INFLUENCE OF THE “LEARNING RELATION” ON EXPERIMENTAL SKILLS IN PHYSICS: FLUID PRESSURE

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Abstract

Chevallard and Charlot [1,2] made the hypothesis that learning requires a factor commonly underestimated: the “learning relation”. The necessity to change the conceptions in scientific learning is claimed by Giordan’s allosteric model and KVP model of Clement [3,4]. This study’s aim is to see the impact of the “learning relation” on high school pupils with the experimental skills evaluated in the French Educational system - only used to evaluate experimental sciences - and to confirm the link between the “learning relation” and the evolution of scientific conceptions in Physics (fluid pressure). Indeed, a previous article [5] which was about Biology this time, showed a correlation between the “learning relation” and the evolution of scientific conceptions. To the best of our knowledge, no study has analysed the relationship between experimental skills in physics and the “learning relation” yet.

A distributed survey (to the n=31 pupils of the classroom) allowed us to determine a set of learning relation's profiles. Another survey, useful to identify the conceptions, was distributed one month before the learning sequence (phase 1), one month after the learning sequence (phase 2) and three months after the learning sequence (phase 3). In addition, we quantitatively measured the evolution of the acquired experimental skills throughout evaluated tests all over the year, and we compared these acquired skills with the learning profiles of the pupils.

Our first results show that the utilitarian profile (U) seems to be the best profile to improve the evolution of the scientific conceptions after training, like shown by our previous study in Biology [5]. However, it seems that the elaboration of the acquired experimental skills is higher for pupils with intermediate profile (I), touristic profile (T) and reject profile (R).

We think, from these data, that the use of these experimental skills could be interesting for pupils with scholar difficulties or with a bad vision of school.

Keywords: conception, knowledge, experimental skill, science learning.

1 INTRODUCTION

This study deals with the impact of the “learning relation” on the evolution of the experimental competencies amongst high school pupils. First, it aims to study the hypothesis that, in order to learn, it is necessary to take into account the learners’ relation with knowledge and learning. Indeed, it is interesting to know if the “learning relation” factor may influence the learning of scientific notions and have a positive influence on its dynamic. Several authors [1,2,6] have examined the “learning and learners’ relations”. This article establishes a definition of the relation the learner has with the world, people around him and his own needs concerning the learning process.

From a theoretic point of view, this concept allows a new approach on didactic situations: this means that it is not possible to learn without mobilising our relation with learning at the same time. In these conditions, it is thus essential to evaluate the learning relation so that it is possible to determine its influence on initial conceptions as well as its impact on their evolution (pointed out in our previous works).

This is where our study is set and will first verify the influence of the learning relation of each learner on the evolution of its conceptions, then it will analyse the influence of the learning relation on the evolution of the experimental competencies as used in Physics and Chemistry in French high schools. This study is brand new and will allow an identification of the learning relation’s influence on a new dimension of the learning process, different from the conceptions but quite linked with these latter. In fact, as Clément [4] defined it, the conceptions are represented by a tryptic: KVP, K (Knowledge), V (Values), P (Practical). The competencies (formed by knowledge, social skills and savoir-faire) are...
thus undeniably useful to the construction of a learner’s conceptions. What needs to be known is if this 
learning relation also influences the other dimensions that are mobilised while learning, i.e. capacities 
and attitudes, and how.

2 METHODOLOGY

2.1 Surveyed sample

This paper is about a study case that required 31 pupils in Year 11 (so around 15 years old). The data 
gathered and shown in this study were collected at three different periods: the initial data were created 
before the training sequence (called T1, around 1 week before); the same data were gathered once 
again at the end of the training sequence (called T2, around 2 weeks after); finally the last data were 
brought together three months after the training sequence (called T3). The training sequence on which 
the data are based deals with the fluid pressure in Physics.

The conceptions during these three phases were gathered thanks to open questions and drawings 
such as “What is a gas pressure?” or “Show the water’s trajectory at the dam’s different levels”.

Before the initial conceptions, the pupils’ learning relation was examined through specific questions 
such as suggested by Charlot [7], Montandon and Osiek [8].

2.2 Data processing

The pupils were divided into several categories according to their learning relation and based on 
different profiles such as described by Montandon and Osiek [8]:

- R (Reject: educational system is rejected),
- T (Touristic: pupils only go to school to have fun),
- I (Intermediate: school is viewed like useful and pleasant),
- U (Utilitarian: school is viewed as useful for the future),
- P (Pleasure: learning is a pleasure independently of its usefulness).

