Interrogative model of learning

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1 Introduction

Jaakko Hintikka has developed a model of scientific reasoning, called *interrogative model of inquiry*. The model has been philosophically very fruiful. In the following we will give a simple characterization of the model. Moreover, we will explicate some interesting properties of the modelwhich allow us to explicate extremely important difference between the interrogative model and ordinary deductive model of scientific reasoning.

The model can be directly used in an analysis of the notion of learning. However, we will specify some factors that makes the analysis more concrete. As we will see, all these specifications are part and parcel of the original model. However, our analysis gives us *interrogative model of learning* or *inquiry based learning.* [1]

2 Interrogative model of inquiry

Professor Jaakko Hintikka has developed a new model of scientific reasoning - called *interrogative model of inquiry.* The basic idea behind the model is extremely simple. Inquiry is "the action of seeking for truth, knowledge or information about something".[2] An inquirer is not a passive observer[3], but he or she, in the Kantian spirit, enforces "nature to give answer to *questions* of reason's own determining".

[1]For further information see the referents below.

[2]Hintikka and Bachman 1991, p. 4.

[3]Of course the role of the scientist can be different in different fields of inquiry. For example, in the *astronomy* the scientist is mainly an observer - not necessarily a passive one, but he or she carefully plans what to observe - and in the *experimental physics* the scientist is active experiment maker.

At the beginning of inquiry the inquirer has some knowledge about the world - called *background knowledge*. Moreover, there is something that the inquirer wants to know, i.e., there is a *problem to be solved*.

It may happen that the inquirer can find out a solution on the basis of the background knowledge alone. In this case the inquirer need no additional information about the thing under inquiry. However, usually this is not the case but the inquirer cannot solve the problem without some auxiliary information. To get new information the scientist has to *ask questions*. The need of information determines the questions that are reasonable to ask. So, in inquiry the questions asked are determined by the background knowledge and by the problem to be solved.

In an inquiry there exist two factors: the object of inquiry (*nature*) and the *inquirer*. The inquirer is trying to get to know something about the object of inquiry.

Let L be a first-order language. The world under inquiry is an L-model in which the background information is true. The basic framework can be characterized with the help of the following factors:

> (i) nature: a given model $\mathbb{A}$ (intuitively, a part of the reality that is under interest),[4]
>
> (ii) inquirer: a given background knowledge (given at the beginning of the inquiry),[5] denoted by T, power of inference,[6]
>
> (iii) a problem under interest,
>
> (iv) rules that restrict what the nature and the inquirer are allowed to do (definitory rules).

Let Ψ be an inquirer, let $\mathbb{A}$ be an L-model (the underlying "world") and let T be a set of L-sentences (background knowledge). By assumption Ψ knows (believes) that T and $\mathbb{A} \models T$. Let φ be an L-sentence. Let the problem under interest be whether or not the sentence φ is true (in $\mathbb{A}$).

To solve the problem the inquirer may try to deduce the sentence or its negation from the set T. However, it may happen that the sentence or its

[4]We will denote models with capital letters written by blackboard bold font, and the corresponding universe is the corresponding capital letter with the normal font.

[5]For further information, see Hintikka 1984 and Hintikka and Bachman 1991.

[6]Here we assume that all the inferences that the inquirer can do are deductive. For further information, see Hintikka and Bachman 1991, Kelly 1996, Hendricks 2001.

negation cannot be deduced from the set T alone. In this case, the inquirer needs some additional information about the world $\mathbb{A}$ to get a solution to the problem. In a happy case, the inquirer gets the information which makes it possible to deduce the sentence φ or the sentence $\neg\varphi$ from T and the set of answers.

So, we can characterize the model as follows.[7] Let D be a set of sentences that includes all the possible answers that the inquirer Ψ can get to his or her questions.[8] We say that the sentence φ is *interrogatively derivable* from T in $\mathbb{A}$ if it holds that

$$T \cup D \vdash \varphi.$$

It is interesting to consider the role of the set D more closely. First, the set consists in the nature's answers to inquirer's questions. The answers may speak about some specific individuals from the universe A. So, the set D is expressed in the extended language $L(A)$ in which the vocabulary of the language L is extended with the names for all the individuals from the universe A. Second, the set D reflects nature's capability to answer questions. If there is no restrictions in the capability then the set D would be *elementary diagram* of the model.[9] In this case the notion of interrogative derivability would be coextensive with the notion of truth in the model $\mathbb{A}$. The other extreme is that nature cannot give any answers. That is the set D is empty. In this case the notion of interrogative derivability would be coextensive with the notion of derivability. Usually, the notion is between the two. For example, assume that the answers that nature can be expressed with atomic or negated atomic sentences of the language $L(A)$. Hintikka 1984 calls this *atomistic assumption*. In this case the set D is the *Robinson diagram*, $D(\mathbb{A})$, of the model $\mathbb{A}$.[10]

Let us assume the atomistic assumption. Moreover, let φ be a sentence which is interrogatively derivable from the set T in $\mathbb{A}$. So, we have that

$$T \cup D(\mathbb{A}) \vdash \varphi.$$

By compactness we have that there is a finite subset $D^*(\mathbb{A})$ of $D(\mathbb{A})$ such that

[7] See Hintikka 1984. For further information see Hintikka and Bachman 1991 and Sintonen 1993.

