Sophisticated scientific reasoning process in five-year-old children using ISLE-based activities

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Abstract. Can preschool children act as scientists discovering the properties of the colour of the water? In our pilot study, we engaged a group of eight five-year-old children in scientific reasoning, enacting an ISLE process. They were guided in an observational experiment, discovering the colour of the water in different glasses, and they tested their hypothesis based on a prediction of a testing experiment. In the end, they were able to generalise the results to other situations (application experiment). Even with the necessary simplifications, our research highlights that children, if appropriately stimulated, are capable of carrying out scientific reasoning.

Introduction and theoretical framework

Preschool Children live in two worlds: the world created by their imagination and the "real" world, which is part of their everyday discoveries. These two worlds coexist without conflicting too much.

Some studies on STEM engagement in early childhood [1] were already carried out, demonstrating that great engagement can also be achieved with female preschoolers. However, our research question is based on an education-disciplinary point of view and not on the pedagogical one. Can children, under a guide of teachers, enact real scientific reasoning, mirroring scientific practices? For students in higher grades, it is demonstrated that the ISLE-Investigative Science Learning Environment [2] represents an authentic inquiry [3] method that allows students to mirror scientific practices [4]. But ISLE is normally used in a disciplinary context, as kindergarten represents what we could call an Early Physics teaching learning domain [5,6]. Our challenge was to see whether it could also be successfully applied to this context.

Research context

We choose a gender-mixed group of eight five-year-old children in a Slovene kindergarten in Gorizia. Some months before, the children read with their teachers a legend about the colour of the Soča/Isonzo river that has its aqua green colour as a gift from a fairy for winning a competition. In their imagination, they had accepted that the colour of the Soča/Isonzo water was aqua green. This was the starting point for conducting our activity, we wanted to bring out the true colour of the water through scientific reasoning carried out by the children themselves. We recorded the audio of the entire activity.

Methods and findings

Firstly, we asked the children to observe five different coloured glasses containing water and to describe what they saw. What was the colour of the water in the glasses? Throughout the activity, they were asked to draw their drawings as the greatest representation tool and only later to explain their drawings because the concepts were often too abstract to be explained verbally.

In the second part, we asked the children to make a hypothesis about water's colour and think of a simple experiment that could test a prediction. The children were asked to draw a

prediction before enacting the experiment. Once we tested the hypothesis that the water has no colour, we went to the Isonzo River and repeated the experiment with its water.

We analysed the children's artefacts, looking to see if they were complete and coherent with their explanation. Children used the drawing as a representation of a mental image and to make a prediction as their verbal language was not adequately developed, so the hypothetical deductive reasoning was explicated.

We also analysed the audio recordings and their transcriptions, looking for the activation of scientific reasoning. Even though the children's reasoning was often fragmented and the teacher helped them verbalise their descriptions of the drawings, all the elements that hide structured scientific reasoning were noted from the drawings. The children were also able to generalise the findings to other contexts.

Conclusions

In our pilot study, we observed that it is possible to activate the scientific reasoning process even in five-year-old children when the learning environment allows the construction of such a process. We found that the Investigative Science Learning Environment (ISLE) enables us to achieve this goal, in fact, children can make all the steps required by the ISLE-process [3]: observation experiment, testing experiment and a sort of application experiment by extending the results to other situations. Therefore we recommend its adoption even in an Early Physics teaching learning domain [5, 6].

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