The experimental competencies that follow are the ones in use for the evaluation per competencies 
(as carried out for the Baccalauréate in Physics and Chemistry):

- RCO (knowledge restitution)
- APP (Appropriate knowledge from documents)
- ANA (Analyse information/data, suggest hypothesis)
- REA (Realise several tasks : analytical/numerical/experimental)
- VAL (Validate hypothesis)
- COM (Communicate about one’s work; both written and oral)

The results were gathered and compiled in double entry charts and indicate the correlation between 
the level of elaboration of the conceptions and their connection with the learning relation (profiles R, T, 
I, U, P) between T1, T2, T3.

In order to measure the influence of the learning relation on the evolution of the experimental 
competencies, the percentage of the acquired competencies evaluated during tests all over the year 
were gathered. Indeed, every test given to the pupils was evaluated by competencies: every question 
of the tests had on top of it one of the six experimental competencies written, such as described 
previously. After every test, all the results per competency and per pupil were analysed and evaluated 
according to its percentage of success. In order to measure this percentage, four levels have been 
established and are attributed depending on the pupil’s test and the indicators linked to the questions 
in the test. The levels are:

- Level A: the chosen indicators almost appear as a whole;
- Level B: the chosen indicators appear partially;
- Level C: the chosen indicators appear insufficiently;
- Level D: the chosen indicators are not present.
An average of this acquired percentage was made considering every competence, tests taken at the beginning of the year (thus, three tests for the 1st period) and the same was done exactly identically at the end of the year (again there were three exams for the 2nd period).

Based on these data, we were able to quantitatively measure the influence of the learning relation on the evolution of the experimental competencies. In order to represent these data, several graphs were created to reveal the evolution of the pupils’ acquired experimental competencies between the beginning and the end of the year according to the pupil’s profile. Another graph has also been created to show the exact number of pupils (out of 31) which experimental competencies have decreased, stagnated or increased over the year.

3 RESULTS

3.1 Collective evolution of the pupils’ conceptions

The pupils’ conceptions were gathered into four different levels of scientific elaboration (sorted in an ascending order):

- **F**: false (stands for a wrong scientific conception on the pressure),
- **S**: simple (stands for a simplistic conception on pressure. The representation is mainly linked to the material consequences of pressure in the everyday life such as explosions etc…),
- **EL -**: elaborate minus (stands for a conception in which the force is acting in the recipient where the fluid is, without clarifying the donor and the acceptor of the interaction),
- **EL +**: elaborate plus (stands for situations where the conception let intervene the notions of elementary units such as molecules/atoms that apply a pressing force on the inside of the recipient).

As during our previous study in Biology [5], we measured the collective evolution of the pupils’ conceptions at three different periods (T1, T2, T3) which is represented in Chart 1.

The results showed that, before the training sequence in T1, most of the pupils possessed an F level of elaboration (around 52%) and the other half (48%) were situated in an S level of elaboration. It is important to notice that none of the pupils had a level of elaboration EL- or EL+.

After the training sequence, thus in T2, one can observe that pupils with a level of elaboration F are fewer than before (23% instead of 52%) as well as for the pupils with a level of elaboration S (10% instead of 48%). Nevertheless, there is an increase for those with an elaboration EL- or EL+: almost one out of two pupils reached the EL- level of elaboration (approximately 48% of the pupils) and almost 20% of them obtained a level EL+, while in T1 none of the pupils had succeeded to reach these two levels.

Several months after the training sequence, called T3, one can notice that the level of elaboration did not really fall down, it is still around the same level. As a matter of fact, while the number of pupils possessing an F level of elaboration is decreasing, in parallel, there is an increase of the number of pupils with a level of elaboration EL-.

**Chart 1**: Collective evolution of the conceptions from phase 1 (before the learning training) to phase 2 (after the learning training) and to phase 3 (three months after the learning training).

<table>
<thead>
<tr>
<th>Level of elaboration</th>
<th>Conceptions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T1</td>
</tr>
<tr>
<td>F</td>
<td>16</td>
</tr>
<tr>
<td>S</td>
<td>15</td>
</tr>
<tr>
<td>EL -</td>
<td>0</td>
</tr>
<tr>
<td>EL +</td>
<td>0</td>
</tr>
<tr>
<td>Total of pupils</td>
<td>N=31</td>
</tr>
</tbody>
</table>
3.2 Evolution of initial conceptions and individual evolution of the pupils:

In the following chart (Chart 2), a more detailed study shows the correlation between the evolution of the pupils’ initial conceptions and their relation with learning.

