Epistemological Models of the Teacher-Students Interaction in Academic Learning

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Abstract

This study deals with the most popular forms of the classroom communication related to the scientific cognitive models. The teachers tend to use simple intuitive models to describe the teaching issues: "Bucket theory"; "Knowledge floodlight"; "Interaction"; "Rationalism"; "Criticism"; "Anamnesis"; "Cognition cycle"; "Anything goes". Nevertheless, we can find all these models in university courses of history, philosophy, psychology, pedagogy and didactics. However, the opinion of a physics teacher, who thinks that he has invented a radically new pedagogical instrument, is quite interesting. Many teachers use these models unconsciously and in a peculiar interpretation. And their experience is remarkably useful.

Keywords: *Learning Models, Teaching Practice, Epistemological Schemes, Physics Teaching*

Introduction

Practicing physics teachers avoid any theoretical sophistication. They tend to use simple visual models to describe the practical teaching issues. These models are easy to detect, talking to teachers. Furthermore, we can compare them to analogues of rigorous theoretical philosophical and psychological projects that we know from the history of science. These teachers' models often appear spontaneously, derived directly from their daily teaching experience. Teachers perceive them as their own original discoveries, promoting later on local professional workshops and meetings. So, what kinds of models are operated (consciously or unconsciously) by practicing physics teachers? We'll consider some of them.

1. "Bucket theory"

According to this model we put the knowledge into the student as if we pour water into the initially empty container. Teaching practitioners intentionally or unintentionally use the thinking model, based on the epistemological theory that describes the process of learning like knowledge filling procedure through the sensory organs (eyes, ears, nose, etc.). The external stimulus repeatedly affects human feelings, and after accumulation of the experience we begin to identify what we regularly face. We (and our students) fill our mind (which is originally empty) through our senses, and then knowledge is accumulated and digested inside. This model is critically interpreted by Karl Popper (Popper, K. R., 1979, p. 61).

Despite the obvious naivety and vulnerability of this model, it is incredibly tenacious. Even through Immanuel Kant with his categorical assertion "There is no doubt whatever that all our cognition begins with experience" (Kant, I., 2000, p. 136) we find infinite opportunities exclusively for "pure reason". Knowledge is not like a fluid, it cannot be divided in half, and it cannot be poured from one head to another. The bucket becomes empty, if it is not used. "…the correct analogy for the mind is not a vessel that needs filling, but wood that needs igniting" (Plutarch, 1992, p. 50).

2. "Knowledge floodlight"

According to this model, experiments and observations are secondary (subordinated) to the hypotheses: firstly we decide where to direct the "floodlight of knowledge" (our torch, our source of light), and then we conduct our research. Unfortunately, the knowledge horizons are too small, and we see only what our floodlight can illuminate). Luckily we can always improve our source of light. We investigate one area or another according to our own intentions.

The area illuminated by a torch is our focus of learning. The teacher's role is to help find the direction and maintain sufficient brightness. Of course, the car headlights cannot illuminate all the way between cities at night. It is enough to illuminate a few tens of meters ahead of the car. The moving car illuminates the nearest section of the road, then the next, and so on until we reach our destination. In other words, we decide ourselves whether we drive along the more easy (or hard) road.

3. "Interaction"

Interaction means that two or more objects have an effect upon one another. We interact with nature, studying it. An object and a subject are terms often used in contrast to each other. A subject is an investigator and an object is a thing under investigation. Any object (material substance) can be understood only when it interacts with the researcher (subject). Cognitive dualism (denoted the state of two parts) of René Descartes means that body (material part) and mind (immaterial part) interact with each other (Wozniak, R. H., 1992).

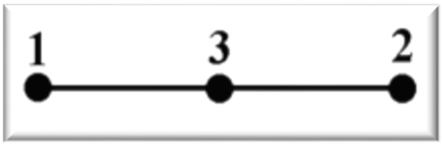

Figure 1. Object (1), subject (2) and interaction (3)

The interaction is the starting and the ending point of the study in this scheme (Figure 1). However, there are three groups of problems here. Object (1), subject (2) and interaction (3) do change in the studying process due to the study. Studying the world we change it, change ourselves, and interaction with the world changes too. We face the problems like these even in everyday life. This model is easy applicable to describe the spectrum of interaction between teachers and students.

4. "Rationalism"

Best of all, this model is described by the words of Karl Popper: «I am not prepared to accept anything that cannot be defended by means of argument or experience». And further explanations: "We can express this also in the form of the principle that any assumption which cannot be supported either by argument or by experience is to be discarded" (Popper, K. R., 2007, p. 217). The weak point of this approach: it cannot be argued by any evidence or experience, and, therefore, should be rejected. This model can be very effective in solving many problems of learning, but can be defeated by its own chosen weapon.

