends that the active problem-solving often set as homework is more usefully completed in class, when skilled educators who can help are present. At the same time, the didactic presentation of content and limited interactions that are often the hallmark of lectures, seminars and tutorials could be facilitated online via videos, forums and other means.

Context

Discipline Physics
Faculty Science
Institution Monash University
Level First year
Class size Overall enrolment of almost 400 learners, but classes are conducted with 100 learners at a time in a large lab room with multiple whiteboards and display screens
Contact hours Per week, learners attend three 1 hour workshops and one 2 hour lab class. In these sessions there is one educator and two tutors present to facilitate the flipped class approach
Assessment types

- Experimental work worth 30% ('worked solutions' submitted on entry to the lab sessions, in-class quizzes, three formal laboratory reports – a pass grade in this experimental work is a hurdle requirement)
- Tests/assignments worth 20% (three written assignments with a mathematical focus, as well as in-class quizzes at the beginning of workshop sessions)
- End-of-semester exam worth 50%

The teaching team and educational design staff also noted that the literature indicated that assessment and feedback cycles are most effective if aligned so that each cycle builds on the previous, allowing learners to develop their abilities. In other words, learners need multiple opportunities to demonstrate their understanding, to be able to seek and receive useful information that can influence their next task and, importantly, for their next task to give them further opportunities to demonstrate their understanding.

In the past, this subject included a weekly lecture and a tutorial on theory, along with a laboratory class in which learners tested that theory. Under this previous model, learners were expected to independently work out solutions to problems as part of their 'homework'. In the newly designed subject, there is no longer the need for lectures, as content delivery is provided online through videos of the educators and other materials such as textbooks. Learners are asked to engage with these materials and to complete some tasks, such as working out the solutions to several mathematical problems. The learners then attend three one-hour workshops and a two-hour laboratory each week. Each lesson has approximately 100 learners arranged in group seating, a team of three educators, and a focus on 'active learning' in which learners are engaged in multiple feedback loops – offering them opportunities to iteratively test and improve their understanding.

The educator-in-charge indicated that some learners found it difficult to work in this new way, but others

> really thrive in the environment, and that instant feedback they're getting from the clicker questions and from doing problems on the board and having a [tutor] watch them over their shoulder and things like that… it improves their skill set dramatically over what they would otherwise be getting.

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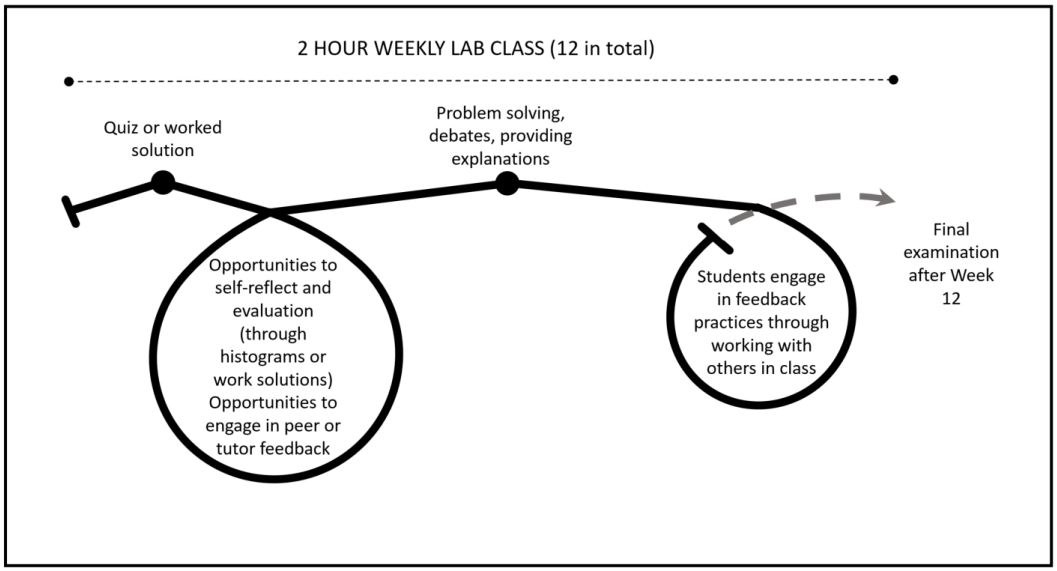
This diagram represents the feedback practices within the weekly lesson:



Linked assessment and feedback loops used in weekly laboratory sessions.

Each lesson begins with a short, graded assessment task (quiz or worked solution) designed to provide the teaching team with information about the learner's understanding. This then helps the teaching team shape the focus for the first part of the class.

