Gowin’s V as an instrument for systematization of chemical knowledge

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Abstract

In diverse schools nowadays, the assessment of chemistry experimental work is reduced to taking pencil and paper tests about the theory related to the experiment conducted by the students. What happens is that experimental work is not being assessed as such, even though there are proposals based on the assessment of skills focused on designing a problem, formulating and choosing hypothesis, interpreting data and obtaining conclusions. Hodson (1996) criticizes the assessment of specific skills. He argues that if “making science” is a holistic activity, then it can only be through and learned the same way, and it should be, therefore, assessed accordingly. In this sense Gowin’s heuristic ‘V’ is a way to the systematization of knowledge and to showing the coordination of what the student knows, thinks, decides and does. Our proposal for classroom work emphasizes the following logic: a) Formulation of a main question that is directly related to the research hypothesis, b) the hypothesis has to contain the variables of the study, c) showing the data (as objective systems), d) interpreting data to answer the question and, finally e) systematizing a conclusion that answers the question and the hypothesis using the data gathered.

Keywords: Gowin’s Vee, labwork, assessment, chemistry

1. Introduction

The Gowin’s V has shown itself as a useful instrument for curriculum analysis, for assessment and as a teaching and learning resource (Novak and Gowin, 1988; Moreira, 1990b; Moreira and Buchweitz, 1993). It has also been useful for the analysis of laboratory experiments (Moreira and Levandowsky, 1983; Gurley-Dilger, 1992), of research structure (Moreira, 1990a) and the statement of a problem.

In this work we analyze the utilization of the V diagram developed by Gowin (1981) as a useful tool for the students to give evidence of the links they can establish between theory and practice, from an approach based on the “scientific realism”. This approach recovers one of the science aims: searching for explanations of nature’s behavior and its forecasting. From this point of view, the creative component of the scientific method is recovered, based on formulating original questions and hypothesis on natural phenomena. The former objective being necessary, we think it is not enough by itself, but the explanations have also to be regulated by rationality and objectivity criterion. In other words, it means recovering the method’s logic by insisting on the need of looking for evidence as axiological criteria (Bunge, 1969; 1980; 1981). Under this paradigm we understand the interrelationship of the conceptual command (concepts, principles, theories...) and the methodological command (records, transformations,
formations, statements...), as implicit in an experimental practice, in order to produce knowledge (ex.: the answer(s) to the problem given).

The different theoretical orientations of research about laboratory practices have generated different regulatory models that are eventually going to be implemented in the classroom, or they have interpreted problem solving whether as an individual cognitive function (Larkin and Reif, 1979; Mettes et al., 1980, 1981; Reif, 1981; 1981; Mestre, 1991; Mestre and Touger, 1989) or as a «distributed» one, where knowledge is mutually built by the ones involved in that activity (Salomon, 1993).

Below, we are going to slightly explain the basic elements of a simplified epistemological V in order to exemplify the conceptual and methodological elements we have been using for the development and assessment of laboratory practices.

2. Literature review

2.1. Learn chemistry in lab work

For Hodson (1994), not every way of learning in the laboratory equally benefits the meaningful knowledge acquirement. In fact, the more monotony learning is, the more inert or crystallized is the resulting knowledge and the more difficult its movement, application and transference get. This is why, if the teacher’s objective is to make the students able to apply what they know in an autonomous way (it means, looking for learning in a meaningful way), laboratory work should fit to this objective, aiming at a “tuning” between thought, speech and action. A reiterative practice, instrumentalized and algorithmic produces poorer and more limited learning if compared to a reflective one, which, in other words, is conducting different activities in order to promote the metacognitive careful thinking on what is being learnt and how it is being learnt. However, a reflective practice is usually slower and more demanding for the students than direct teaching of certain techniques, protocols and declarative knowledge; therefore, it requires better work conditions and a proposal that gathers what already exists and teaches how to work with self regulation. Séré (2002) insists on this idea, making it clear that it is necessary to design lab work in such a way that the students understand its theoretical basis well and, also, that they have the chance to put it in practice when interpreting the experimental data through abstract, complex and rich models and languages.

2.2. Regulation of learning in the chemistry laboratory

Georgette Nunziati (1990), emphasizes that each person has their own learning system, which has been progressively and autonomously built through the years, and that being able to identify these systems helps to keep on learning. The so called continuous regulation of learning basically pretends to teach the students the metacognition and self regulation of their thinking processes in order to make them find their own way to build a sound and internalized work system of learning and to make them improve it progressively.

