

A Tag-Team Approach for Teaching Mathematics and Programming

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Abstract

As educators we constantly strive to present material in the most accessible way for students in our classrooms. Many novel delivery mechanisms have been tried with mixed rates of success. This paper presents a tag-team approach that has been used by the authors for a number of years. It involves the active participation of multiple lecturers in the delivery of lecture material and leads to improved participation and engagement from the students. While the technique presented requires a small amount of extra preparation when compared to a standard single-person lecturing model, it is our opinion that the effectiveness of the technique makes this extra time investment more than worthwhile. The paper describes the details of the method, its advantages and disadvantages and discusses feedback that we have received both from students and colleagues alike.

Keywords

Tag-team lecturing, teaching style.

1. Introduction

Mathematics and programming are vital subjects in any computing curriculum and are often considered the most difficult to teach (McLoughlin & Hely, 1996). It can be very difficult to sufficiently motivate the students, in particular in the mathematical modules, for their successful completion of the course material. Over the last few years we have investigated the possibility of delivering courses using a tag-team style of teaching. In this model there are two lecturers present in the classroom both of whom take an active role in the class. The authors had delivered occasional lectures in both UCD and GCD using this approach and received an enthusiastic response from students, and also from colleagues who attended these classes (O'Riordan, 2007). This semester we have just completed two courses given in Fudan University in Shanghai, China using this approach. Both of these courses were programming related, the first was a second year module in Functional Programming and the second a third year module in Logic Programming. Both modules involved a significant amount of mathematics. We were very happy with the results of this approach.

In this paper we will outline the motivations for this tag-team approach and the requirements necessary to achieve success using this approach. We will give an indication of preliminary results as to the success of the approach and discuss feedback that we have received from colleagues and students alike.

2. Motivations

Over many years teaching the authors have noticed a decline in the interest levels of students. It seems to be more difficult to engage students with material effectively. For successful education to occur these days it is no longer sufficient to send the student to the library! There needs to be more engagement in the classroom setting. For instance (Kirkland and O'Riordan, 2008) introduced the notion of using games as a means to stimulate interest in the lecture. They studied the effect of a "Who wants to be a millionaire" style game show in the classroom. O'Sullivan (O'Sullivan, 2008)

examined the use of the Mozart Effect – that students who are exposed to music as they study are more engaged with the material in question. However, the problem with both of these approaches is that the time spent organising the competitions or the music could take away from teaching time.

In recent years the computing domain has looked to using computers to help us teach. First-year programming is now routinely taught using graphical environments; Alice, Scratch, Greenfoot etc. (Fincher et al., 2010). It would appear that teachers of computing have stopped examining means of improving traditional teaching and are now focusing on new and innovative means of delivering content. We argue that the computing faculties should investigate changes that can be made to traditional techniques in order to motivate and engage the students.

For the last few years the authors have felt that a “tag-team” approach ie. Having two lecturers teaching together was good to motivate students. The authors have tried this on many one-of lectures over recent years and anecdotal evidence has shown that it has worked very well. This past semester the authors were able to teach two modules on the UCD / Fudan Joint Degree Programme using this technique. The modules in question were both related to programming, a second year functional programming module and a third year logic programming module. Each class had approximately 50 students in it. The following section describes the methods we employed.

3. Tag-Team Teaching – The Method

In this section we describe the method of tag-team teaching that has proven most effective in our experiences. The process begins prior to the commencement of the lecture as the lecturers need to plan the exact material to be covered. The only difference between this and normal lecture preparation is that here there is more than just one person involved. As an example of this we refer to the theorem proving section of a standard logic programming course. Planning for this would involve deciding on the exact theorems to be covered in class and which member of the teaching

team would 'take the lead' on a particular theorem. We would also decide which of the theorems to set as in-class exercises.

Lectures would usually begin with the lead-lecturer for the first topic in front of the class and the second lecturer amongst the students. The lead-lecturer begins covering the material as they would do in a standard single lecturer format. The second lecturer observes the students and most importantly the lead-lecturer.

When observing the students the second lecturer is responsible for ensuring that the students understand the material. This can be achieved from looking at facial expressions to see if they comprehend, by over-hearing queries between students, and once the students become comfortable with the format answering a direct question from a student. If at any stage the second lecturer feels students are getting lost (s)he can interrupt the lead-lecturer in order to clarify a point. These interruptions are not a criticism of the lead-lecturer; it is solely that the observer is better placed to judge the student's reaction than the lead-lecturer is. This format allows for the early identification and solution of problems, rather than the current single-teacher model where students may not ask a question until the end of the lecture (or in a worst-case scenario, the day before an exam).