However, rational arguments in school discussions are a favorite weapon of teachers.

5. "Criticism"

Slightly paraphrasing the statement of Karl Popper, we can more accurately express the essence of the model: I may be wrong and you may be wrong, but through joint efforts we may get nearer to the truth. Criticism helps us to discover the boundaries of reason and its possibilities.

Criticism is the starting point of philosophical reasoning of René Descartes: key to knowledge is a doubt of the truth to generally accepted knowledge. However, René Descartes does not develop this idea to the top, denying the positive role of criticism in the process of learning, seriously retreating and backing away: "Nor have I ever observed that, through the method of disputations practiced in the schools, any truth has been discovered that had until then been unknown. For, so long as each person in the dispute aims at winning, he is more concerned with making much out of probability than with weighing the arguments on each side" (Descartes, R., 2000, p. 77-78). Immanuel Kant points to the positive role of criticism. It helps us to discover the boundaries of reason and its possibilities.

The ability to perceive critical comments is one of the most important things in academic learning. A mutual criticism brings us closer to the truth in the process of cognition and especially of learning. Trends and depth of the critique are determined by criticizing teachers and students in accordance with their views on the relevance or irrelevance of the learning tasks.

6. "Anamnesis"

Plato's theory, explaining that humans already possess all knowledge from past incarnations, and that learning process is rediscovery. Consequently, learning process appears as a process of remembering (anamnesis). Through a process of questioning and answering, the human can remember the ideas in their pure form; and as a result our student acquires the wisdom. This method of learning is considered in sufficient detail in Plato's dialogues "Phaedo", "Theaetetus" and "Meno" (Plato, 2010). There is a huge number of teachers who are fans of different versions of this method. Socratic dialogues are the most popular form of the classroom communication.

7. "Cognition cycle"

It is very popular opinion that scientific research is always carried out in a cycle. Cognitive cycles have been considered in the Russian didactical literature (Multanovsky V.V., 1977) for a very long time. There is a great amount of practical experience of their use in the process of physics teaching (Razumovsky V. & Mayer V., 2004).

We can understand the cycle as "any complete round or series of occurrences that repeats or is repeated" or (in Physics) as a) "sequence of changing states that, upon completion, produces a final state identical to the original one"; b) "one of a succession of periodically recurring events"; c) "a complete alteration in which a phenomenon attains a maximum and minimum value, returning to a final value equal to the original one" (Cycle. Dictionary.com).

Unfortunately, it means that a cyclic cognitive activity of a researcher is meaningless. Learning is the opening process, i.e. any other process except cyclic. Many researchers have paid attention to it. In particular, for this reason, Karl Popper criticized to Henri Poincaré, Pierre Duhem, and Arthur Eddington: "The contention that science is circular cannot be upheld" (Popper, K. R., 2007, p. 247). In reality, scientific cognition never goes in a circle. It would be naive to think, that the way of the researcher is reversed back to the starting point. And the search of a starting point in such a scheme is meaningless.

Of course, the finite numbers of words, existing in human languages, fundamentally do not allow the description of infinity. Perhaps this is the reason for the temptation to make a loop for cognition, directing it toward another infinity, hoping for mutual compensation of these two infinities: the external world (outer Universe, Nature) and internal one (inner Universe, Consciousness).

8. "Anything goes"

This is quite a radical model, postulating that there are no universal methodological rules. Carefully following the methodological rules does not lead to success. "If we want to understand nature, if we want to master our physical surroundings, then we must use all ideas, all methods, and not just a small selection of them" (Feyerabend P., 1975, p. 306). This very sensible idea seems honorable and potent, if not taken to the absurd. Paul Feyerabend described his idea as Anarchistic Theory of Knowledge.

On the one hand, this model can justify the chaotic actions of young teachers (however, sometimes the results of novices surprise even experienced teachers). On the other hand, it is an occasion for the teachers (with many years of experience) to invent and to probe the new elements of teaching. Even if their pedagogical inventions are contrary to their life experience and the generally accepted ideas, nevertheless they can be successful.

A human is not equal to the world. A map is not a reality. The reason for the selectivity of any scientific studies is the inexhaustibility of the world. Cognitive opportunities of people are limited. We cannot embrace all the aspects of existing reality. Any world picture has a limited number of touches. A scientist (like an artist) can draw a "picture of nature", to make the finite amount of "brush strokes" or "pencil touches". This limitation can present to an honest researcher a feeling of arbitrariness: “I can draw whatever I want, even using the real landscape, saying that I draw a nature”. Or “I can get any result, but I only need to choose the right facts, the desired characteristics, and necessary elements”. Anyway I can take as many as necessary from the surrounding infinity. I can write an arbitrarily large number of geometric shapes in a perfect circle. Could we deny all that we wish? Could we discover everything that we want?