On the same line of cognitive regulation, Salomon (1993) disagrees with the conception of intelligence as being a mind’s “property”. He argues, instead, that intelligence has to be seen as executed, not possessed. This distributed intelligence would be always present on tools, on representation ways and in other devices we create to take off from our shoulders what would otherwise be a cognitive burden too heavy and prone to execution mistakes. Continuing with these ideas, the model of the ‘distributed cognition’ shows the way external resources regulate the activities’ functional system, which influences our conception of what, how and why we need to know or learn. The classical goal of making all the students have basic chemistry knowledge loses territory to the new goal of problem evaluation and solving, activities that consist in reasoning with tools available in the class, regulated and self regulated. It is therefore understood that it would be preferable to highlight in class the importance to access to tools to think instead of fostering an understanding “in loneliness”, without tools. Then, it is crucial to associate with others for learning; instead of only cultivate the cognitions present in “our own head”. All these elements modify
our concept of scientific experimentation at school: we want to pass from the “command” to the execution in group, and from “competence” to self regulation.

2.3. The Gowin’s V, a tool to think chemistry lab work

Gowin (1977) created a heuristic in $V$ as a way to represent the elements involved in knowledge structure. The principle was developed to help making the nature and objectives of science lab work clear (Novak and Gowin, 1988, p. 76) and, lately, to decode the «packaged» knowledge and its production process in any area. However, to solve a lab work, following an explicit or implicit model, in a more or less conscious or unconscious way is an activity that can be also interpreted in the form of a $V$. The basic elements proposed—that we have been using to work in the laboratory practices with our chemistry students—for this simplified $V$ are shown in Figure 1 and the examples of teachers’ production, in Figure 2. We have introduced some changes in the $V$ for it to have a double function: to support the students in their learning and to give teachers information that would make them follow up their students’ process, and finally, to assess them (See Table 1). Following the proposal of Chamizo & Izquierdo (2007) in table 1 we give criteria for their assessment which try to interrelate the four parts of the diagram (facts, question, think and act) in the answer.

![Figure 1. Heuristic Diagram](image)

In the base of the $V$ there are facts or objects, phenomena of interest to ask key questions about. Intermingled with these facts there are the concepts and recording of these facts, which are the simplest structure of knowledge. There is where the production and creation of knowledge begins. The left side refers to the conceptual aspect of knowledge building (concepts, constructs, principles, conceptual systems, theories, etc.), whereas the right side is related to the methodological elements of this production (records, data, transformation, knowledge and value statements, etc.) The records’ meaning is always interpreted to the light of the conceptual background available, and as it is limited and evolving, it is only possible to make statements about how we think the «piece» of the world we are studying functions (Giere, 1999; Izquierdo, 2005.)
Figura 2. Examples of V made by high-school students.

Table 1. Components of the V where assessment reinforcement is needed.

<table>
<thead>
<tr>
<th>Components of the V</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question</td>
<td>Guideline 1: The question must be formulated in such way that it is original and reflects the problem studied.</td>
</tr>
<tr>
<td></td>
<td>Guideline 2: The question must include study variables, because without them, the question does not make the methodological process possible.</td>
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<tr>
<td></td>
<td>Guideline 3: A good question has: a) Content, b) Study Variables, c) A cause-effect, effect, correlation relationship, etc., d) It allows to understand the general idea of the experiment that is going to be carried on without need to describe.</td>
</tr>
<tr>
<td>Transformation/Interpreting of data</td>
<td>Guideline 4: Based on the result reading, data are interpreted, using bibliography indicated for that phenomenon. This is how the data makes sense in the context of the work.</td>
</tr>
<tr>
<td>Conclusion</td>
<td>Guideline 5: Data and interpretations are gathered to get to a conclusion on the subject. Based on the data, in the conclusion it is indicated if the hypothesis is true or false.</td>
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</tbody>
</table>

3. Conclusion

In this work the V diagram has been used as an instrument to develop and assess the lab work. It is expected that it would be useful for chemistry teachers. The heterogeneity of the students’ capacities and interests requires from us to count with alternatives to assess the activities conducted in the laboratory. Gowin’s V helps the students to establish, make evident and to self regulate the interaction between two components: thinking (left side of the V) and acting (right side); both necessary to understand the nature and the production of knowledge. The utilization of a simplified V as a tool can help reorganizing meanings as the students reflect on the essence of a lab work, on its solving and on the basic elements that compose it.

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