Mathematics into School - Executive Summary of Reflective Journal

Tom Mann

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Introduction

I spent 9 weeks at Our Lady and St Thomas Catholic Primary School, and as part of my time there I delivered 6 sessions to a group of girls in the Year 6 class. During my time in the classroom and running my sessions I had many of my preconceptions around teaching challenged. I would like to discuss these, starting with the use of competition in the class, including both students competing against themselves and against other students. This will be followed by how to write effective questions to assist students' learning, and finally the effect of a coeducational experience on students.

Competition in the Classroom

During the later weeks of my placement I observed the class I was in playing a "Times Tables League". This consisted of the students completing a 12 by 12 grid of times tables questions against the clock (Journal, Week 16). They then read out their times and they were awarded points based on their time, with a bonus point for moving down into a new minute bracket. Their scores were kept track of over the year, with a prize awarded to people with the most points at the end of each term. I initially thought that this kind of competition was detrimental to students learning due to two reasons. Firstly, some students may become demotivated as it is impossible for them to catch up to the students with the most points. Secondly, competition may increase students fear of failure or lead to low self-esteem.

One study found that students in "competitively structured discussion" are more anxious and lose self-assurance [1]. This is something my observations from the classroom agree with. Earlier in my placement the students took a 10-minute arithmetic test, where similarly their scores were read out. Afterwards I heard two students exchange "What did you get?", followed by "I don't know" (Journal, Week 12). This clearly shows how even when students aren't directly competing, simply having their score shared with their peers can make them feel anxious.

In my last week at the school, one of the more maths-confident students asked to do another round of the "Times tables league", to my surprise when it was put to a vote the vast majority of the class wanted to take part (Journal, Week 19). It appears that competition does act as an effective form of motivation for the children. Shindler agrees that competition is an extremely powerful tool for motivation, but there are features of competition that make it healthy or unhealthy [2]. Most importantly a competition must be short term, have no real or significant reward, all individuals have a reasonable chance of winning and the goal is primarily fun. The "Times tables league" met some of these

criteria, but the combination of the long term points system and it being almost impossible for some students to win pushes it closer to unhealthy competition.

One study of undergraduates found that introducing a competitive element to game based learning improves learning outcomes and motivation of participants [3]. I hoped to recreate the benefits seen in this study in my last session with the students. The session involved the students playing a simple game against me and their peers, importantly there was no prize, the game was simple enough that all students could win and the competition was only 20 minutes. This proved extremely effective as some of the more uninterested students put more effort into this session than previous ones (Journal, Week 19). The two main things that differentiated this from standard competition is that the students benefited even when they lost, and the only thing the students were competing for was the pride of winning. As the main aim of the session was to develop a strategy for the game, the children learn by losing which likely took the fear of failure away. A standard competition involves a resource or goal that cannot be shared by everyone competing, in this case this is only the pride of winning, which is minimal as the competition was so short.

How to Write a Good Question

Questions are usually only thought about as a way to examine knowledge not a way to teach, but a good question can help students understanding and a bad question can set students back. It was in my second week at the school that I noticed the first badly written questions given to the students. The students were studying ratios, and were given a question similar to "If it takes 6 builders 9 days to build a kitchen, how many days would it take 2 builders?" (Journal, Week 12). While there is nothing immediately wrong with this question, none of the children answered it correctly, showing that it did not provide a learning opportunity.

According to Sullivan there are three features a good question should have, it should involve more than simple recall or the repetition of a skill, students should learn from answering the question (and teachers should learn from students' answers), and there may be several acceptable answers [4]. I think the most important feature here is the ability for students to learn from a question, if a student can learn from a question it likely includes more than recall. One paper on how to write valid maths questions posits that one reason students get maths questions wrong is because they identify the wrong schema [5]. Students will often store models of how to answer certain questions in their working memory, and when they recognise a similar problem they will call upon the schema most closely related to it.

In the earlier example, the only similar schema the children had was how to solve a simple ratio problem, so that is the one they called upon. In this example the ratio 6:9 is the same as 2:3, so the incorrect answer is it would take three days. This question fails to recognise that the students would need guidance to build a new schema which they can call upon in the future. This question should have at least two parts, one asking how total days it took to build the kitchen, and then the second using this answer to solve a simple ratio problem.