In the workshop learners complete a short, graded multiple-choice quiz through the use of a learner response system ('clickers'). The teaching staff then display a histogram of learner responses on an in-class screen and employ several strategies to engage learners in explaining their thinking and working through the problem. As the educator-in-charge explains, "[w]e discuss with the learners, in an interactive way, what some of the common misconceptions were and why people answered in certain ways and why they answered in other ways." Variations on this cycle characterise the remainder of the workshop. The educator poses a problem and invites learners to respond in a variety of ways, including: learner response systems; explaining their thinking to the rest of the class; debating; working in pairs or groups; or writing on the many boards around the room. The teaching team circulate and support these learning activities. One of the learners we spoke with told us:

> that system, of having the group work tables with the [educators] worked very well… there was always someone who understands the content well enough if other people don't, and failing that there's always [educators]. So that worked well.

It is worth noting that, in an attempt to maintain a focus on active learning, the educator does not include any traditional theory content on in-class slides; instead, each slide simply displays a problem, question or other stimulus for active learning. One learner commented on this approach, saying that the lecturer "kind of provoked you to think about it yourself, as opposed to just, like, spoon-feeding."

In the laboratory, the learners are asked to bring a 'worked solution' to a problem that is based on and provided alongside their pre-class materials. The learners submit the work to the educators, who then hand out the work to other learners for them to peer-assess the work. The correct solution is displayed on the board and an educator explains the solution. One of the learners noted that they are also encouraged to provide explanatory comments on the work, not just a grade. One of the learners we spoke to told us that "you could see what they were trying to explain pretty clearly… it was a good exercise." The rest of the laboratory

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lesson consists of opportunities for learners to demonstrate their understanding and to receive feedback via peers and educators.

The workshop quizzes and the laboratory solutions are graded, but amount to less than 10% of the subject's total marks. The educator-in-charge feels that this small mark allocation helps motivate learners to complete the pre-class materials and activities.

During the semester, learners are also expected to complete three workshop assignments, each designed to build on the skills required by the previous assessment and, consequently, each more heavily weighted than the previous. This same approach is taken with the three laboratory reports; in fact, the assessment criteria for the third lab report includes an item that asks learners if they have acted on the advice educators provided on their first and second reports. After each of these submissions learners are given brief handwritten feedback – comments or mark-up on their documents, as well as a general rubric – in a short one-week turnaround.

The assignment feedback is reported by learners to have had an impact on what they did in subsequent work, including how they approached the process of expressing their ideas. One learner notes, "I definitely looked over the first one in detail, all that feedback, and… I used the feedback in my process". The individualised nature of the annotated assignment itself was valued for its specificity over the more general rubric, as a learner we spoke with explains: "since they were very detailed [unlike the rubric], and there was a lot of them throughout, really criticising pretty much everything on the report, then I felt like I couldn't ignore it."

In addition, time is spent during the workshops and laboratory sessions working through the particular assessment task, thereby engaging learners in further opportunities for feedback. Finally, all of the workshop assignments and laboratory reports are designed to prepare learners for the final examination, for which learners receive no feedback other than a grade.

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Why it worked

The design

In this case, feedback was considered to be successful particularly because of the following key elements:

- **Alignment of assessment and feedback loops:** the in-class assessment and feedback loops supports the subject assignments and, in turn, assignment feedback is designed to build learner ability in preparation for the exam. The success of this design is partly ascribed to communicating this purpose to learners from the beginning of the semester – that is, highlighting that all of the tasks are carefully constructed to give learners opportunities to receive useful feedback.
- **Immediate in-class feedback:** the use of the online quizzes and learner response systems (clickers) helps educators to gain an overall view of how learners are understanding the learning material. Where problems arise, these can be addressed immediately by the educators during class.
- **Frequent opportunities and a variety of sources of feedback:** each week, learners are provided with multiple opportunities to demonstrate their understanding – such as quizzes, worked solutions, problem-solving and debating in class – and to engage in feedback from a variety of sources – including peers, self-evaluation via exemplars, in-class activities and dialogue, and a flexible workspace with educators on hand to assist if needed.

To watch educator-in-charge Paul Lasky and education manager Theo Hughes explain what worked in this subject and why, visit https://youtu.be/FjRemCKGeFM

Enablers

Some of the enabling factors for this feedback design included:

- **Space and technology:** the classroom timetabled for workshop and laboratory sessions is well-equipped to facilitate the subject's flipped teaching design. Along with sufficient space for 120 learners to sit in groups, the classroom is equipped with a range of technologies to support learning: screens and whiteboards spread throughout the room for easy viewing and access; microphones to allow the teaching team to project their voices; and 'clickers' to facilitate in-class polling.

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- **Long-term vision for the subject:** a long-term plan for the improved design of the subject was developed based on best-practice literature, and this plan was actively driven and supported by an education manager.
- **A stable and skilled teaching team:** the educator-in-charge is aware that he will be in charge of the subject for several years. The teaching team are experienced and are trained in the assessment and feedback expectations for the subject.
- **Leadership:** the subject redesign was brokered by senior leaders in the School, and an education manager was appointed to oversee both the long-term development of the subject design, and the design of the broader course it which the subject sits.

