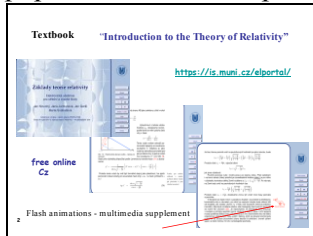


1. Ladies and Gentlemen I would like to present to you a brief report about our activities for STR teaching.

2. At first I should noted that the ideas for our research study were coming from one nice and quite popular textbook completed in 2007.



The textbook title is Introduction to Theory of Relativity. It was created as a voluntary work. The authors are almost great university teachers in this field. They did the best to explain a relativistic concept for students and for beginners.

The text also contains a number of problems, historical notes, fun pictures.

Sample pages you can see here in preview.

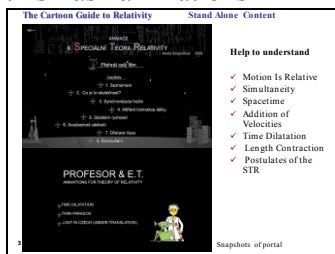
The whole textbook as e-book is still available for downloading at this address.

Originally animations were only a part of textbook. We made them for improving content and amusement.

3.

Now, the every animation is prepared as an independent file.

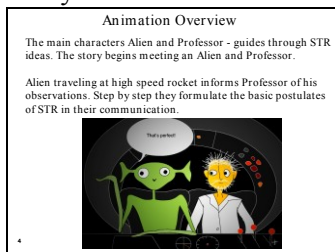
It can be use stand alone as learning – teaching tool online or offline. All visitors are able to access this flash animations



The Animations can help to understand STR terminology and ideas. Here you can look at portal snapshot of the site in Czech and in English. Link: <http://www.ped.muni.cz/wphy/>

#### 4. Animation Overview

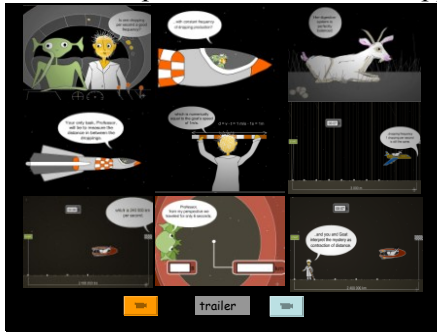
Every animation is narrative, combining story-telling and visual cartoon.



The main characters Alien and Professor are guides through basic STR ideas. The story begins meeting an Alien and Professor. Alien traveling at high speed rocket informs Professor of his observations. Step by step they formulate the basic postulates of STR in their communication.

5. There are several snapshot for your illustration -

At first sample - trailer- we watch apparently strange consequences of special relativity



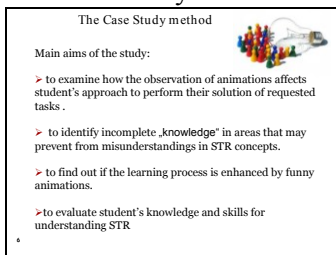
We follow a professor's attempt to measure length contraction. The goat represents an ideal clock here.

At the second trailer we can watch a twin trip - the well-known paradox of twins. Twins grow up in different environments (one with a professor on earth, the second with Alien in spaceship high speed traveling. We can observe differences in twins evolution ...

6. Now, I turn attention to our research study.

I want to mention what we found when we used the animation in teaching. We selected CS method for research.

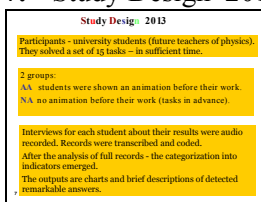
The Case Study allows a rich exploration of student perceptions into common situations



Main aims of the study:

- to examine how the animation observation affects student's approach to perform their solution of requested quiz tasks.
- to identify an incomplete treatment in areas that may prevent from misunderstandings in STR concepts.
- to find out if the learning process is enhanced by corresponding theoretical tasks and funny animations.
- to evaluate student's knowledge and skills for understanding STR

7. Study Design 2013



Participants were our university students. They solved a set of 15 tasks in sufficient time.

Students were divided in 2 groups: (label) AA students were shown an animation before their work.

NA no animation - participants didn't have an opportunity to see it.

Interviews for each student about their approach and work results were audio recorded. Records were transcribed. The method of categorization into indicators emerged during the analysis of records.


The outputs are charts and brief descriptions of detected remarkable answers.

8. Observed symptoms and indicators:

- careful reading
- Initial acceptance of the task (without any intervention)
- clarity in explanation
- ability to reformulate task by own words
- adequacy of graphic representation
- use knowledge of STR
- transfer of knowledge and skills from other disciplines
- value judgment - a solution based on reasoning
- limitation of own approach
- creativity
- success in task solution
- ability to maintain attention

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- use knowledge of STR
- transfer of knowledge and skills from other disciplines
- value judgment - a solution based on reasoning
- limitation of own approach (feedback)
- creativity
- success in task solution
- ability to maintain attention



9. Here are several examples of specified tasks. Test questions were intentionally assigned more generally. Test assignment was designed so that it examined the prerequisites of math, geometry and graphics.

Example of Tasks:

Is the nonsimultaneity of hearing thunder after seeing lightning similar to relativistic nonsimultaneity?

Petard A is 300 m from you, petard B is 600m from you in the same direction. You see both explode at the same time. Define event A to be „petard A explodes“ and event B to be „petard B explodes“. Does event A occur before, after or at the same time as event B?

Event A occurs at spacetime coordinates (200fm, 2ns)

Event B occurs at spacetime coordinates (1200fm, 6ns)

Could A possibly be the cause of B?

Event C occurs at spacetime coordinates (2400fm, 9ns).

Could A possibly be the cause of C?

Two lines meet at a point O (angle vertex) is beyond the drawing surface. Thus O is the inaccessible point. Bisect the angle between lines.

10. Our case study focused on the following research questions.

What indicators are changed after student’s observation of cartoon animation?

Is there a relationship between graphical and geometrical competence and ability to solve the set of tasks?

Does the student's ability to clearly formulate their own approach affect the result of test?

Research Questions:

- What indicators are changed after students observation of cartoon animation?
- Is there a relationship between graphical and geometrical competence and ability to solve the set of tasks?
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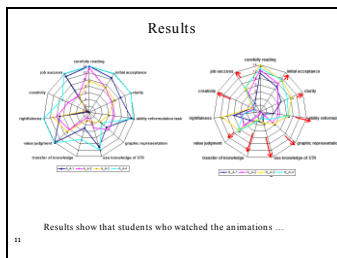
## 11. Results

The graph, chart shows the different distribution of "performance" indicators for the first and the second groups. The length of red arrows correspond to increase of the indicator.

The first group AA shows greater courage to accept tasks and have a better ability to reformulate task in own words. These students were more successful in solution tasks.

The **comparison** [kəm'pærɪsən] on both groups indicates that the influence of fun animations is significant in the majority of items.

The most pronounced [prə'naʊnst] influence is in indicator transfer of knowledge...



## 12. Conclusion

Many students seem to face difficulties in dealing with relativity of motion, in using frames of reference and in using **postulate** about light speed.

The students who were undertaken Cartoon Animations have obtained several benefits in their learning approach.

We can conclude that viewing animation is certainly not a wasting time in the classroom.

Animations were presented in the Technical Museum, the projection accompanied by instructed commentary was very popular attraction for all visitors.