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ABSTRACT

This paper tries to explain why all the students of a same class who have got the same teaching do not go so far in their conceptual change. Here we have studied the students' conceptual change about volcanoes in a French 5th grade. The different students' preconceptions before teaching have been categorized and related to the well-known historical and epistemological obstacles. After a specific teaching whose objectives were to overcome these obstacles, we have looked how the conceptual change has taken place for each student. In order to explain the diverse individual conceptual changes, we have introduced the concept of individual "relation to knowledge" and for each student this relation to knowledge had been determined. Those who undertake the largest conceptual change have the most positive relation to knowledge. (Author)

Conceptual Change and Relation to Knowledge: The Case of Volcanism at Primary School

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Abstract

This paper tries to explain why all the students of a same class who have got the same teaching do not go so far in their conceptual change. Here we have studied the students' conceptual change about the volcanoes in a French 5th grade. The different students' preconceptions before teaching have been categorized and related to the well-known historical and epistemological obstacles. After a specific teaching whose objectives were to overcome these obstacles, we have looked how the conceptual change has taken place for each student. In order to explain the diverse individual conceptual changes, we have introduced the concept of individual "relation to knowledge" and for each student this relation to knowledge had been determined. Those who undertake the largest conceptual change have the most positive relation to knowledge.

Introduction

Very often, the French research in science education does not take the student diversity existing in a classroom into account and used to consider a student as an epistemic subject with no gender, no age and no social specificity. However, several elements should broaden the view of a pure epistemic student to new aspects. First, for a long time sociological studies have shown that success at school depends on the students' social origins. Second, we also have to consider that learning is an interactive process: on one hand interaction with pieces of knowledge and on other hand interaction with individuals (peers and teachers) through social practices, as for example the practice of writing at school. So, the learning ability of each student is then determined by the relationships that he/she entertains with these social practices. These different reasons can explain the student diversity in learning specific subject matter. Anyway, research on student diversity in science learning is practically inexistent in France, excepted a recent study made by two psychologists (Rozencwajg and Troseille, 1996).

In this proposal, we will show how the individual diversity in conceptual change can be tentatively related to the student's *relation to knowledge,* a concept which has been recently developed in France.

Methodology

The class is one 5th grade with 28 students (9 girls and 19 boys). The research includes a teaching part and several data gatherings:

1 – ***Teaching***

The teaching includes several phases:

- the first one was the gathering of preconceptions' students on volcanoes by drawings and questions.

- the second one was the teaching. The teaching lasted 8 sequences, each one of about one hour a week. The students worked on some documents: pictures, videos, a map of ocean floors, and a newspaper account of the Piracutin eruption in Mexico. Moreover the tectonic plate motion was introduced at an elementary level and simulated with plastic foam and clay plates. This teaching aimed explicitly at overcoming the epistemological obstacles students have (see below).

- the third phase took place three weeks later and was a student assessment in order to see how their conceptions on volcanoes had evolved.

2 – ***Data gatherings***

In addition of having collected the preconceptions and the conceptions after teaching, we gave each student two questionnaires called 'learning assessments' (in French '*bilans de savoirs*') in order to determine his/her relation to knowledge. These learning assessments were inspired from Charlot *et al.* (1992) and Montandon and Osiek (1997). The first one was given at the beginning of September and the other four months later. Four questions were asked. Only the first one was different between the September's assessment: "Since you started school, you have learnt..." and the January's one: "Since you started your 5th grade, you have learnt..." The three other questions were the same: (i) "What important 'things' have you learnt so far and what is important to learn at school?" (ii) "Explain what to learn means for you" and (iii) "What do you feel you can learn this year?"

Conceptual change

The students' preconceptions on volcanism are not far from well known historical conceptions (ASTER, 1995). So there are mainly two ideas: the local one and the central one.

With the local view, the students believe that a volcano is always an isolated mountain located in a precise geographical site. The lava is already present inside the volcano chimney. The idea of volcanoes organized in a systematic way at the earth surface does not exist: a volcano is always seen as a local phenomenon.

On the contrary, in the central view, the students believe that there is a huge and underground reservoir of hot magma at the Earth center that blows up through active volcanoes spread on the entire earth surface. In this second belief, volcanism is not considered as a set of isolated volcanoes anymore, but rather as a system. The earthquakes are seen as consequences of volcanoes entering into eruption.

The evolution from a local view to a central one needs that the student has to overcome the epistemological obstacle of considering a volcano as an isolated mountain. Once this obstacle is overcome, the issue of the eruption origin may be then raised.

Historically, there is a third conception, which is very recent and has revolutionized Earth sciences in the 20th century. In this view, volcanism is just one of the phenomena related to the motion of rigid

plates floating on a viscous underlayer in the mantle. Most of the world's volcanoes are found along the margins of huge plates into which the Earth's crust is divided. The other phenomena due to the plate tectonics are the ocean opening, the continental drift and the formation of the world's mountain belts. This global view is out of scope of teaching at the primary school. However some elements of this theory can be approached such as the volcano localization on the earth globe related to the plate motions.