[8] We assume that all the sentences in the set D are true (in $\mathbb{A}$).

[9] See Hodges 1993.

[10] For further information, see Hintikka and Bachman 1991.

$$T \cup D^*(\mathbb{A}) \vdash \varphi.$$

In the ordinary deductive model all the inferences that the inquirer do are deductions from the theory T. The best theory is the one which allows the inquirer to solve all the problems. In this case the theory is *complete*. However, in the case of interrogative model (with atomistic assumption) the best theory is *model complete*. The two notions, completeness and model completeness, are different ones. There are complete theories that are not model complete and model complete theories that are not complete.

3 Interrogative model of learning

It is a trivial fact that in scientific inqury the inquirer *learns* something new. In an inquiry the inquirer is looking for some new knowledge about the object of inqury. In this sense the interrogative model of inquiry is an analysis of learning processes - an analysis of rational learning.

Usually, in the analysis of the notion of learning the role of teacher is also taken under consideration. However, in the interrogative model of inquiry we could specify the sources of information more closely. Then the role of colleagues and teachers would play very central role - in fact very similar as teachers in all teaching.

A pupil has two or more sources of information: a teacher and the object of learning. Just similarily as above the pupil may address questions to the object of learning by making experiments or by observations. However, he or she may also address the questions to the teacher. In this sense, the teacher is just a similar source of information as nature. So, this does not add anything new into the model above.

However, teacher has also other roles in the learning process. He or she *motivates* pupils for the study. In a classroom the teacher discusses together with the pupils - as an end of the discussion the object of learning has become as a problem *for* pupils. So, pupils "feel that *there is a premium on solving it*".[11]

Moreover, teacher helps pupils in their solving process. To do this teacher may do several kinds of things. Let us mention the following two. In our characterization of the interrogative model above the inquirer has two kinds of acts to do. First, he or she can make inferences from the information that

[11] Laudan 1977.

he or she already has. Second, he or she can ask some further information. However, teacher may help pupils in both kinds of acts.

A teacher may ask questions that explicates what pupils already knows. In fact, sometimes it is assumed that this is the most central task that questios in examinations do. On the other hand, a teacher can ask questions that denote the lack of information, i.e., questions that denote what one should know before he or she can solve the problem.[12]

However, the teacher cannot separate these different kinds of tasks he or she has. The teacher has all the time do all these different tasks. Moreover, to be effective the process of teaching and learning has to be dilogical.[13]

We have seen that the interrogative model of inquiry can be applied also to the school learning process. However, there is one very central difference between scientific inquiry and school learning. That can be explicated with the help of "an important distinction between two meanings of the world *knowledge - knowledge in the subjective sense and in the objective sense*".[14] The subjective sense is relativized to a single agent, and according to Popper, scientific knowledge has nothing to do with such relativized notion.

However, here it is possible to sharpen our explication of the interrogative model. In the explication above the role of the inquirer Ψ remains open. If the model is relativide to a single specified inquirer Ψ we get a model that is closely related to the model if learning. The specification of the inquirer Ψ consists in the specification of the background knowledge and the specification of the strategy of inquiry. To get objective inquiry the specification of the inquirer consists in the best possible strategies and power of inference.[15]

References

[1] Hendricks, V. F., 2001, *The Convergence of Scientific Knowledge - a View from the Limit*, Kluwer Academic Publishers.

[12] Usually is (school) teaching there is something that is assumed to be known. Above we called this background knowledge. A aim of the discussion is to explicate what the background knowledge is. This is part of the motivation process - the teacher checks out the each student understand the very problem.

[13] See Hintikka 1982.

[14] Popper 1994, p. 8.

[15] See Hendrics 2001.

[2] Hintikka, J., 1982, A Dialogical Model of Teaching, *Synthese* 47, pp. 39-59.

[3] Hintikka, J. 1984 The Logic of Science as Modeloriented Logic, in P. Asquith and P. Kitcher (eds.), PSA 1984, 1, Philosophy of Science Association, East Lansing, ss. 177-185.

[4] Hintikka, J., and Bachman, J., 1991 *What If...? Toward Excellence in Reasoning*, Mayfield Publishing Company.

[5] Hodges, W., 1993, *Model Theory*; Cambridge University Press, Cambridge.

[6] Kelly, K., 1996, *The Logic of Reliable Inquiry*, Oxford University Press, New York, Oxford.

[7] Laudan, L., 1977, *Progress and its Problems: Toward a Theory of Scientific Growth*, Berkeley University of California Press.

[8] Popper, K., 1994, Knowledge and the Body-Mind Problem, Routledge.

[9] Sintonen, M., 1993, Scientific Explanation, *Philosophica* 51, pp. 55-81.