Fostering engagement in mathematics education essay

Education

Part 1: Drawing on 5 research articles or chapters provide a summary of effective instructional practices that support students' motivation and interest in mathematics lessons.

Motivation is not a single element but a process that an individual goes through to achieve a goal or goals. Motivation can be described as the desire to do things and it is an essential component in student attitude in order to achieve success. Motivation in students can be the difference between successful and unsuccessful teaching and learning. Student motivation and interest are key ingredients to learning. Teaching is a complex job with a diverse range of abilities and needs in classrooms. Educators cannot teach year level content to the majority of students in their class and expect all of the students to be engaged and successful, nor can they realistically teach to five separate levels across the period of a lesson as it spreads their time thinly and causes a range of issues that do not justify the workload of teachers versus the learning (Fergusson, 2009). So how do teachers meet the needs of all of the students in a classroom? Curriculum differentiation is needed to address the needs of a diverse group of learners to improve motivation and interest of students. What follows is a brief discussion about intrinsic motivation and then a summary of effective instructional practices that support students' motivation and interest in mathematics lessons. Teachers can provide extrinsic motivation such as rewards and even punishments but this is unlikely to benefit student learning long term. Ideally it is intrinsic motivation that is desired, the motivation that comes from inside a person and the type of motivation that results in high quality learning. Intrinsically motivated students are driven by their own desire to know and understand mathematics; therefore they engage in tasks for their own achievement and enjoyment resulting in an understanding of concepts (Mueller, Yankelewitz, & Maher, 2011). Motivation in students is important as learning is more likely to take place when students experience enjoyment and motivation (Downton, 2005). To maximize the likelihood of achieving a higher level of motivation in students, teachers need to create lessons that improve students' feelings of control and competence in mathematics within a classroom that promotes cooperation and supports positive student interactions (Jones, 2008). So what do the lessons that improve students' feelings of control and competence entail? And how do we create a community of learners in our diverse classrooms? Improving how students feel about control and competence requires specific action by teachers. Jones (2008) describes three characteristics of lesson design and implementation that help increase motivation in students; contextualising the mathematics, exploring multiple solutions and providing task choice. Downton (2005) talks about the importance of the type of task, level of task and the learning environment needed in order to improve student engagement. Sullivan, Mousley, & Zevenbergen (2006) examine three teacher actions that address engaging all students: using open-ended tasks, preparing prompts to support students experiencing difficulty and posing extension tasks. Mueller, et al., (2011) identified in their studies that a supportive classroom environment that includes meaningful teacher questioning, well designed challenging tasks and student interest are crucial. With these elements students strive to make sense and meaning of the mathematics and therefore become intriscally motivated along the way. The type of tasks provided to students is a crucial element of lesson design. Worthy tasks are those that are open-ended and allow students to explore multiple solutions to problems so that a whole class can use the same problem and so individual learners can get benefit out of the task at their level. Ferguson (2009) states, " what teachers need are tasks in which the whole class can engage and which are easily adjusted so they can be increased in complexity to extend understanding or simplified to scaffold student learning" (p. 33). When a teacher presents an open-ended task or a task with multiple solutions to students and encourages them to use their own reasoning ability to solve it, students are more likely to feel greater control over their learning, feel valued for their contributions and are more likely to display an increase in confidence. Contrastingly when a teacher teaches a strategy to students and insists they follow the same strategy in order to answer a problem he or she, intentionally or unintentionally, is implying that students need to use the teacher's thinking to solve the problem. This does not value student contributions or thinking and can potentially do more harm than good, especially when contributions are undervalued because student contribution is not within the intention of the lesson. When solving and sharing their thinking around open-ended tasks or tasks that have multiple solutions students are more likely to feel like their contributions are being valued (Jones, 2008). Being able to explore multiple solutions enables students to feel their contributions are valued by the teacher and other students. They have the opportunity to observe how other students think and make connections. Open-ended tasks encourage students to draw on their reasoning capacity to make sense of the methods they use so not only can the confidence and independence of the student increase but so does student understanding because it is being built upon existing knowledge, understanding and experiences. When using open-ended tasks it is student thinking that generates solutions to problems rather than a regurgitation of the teacher's thinking. This type of task builds student capacity for thinking and reasoning and can cause student mathematical misconceptions to be exposed and therefore confronted (Ferguson, 2009). Mueller, et al., (2011) research states the use of open-ended tasks created multiple strategies which prompted various forms of reasoning. The depth of the reasoning was one of the results of intrinsic motivation. Tasks that give students the ability to explore multiple solutions including open-ended tasks give students choices about how they choose to solve problems and choice gives students greater independence. Choice is empowering so it is important that there is an element of choice in every mathematics session. Giving students choices about what and how they will learn provides them with opportunities to develop independence (Ferguson, 2009). Open-ended questions provide students with a choice on how to tackle problems. Another way to provide task choice to a