Our results indicate a “positive” and rather pronounced correlation between the learning relation of Utilitarian pupils (U profile) and their level of elaboration.

Chart 2: Crossing data of the pupils’ “learning relation” and their conceptions at T1, T2 and T3.

<table>
<thead>
<tr>
<th>Profiles</th>
<th>Conceptions at T1</th>
<th>Conceptions at T2</th>
<th>Conceptions at T3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>S</td>
<td>EL -</td>
</tr>
<tr>
<td>R</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>T</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>I</td>
<td>4</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>U</td>
<td>6</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>P</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Total of pupils</td>
<td>16</td>
<td>15</td>
<td>0</td>
</tr>
</tbody>
</table>

3.3 Elaboration of the acquired experimental skills:

The graphs following this paragraph are representing every profile (P, U, I, T, R) with the percentage of acquisition (average of the three tests) and all the experimental competencies. These graphs are called Graph 1, 2, 3, 4 and 5.

If one compares the percentage of acquisition between the beginning and the end of the year for every profile, one can see that the evolution of the acquired experimental competencies is more important for the Intermediate (I), Touristic (T) and Reject (R) profiles.

Moreover, the sixth graph represents the evolution of the pupils according to the competencies. Thanks to this graph, it is noticeable that the competencies in which the pupils made more improvements are RCO and COM. The latter are respectively “Knowledge Restitution” and “Communicate about one’s work; both written and oral”.

Graph 1: Average percentage of the competencies acquired for the Pleasure profile (P)
Graph 2: Average percentage of the competencies acquired for the Utilitarian profile (U)

Graph 3: Average percentage of the competencies acquired for the Intermediate profile (I)
**Graph 4** : Average percentage of the competencies acquired for the Touristic profile (T)

**Graph 5** : Average percentage of the competencies acquired for the Reject profile (R)
4 DISCUSSION-CONCLUSION

This paper confirms the results that we obtained in our previous study in Biology [5]. Indeed, the pupils with a Utilitarian profile (U) have a better elaboration of their conceptions during a scientific training sequence. Thus, it seems that these pupils possess more abilities to reach an elaboration process and see their initial conceptions evolve “positively”.

Besides, the results presented through this study showed that the evolution of the acquired experimental competencies is more important for pupils with Intermediate (I), Touristic (T) and Reject (R) profiles. Indeed, pupils with P or U profiles predominantly already have a strong percentage of acquired competencies, even though the ANA competency for the U profile is poorly acquired. Furthermore, the competencies that showed better improvements from the pupils through the year are mainly RCO and COM which are the competencies that allow less reflexion and an abstract mind.

Qualitatively, one can notice that the pupils with an Intermediate profile (I) increase a lot more in competencies like COM, then APP or RCO. T profiles have better improvements in VAL, then APP and RCO while R profiles see their results increase in VAL and APP.

It is also interesting that these profiles (I, T, R) have such an increase in these competencies (VAL and APP) for the percentage of acquisition was initially poor in these competencies (and now it is the highest).

Through this study, we can see that working via competencies may help pupils with I, T or R profiles (those with more difficulties at school) to enhance their capabilities, mainly in VAL (Validate hypothesis) but also in APP (Appropriate knowledge from documents).

It thus seems that this system of evaluating through competencies is relevant for pupils in difficulties so that they can improve their experimental capacities, mainly in VAL and APP. Finally, it appears that pupils with a U (or P) profile, thus with more elaborated conceptions as our study revealed, also have a high acquisition percentage in all the competencies initially evaluated.

This type of evaluation would be of great interest for pupils with difficulties at school and/or pupils who have a negative image of school and would help them find meaning to learning.

It would be interesting to deepen this study and widen the studied statistics (with several classes of the same age) or even widen the scientific themes (different notions in the same age classes) in order to see if the results are dependent on the scientific theme seen during the training sequence. It would...
also be interesting to evaluate the pupils’ motivation so that the impact of this evaluation per competencies may be measured on the implication of the pupils during their learning.

REFERENCES