The other duty of the observer is to observe the lead-lecturer. Before we discuss this in detail it is necessary to describe in more detail the courses we teach and the methods we employ to do this. All of the courses that the authors teach in computing are centered on mathematics or programming. The learning outcomes of these disciplines include such phrases as “the ability to prove unseen theorems” or “the ability to solve unseen problems”. In all cases the students are expected not to regurgitate previously seen work but to create solutions to unseen tasks. As such the key skill we teach is a method: a method of proof; a method of programming. This means that static powerpoint presentations are of little or no use. Hence every proof / program is constructed on the white board.

In observing the lead-lecturer the main responsibility of the second lecturer is to observe any mistakes. Due to the dynamic nature of the material mistakes will occur! The lead-lecturer will find these difficult to spot at the time whereas the second-lecturer should find it much easier. This allows the second lecturer to immediately correct the mistake and set the students on the correct path. This has an added benefit for the student in that they see the 'experts' making mistakes and are exposed to the dynamic nature of the task.

3.1 Requirements

In order for the the tag-team teaching method to succeed there are certain requirements that we have identified which we see as being essential to its success. Some of these requirements we feel are essential for all delivery methods. For instance the teachers must be enthusiastic about the material that they are presenting. This has long been accepted as an essential requirement in order to motivate students. Other standard requirements are that the teachers must both be knowledgeable about their subject area, and that preparation is done well.

In order to successfully use the tag team approach there are some extra requirements necessary for successfully employing this approach. The main requirement we have found is that this technique will only work if both teachers involved are able to accept criticism from their colleague in a public, classroom situation. If this is not the case one of the main benefits of tag-team teaching, that of correcting errors that might be made during teaching, will be lost. We also feel that it is essential that the teachers have a very good relationship outside of the classroom. This leads to more “banter” in the classroom situation, our experience suggests that this “banter” encourages student participation more than anything else.

3.2 Advantages of Tag-Team Teaching

There are many advantages to this tag-team teaching approach. These include:

1. **Range of perspectives on material:** Having more than one teacher involved exposes the students to more than one perspective on the material. In order to help the students develop their critical thinking / problem solving skills it is helpful for them to see that multiple perspectives exist. In the computing arena this manifests itself as different solutions to a given problem. We each see a problem in a different way and the more of these possible solutions the students are exposed to in their formative years the better they will be at solving problems in later life.
2. **Dialogue of teachers encourages participation from students:** In the standard one teacher model students may be reluctant to participate fully in the class. No matter how encouraging the teacher is, the students may find it intimidating to interrupt the teacher¹. With the tag-team teaching model the teachers are engaged in a discussion during the course of teaching the material. The student will see discussion as the natural way in the classroom and as such is more likely to partake in this discussion. We found that the students were more involved in the class when using the tag-team approach to teaching.
3. **Demonstrating the excitement in the subject area:** Tag-team teaching allows for two enthusiastic teachers to communicate the excitement in the subject to the students. The authors have always felt that the best way of engaging students with material is to ensure the teacher's enthusiasm is communicated to the students. This will spark an interest in the student as they try to understand why the teacher finds the material so interesting. We find it much easier to communicate this enthusiasm for a subject using the tag-team method as we conduct dialogues in the class related to the material.
4. **Allows for classroom monitoring:** In the main, at any stage in the tag-team process only one teacher is speaking at a given moment, this affords the other teacher the opportunity to observe the class. This leads to more immediate feedback from the lecturing process than is

¹ The authors found this to be a large problem in China where the culture insists that the teacher is always right and deserves the student's respect.

otherwise available. The teacher who is not actively teaching at a particular moment can survey the class' reaction to the material being presented in a more effective manner than if they were speaking.

5. **Students more likely to approach a teacher:** We are all aware that students relate better to some teachers than to others. With tag-team teaching each student is more likely to be able to relate to one of the teachers and as such is more likely to approach them.
6. **Inclusion of in-class exercises:** A great way to ensure that the students are engaging with and understanding the material presented in class is through the use of in-class exercises. We find that the tag-team lecturing approach makes this a more worthwhile exercise due merely to numbers. The extra lecturer in the room means that more students can be spoken to regarding the material and their attempted solutions. We have found this to be a great way to ensure that the students are understanding the material and if not we can identify the problems they are having and alter the remainder of the lecture accordingly. This means that it is very rare for a student to leave the classroom unsure of the material covered in class as the lectures are altered dynamically to cater for any difficulties. Having two teachers also allows for one to spend a large amount of time with a student who is really struggling without the remainder of the class feeling hard-done by as there is still a second lecturer to answer their queries.
7. **Fun!** Many students (and peers who have witnessed the lectures) have told us that the lectures have been great fun. This helps to motivate the students in the classroom causing much engagement with the material in question.

3.3 Limitations of Tag-Team Teaching

In this day of budgetary constraints tag-team lecturing may not be feasible in all institutions. The major drawback of the technique is resourcing. Departments are less likely to allocate two lecturers to a module due to the cost involved in this. In order to overcome this there are a few potential

solutions, although all of them will dilute the effectiveness of the technique to some degree.

