

# Investigating evidence of Meaningful Learning in a minicourse about observing the Sun

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**Abstract.** This study aimed investigating Meaningful Learning occurrence in fifteen-group students at Integrated Technical Education in a Federal Institution in Minas Gerais, who took part in a four-hour minicourse about observing the Sun. The minicourse worked on knowledge related to Sun's structure, observable phenomena in the solar photosphere and its location in the Solar System, as well as highlighting the method of projecting Sun image, among several other observation methods. Applications were also presented that allows visualizing by simulation, many of the phenomena observed in the Sun. Data were collected through a questionnaire with fourteen discursive questions applied as a pre-test before starting the minicourse and, as a post-test, four months after its end. This is a quali-quantitative study, characterized by a case study and whose theoretical background is David Ausubel's Theory of Meaningful Learning. Among the results highlight the improvement of concepts observed in 87% of the questionnaires analysed. In addition, the application of Student's T-test to compare students' pre and post-test performance revealed evidence of Meaningful Learning. Finally, the qualitative analysis showed that prior conceptions remained in 45% of post-test responses and students' difficulty in answering questions with numerical data.

**Resumo.** Este estudo teve como objetivo investigar a ocorrência de Aprendizagem Significativa em um grupo de quinze estudantes do Ensino Técnico Integrado de uma Instituição Federal de Minas Gerais, que participaram de um minicurso de quatro horas sobre observação do Sol. O minicurso trabalhou o conhecimento relacionado à estrutura do Sol, fenômenos observáveis na fotosfera solar e sua localização no Sistema Solar, além de destacar o método de projeção da imagem do Sol, dentre vários outros métodos de observação. Também foram apresentados aplicativos que permitem visualizar, por simulação, muitos dos fenômenos observados no Sol. Os dados foram coletados através de um questionário com catorze perguntas discursivas, aplicado como pré-teste, antes do minicurso e, como pós-teste, quatro meses após o seu fim. Trata-se de um estudo quali-quantitativo, caracterizado por um estudo de caso e cujo referencial teórico é a Teoria da Aprendizagem Significativa de David Ausubel. Dentre os resultados, destaca-se a melhoria dos conceitos, observada em 87% dos questionários analisados. Além disso, a aplicação do teste T de Student para comparar o desempenho pré e pós-teste dos estudantes, revelou evidências de Aprendizagem Significativa. Por fim, a análise qualitativa mostrou a permanência das concepções prévias em 45% das respostas do pós-teste e a dificuldade dos estudantes em responderem questões com dados numéricos.

**Keywords.** Teaching of Astronomy

## 1. Introduction

According to Ausubel, Novak & Hanesian (1980), teaching should be based on what the learning already knows. From this perspective, the material to be taught should be organized hierarchically, starting from the broader concepts to the less comprehensive ones and establishing relationships between their meanings, in order to promote Meaningful Learning.

Studies involving astronomy teaching and Meaningful Learning is extremely relevant as it shows the reality of many educational institutions and suggests alternatives designed to improve concept learning.

Based on this premise this paper was carried out aiming to investigate evidence of Significant Learning occurrence in a fourteen-group at Integrated Technical Education students from a Federal Institution of Minas Gerais, who took part in a minicourse on Sun observation. At this minicourse several issues involving the Sun's structure and the its main phenomena, were discussed.

The minicourse aimed to show among the methods used for the observation of the Sun that one which consists of the projection of an image obtained by telescope on a projection screen. All the procedures necessary for its accomplishment using low-cost telescopes were demonstrated as well as the steps to be followed for the projection screen's construction.

Finally, some mobile applications were presented that allow simulating on smartphones many of the phenomena that can be observed in the Sun.

## 2. Development

At first, the analysis of Common National Curriculum Base (BNCC) from Elementary School (Brazil, 2017) was performed searching for astronomy's related themes and above all to the Sun.

Then, two elementary school textbooks collections from the first to the fourth grade (Pessoa & Favalli, 2017), (Yamamoto, 2017) and two other collections used from the fifth to ninth grade (Carnevalle, 2014), (Pereira, Santana & Waldhelm, 2012), were also analysed in order to identify how these topics are covered.

Based on the analysis' results and the theoretical background adopted, a conceptual research fourteen-questions questionnaire was elaborated and a minicourse which was given as a lecture consisting of slideshows, simulations and videos.

At the beginning of the minicourse a questionnaire (pre-test) that lasted thirty minutes to be fulfilled was applied followed by a lecture, which lasted approximately two and a half hours. The end of the minicourse was marked by presentation of software and applications for smartphones and the description of the steps in order to prepare a telescope for Sun observation using low-cost materials.