group of students is to create parallel problems. Parallel problems are basically the same task aimed at differing levels but focus on the same big idea as each other. Open-ended tasks are accessible to everyone at the start at a variety of levels, this means that students can bring what they know and apply their knowledge and understanding to the problem, it also means that students can access mathematics at levels beyond their current level. They make learning accessible for a wider range of students (Ferguson, 2009). This is reiterated by Downton (2005) who states that the level of a task given to students needs to extend them beyond their level of understanding. Rich mathematical tasks build on and develop student thinking and reasoning by putting students in the position of working at their limit, the place between what they know and don’t know and what Vykotsky refers to as the " zone of proximal development" (as cited in Ferguson, 2005) . Open-ended tasks allow students to be extended beyond the level at which they are judged by teachers rather than be limited. If a student is experiencing difficulty along the way, the use of enabling prompts, scaffolding or visual aids and materials can be used to support their thinking. The use of prompts enables students within the class to feel fully involved, all on the same trajectory (Sullivan, et al., 2006). Mueller, et al., (2011) studies identified one of the factors deemed to be instrumental to the development of intrinsic motivation in students was the careful questioning to support students when it was needed however students were able to judge what made sense which gave them control. Scaffolding a task is also a useful way to provide support yet still encourage independence. Downton (2005) describes scaffolding as working from the known to the unknown and is an appropriate strategy with potential to motivate students. The availability of mathematical tools also supported students to develop their mathematical reasoning. The use of visual representations and concrete materials are able to support open-ended tasks to make them rich (Fergusson, 2009). The use of appropriate games and materials can create an environment of fun and challenge where students are engaged while supporting mathematical understanding. They are useful to motivate and engage students as they hold value in their ability to encourage active rather than passive learning. Games can be adapted to the needs and abilities of students and are able to develop positive attitudes towards mathematics (Downton, 2005). Real life contexts within mathematics address motivation and interest because they answer the commonly asked question from students ‘ why are we doing this?’ When students see benefit or reason for doing something their interest increases. Real life context promotes interest for students, stimulates imaginations, assist in making connections and provides useful functional mathematical knowledge (Jones, 2008). Downton (2005) talks about creating tasks that use a real-life problem solving approach that includes reasoning and estimating to engage and motivate learners. While Sullivan, et al., (2006) agree they caution that " the contexts used to engage students " are doorways to, not substitutes for, the mathematics" (p. 122). Along with positive attitude students need a positive self-image of themselves as mathematicians. If students have positive self-efficacy beliefs then they are more likely to be motivated and succeed because they believe they can (Mueller, et al., 2011). One of the things that can harm positive attitude however is ability streaming. Streaming does not foster a cohesive community of learning and ability grouping reduces opportunities for students, especially for those that end up in the lower groupings (Sullivan, et al., 2006). A better approach to providing support for struggling students is targeted support within the classroom around what the whole of the class is doing (Sullivan, et al., 2006). Key to achieving a mathematical community is that all students within a class need to be included, that means giving students who are struggling or excelling different work is not acceptable as these students are being excluded from discussion and learning within the community. It is teachers that create the culture in their classrooms and it is anticipated that all students should have some experiences that are shared (Sullivan, 2006). The learning environment and classroom culture is a major contributor to positively engaging students and teachers need to spend a lot of time to build this (Downton, 2005). Mathematics as a communal experience is where all students are included in class discussions, are able to share, challenge and offer their ideas and ways of thinking. Students need a classroom environment that promotes cooperation and supports positive student interactions (Jones, 2008). Open-ended mathematical tasks, real life contexts and choice encourage student thinking, discussion and cooperation and these elements in a classroom foster mathematical communities. Open-ended tasks enable a community of learners to reflect upon a common experience which can be used for further development (Ferguson, 2009). In the Mueller, et al., (2011) studies students were encouraged to be a community of learners where they shared their ideas, listened to, questioned and convinced each other of their reasoning for their solutions. Mathematical communities promote student/student and teacher/student relationships, a community where ideas are valued and responsibility for learning does not entirely fall on the teacher. Mathematical communities and rich mathematical tasks assist to increase effort and learning and encourage independence in learners (Jones, 2008). When students take responsibility over their learning they are likely to have an increased motivation and interest in mathematics. In order to increase motivation and interest in students educators need to use strategies to develop intrinsic motivation in students. To do so teachers need to increase student feelings of control and competence within mathematical communities of learners. Students gain control when they have choices. They also gain control over their learning when they are encouraged to think for themselves and apply their own logic and reasoning to open-ended and rich mathematical tasks with multiple solutions. Student competence increases alongside the increased feelings of control. Students gain confidence and understanding as they learn at their zone of proximal development. When students are able to discuss and explore ideas with others that stem from the use of good tasks mathematical communities are formed. An increase in motivation results in better understanding of mathematics for all students.

