KINDERGARTEN STUDENTS SOLVING ENGINEERING CHALLENGES IN A STEM LAB: MANIFESTATIONS OF SPATIAL REASONING SKILLS

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THEME:

Engaging students in STEM education

BACKGROUND AND AIMS

We will report results of a study featuring Kindergarten students' work in a primary school STEM Lab/Makerspace solving an engineering challenge consisted in building a shelter for a stuffed animal they chose using different carton materials and tools. Our analysis focuses on spatial reasoning skills that emerged from students' intuitive exploration of space and shapes. Through a design thinking process as part of solving an engineering challenge (Hughes et al., 2019), students mobilized spatial thinking skills, which are considered as key element of geometric activities (Olkun, 2003).

METHODOLOGY

Two groups of 20 students and two teachers agreed to participate in the study. The researchers collected data during students' work using videorecording and post-project interviews. In this paper, we analyze data from one group working on the following challenge: *Build a shelter for your stuffed animal. The shelter must protect the animal from rain and high winds.* Students worked in small groups of 2-3, with little teacher guidance. Twelve video-segments were first analyzed on the presence of spatial reasoning skills; then assigning initial codes from each video-segment, to finally, investigating common aspects across all segments.

RESULTS AND CONCLUSIONS

The **process of solving the challenge** is very complex in contexts where students mostly work on their own with very little help from the teacher. We identified three main phases of the process. Planning – Realization – Testing and Adjusting.

The **initial phase** of the project shows students' discussion of the problem and ideas including *estimating* the size of their shelter *using gestures* (Figure 1).

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This discussion and the planning show that the students are ***motivated*** *to start working on their project. All the* ***measurements*** *made with their arms are bigger than the stuffed animal, which suggests that they have understood the assignment. They have concluded that it must be bigger than the animal so it will fit inside. The teacher did not tell them what* ***size*** *the shelter should be, they are figuring it out all on their own.*

Afterwards, students seem to be ***organising*** *their tools. For example, they are putting their screw and screwdriver aside.*

In both cases, there is ***planning*** *phase of problem solving (Polya)*

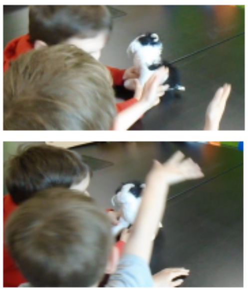

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Figure 1. Students use gestures to estimate the size of their shelter.

The second phase consisted of **building a prototype**. At first, students opted for a *rectangular shape* by synchronizing their movements to produce a *desired shape* (rectangle). They also had to decide how to fasten the joints of the faces of their construction. (Figure 2).

The students placed one piece of cardboard on each side to form a ***rectangular shaped prism.***

The stuffed animal is strategically placed so it ***lays flat*** *in the center to assure the* ***correct dimensions****.*

Teacher: *OK so you got me holding this. Now what?*
Student: *We're going to screw it down.*
Teacher: *Oh! You're trying to screw it down, that's interesting. I'm very impressed boys! Maybe you could look back and come see how you did it on this side, see if that will give you a clue.*

The student is ***pressing firmly on his tool*** *to cut the cardboard. He is* ***intuitively*** *cutting* ***a straight line****, while with his other hand, he is holding the cardboard* ***perpendicular*** *to the floor.*

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Figure 2. Students build a shelter for their lion.

The final phase was **testing** and making their construction **more solid**: "waterproofed" and withstanding against the "wind". They had to *readjust* their construction, for example, by *switching* to a triangular shape. (Figure 3):

(3 :55)

This team seems to have ***transitioned*** *from a* ***rectangular*** *prism to a* ***triangular*** *prism. It appears that they decided to bend the two side walls so that they meet in the center.*

Figure 3. Transforming space and shapes.

Our findings point at fertility inter-, cross-, and transdisciplinary teaching and learning STEM practices (English, 2016) helping students to gain experience in exploring space and shapes while getting insight into their intuitive representations of key mathematical concepts.

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