Figure 1 that is composed of a set of images, shows one of the telescopes prepared for the observation of the Sun through the projection method and on photo of the image obtained on a projection screen composed of a cardboard sheet.

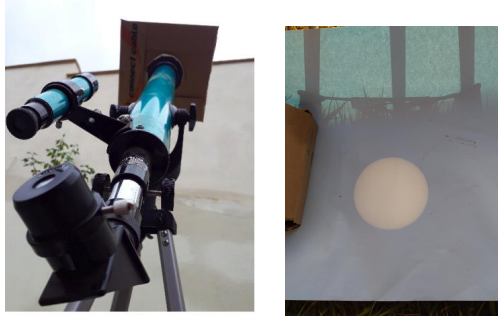


FIGURE 1. Telescope and projected Sun image

The post-test was applied four months after the minicourse's beginning trying to reproduce the same conditions under which the pre-test was performed.

The performances obtained by the students were measured by assigning a score to each question, in this case, the unit value. The questions' correction was performed by comparing the answers given by the students with a set of pre-elaborated answers, with reference in the analysed material in Mourão (1987), Oliveria Filho & Saraiva (2014), Inape (2019).

The obtained data were organized in an electronic table so that they could be submitted to qualitative and quantitative analysis. The comparison between pre and post-test performances is presented in Figure 2.

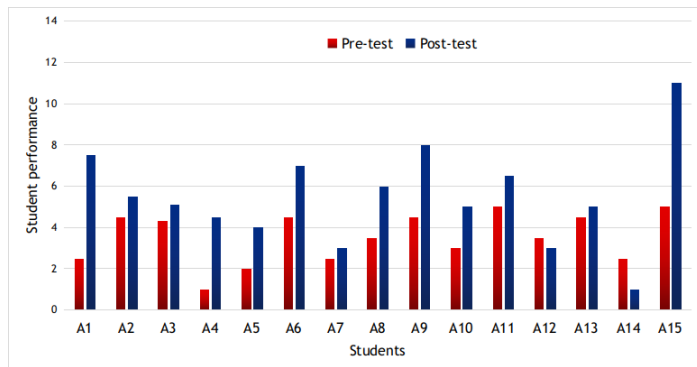


FIGURE 2. Pre-test and post-test students' performances

Performances' comparison was showed that the post-test results were slightly better than pre-test ones.

In order to verify the existence of a significant difference between these results, which may or may not corroborate this finding the Student's T-hypothesis test for paired data was applied, whose can be observed in Table 1 and in Figure 3.

Finally, after the statistical analysis of collected data, a qualitative analysis of the pre-test and post-test response structures was performed.

This procedure sought verify the existence of possible changes in the concepts or the persistence of previous conceptions in the students' answers, aspects that are not evidenced by the statistical treatment performed.

Table 1. Student's T-test

|                             |            |            |
|-----------------------------|------------|------------|
| Alfa                        | 0,05       |            |
| Hipotetical mean difference | 0,00       |            |
|                             | Variable 1 | Variable 2 |
| Mean                        | 3,52       | 5,47       |
| Variance                    | 1,49       | 5,76       |
| Observations                | 15,00      | 15,00      |
| Pearson correlation         | 0,56       |            |
| Observed Mean difference    | -1,95      |            |
| Variance of differences     | 3,98       |            |
| df                          | 14,00      |            |
| Statistics t                | -3,79      |            |
| P (T<=t) one-tailed         | 0,00       |            |
| t One-tailed critical       | 1,76       |            |
| P (T<=t) two-tailed         | 0,00       |            |
| t Two-tailed critial        | 2,14       |            |

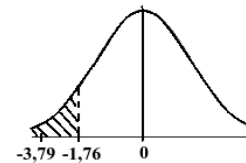


FIGURE 3. Student's T-test result

### 3. Results

The analysis of Common National Curriculum Base (BNCC) from Elementary School (Brazil, 2017) revealed the presence of themes related to the Sun which should be addressed in several years of this phase of Elementary School.

The textbooks' analysis showed that the collections are following what was established by BNCC (Brazil, 2017). Besides, differences were observed in the ways of approach and the deepening of concepts related to the same theme.

From the questionnaires' analysis stand out:

- student's performance improvement observed in 87% of the analysed questionnaires and confirmed by the applying of the Student T-test;
- retention of previous conceptions in 45% of post-test responses;
- little retention of concepts involving numerical data, which were explored in some of the issues.

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