Food for Thought

A conversation starter for staff meetings or PLCs

The role of manipulatives in the teaching of fractions

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Manipulative materials

In general terms, manipulative materials have been central to the call to reform mathematics teaching. Cramer and Henry (2002) expressly called for the use of manipulative materials early in the development of the concept of fractions. This was predicated on the belief that developmentally it is advantageous for students to be allowed to move from the concrete to representational (pictorial) and then to the abstract. Through touching, seeing and doing, students are enabled to gain deeper and lasting understandings of mathematical concepts. Research also indicates that students of all ages can benefit by first being introduced to mathematical concepts through the use of manipulative materials (Fraser, 2013).

Perry and Howard (1997) defined manipulatives as including materials which can be experienced through senses of sight, touch and/or sound. Manipulative materials are used to create an external representation that stands for a mathematical idea in order to eventually develop an internal representation.

It has been shown that manipulatives have a positive effect on learning and can promote positive classroom behaviours. Strom (2009) reported that students who use manipulatives in their mathematics classes usually outperform those who do not; a benefit which holds across all year levels, ability levels and topics. The important proviso they made with this assertion is that this applies when the manipulative is appropriate to the topic. This means it must be carefully selected and must stimulate students' thinking.

Merriam and Brockett (2011) stated that the use of manipulatives is a strategy by which teachers can make a lesson more engaging by providing a hands-on experience. Further, the utilisation of concrete materials enables the teacher and learners to break away from the traditional classroom setting and instructional style. It also allows the students an effective way in which to represent their thinking in a manner which the teacher then can explore further. It enables the teacher to determine if there are any misconceptions in the student's understanding of fractions.

Some may believe that children will automatically understand fraction concepts simply as a result of using the various representations or manipulatives. This is not necessarily the case (Puchner et al., 2008; Viadero, 2007). For instance, some students define a fraction as "a piece of pie to eat," because they have only seen fractions represented using circle diagrams.

Virtual manipulative materials

The proliferation of computers, tablets etc. and internet access has brought the use of virtual manipulatives into the majority of classrooms in the developed world. In responding to the needs of today's students, many of whom are adept at accessing and manipulating technology devices, virtual manipulatives provide a variety of classroom opportunities.

There is a well-established body of research regarding the efficacy of information and communication technology use in classrooms (e.g., Cavanaugh, Billan, & Bosnick, 2008; Clements & Sarama, 2007; Moyer-Packenham & Westenskow, 2013), and much of the research shows improved learning outcomes through its use. However, there has been something of a debate as to whether materials rendered on a screen can be classed as being manipulatives. As early as 2002, Moyer, Bolyard and Spikell had defined a virtual manipulative as "an interactive, Web-based visual representation of a dynamic object that presents opportunities for constructing mathematical knowledge" (p. 373).

Dynamic virtual manipulatives are unique in that they offer a visual image like a pictorial model, but can be manipulated like a physical model. Due to the fact that some virtual manipulatives contain links among enactive, iconic and symbolic notations, their potential for increased mathematically meaningful action for users is increased (Moyer-Packenham, Salkind & Bolyard, 2008).

Not only do virtual manipulatives have a role as a learning tool in themselves but they can also act as a bridge in the progression from physical objects to representational forms. There is, however, the same warning which comes with physical manipulative materials: the manipulative in no way guarantees learning will happen. Carefully helping students make connections between what is hoped to be learned and the materials is essential (Reimer & Moyer, 2005).

Questions for consideration

- Marshall and Swan (2008) described how manipulatives, although widely regarded by, and available to teachers, had a low usage rate. Why do you think this is?
- There is a line of thought that states that where ever possible, virtual manipulatives should follow, not precede the use of concrete manipulatives. Explain your position with regards to this statement.
- On average how many occasions in a month would the students in your class access virtual manipulatives? What determines this frequency?
- What is the school's position, with regards to the use of ICT in the teaching and learning space?

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