Investigating students' insight after attending an optimized research-based planetarium presentation about the apparent motion of the Sun and stars

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Abstract. We investigated the extent to which attending a planetarium presentation increases secondary school students' understanding of the apparent motion of the Sun and stars. We developed a new planetarium presentation with particular attention to the use of the celestial sphere model and a learning module that prepares students at school for this presentation. We measured the learning gains among 16-17 years old students using the AmoSS test. We find that the learning gains for the star questions are significantly higher than what we found in earlier studies. This is due to better scores on questions about the yearly apparent motion.

Introduction

Young children, students and adults may have difficulty to correctly describe and explain the apparent motion of the Sun and stars [1–4]. For example, they do not realize that the sunset position changes daily or that stars describe a star trail during the night [3]. Many planetariums consider their planetarium environment the preferred place to teach this topic [4]. In a previous study, we investigated the extent to which the classical presentation in the Brussels Planetarium, as it is currently offered to secondary school groups, gives the students insight into the apparent motion of the Sun and stars [5]. The learning gains were rather small and the scores improved more on the Sun questions than on the star questions. The difference between Sun and star is largest in questions about the yearly apparent motion. We found that this is because many students copy their knowledge about the Sun to the stars.

Therefore, we investigate to what extent an optimized, research-based planetarium presentation supports 16-17 years old school students to gain a better understanding of the apparent motion of the Sun and stars. It is relevant to study this age group because the apparent motion of the Sun is part of their curriculum in Flanders and a lot of schools make a trip to a planetarium in the context of these lessons.

We developed a new planetarium presentation with a particular focus on the 3D model of the celestial sphere. We also designed a learning module to prepare for the trip to the planetarium at school. During both the presentation and the learning module, we used 3D models that students could manipulate themselves. In this talk, we report on the measured effectiveness of the new presentation and learning materials.

Methods and findings

We used the AMoSS test [6] in a pretest/posttest/retention test setting to measure learning gains and improved insight of 339 students (16-17 year olds), from six different Flemish schools. The AMoSS test is a questionnaire with six multiple-choice questions about the Sun

and six parallel multiple-choice questions about the stars, on the daily and yearly apparent motion and the observer's position. We also asked the students to explain their choices.

We divided the schools into three groups:

- Group 1: These students attended the planetarium presentation after working through the preparatory learning module with their teacher.
- Group 2: These students only worked through the learning module and did not attend the planetarium presentation.
- Group 3: These students only attended the planetarium presentation without taking the preparatory learning module.

In all groups, the results showed better scores for the Sun questions than for the star questions, but the learning gains were significantly larger in the posttest for the star questions than for the Sun questions. This was mainly due to the learning gain in the questions on the yearly apparent motion of the stars. It was striking that in the retention test, the learning gain was maintained for the Sun questions, but decreased somewhat for the star questions. We found that the group of students who answered all questions correctly in the posttest became smaller in the retention test because several students again scored less on the star questions about the yearly apparent motion. It seems that immediately after the new presentation, several students adjusted their mental model that star trails, like the Sun's path, are higher in summer than in winter. However, a few weeks later, they returned to their original idea, so that the questions about the yearly apparent motion of the Sun and stars, were again answered incorrectly. This suggests that they have not properly understood the 3D model of the celestial sphere and their mental model still differs from the scientific one.

Noteworthy is that the different groups achieved similar learning gains and that students who prepared the presentation at school did not necessarily score better than those who did not.

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