Challenges

Some of the challenges for this feedback design included:

- **Being adaptable:** in responding to in-class performance information, such as learners completing quizzes, educators need to constantly evaluate and be prepared to change the pace of the lesson. As the educator-in-charge explains, “if you go too quickly you’ve lost the ones who are a bit slower, if you go too slowly you’ve disengaged from the faster [learners]”.
- **Rich individualised feedback:** while there are many opportunities for learners to seek and receive feedback in this subject, constant pressure remains to find sustainable approaches to providing highly individualised comments. The educator-in-charge told us that, while learners indicate they are happy with the subject’s assessment feedback, he feels that “a lot of the comments [are] just insufficient for [learners] to be able to actually improve their skill set enough”. Potential solutions to this perceived problem come with their own complications. For instance, simply adding staff – to increase capacity for detailed feedback while maintaining the weekly turnaround on assignment feedback – makes it more difficult to achieve the degree of consistency and skill that learners value.
- **The flipped classroom approach does not suit all learners:** learners are educated about the purpose and process of the flipped classroom before they commence the subject, through the subject guide; however, while some learners thrive, others struggle to engage. There is no simple remedy to this challenge as learning is rarely a case of ‘one size fits all’.
- **Time:** it takes time for educators to experience and learn from previous iterations of teaching and feedback designs.

What the literature says

This case has a complex assessment and feedback design. However, we have highlighted two key elements of the design that are worth exploring further: the *flipped classroom or active learning* approach, and the use of *in-class response systems* as a means of facilitating ‘instant’ feedback for both learners and educators.

The flipped classroom model reinforces the idea that class time should be active learning time, by reversing traditional lecture and teaching ideas of what is normally done in class and what is normally done as homework (Herreid & Schiller, 2013). Anything that resembles passive consumption by the student, or didactic teaching by the educator, is treated with suspicion. Often a flipped classroom model is characterised by the educator posting recorded lectures online, with the expectation that learners will view them prior to class before engaging in active learning activities during class time (Herreid & Schiller, 2013; McNulty, 2013; Rutherfoord & Rutherfoord, 2013). However, pre-recorded lectures are not the only pre-class preparation which may be used; other digital materials and related activities may also be used (McNulty, 2013). Having said this, there is no real need for any digital artefact to be produced for learners to engage with prior to class. As with this case study, the pre-class activities can be textbook-based. Nevertheless, educators adopting the flipped classroom

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approach should be aware of the need to shift their approach from being transmitters of knowledge to becoming facilitators of active learning.

While the flipped classroom approach has been demonstrated to be successful in many cases, there are also potential challenges. Learners may initially feel concerned by – and even resistant towards – the flipped classroom, as this approach requires learners to take on more responsibility for their own learning (Findlay-Thompson & Mombourquette, 2014; Herreid & Schiller, 2013; Sankey & Hunt, 2013). It is crucial that flipped classes are carefully tailored, to prepare learners for in-class activities and maximise their learning experience (Herreid & Schiller, 2013; Sankey & Hunt, 2013). Training the teaching team in how to effectively structure and implement flipped classrooms may require a significant initial outlay of time and effort for an educator-in-charge (Findlay-Thompson & Mombourquette, 2014).

While in-class or 'live' polling has existed in higher education for decades, advances in digital polling allow learner responses to be quickly and accurately collated and displayed to a class. Digital polling also allows learners to respond anonymously, potentially increasing participation in high-risk cases or by less confident students. Live polling is recognised as supporting active learning by students, with in-class polling associated with significant improvements to learner participation, engagement, learning and assessment (Kay & LeSage, 2009). It is important that polling questions are effective and challenging to students, and that educators are equipped with strategies to respond meaningfully to learner responses (Kay & LeSage, 2009; Wieman et al., 2009). Learners may resent the use of live polling if they feel that questions are too easy or polling is simply being used to "keep them awake" (Wieman et al., 2009, p. 10). The value of live polling instead lies in leveraging the strategy's interactional affordances in a class context.