One article classifies the types of errors students make into: translation and understanding, understanding and calling upon relevant knowledge, planning, and execution [6]. This respectively relate to the knowledge requirements: linguistic and factual, schematic, strategic, and algorithmic. I would argue that linguistic, factual, and algorithmic knowledge are the most basic as a question to recall a fact or reproduce an algorithm does not

necessarily require schematic or strategic knowledge. This suggests that questions used in the classroom should focus more on schematic and strategic knowledge, in particular scaffolding and structuring questions to help students build schemas. Whereas in most cases maths questions often have the property of being all or nothing, they are like a puzzle in which students try different approaches until one works [5].

Even when a question is split into multiple parts, often times it can still be unnecessarily confusing. During my third week at the school the students were learning about scale drawings. They were given a question that involved a 18cm square that had been drawn to scale on a square grid as a 3 by 3 square. The question given was

a) $18 \div \_\_\_ = 3$

b) One small square is worth $\_\_\_$ cm.

All of the students could solve the first part easily, but had no idea how the two parts linked together. I think the question would achieve a better desired effect if the first part was a) $3 \times \_\_\_ = 18$. While they convey the exact information, I think the structure emphasis the link in a more natural way as multiplication is more intuitive to most people than division. This means the students are more likely to learn from the question and develop a schema they can use in the future.

Girls & Boys

All of my schooling has been in a coeducational environment, and up until my placement I had never considered the possibility of anything else. Mixed sex education has become more common, in recent decades a significant number of formerly single-sex schools have transitioned to coeducational models. In particular the percentage of single sex schools in the UK has decreased from 24% in 2014 to 18% in 2024 [7, 8]. The benefits of coeducation are clear, such as promoting gender equality and improving social skills. It was not until my project which focused on improving the self-confidence of Year 6 girls in maths that I considered how a mixed education may be detrimental.

During my session with the girls, we talked about why they may be anxious or worried in a maths lesson. One of the most common answers was a fear of judgement from other students (Journal, Week 13). Gillibrand argues that when girls are free from the competitive nature of boys and the perception of not being up to the boys standards they are more likely to participate actively in the classroom [9]. This agrees with an observation from a session, one girl volunteered to answer what "data" is when none of the other girls in the session put their hand up, this shows girls may not fear judgement in an academic sense as much in a single sex environment.

The impact of mixed education may be more detrimental in STEM as girls in single sex schools are substantially more likely to take STEM A-levels than girls in mixed sex schools [10]. This is not due to greater access of these subjects as all-girls schools are only marginally more likely to offer most STEM A-levels than mixed schools. One of the reasons mixed education may be more detrimental to girls in STEM is because of the different learning styles of boys and girls. Hughes argues that girls are more likely to benefit from a collaborative learning environment as they utilise more words in the learning process and this allows girls to communicate with each other about the topic at hand, whereas boys focus on completing the task well without as much attention to emotions [11]. This may suggest that boys are more comfortable learning in an environment involving competition. As mentioned previously, one boy in the class asked to do the "Times Tables League" and when it was put to a vote most of the class agreed and the few that didn't were mostly girls (Journal, Week 19). This difference in learning style may be more exaggerated in

mathematics as at school level it is naturally less cooperative and more competitive as answers are either right or wrong. This again links to how maths questions are puzzle like, it is difficult to collaborate on questions where students either get the answer immediately or never get it.

While I have mainly mentioned how mixed sex education can be detrimental to girls, it is important to note it can be just as harmful to boys. Lessons can be adapted to meet boys' learning styles better in a single sex environment as well, such as increasing movement in the lesson [11].

This is a well debated topic with abundant evidence both for and against the argument that single sex schooling increases academic achievement. Regardless of whether this is true or not I think it is important to consider how single sex schooling may impact qualitative factors such as student satisfaction and self-confidence.

Conclusion

Overall, this experience has allowed me to explore various pedagogical theories and the realities of applying them in a classroom. Seeing the contrast between theory and application has allowed my develop my understanding and effectively incorporate theory in the planning of lessons.

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