Part 2: Outline with reference to a struggling student specific steps that you have taken to support this student's engagement in mathematics. Provide some critical reflection on the effectiveness or otherwise of these interventions.

Jack (not his real name) is a Year 5 student who was working below the National Standard in mathematics at the beginning of the year; he was working at early stage 5 of the Numeracy Project across all domains. I observed Jack in his classroom and I noticed that he was self-conscious about his ability in front of other boys. Jack arrived in my maths support group with a poor attitude towards mathematics. Initially we spent a lot of time in the early sessions of the maths support group playing games and getting along as a group. We established ground rules such as not putting hands up and that everyone needed to be prepared to contribute and let everyone else contribute. After a few weeks Jack's attitude changed remarkably and he began to confidently share, explain and listen to others in the group. Jack had settled into the group and began to enjoy attending. Early on I discovered that Jack was able to use his place value knowledge to solve addition problems but subtraction was an issue. With careful prompting he was able to write number equations that stemmed from a word problem but when it came to solving subtraction all of his reasoning ability disappeared. He would go about solving problems using what I call manipulating some digits. He was not alone as the other five students in the group did the same thing and no amount of questioning seemed to change this behaviour. When prompted to explain why they were doing what they were doing the blank faces looking at me told me they had no idea. So I deducted that the students lacked understanding and/or the confidence to use their own strategies and they all reverted to the poorly remembered procedures they had been taught to solve subtraction problems. I began to realise that the addition strategies Jack could use successfully were also procedures and there was limited understanding of what it was he was doing in addition while manipulating the digits or why he was doing it. (Just because a student can solve something using a strategy correctly doesn’t mean they have understanding of what it is they are doing which concerns me because when they reach a level of more difficult maths where they need to apply understanding and reasoning they will lose confidence and their attitude and motivation in mathematics will decrease.)At this point I began to give the students open-ended tasks each day. These tasks created a deeper understanding of place value, operations and equality. It did not take long before I noticed Jack could confidently apply his reasoning ability to what he was doing. I observed that when errors occurred he knew that there were errors in his work and he would start over, rethink or ask for help. The rich tasks also created a community of learners within that group that I had not seen before. The students were happy to challenge each other and be challenged or cooperate to figure things out if the task required it. The rich tasks gave them discussion and concepts to think about. I did not see any of the avoidance behaviours that I had seen Jack display previously. Jack had greater confidence and began to ask for harder parallel problems to the rest of the group because he was enjoying the challenge of maths. The other element I added into our sessions was real life contexts. I knew that half of the group took the bus to school each day so for an entire week we solved problems that involved buses and children. After this we used horses and paddocks as half of the group were horse mad. When students shared how they solved problems another student would manipulate the materials to check that solutions to problems made sense while others were able to question and clarify thinking. Jack began to choose contexts that worked for him independently and whenever I noticed he was beginning to manipulate some digits in a problem he was prompted to think of concrete objects which helped him to apply reasoning. Jack's self-esteem, his motivation and interest in mathematics increased over the period of 6 weeks, he went from a student unwilling to apply his reasoning and sense making abilities to a student with the motivation and confidence working at the zone of his proximal development.