
The More Maths Grads HE Curriculum Team – Neil Challis, Mike Robinson and Mike Thomlinson

Small-group teaching

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If you were to ask someone with no experience of university about different HE classes, you might expect that they would have some notion of two types of classes: lectures, and small-group classes. They probably have a very traditional view of what the former would be. They might be less clear about the latter, both in terms of what a small-group class is called (supervisions, tutorials, seminars, exercise classes, workshops, PC labs - depending on the subject and the institution) and about what might actually happen in this class, although they would probably expect more of a conversation between students and tutors.

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At the start of the More Maths Grads project, we surveyed 223 first year students in three institutions before they had had their first class, and asked them about their expectations. By and large, their ideas chime with a (traditional) split between the types of classes: lectures, they thought, would be large groups where the lecturer talks and writes on the board whilst students take notes, and small-group classes would be where students can ask questions and a tutor will help out either individually or with groups of students.

Having discussed lectures in an article in the last *MSOR Connections*, this month we focus on small-groups and the distinction between them and lectures. To what extent does the traditional view reflect reality? How has this model survived the increase in student numbers? How much variation is there, and should there be more? Could we improve the system?

We talked to staff and students in four HEIs, including our own, and of course found a variety of practices. Before going any further, we should mention that there is little consistency in what classes are called in different universities, so the names given here are chosen only for the purposes of clarity in this article.

Exercise classes

In three of the HEIs, this was the main form of small-group teaching. The class is attached to a specific module, students are expected to be working on exercises set by the lecturer, and assistance is available from tutors. We include in this category classes based in PC rooms where the model is usually the same.

Staff go around, answering questions and the way we usually do that is we don't actually do the homework for them, but if they'll say "What does such and such mean?" We usually say "Well you tell me. Get your notes out, we'll have a look." Really the purpose of these classes is to try to teach them how to learn.

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Class sizes vary between institutions, nominally being 25-50 students, although the staff we talked to often talked about poor attendance which reduces the number significantly, although sometimes we can see the positive side of that!

“You have perhaps nominally 50 students with 3 or 4, well, a mix of staff and post grads, but because not all the students attend it’s a much smaller student staff ratio and that should make things a bit more personal.”

As this indicates, examples classes might have more than one tutor in attendance, and teaching staff might be assisted by postgraduate students or post-doctoral fellows. In the two post-1992 universities in our study, there is little scope for using researchers in this way, and classes are universally taught by lecturers, with one member of staff present. In both these cases, class sizes don’t exceed 30.

The students we spoke to were positive about exercise classes. As one put it:

“One exercise class is worth ... three lectures, because you’re actually physically doing the work. And there’s postgraduates there to actually help you.”

Sadly, we had little opportunity to talk to the students who don’t attend classes. Our own experience suggests that there are students who attend lectures but think exercise classes are less important, and perhaps they are sometimes right. Timing may play a part here; at Sheffield Hallam exercise classes are usually directly after the lecture, so students have not had any time to try the exercises before the class. This ensures that students who attend practice what they should have learnt in the lecture whilst it is still fresh in their mind, but it limits the opportunities for them to think and struggle with a problem and, perhaps, encourages them to ask for help too soon. It also raises questions about the effective use of our contact time.

“What tends to happen is the students spend the bulk of the time trying to figure out what it is they’re supposed to be doing, not making very much progress through the task and by the end of it one or two of them are ready to ask you a question. So for the tutor, you spend most of the tutorial time stood around, twiddling your thumbs ... or waiting for them to ask you a question, or you might wander around leaning over their shoulder and try and get them to ask you a question but then you wonder if you’re interfering, so all the time you feel as if your time’s not well spent.”

As a response to that, we have experimented in some modules with holding the exercise classes just before the lecture. Students therefore have had a week to try the set work before arriving at the class. We find that the tutor is busier during the class, and attendance is improved, although as the change has been combined with a requirement to hand in coursework during the tutorial, we can’t claim that it is the timing which has solved the problem. The downside is that some students have not tried the work during the week, and arrive at the class expecting to start the

exercises then, but at least their lack of work outside classes is apparent to the tutor and can be challenged.

