# Introduction of Newton's laws through model rocket construction

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**Abstract.** The research focuses on the effectiveness of classical dynamics teaching methods. A group working with a frontal teaching method was compared with two groups working with a learning activity-based method, one of which used a model rocket project to learn the subject. We investigated whether there were differences between the groups in the occurrence of conceptual changes related to dynamics and the impact on students' attitudes towards physics and their career choice plans.

## Introduction

There are a lot of misconceptions about classical dynamics among high school students and university students [1]. Newton's laws are the basis of dynamics, so their introduction needs special attention. We have developed a method based on student activity, which introduces students to dynamics through the construction of a model rocket.

The aim of the research is to measure the effectiveness of the participation in the rocket project in replacing students' misconceptions with elements of Newtonian dynamics and in developing a positive attitude towards physics. The Kolb learning cycle, which has been successfully applied in science education [2-3], is the basis of the student activity-based methodology.

## Research

The research was carried out in Szeged, with 121 9th grade high school students, to investigate whether the developed project is more effective in introducing Newton's laws than the traditional method in Hungary. The students were divided into three groups. With the "absolute control" group, we followed the traditional method for the dynamics (frontal work most of the time, with teacher demonstration experiments and, where appropriate, student experiments).

With the "experimental" group, we worked with methods based on student activity, and the introduction was through the construction of a model rocket. For most of the lessons, we used a Kolb cycle-based session, where students could first have an experience of the phenomenon and then carry out an experiment. This was followed by a short frontal or group activity to generate concepts, which the students then had to apply to new phenomena in the fourth phase. In addition, the students built their model rockets in groups, lesson by lesson, using what they had learned, which were launched at the end of the project.

The third group was the "control" group, which also used the student activity-based methods but did not build a model rocket. This was necessary in order to measure separately the effectiveness of the model rocket project and the methods developed in developing knowledge and influencing attitudes.

To test knowledge building, we created a test with multiple-choice questions on common misconceptions identified in the literature. To test attitude change, we used a Likert-scale questionnaire, also developed in-house. Students completed the knowledge measurement and attitude test questionnaires before and after the project.

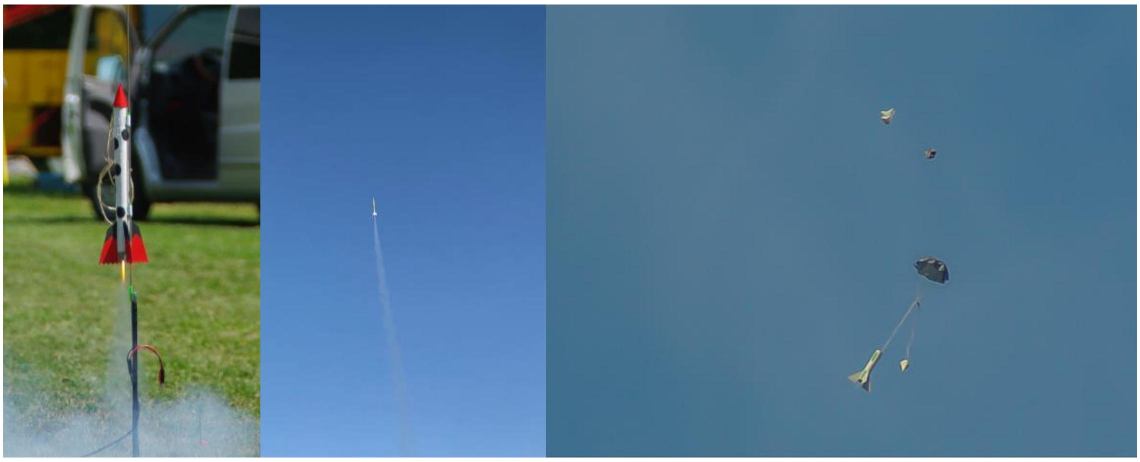

Fig. 1. From left to right: a) model rocket launch, b) powered ascent phase, c) parachute descent phase

The results are used to answer the following questions:

1. *Is there a difference in terms of students' knowledge between the three methodological groups?*
2. *Are there differences between the three methods in the development of students' attitudes towards physics?*
3. *Does the rocket project have an additional motivational effect on students' career choice compared to the other methods?*

## Preliminary results

The attitude tests were subjected to factor analysis, which identified five factors in students' attitudes towards physics (1. perceived quality of lessons, 2. vision of further learning in science, 3. student energy invested in learning physics, 4. difficulty of physics, 5. failure in physics). Students' mean scores on these factors were used to assess attitudinal change and, related to this, change in knowledge, which was assessed using analysis of variance.

No significant change in attitude was found between pre- and post-tests for any group, but for factor 2, the experimental group scored significantly higher than the absolute control group. The results of the knowledge tests are very encouraging, as initially no significant difference between the groups can be detected, but in the post-tests both the control and the experimental group performed significantly better than the absolute control group.

## Conclusion

The results of the knowledge test and the significant difference in Factor 2 (i.e. that students were more motivated to choose a career in science) indicate that it is worth using student activity-based methods combined with a model rocket building project to introduce Newton's laws.

## References


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