Walk of the Planets. Students Concepts of the Solar System

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Abstract. With the reintroduction of astronomy into the school curriculum in North Rhine-Westphalia, the question arises as to what ideas learners have about our solar system, how these may have been created and what teaching methods can be used to influence them. To capture learners' mental models in relation to the solar system, we collected and analysed drawings of the solar system (N=100). After categorising the drawings, we identified specific gestalts. Additionally, we focused on the evolution of these gestalts facilitated by teaching artefacts, and which constructs these models form.

Introduction

With the reintroduction of astronomy into the school curriculum of Northrine Westphalia, questions of what and how to teach in this large subject have arisen. Salimpour et al. [1] speak about Astronomy as a "Gateway to Science" that could be used to teach Nature Sciences, while they also showed that most OECD states are teaching astronomy more than Germany. Bergstrom et al. [2] observe that the decline of interest in astronomy with age has no significant difference between male and female students, also suggesting an initial interest due to the popularity in public media, which could make it a starting point to raise long term interest. With that in mind, it is of great importance to recognize (inadequate) concepts to build upon.

Theoretical Framework

In educational research, concepts have been deemed increasingly more important for facilitating effective instructions and sustainable learning over the years. As such, knowing about typical developments in students' developments of understanding is of essence for instructors. In astronomy, these have for example been previously examined extensively for the Earth [3] and a typical pathway of conceptual development has been shown to exist. From this, the question arises whether the same can be said for a more complex system like the solar system. Is there a single learning trajectory as well or are several paths possible? Recent works [4] have found that students' understanding of (mental) models can be described by using two different cognitive dimensions: Fidelity of Gestalt, which describes how much students think their models look like the real thing and Functional Fidelity, which describes how much students think their models work like the real thing. It might therefore be of merit to first look at what different gestalts are typically arising during the learning process of the solar system when examining typical conceptual pathways, to have a base for future research on what functionalities are associated with these gestalts in a later step.

Research Questions

Due to the nature of the topic and our aim to understand the mental models of the students better, the following research questions have arisen:

1. What typical gestalts do the students provide when asked to draw the solar system?
2. What characteristic evolutions can be observed due to the influence of a teaching artefact?

Methodology

In an initial pilot study, we have explored a sample of N = 100 German students, classes 5-12, to get an initial glimpse about the typical gestalts we are to expect when asking students about their mental images of the solar system. For that we conducted a pre- and posttest where students were asked to draw the solar system. An embodied intervention of sequences with teaching elements of astronomy during the Erasmus+ Project "Aristarchus" have been conducted to facilitate some change in the ideas about the solar system. First preliminary groupings have been made by assessing the most striking structural differences of the drawings, such as whether the planets were grouped or lined up or the presence/absence of orbits. However, these must be further tested with regards to their reliability and categorial satiation with a bigger dataset in the future. In the main study, this is repeated, though the drawings are done more often during the teaching sequence of about 5 hours. The study is currently ongoing with a larger sample size, with initial results to be expected for the WCPE.

Discussion and Conclusion

In the pilot study (N=100) we were able to identify 5 typical gestalts and were able to put them into a map (N=90) with rather typical trajectories of development (Fig 1), answering the research questions for this case. However, this will be further supplemented with more data from the main study by the time of WCPE to give a more robust assessment. Going by the current results we expect to see an even stronger tendency for the students to abandon most gestalts for two main gestalts, as the data would suggest. Some trajectories also suggest the forming of subgroups, where some gestalts seem to represent typical development steps towards other gestalts. In the future, functionalities typically associated with these drawings will be examined and categorized as well, enabling a description of typical developments of student understanding of their mental models of the solar system.

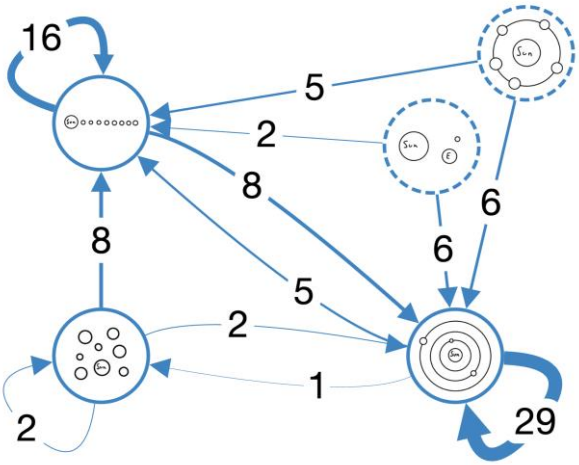

Figure 1: The Nodes show the 5 typical gestalts (N=90), while the arrows show the trajectories of development, comparing a Pre- and a Post-test. Dotted Lines mean that the gestalt vanished altogether in the sample.

References

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