Maths is about preparing students to play 'the game of life'

So we need to teach students the rules, and then play it with them!

Siobhan Merlo

"And of course, the things they do not know must be taught to them by other people who do. The people around them must give their assistance. Education is not intervention but assistance towards self-reliance. For example, how would it be if one were thrown into society without knowing any traffic rules; without knowing the meaning of red lights and green lights? Or, if one had no car-driving skills and found oneself behind the wheel? Naturally, there are rules to be learned here and skills to be attained …"

(The Courage to be Happy by Ichiro Kishimi and Fumitake Koga p. 14.)

I have often wondered why there are some controversies which persist for a very long time. Take, for example, the explicit instruction versus inquiry debate in maths education. On the one hand, proponents of explicit instruction argue for the importance of teacher-led synthetic, structured and systematic instruction for teaching academic skills, while inquiry approaches aim to support students to construct their own knowledge/schemas by providing engaging tasks intended to pique their natural curiosity. This is indeed a very hot topic – there is a lot at stake here. Australia's mathematics PISA (Programme for International Student Assessment) results have declined over the past 15 years (see report here), rankings have dropped relative to international standards, and stakeholders in this space are scrambling to work out why, and what can be done about it. This is not to mention the impacts that lack of skills in mathematics have on the economy and the country in the global context.

After much contemplation, and I know I am heading into dangerous waters here, I have come to the conclusion that the reason this debate has persisted is because: both sides are right! The only problem is, neither side in its purest form captures the entire story, and this is why:

Maths, survival and agency

In my previous conversation piece, I addressed the issue of why mathematics is not only relevant, but critical for survival, especially in today's complex world. I argued that:

> *"Children need to build the foundational skills necessary and be versed in the socially-agreed upon mathematical conventions by which to communicate and interact with others, so that they can use critical thinking and logic to make astute decisions and solve increasingly complex problems. In these ways, they are able to optimise favourable experiences and minimise negative outcomes. Thus, mathematics is not only relevant, it gifts children with agency in their lives and is essential for survival."*

If we accept the purpose of mathematics education is to prepare students for 'the game of life' and not merely to cover content in the curriculum, then setting students up for repeated success ensures they will continue trying, take on new challenges and develop the agency needed to survive in a complex world.

In other words, the purpose of mathematics education is to prepare students for 'the game of life'.

'Mastery' is an element of control which is a human drive implicated in 'the game of life'. Similar to the smell of fresh bread, when a person has 'mastered' something, neurochemicals such as dopamine are released in the brain, which are recorded in memory and drive the individual to repeat the same behaviour again. Interestingly, we know from the research that motivation in mathematics at school is linked to mastery. Motivation is not linked to teachers trying to convince students that 'maths is fun', or textbooks featuring bright colours and images of ice cream. Neither is it linked to presenting students with challenging problems which they do not have the skills and knowledge to solve.

Correspondingly, there are serious implications for a person's wellbeing if they are subjected to persistent failure. As I wrote in my previous conversation piece:

> *"Repeated failure in mathematics may have devastating impacts on the life trajectory, including during school: anxiety, learned helplessness and poor self-concept, social isolation, behavioural implications, school refusal, leaving school early and school detachment. In transition to adulthood, it often translates into difficulty maintaining employment, unemployment, not venturing into further study, low income, mental health problems, poor financial decision making, never owning one's own home, and in the most dire of circumstances, incarceration."*

In other words, students experiencing repeated failure in mathematics often start to 'bow out' before the game has even started.

Educators and schools have a significant role to play in determining which path their students take. By adopting sound pedagogical approaches and ensuring that tasks are pitched at a level which enables students to experience outcomes in favour of success and not failure, schools are effectively making a significant contribution to their wellbeing and indeed, their survival. If we accept the purpose of mathematics education is to prepare students for 'the game of life' and not merely to cover content in the curriculum, then setting students up for repeated success ensures they will continue trying, take on new challenges and develop the agency needed to survive in a complex world. So, how do we prepare students for 'the game of life', and what implications does this have for pedagogy?

Relevance!

