

# Multiple Perspectives of Thinking Journey as Helping the Learners of Physics Using Computerized Model

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## Abstract

Thinking Journey (TJ) approach suggests the way to improve learning physical concepts in introductory physics teaching. The approach suggests explicit determination of the learner's perspective and its frequent change, instead of the presentation from a unique perspective, as it is usual in teaching practice. Changing perspectives allows students to overcome their natural egocentric view, which is important in learning physics in general and astrophysical concepts, in particular. We exemplify the method of TJ mediation in regular teaching using a computerized model of the Earth and the Moon (day-night cycle) and summarize the features of the method making it effective in conceptual learning of physics. We mention students' merits of cognitive nature caused by the method of mediation in teaching which may improve the lack of students' success in a regular as well as in the constructivist based teaching of physics.

## Introduction

The advantages of the recently suggested mode of teaching physics through a Thinking Journey (TJ) (Schur 1999; Schur et al. 2002, Schur & Galili 2006) can be illustrated when this approach is introduced together with using a computerized tutorial modeling the solar system for the purpose of learning astronomy (Yair et al. 2001, 2003). In the regular use of the computerized tutorial for teaching astronomy students are informed about celestial objects of the solar system, especially about planets, the Earth and the Moon. The subjects are described in a unified template: general information, size, composition, orbit, weather, historical notes, etc.

Unlike the common teaching presenting certain scientific content, TJ approach suggests a special arrangement of knowledge construction taking place in the course of an imaginary journey. During the established *teacher-students discussion* around certain intriguing context the particular scientific knowledge is *mediated* by a teacher who detects and reacts to the difficulties revealed in the discussion. Moreover, instead of a unique context of presentation, TJ approach introduces a context of multiple perspectives, naturally incorporated in the script of a journey. Variation of perspectives presents the central cognitive tool of the TJ teaching. Students are guided to appreciate specific manifestations of the considered concept and their relationship with variation of environment in the course of the journey.

Here we will address a small part of the computerized program, the model of the Moon revolving the Earth and explain how TJ mediation facilitates a different learning reinforcing the common way of instruction.

## Thinking Journey rationale

TJ intends to combine Feuerstein's method of Mediated Learning Experience (MLE, Feuerstein et al. 1980) and the constructivist approach to teaching physics (Driver & Oldham 1986, Driver et al. 1994). This mode tries to encourage conceptual learning of scientific contents through a special type of interaction between the learners and teacher. In this special route of learning, the teacher listens and guides the students suggesting how and what to observe in the considered representation of a certain natural phenomenon. The teacher acts as a collaborator and mediator in making scientific sense of the selected environment by students and as a facilitator of their need for information and tools for understanding.

TJ comprises a series of learning activities (*interactions*) organized in a scenario of imaginary, challenging, and often surprising, "thinking journey". The location of the learner in each interaction is explicitly determined. Thus, TJ appeals to the imagination, inviting students to consider certain phenomenon from several perspectives. Visiting to an unusual

environment is often followed by a “return back home”. Students are invited to discuss their experience and compare between the different appearances of the phenomenon from the considered perspectives. Short interactions (student-teacher as well as student-student), during the TJ, stimulate both perceptual and conceptual changes. The change in students' knowledge is not realized by criticizing mistaken schemes of knowledge (e.g. Galili and Hazan 2000); at least, this is not the major focus of the activity. Rather, the change comes from a broadening of the initial knowledge, causing its growth, modification and maturation, stimulated by the variation of perspectives, eventually converging to the new understanding of the concept emerging as an invariant core of many appearances. This is the new way to reach conceptual change.

### **TJ applied in using astronomical model**

The first TJ activities were suggested in the domain of astronomy, possessing a rich repertoire of images challenging students' imagination and attracting their curiosity. Therefore comparing common and TJ instruction is appropriate to make addressing operating the computerized model of the Moon revolving around the Earth. In the instruction using the model students observe one revolution of the Moon from the point of external and emptied observer. A flag is put on the certain place on the Moon, and it slowly rotates remaining towards the Earth during the whole circle (representing about 29 days). This is to demonstrate that the Moon preserves the same side towards the Earth. A special window shows the phases of the Moon as observed from the Earth during the circle. As mentioned already, students observe the animation and the teacher directs their attention to the special features of this reality:

1. The periodic motion of the Moon
2. The fact that the same side of the Moon faces the Earth
3. The phenomenon of Moon's phases, as observed from the Earth.

Several difficulties were detected in such instruction (Gazit et al. 2005). As a main cognitive difficulty the *egocentricity* of students was reported, that is, their inability to imagine any appearance of the situation but that from the point of view from the Earth. It was also stated that the ability to employ *multiple perspectives* to account for this natural phenomena is essential for the meaningful learning. However, no attention is usually given to develop this ability in students. The regular teaching solely presents the view of the imaginary outside observer, shown as problematic to many students (Gazit et al. 2005).