That said, all the HEIs that have exercise classes reported poor attendance, regardless of the timing of the classes. We all know that this can be a problem across the board, but perhaps the nature of this type of class contributes to the problem. If students are engaged in working through exercises individually, it is unreasonable for them to conclude that they can do so just as effectively elsewhere? Of course, they miss out on the opportunity to ask questions, but in a class of 30 with one tutor present, just how much attention are they likely to get? Are we offering them a poor experience and then complaining that they don’t make use of it?

‘Lectorials’

At one university, the student cohort is significantly smaller than in the other three – roughly 30 students. On paper, their timetable has a one hour lecture followed by a one hour tutorial, but because of the small number of students, in practice this is sometimes used as a two hour class without a clear distinction between the two halves. A two-hour class might consist of 20 minutes of lecturing, followed by worked examples from the homework or time for students to try examples with staff assistance, followed by more lecturing.

There are clear advantages to this approach: firstly it tackles the problem of attention wandering during a lecture by varying the activities; secondly it mimics the approach adopted by most schools, judging by the responses given in our questionnaire of incoming students, where most reported something similar as typical of their maths lessons. It may therefore make the transition to university easier.

At first glance it may appear that this system would be unfeasible with larger student cohorts, but here at Sheffield Hallam we hope to get some of the advantages of this system with an experiment starting in October where in two modules a one-hour lecture will be replaced with a two-hour ‘lectorial’ (for a cohort of 80-100 students). The staff resource for this will be generated by having one fewer exercise class group (with correspondingly larger groups). Whether this is successful – and whether students appreciate the extra hour’s contact time – remains to be seen.

Tutorials

One university organises its small group teaching very differently. Rather than having time allocated for each module, the students in the first year have three tutorials – one per week each for pure and applied maths, and one every week or fortnight for statistics. Tutorial groups are of approximately six students, and are sometimes taken by teaching staff and sometimes by post-docs or postgraduate students. In pure maths and statistics the students’ work is usually marked by the tutor, but

in applied the marker may be a different postgraduate student. Students usually have one tutorial with a staff member who is also their personal tutor.

In these classes it is much less likely that students would be working individually on exercises; rather they are expected to arrive having made a serious attempt at the problem sheets and with questions for the tutor. Typically, the tutor would go through exercises which are causing problems for the students on the board, with input from the students.

“In general staff and students talked about the classes being primarily focussed on the latest homework sheet, although one reported that the small groups enabled a broader style of discussion.”

The students are generally appreciative of the system.

“...very helpful. Yeah ‘cause you know the homework we get like a homework every two weeks and we go to the tutorials, and some of the questions like I have no idea about what you have to do and then they get explained to you like it makes sense then you can go away – because in the tutorials you can ask questions that you can’t ask in the lectures really. Yeah they’re really good.”

In general staff and students talked about the classes being primarily focussed on the latest homework sheet, although one reported that the small groups enabled a broader style of discussion.

“This year I’ve got a group who, they won’t stop talking which is really good actually, ‘cause it means we really have a discussion, it feels more like an art seminar, [like] it would be in my imagination anyway. And they’re really enjoying that, I think if I can do that in future years it would be good. But I think it’s a lot to do with the fact that these students are really engaged. But they, part of what they’re saying is ‘why do we have to do all this?’ They really need some kind of justification, motivation to do it.”

Perhaps the biggest advantages of this system are not within the class itself but in the formation of relationships, both between students, and with the tutor. In the last issue of *MSOR Connections* we reported that most students seek help from their peers in the first instance. The tutorial group system gives every student an opportunity for a ready-made group of peers to discuss problems with.

“Some of us have got this question, some of us got the other; we band together and like explain to the others like why we can do it. And they explain why they can do another question. It’s quite helpful.”

Students also reported a much greater willingness to ask questions of their tutors than of lecturers:

“[Lecturers] don’t know who you are, and I just don’t see them as that accessible because I know my tutors quite well, but I don’t know the lecturer apart from I sit through two hours of his talking a week.”

Nevertheless, some students described these small groups as initially ‘daunting’ and one tutor still finds some students reluctant to engage fully.

