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Make practice more productive – Introducing productive practice

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Repositioning the role of practice in mathematics learning

There is a growing concern about effectively carrying out practices for enhancing the students' procedural fluency (Coddington et al., 2011). Nonetheless, the function of practices is often inadvertently reduced to a way of mechanical skill training. It is believed that the didactic potential of practices is far more than this. Wittmann and Müller (2017) carefully categorise three types of practice that give us a clear purpose of doing practice: Introductory practice, Basic practice, and Productive practice. Introductory practice helps students to familiarise themselves with the new knowledge; Basic practice focuses on the small set of skills which should be mastered automatically; Productive practice integrates the practice of skills with the training of higher-order skills (e.g., exploration and explanation of patterns, problem-solving) (Wittmann, 2019). These three types of practice have their own unique functions in the learning process, so they are important and irreplaceable.

This study aims on investigating how the learning environments of productive practices can be embedded into the daily lessons as a part of the curriculum for basic skills and higher-order skills training. The aim of this poster is to introduce and provide some examples of productive practice.

Productive practice

Wittmann (2019) emphasises that productive practices are mathematically rich and well-structured small tasks, which provide unique opportunities for exploring and explaining the mathematical patterns while encouraging students to have plenty of basic skill practice. Two examples of productive practices (Wittmann & Müller, 2017) are shown below:

Schöne Päckchen (Pretty Packages)

Pretty Packages (Figure 1) are deliberately arranged in columns with flexible addends that either ascend or descend. While students are having plenty of practice time on addition, they also have the chance to explore the patterns and understand the concept of particular arithmetic laws (in this case, the associative law). They can make use of what they discovered and solve the questions effectively.

12+15=?	12+15=?	12+15=?
12+16=?	13+16=?	13+14=?
12+17=?	14+17=?	14+13=?
12+18=?	15+18=?	15+12=?
:	:	:

Figure 1: Schöne Päckchen (Pretty Packages)

Number pyramid

Number pyramid is commonly used in school for practising addition and subtraction and itself is based on Pascal's triangle, which is a source of rich mathematical properties in mathematics. It can become a good example of productive practice because the numbers in the bricks can be arranged

deliberately to create different circumstances for exploring. For example, set A in Figure 2 with the number in the right bottom one increases by 1 and set B in Figure 2 with the number in the middle one increases by 1 create different effects to brick A. During the process of dealing with the actual numbers and finishing a collection of additional exercises, students can observe how the pattern of the given numbers at the bottom might affect the later answers and explain it mathematically. Students are not expected to explain the pattern in terms of algebraic expression, but they can have an important pre-algebra experience.

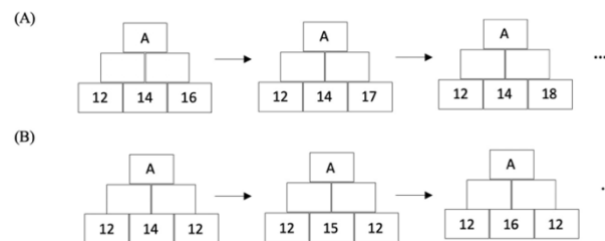


Figure 2: The bottom bricks of number pyramids are intentionally arranged

A problem-solving task with various solutions can be created by arranging the number pyramid in another way (Figure 3). While practising the arithmetic, students also have a chance to enhance their problem-solving skills through the process of observing, conjecturing, justifying, and reasoning.



Figure 3: Productive practice which nurtures problem-solving skills

What's next?

Productive practices are not some separated tasks for specific problem-solving skills; instead, they are well-designed packages of learning environment which are fully merged with the curriculum. They can prompt deep procedural learning, meanwhile create opportunities for students to understand phenomena in a mathematical way and enhance their high order thinking skills. To evaluate and further develop the design of the learning environment with the use of productive practices, a design research study of using number pyramids in grade 2 classroom will be conducted. In the study, the lessons will be observed and some of the students will be invited for interviews afterwards; thereby analysing their mathematical thinking process while doing productive practices.

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