### **Teaching the same topic using TJ activity**

Thinking journey can reinforce teaching the subject using the mentioned computerized model. Within such an approach students are invited to address the phenomenon changing the perspective of its observation. Each perspective allows the students to see the day-night cycle from a different point of view. The following perspectives are considered being supported with the pictures we brought next to the brief description of the correspondent interactions.

#### *a. The first perspective: The Moon environment (Fig. 1)*

Teacher suggests to the students:

*“Put yourself on the Moon in the place where the astronaut stands (the place of the flag – in the model). Describe your immediate environment. Write down the questions that you have.”*

Students consider the environment of the Moon and not the Moon as a remote sphere.



Figure 1

**b. The second perspective: The movement of the Moon (Fig. 2)**

Teacher suggests to the students:

*“You are standing on the Moon while it revolves around the Earth. Describe the way you view the Earth, the sky and ground of the Moon during the revolution of the Moon around the Earth. Describe the day-night cycle on the Earth and on the Moon.”*

Students imagine and compare the manifestations of the revolution of the Moon, as they are observed from the Moon and from the Earth, using both the computerized model and the picture.



Figure 2

**c. The third perspective: Day-night cycle on the Moon (Fig. 3)**

Teacher asks the students:

*“You are standing together with the astronaut. Is it night or day at the place you are standing? .....Why do you think so?”*

In the course of the TJ teacher asks:

*“Time goes; will it be night or day in the place where you are standing in two hours?” (6 hours, 24 hours, 15 days, 27 days).”*

Students consider the day-night cycle on the Moon, which is much longer than on the Earth (approximately a month).



Figure 3

**d. The fourth perspective: Earth's environment (Fig. 4)**

Teacher suggests to the students:

*“Now imagine yourself returned home, to Israel, standing outside and watching the sky. Describe your experience now and address the way the Moon, the Sun, the stars, the sky appear to you?”*

And he/she proceeds:

*“Describe the day-night cycle now.”*

After the experience on the Moon, students consider the day-night cycle and the Moon's movement from the regular, on ground perspective ("returning home").



Figure 4

**e. The fifth perspective: observation from a spaceship (Fig. 5)**

The teacher suggests to the students:

*“Now you are in a spaceship on the way to Mars. You are watching the Earth and the Moon from the window. Describe what you see. Relate your description to the day-night cycle of the Moon and to the day-night cycle of the Earth.”*



Figure 5

The considered at this stage perspective is similar to the one used originally in the mentioned computerized model. However, students arrive to it now after considering several different perspectives and they find themselves prepared to understand the subject as it is demonstrated

in the model. The day-night cycle is conceptualized in a broader context and thus are better understood.

### Summary of the method

The described series of TJ interactions mediate understanding of the concept of day-night cycle learned by using the mentioned computerized model in a new way. Students experience a different learning which is based on the TJ activities. No longer this process presents general theoretical statements: facts, descriptions and explanations of the phenomenon in its unique ("representative") appearance, but the teaching includes a discussion on the subject in different environments arranged in an imaginary tour. Students are highly engaged and usually enjoy going through a variety of experiences. This type of teaching preserves students' interest in learning physics beyond the introduction, causing vivid discussions, debates and repeating observations of the same object.

TJ activities help students to acquire cognitive skills of changing perspective, conserving quantities and analyzing situations in terms of the common and different, performing analysis and synthesis of observations leading to growing of students' ability of logical inferences regarding the considered subject. Learning to consider what is conserved when situations change, to project the known relation to new situations they encounter, ability of space orientation, and breaking spontaneous egocentricity present enrichments of *cognitive skills* which all are required for a successful learning of physical concepts.

The important feature of the method is an explicit determination of the place of the learner in each considered situation and its frequent change. Students learn to see phenomena from various angles, connect and compare between them. TJ interactions encourage students to infer regarding certain *physical concept* from such comparisons and to personally build scientific concept, emerging as an *invariant* of its appearances in *different contexts* (Marton 2003).

Acquiring scientific concepts, significantly improves following students *observation of the details* of the considered image, picture or demonstration. The concepts learned this way get their basis in a broad perspective of appearances and variety of contexts. This feature of the method makes the acquired knowledge meaningful.

The mediation of the considered model of astrophysical nature through the TJ approach causes students' appreciation of the *complexity* of the model, awareness of its major components: the Earth and the Moon being in a relative motion, as well as the possible multitude of *different perspectives* in considering this system: from the Earth, from the Moon, from aside. Although such learning is challenging it is easily entered by a variety of students' populations.

Importantly, within the TJ approach students are provided with a *sufficient time* in order to make sense of the situation, construct and assimilate the meaning of the processes taking place. "Creative repetitions" in learning concepts with constant changes significantly improves students' success. Further empirical studies will provide better understanding of the processes taking places in the described method of teaching-learning and answer the variety of specific questions regarding the effectiveness of the method already observed.

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