“I have this ongoing battle to make them tell me when they don’t understand, ‘cause I can stand at the board and like talk and jabber on and do questions on the board, but if they don’t tell me when they don’t understand, and I’ll go ‘do you understand?’ and they’ll nod ... and I’ll get to the end and go ‘right, could you do that by yourselves, do you understand it?’ and they’ll go ‘No’. So I say ‘tell me where you didn’t understand it’, and they’ll point at the beginning.”

This system is obviously expensive in staff time, even with the advantage of a large cohort of postgraduate students available to assist, and the department has itself questioned whether this is the best use of their resources. In particular, they commented on the fact that they are only able to do this in the first year, and there is therefore a significant drop in the level of support when students enter the second year.

“Obviously that’s of great benefit to the students in the first year. There is an extent to which come their second year they’ll suddenly find there’s a bit of a step jump down in terms of the support they get there and I think that’s hard for some students... we kind of delay the difficult step until the second year.”

Nevertheless, a suggestion to move resource to the second year at the expense of the tutorial system has been rejected – for now at least, although discussion continues. Some staff described the advantages for students, but also recognised a personal interest in maintaining the current system.

“One of the reasons I don’t want it changed is almost a selfish reason, in that I prefer having these small groups ‘cause then I can get to know the students better and I kind of enjoy it more with just a small number of students ‘cause you get to know the students’ personalities and, you know it keeps me interested, so there is a selfish aspect of this as well.”

Although they may consider this selfish, a tutor who knows the students well and is interested in their work must surely be to the students’ advantage too. The same tutor mentioned another benefit of these small groups

“[If] they’re in a group of thirty or whatever it is ... [the tutor is] not going to be noticed if they’re not there... whenever somebody’s not there in my tutor group, you know we all know this.”

Indeed, it was noticeable that the issue of students missing classes was mentioned less often at this university than at

any of the other three. However, it is far from clear-cut; one of the other universities in this study reported:

“We used to divide them into tutorial groups of six and have them in our private offices. And then after a while we found that the people who needed help most just weren’t coming,”

so smaller tutorial classes clearly don’t guarantee better attendance. Perhaps the higher entry requirements at the university which runs tutorials ensures a better work ethic in its students.

On a similar note, we speculate that students in a smaller class are more likely to be actively engaged in the work. Students in a large exercise class engaged in individual work might consider it perfectly reasonable for them to use ‘their’ time reading emails or chatting with their friends about unrelated things, and it is certainly harder for a tutor to prevent it. In a class of six, this is surely much less likely to happen.

Surgeries

Three of the departments in this study – including the one which uses the tutorial system outlined above – timetable a class which is not tied to a specific module. Typically, these are 2 hours per week. In style these are similar to exercise classes, although there is often less expectation that all students should attend. Nevertheless, the question of attendance was raised by staff, alongside another difficulty:

“You get the mixture, you get the students for whom it’s really beneficial and therefore they keep turning up. You also get the high fliers who just want to be sure about the last little bit... that they quite understand. So you are playing to two different audiences there.”

In essence, these classes are very similar to the drop-in support sessions which many universities run, as we reported in the last issue of *MSOR Connections* [1], but there are two significant differences. Firstly, these classes appear on the student timetable in a way that university-wide drop-in sessions may not, which we speculate might help to create an expectation that students should attend. More significantly, because they are targeted specifically at first year mathematicians, students are more likely to come with similar problems and this provides an opportunity for the tutor to break away from individual help in favour of group teaching if appropriate, so that the class becomes closer in style to that outlined in the next section.

Where this approach is adopted, it does of course require the tutors to be knowledgeable about all the modules; perhaps this is one reason why surgeries are not used in later years of the courses we looked at.

Cross-module structured classes

One university runs, in the first semester, a class which was originally intended as revision of A-level and was more structured than a surgery. Following student feedback,

the class is now more closely related to core modules. Here, working on or asking about coursework is officially discouraged, albeit to different degrees:

“What a lot of them do is bring us their homework and ask us questions as well - I don’t think they’re supposed to do that, but they prefer it - and it’s not up to... I told them they should use their contact time however they wanted - it’s up to them.”

Clearly, where a department runs surgeries or cross-module structured classes, it is easy to blur the boundaries between the two styles of class from week to week or indeed within the same class.