First and foremost, would you start teaching a child the rules of a game without telling them why? This may seem preposterous, but judging on how many times students have said to me that they have no idea why they are doing the maths they are being asked to do, this happens more than it should. Students need to understand why the maths has a functional purpose in their lives, but this is often a tricky tightrope: we need to explain the purpose, but we can't expect them to play the game without knowing the rules first. Throwing students into the deep end with minimally guided approaches when they are not yet ready, is another educational trap which can be made when attempting to make maths 'relevant'. So, students need to know the goal of the game and that we, as educators, will teach them the rules so they can play it.

If math is preparation for life, explicit instruction is about rules

Now for a second question: would

you ask a child to play a game with you, without telling them the rules? Would you ask them to just start playing and say: "You'll pick up the rules as you go"? I don't believe many people would, because this would place the child at a serious disadvantage, especially if they were competing against other children who *did* know the rules. This is not to mention the amount of time it might take, that they may pick the rules up incorrectly, or they may not work out the rules at all. And then, there are the implications for students' wellbeing, knowing that other children seem to understand something they do not. Explicit instruction in mathematics is about teaching students the rules and conventions for playing 'the game of life' so that students can be set up for success.

Conceptual knowledge in mathematics is essential, but drill is also necessary (and kind!)

Imagine arriving in secondary school, like many Australian school students do, and being required to make measurement conversions swiftly, find common denominators, understand percentages and more, without automatic number fact and times-table knowledge? How long would it take if you were still using concrete methods and repeated addition to work these things out? How would you feel if you looked around the room and other students were doing the same schoolwork effortlessly? Lack of automaticity in significant mathematical skills stymies mathematical growth. It also sets students up for failure experiences which may ultimately damage their self-concepts and affect their wellbeing.

This is not to minimise the critical importance of conceptual knowledge which enables students to develop increasingly sophisticated understandings that can be applied to novel situations. It just means that once children have been taught mathematical conventions through explicit instruction, they need to practise them and develop increasingly efficient strategies to solve problems faster. The automaticity which results enables them to be successful when tackling increasingly sophisticated mathematical challenges. So, just like going to the gym to improve fitness, students need drill to be able to achieve mastery.

Inquiry approaches are about rehearsing for the game

Now – for a final question: Would you teach a child the rules of a game, and then not play it with them? That would definitely not seem right, as children need to be able to apply their knowledge to novel situations, so they can build increasingly sophisticated schemas. These schemas allow them to solve the problems they encounter and make decisions which promote positive outcomes and minimise negative ones in their lives. This is not to mention how disappointed they would be if they had worked hard to learn the rules and then had no chance to play the game! Inquiry and other minimally guided approaches work when students have already been taught the rules through explicit instruction and mastered them through practice. Such pedagogies are also engaging because they allow students to apply the knowledge they have mastered and provide a 'carrot' for keeping students in the game. Opportunities provided through this type of approach are not only engaging but allow children to rehearse for 'the game of life'.

An integrated direction for Australian mathematics education

If the purpose of education is to support students to develop the temperaments, skills and knowledge necessary to play 'the game of life', it is an ethical responsibility to set children up for repeated success in mathematics so that they 'stay in the game'. Not only does this have implications for the wellbeing of individuals, but also for the wellbeing of the country. I have no doubt that highest ranking countries on international mathematics tests conceptualise mathematics as critical for 'the game of life', with subsequent implications for pedagogy as I have described here.

The Singapore syllabus, for example, includes a strong emphasis on relevance and cultivating positive attitudes towards mathematics, explicit instruction, practice towards mastery (drill), and inquiry and application to novel problems. It is also not surprising that Singapore has a strong economy to boot. If we do not want our children to be the students who do not 'know the rules' or who have never had a chance to 'rehearse for the game' among others who have, we need to start working together and accepting that there is a place for both explicit instruction and inquiry pedagogies, and that neither one on its own is sufficient. There would not be international tests for both the conventions of mathematics (Trends in International Mathematics and Science Study – TIMMS), and the application of mathematical knowledge (Programme for International Student Assessment – PISA) if either pedagogy was. As I have argued here, students also need to understand the functional purpose of the maths they are being asked to do from the outset, and they need to practise until they achieve mastery. In these ways, we can move towards a more integrated pedagogical approach which sets students up for success and facilitates our children's ability to optimise positive outcomes and minimise deleterious ones in 'the game of life'.

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