From the students' answers showing their conceptions of volcanism before and after teaching, for research purposes, we refined each major view into two components. For the local ideas, we introduced the pure local view (called *L*) and a more elaborated (called *L+)* in which under the volcano, in the earth depths, would exist a huge pocket of magma ready to blow outside of the volcano in a violent eruption.

In the same way, the central conception is also divided into two components: the Central (*C*) and a more elaborated Central *(C+*). In this last conception, the students knows that (i) the hot magma is inside the Earth and (ii) the Earth crust plates move, but volcanism is not related to this motion.

Finally, after teaching, we introduced a pre-Global conception (called *G*) in which the student knows the existence of moving plates at the Earth's surface and links together volcanism and earthquakes.

Before teaching, out of 28 students: 21 have the *L* representation, 5 the *L+* and 2 the *C*. After teaching, Table 1 shows how the conceptions on volcanism have changed.

This table shows clearly that the students' ideas on volcanoes changed and there was a general progress among the different ideas. The more elaborated the initial idea is, the more important the conceptual change is. However all the students did not get the *pre-Global* view, nor the advanced *Central +*. In the second part of this research we try to explain why the students' conceptual changes are different. A real question to improve science teaching!

			After teaching			
		n	*L+*	*C*	*C+*	*G*
Before teaching	*L*	21	1	13	5	2
	L+	5	–	1	1	3
	C	2	–	–	–	2

Table 1 - Evolution of students' ideas on volcanoes

Relation to knowledge

A promising theory and a concept enable us to go further in our attempt to understand the students' conceptual changes. That is the concept of *Relation to knowledge* (*'rapport au savoir'*) that comes from Charlot's theory (Charlot, Bautier and Rochex, 1992, Charlot, 1997). It is a concept at the interface of micro-sociology and the subject's identity. Charlot defined it as "*a relation to learning,*

...and not only the relation to a knowledge-object, which is one of the component of learning (1997, 89)". If this concept begins to spread among French educational researchers, it is still difficult to get a precise and operational definition.

Here, we have tried to make effective the notion of 'relation to knowledge' in taking into account different indicators pointed from the two 'learning assessments'. These indicators are:

1 – the use of the first person by a student *("I do...", "I learn...")* or general statements which indicates how the student is involved in school;

2 – the statements used to describe the school finality: either statements showing a utilitarian view of school ("*succeeding", "getting into the next grade", ...*) or statements showing how school can participate in personal development (*"understanding", "progressing", ...);*

3 – the way the students project themselves into the future. This projection into the future can be (i) unconscious or vague, (ii) in the short term (at the end of the term, or into the next grade), (iii) in the long term (at the high-school or even at the university);

4 – the objects of the learning. What does a student learn? (i) things of everyday life such as playing new video games, (ii) subject matters such as mathematics or French spelling, or (iii) specific objects of knowledge such as fractions or digestion.

5 – the students' conceptions of learning. Does a student consider learning as a 'job' (student's job)? as a series of unrelated and external activities with no meaning? or as a meaningful activity in which he/she is really involved?

The answers to the 'learning assessments' have lead us to categorize the students into five categories according to the importance they give to knowledge and to their ability to learn something:

- rejection (n=2). These students reject school and what is taught in class. The true life is outside school!
- tourist-type (n=3). These students consider school as a place where they can develop social relationships, make friends and play. Playing is more important than learning!
- intermediary (n=5). In this category, the relation to knowledge is not clear, it varies from the tourist aspect to the utilitarian one.
- utilitarian (n=6). These students take school seriously. They do their student job well: they do their homework and they learn the lessons. School is considered as a way to succeed in the future, to get a good job. Learning is primarily seen as instrumental.
- and pleasure (n=12). These students are the most involved in their learning. They take pleasure to learn new topics and they project in the long term.

Table 2 shows how the students' ideas about volcanoes have changed according to their relation to knowledge. We can easily see that the students who have the most positive relation to knowledge (the utilitarian and those who find pleasure to learn) undertake the biggest step to the most elaborated ideas on volcanoes: the central and the pre-global ideas.

Before teaching		Local (n=21)				Local + (n=5)			C (n=2)
After teaching		L+	C	C+	G	C	C+	G	G
Relation to knowledge	Rejection		2						
	Tourist		3						
	Intermediate	1	2		1			1	
	Utilitarian		4	1		1			
	Pleasure		1	5	1		1	2	2

Table 2 - How the students' ideas on volcanoes have changed according to their relation to knowledge

Conclusion

This preliminary case study shows that the diversity of ways in which students change their conceptions does not depend only of the quality of teaching. It depends on other factors. Here we have explored the student's relation to knowledge as a possible factor that could explain the different conceptual changes observed in a class of science in a primary school. Other studies in progress are necessary to confirm these preliminary results.

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