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Moving forwards

Advice for educators

The participants in this case offered several suggestions for educators wishing to trial the feedback design:

- **Allow sufficient time for redesigning the assessment and feedback structure:** the educator-in-charge pointed out that it takes more time to create materials with a problem-based focus than to create a traditional slideshow of content, and explains, "you need to think up creative questions that are going to get the majority of the [learners] thinking about the problem."
- **Be challenging:** when designing questions for use with learner response systems, it is important to make them challenging for learners. By doing so, the educator will be able to provide feedback that learners can learn from, and learners are more likely to engage in active learning.
- **Train your teaching team:** it is valuable to invest time in developing your team to improve the clarity and consistency of assessment grading, and especially feedback.
- **Resist the temptation to give in to old habits:** educators should be aware that it may be tempting to revert to didactic content delivery. Educators should aim to constantly balance the desire to adopt an active or problem-based learning approach with the temptation of lower-effort didactic delivery.
- **Provide feedback comments that are both backward- and forward-facing:** comments should reflect on how the learner arrived at their current level of performance, such as how they performed in a previous assignment, while also looking forward to what they could most usefully improve in future performance. With this in mind, educators could consider adding a mechanism to assessment feedback that explicitly evaluates the degree to which learners have acted upon feedback from previous assessments. Such a mechanism makes it more likely that assessment will be aligned, that feedback will be more useful for learners, and that learners will more aware of the purpose of feedback.

Advice for institutions

This case offers several useful insights for leaders within institutions wishing to support similar feedback designs:

- **There may be a need to challenge the traditional roles of subject design and management:** there needs to be someone in a position of authority to enact a long-term vision of the subject design, and that of the course it sits within. This is unlikely to be the teaching staff or the typical administrative manager. Often lecturing staff are appointed to lead a specific subject for one or two years, with no certainty or stability. This engenders a short-term approach in which iterative development of significant initiatives is inherently difficult, since new staff will inevitably have different visions for the subject. On the other hand, administrative management or academic leaders of courses rarely have a close hand in the design of the subjects themselves. This case offers one example of how a professional staff member with academic credentials and teaching experience in the field can work with teaching teams to develop coherent and cohesive subject and course designs.
- **It is useful to draw on, or build, empirical research of educational designs:** drawing from the literature and empirical research provides both a starting point for design, and evidence for the effectiveness of the proposed approach. The educational manager for this subject explains, "having that educational research means … you can then go to other people [and say] look it's not just me saying this, I've got the support of all this educational

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literature… and other academics then start respecting that and they go, 'oh you're not just telling me to do something … there's reasons behind it'".

- **Learners "need to be brought along for the ride":** the purpose and value of the subject design should be clearly communicated to learners from the outset. The educational manager for this subject told us that the teaching team for the subject have invested as much effort in communicating with learners as in redesigning the subject design. This is particularly important as an iterative, developmental approach to subject and feedback design may make learners feel as if they are guinea pigs in a series of tests.
- **Sustainable change requires a holistic vision and capability:** too often, subject and feedback designs last only as long as the educator who implemented them, before reverting to old practices. As the educational manager explains, "as soon as that person leaves, everything just reverts to what it was before, because … another academic comes in and [the previous design] is not built into the system, it was so reliant upon that one person running [it]". To ensure sustainability, change should be systemic. This applies not only within subjects, but across courses – there is limited point in redesigning all second-year subjects if in their third year learners will simply encounter the same set of problems.
- **Reconceptualise assessment, especially minor or hurdle tasks as an opportunity for individualised learning**: often minor assessments or hurdles are seen as mechanisms to measure student progress. However, the educators in this case reconceived the hurdle tasks as opportunities to coach learners towards individualised small improvements. As one educator explains: "Here's an opportunity to practice doing it better. …. We've thrown a small hurdle, you've kind of sort of got over it and we're now telling you how to get over it better, lift your front leg a bit higher, your trailing leg hit the thing, you've got to work on that trailing leg, that kind of thing".
- **Keep staffing consistent and avoid ad hoc appointments:** a long-term vision, and a desire for skilled and consistent feedback, is best-served by having a stable and committed teaching team across years. Ensure that the recruitment process is not a secondary consideration to designing the subject.
- **Accept evaluative restlessness:** this case was notable for the highly self-critical staff involved in the development and improvement of the subject. The educator-in-charge, as well as the education manager, told us that while they were proud of the subject's accomplishments, they didn't see any one part of the design as perfect. Room for improvement was sought even in aspects of the design that were felt to be effective, and future iterations of the design are already clearly planned. Empirical data, such as learning analytics, is used to test the effectiveness of design changes.

Resources

The Australian Government Office for Teaching and Learning has funded a project titled *Radical Transformation: Reimagining Engineering Education through Flipping the Classroom in a Global Learning Partnership*, led by the University of Queensland, which is exploring transformative course development through flipped classroom models. Visit the project website for resources and sample flipped classroom materials: http://www.uq.edu.au/tediteach/flipped-classroom/olt-transforming/index.html

The University of British Columbia hosts a large collection of useful resources for in-class response systems, including an instructor's guide to the effective use of personal response systems ('clickers'). This guide includes descriptions of how to organise your classroom, the kind of questions that may elicit different kinds of learning activity, and common challenges. Other resources include videos demonstrating the use of in-class response systems, as well as research articles. Visit the online collection at: http://www.cwsei.ubc.ca/resources/clickers.htm

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