This type of class offers other opportunities, which might address concerns expressed by some staff; for example the chance to draw out the connections between different subjects - to see the bigger picture that modularisation sometimes obscures - or focus on core mathematical skills which are useful across all modules, such as writing mathematics well or constructing logical arguments.

Miscellany

There is a noticeable difference in the ratio of lectures to small-group teaching between the institutions. In both the post-1992 universities, the usual arrangement is to have an hour’s small-group class (from the students’ perspective) for every lecture hour. In the older universities, the ratio is closer to one tutorial for every three hours of lectures. To what extent is this a reflection of historical differences between universities and polytechnics, or central university models? And more crucially, do we have the balance that we want or simply the one that we inherited? We don’t have answers to these questions, but we invite readers to consider them for themselves and their own courses.

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The use of postgraduate students and post-doctoral fellows to teach has the obvious advantage that, in some departments, they are plentiful and cheaper than lecturing staff. It also provides opportunities for the tutors to develop their professional skills and therefore contributes to the health of the overall maths ecosystem. But does having

inexperienced tutors disadvantage the students? In general the students we interviewed thought not; indeed they often saw postgraduate students as closer to themselves and more likely to be helpful as a result.

Building on that idea, one university here has a system of 'peer assisted support sessions' and we have recently experimented with a 'peer assisted learning scheme' where final year undergraduates are used to provide additional support to first year students. Ongoing work supported by the MSOR Network by Indra Singh at the Open University and Steve Kane from Hertfordshire University will report about such schemes.

Finally, it is worth noting that this article focuses on structures and styles of class, but we have said almost nothing about exactly *how* we teach within the classroom; what do we mean when we say we help students when they have questions? This is, partly, simply a reflection of what staff and students said - or didn't say - to us, and perhaps we should have steered the conversation in that direction more. That said, our impression from the interviews is that, collectively, we think we know how to teach. There is no shortage of research on effective teaching of mathematics, but there are many barriers to university lecturers engaging with it. These might include our personal interests, pressure for our time, inaccessibility of educational research to lecturers with limited experience of social science language, a belief that we already know what works, or a reflection of teaching expertise sometimes being undervalued. The question remains: "are we teaching effectively, and could we do it better?"

Ideas and questions

We have reviewed the variety of arrangements for small-group teaching and it is noticeable that the variation across institutions is much wider than in our approach to lectures. As ever, we are interested to hear from anyone who does things differently again, and your views on the most successful methods.

We do not presume to say which of these approaches is best, but in summary we can identify a variety of possibilities which you may like to consider:

- General cross-module classes, provided in addition to module-specific classes - may provide an opportunity for seeing the links between different modules and developing skills which are generic to mathematics rather than specific topics.
- Surgeries can provide a forum for discipline-specific support, are popular with students, and may be used more than drop-in sessions which are open to other disciplines.
- Small-group classes directly after lectures enable students to rehearse the lecture material immediately but may reduce the effective use of staff time and

encourage student disengagement. Holding exercise classes at a different time during the week allows staff to establish an expectation that students will arrive prepared and can result in better use of the staff time.

- The students we talked to generally see their exercise classes and tutorials as being more useful than lectures. Are they right? Should we therefore change the ratio of lectures to small-group classes? Do you do what you do because that's the way it's always been done or because you really think it's best?
- Very small groups, as outlined in the tutorial section of this article, can provide multiple opportunities which are generally appreciated by both students and staff. Since few of us are in a position to increase the amount of staff teaching time, the questions are: what would you need to sacrifice in order to provide such small-group classes? What might you gain?
- Blurring the boundary between lectures and small-group styles of teaching has some educational advantages but may be difficult with larger cohorts. Certainly students want some smaller groups where they feel more able to ask questions, so with large cohorts some small-group teaching is required. But a longer, less transmissive, more varied style of 'lectorial' and consequently larger exercise classes or tutorials may be beneficial.
- There is a wealth of research into effective teaching in mathematics. To what extent do you engage with this - and are you given time and space to do so? Do you think you may benefit from it or believe that it has nothing to offer? Does your department value you for your contribution to teaching, or only for your research?

References

1. Challis, N., Robinson, M. and Thomlinson, M. Student Support. (2009) *MSOR Connections* Feb 2009, Vol. 9 (No. 1):36-38.