1. Do not include two lecturers in every class. It may be that certain classes during a course will be taught as effectively using one lecturer as two. These classes can be decided upon prior to the commencement of the course and the second lecturer need only attend these. This obviously dilutes the effectiveness but also means that the students have less time to get used to the idea of having two lecturers present and hence are less likely to take advantage of the benefits it provides when they do have access.
2. Larger organisations with high post-graduate numbers can use a post-graduate student / post-doctoral researcher as one of the lecturers on the course. In general the cost of these people to the institution for an hour or two a week is very small compared to the cost of a full academic staff member. One benefit of this approach is that it allows the younger members of the academic community to get some experience lecturing in a safe environment. However, it should not be viewed that the postgraduate / post-doctoral lecturer is a junior member of the team. For the tag-team teaching approach to work both lecturers must be seen as equals.

3.4 Adaptation to other disciplines

The authors have only used this tag team teaching technique in a small number of courses in UCD to date. We specifically use it for subjects where the aim is to teach *method* rather than mere facts. However, we feel from our own experiences and conversations with lecturers in other disciplines that the technique could be applied more widely. The technique could easily be applied in any of the sciences as these are problem-solving courses rather than memory intensive courses. In addition we feel that it could be applied in *opinion* courses, such as history. In these subjects the students are expected to form opinions as to the effect of various historical events. The introduction of a second opinion that the tag-team approach would provide would be most beneficial as the students would

be able to see opinions being formed, discussed, evaluated and accepted / rejected. To witness this process would be very helpful to students in this domain.

Domains such as Medicine / Veterinary could also make use of this technique. In the early years of these degree programs students are introduced to basic scientific courses (Chemistry, Physics etc) where it would be easy to use this technique. In later years the students have a mixture of *method* subjects and *factual* subjects. In the method subjects the technique would prove beneficial. Indeed, one of the most important skills that students learn in these courses is the skill of diagnosis. A slight alteration to the tag-team teaching technique might prove very beneficial. This would involve a third-lecturer giving a brief description of a patient's symptoms and then the tag-team could discuss this in front of the class and arrive at a diagnosis (or at least a set of tests that they wish to run). This would show the students the dynamic processes that are involved in making a diagnosis and would hopefully better prepare them for their clinical experience in later years of the degree program.

In the business area the technique would be immediately applicable in accountancy as the best way to show the students the correct methods are to demonstrate them live in the lecture setting. The tag-team approach makes this easier to achieve.

4. Results

The results that we have for the effectiveness of the teaching method are anecdotal. The only way that it is possible to evaluate the technique involves use of a control group (i.e. a group of students who are taught using traditional methods) to test the effectiveness of the technique. We were unable (and unwilling) to do this at this time. Instead we have garnered feedback both from students on these courses and from colleagues who are interested in teaching and learning who have sat in these classes to observe the method in action.

We are very pleased with the feedback to date. Once the students are familiar with the new delivery method their engagement with the material improves. One reason for this is the fun aspect of these lectures. There is nothing more enjoyable for a student than seeing a lecturer's mistake corrected in front of the class. We have found that the level of interaction amongst students increases dramatically when taught using this method. We find that the students are paying more attention to the material than would normally be expected.

Our colleagues from both computing and from teaching and learning have enjoyed the experience of attending these lectures and they have all commented positively on the level of student engagement in the course.

5. Conclusion and Future Work

This paper has presented a tag-team teaching approach that we have employed for the last number of years in various mathematics and programming courses in three different institutions. Over the years we have found that classes in which we use this technique have proven to be some of our greatest teaching achievements. We teach many difficult concepts, from various methods of mathematical proof, to problem decomposition for programming, and have found the technique to work well with all. It is plainly obvious, merely from looking around the room, that the students are much more motivated than usual and genuinely enjoy the lecturing experience. Colleagues who have witnessed these lectures have agreed with this, and have also thoroughly enjoyed the experience themselves.

References

Fincher, S., Cooper, S., Kollin, M. & Maloney, J. (2010). Comparing Alice, Greenfoot & Scratch. 41st ACM Technical Symposium on Computer Science Education, Milwaukee, WI, 2010.

Kirkland, D. & O'Riordan, F. (2008). Games as an Engaging Teaching and Learning Technique: Learning or Playing? In Proceedings of the 1st Irish Conference on Engaging Pedagogies, Dublin, Ireland, 2008.

McLoughlin, H. & Hely, K. (1996). Teaching Formal Programming to First Year Computer Science Students. ACM SIGCSE Bulletin, Vol. 28, Issue 1, pp 155-159, 1996.

O'Riordan, F. (2007). Personal Communication. Informal Feedback on Tag-Team Approach, Griffith College Dublin, 2007.

O'Sullivan, K. (2008). The 'Mozart Effect' in the Classroom. In Proceedings of the 1st Irish Conference on Engaging Pedagogies, Dublin, Ireland, 2008.