Of course the cognitive opportunities are determined by

1) The limits of human thinking and
2) The characteristics of the investigating reality

More accurately:

1) The path of the further progress of science depends on our desires, interests and points of view.
2) The results of scientific research do not depend on them.

Bodies will not stop being attracted regardless of the degree to which we may want it. And even the most biased selection of scientific facts cannot make us doubt the validity of the law of energy conservation. Although the description (formulation) of it may well depend on a variety of subjective factors. The true state of affairs cannot depend on the belief of the scientist.

Results and Conclusion

The general problem of correlation between educational and scientific cognition has repeatedly been studied by various researchers. In contrast, this study formulates another issue: 1) to find out concrete models that teachers use for solving their practical problems; 2) to establish their similarity with the models, which are known in the theories of nature investigation.

The Figure 2 illustrates the results of observations for the activities of practicing physics teachers. Models used by teachers were jointly discussed and concretized for inclusion in the diagram. One model (mostly used) corresponds to one teacher.

Total number of teachers: 67. Minimum (*Anything goes*): 1 teacher. Maximum (*Bucket theory*): 15 teachers. Research period: 2007-2016.

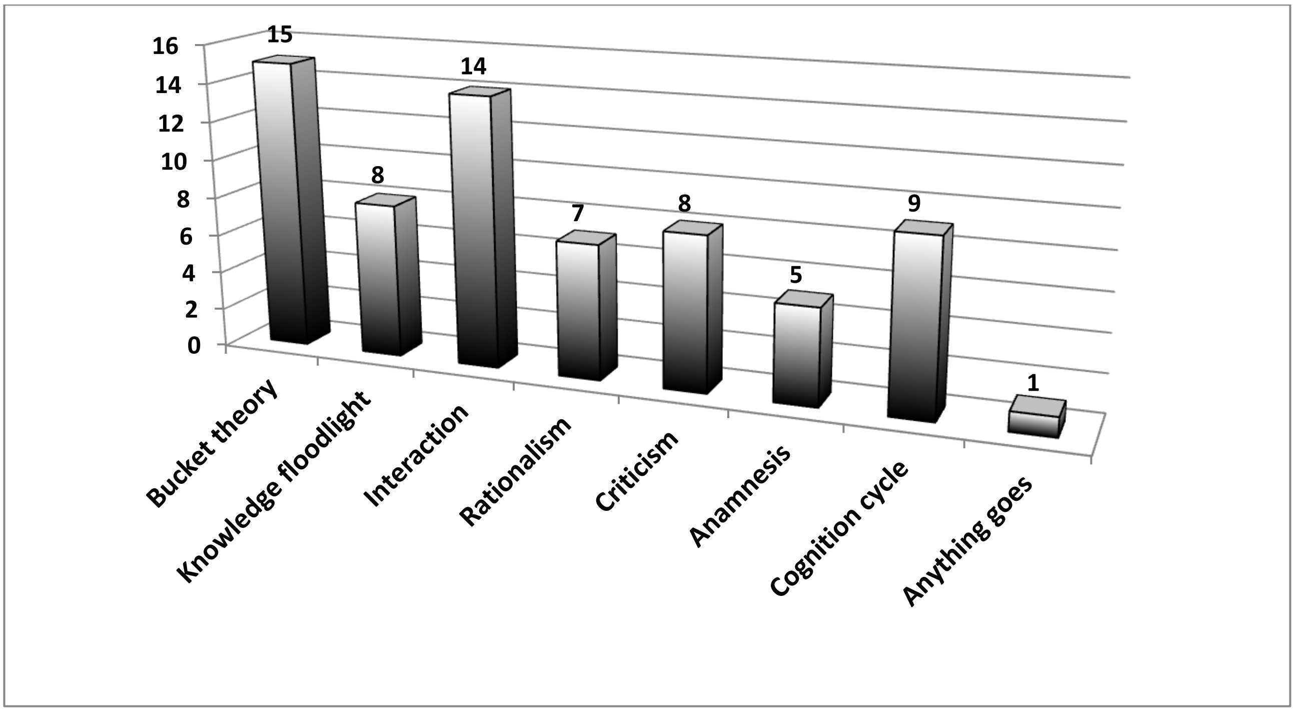

Figure 2. Learning Models Used by Teachers in Comparison to Epistemological Schemes

There is a certain analogy between theoretical models of nature cognition and learning ones. Each of these models is encountered in the daily learning practice. They have the right to exist with the appropriate remarks about limitations of their applicability.

Furthermore these issues are hotly debated by students studying physics. And it would be interesting to know the opinion of teachers of other disciplines, as well as their students'.

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