

## **Organising the chemistry of question-based learning: a case study**

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## **Abstract**

Designing inquiry-based-learning with and for university students develops problem-solving skills, logical reasoning as well as reflective thinking. It involves working as a member of a team, questioning, being creative, and shaping the skills for continued intellectual development. It is argued that inquiry-based group-work is one of the most important learning experiences because it enables the exploration of theoretical ideas and conceptual change. This paper presents results about the use of students' questions to shape these processes. This research has involved one group of three students developing a mini-project on the 'Thermochemistry of fitness'.

Data was collected through participant observation of group meetings and of meetings with the tutor, through semi-structured interviews with both members of the group and the group as a whole, through an analysis of the questions asked by the group in the development of the project (oral and written) and through an oral presentation by the students. The results show that the questions formulated during the development of group mini-projects performed several important functions in the structure of the students' work such as: organising ideas, delimiting the scale of the project, identifying and reflecting on the many strands and sources of information, and in reflecting on the project as a whole. The questions used have contributed to students' engagement in the discipline, bringing an increase of interaction between teacher and students, an increase in the confidence and trust of the students in the asking of questions, and therefore an increase in the quality of classroom interactions in the learning and teaching of chemistry.

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## **Introduction**

There is no reliable rule about how the dynamic will develop and unfold through the history of a group. The configuration of its energies can take many different forms, both positive and negative (Herron, 2002, p51).

The title for our paper compresses many of the issues we discuss. The core of the paper examines the ways in which students' own questions are used in the process of shaping their small group project work, which we call mini-projects, during their study of university chemistry. In essence we bring together four strands of research:

1. an exploration of the use of students' questions as a means of marshalling and organizing this kind of project-based learning
2. the effectiveness of this small group work in enhancing student achievement and motivation
3. the adoption of a case study approach to highlight the 'existential domain' of students' experiences of the process of learning.

The fourth strand relates to the 'chemistry' or dynamics of small groups as they work, as noted in Herron's quote above. The dynamics of a group can in some circumstances serve to generate creativity and industry or can, conversely, induce passivity and ennui – if not downright fractiousness and disunity. The tensions to be addressed within a group of people studying together can surround (i) the learning needs of individuals in relation to the overall aims and objectives of the group; (ii) the 'dynamics' of the group that enable or disable its ability to achieve its goals; (iii) the role of the teacher in shaping, motivating and evaluating the group; (iv) the modes of internal and external evaluation of the outcomes of the group's work and the contributions made by each of its members, and (v) the ownership of the final group outcomes. Through our case study, then, we explore elements of:

4. the independence and interdependence of group members during the process of small group working.

## **Small group work in chemistry**

Four aspects of the literature in this field are worthy of note. First, the use of cooperative small group work is an important and well-researched element of learning and teaching in general (for example, by Felder & Brent, 2001; Haller et al., 2000; Sisovic & Bojovic, 2000; Slavin, 1995). Small-group discussions have been advocated for a number of years, partly as one of a range of learner-centred

teaching approaches or ‘active learning’ strategies, and partly as a response to research in personal and social constructivism (Bentley & Watts, 1992; Barbosa, Jofili & Watts, 2004). There is, too, a considerable array of studies into cooperative learning and collaborative learning in their many forms (well reviewed, for example, by Lazarovitch, Hertz-Lazarovitch & Baird, 1994).

Second, much of the research into group work in its many guises sees this as an exercise in promoting learner autonomy. For example, this is the basis of Cunningham’s (1999) work in self-managed learning and Herron’s (2002) in group facilitation: the fostering of learner autonomy, personal responsibility and self control. This may, at first sight, seem contradictory - that interaction within a group should enhance independence in learning. It is clear, however, that learner autonomy in this sense entails wrestling independence from the teacher rather than from peers, and that shared learning through group work is seen as a half-way-house between full teacher domination and wholly devolved and self-directed responsibility for learning. While we recognise some sense of this ‘staging’ of independence in the research we report here, we also emphasise the tension within the group between what McGill and Brockbank (2004) call learners’ ‘autonomy’ and their ‘mutuality’.

Third, it is clear that membership of a group is a key issue within its success. Groups can be comprised of pairs, triads, quartets or more; be chosen to be homogeneous or heterogeneous by virtue of one criterion or several; participants can volunteer their membership or be dragooned; they can organise themselves through prior relationships or by common goals; they can be brought together by circumstance or happenstance. Much has been written evaluating such modes (for example by, French and Vince, 1999; Gillies and Ashman, 2003; McGill and Beaty, 2001), about the management and development of diverse groups (Cunningham, 1999; Herron, 2002) and shaping the success of groups (Clinchy, 1996; McGill and Brockbank, 2004). In our view, however, little of this has permeated everyday classroom organisation and management. The common practice in university education, for instance, is to sidestep many of these issues by assuming that, as adults, students are practised in the use of small group work, are able to subjugate individual needs in favour of common goals, are adept at managing interpersonal relationships (and possible conflicts) and can act cooperatively to achieve a unified outcome. While this may not entirely be the case (Phipps *et al*, 2001) we feel that such assumptions are not wholly unjustified: if the timescale for the ‘life’ of a group is relatively short then complex and lengthy group selection processes are unwarranted. Care and attention to this kind of detail may pay dividends only where people work together over prolonged periods of time. It is not unreasonable in some situations, then, to ask friends, neighbouring students or ‘thematic groups’ to work together on short projects.

Fourth, a comment about chemistry education. There are relatively few studies in the learning and teaching of chemistry and the reasons why seems a matter of conjecture. Driver *et al* (1995), in their

review of studies in school science, note this paucity in comparison with work in the other subject areas of science. A recent review by Özmen (2004) examines a large number of studies in science education, and notes that the dominant area of research in chemistry continues to be a concern with learners' misconceptions in chemistry over a range of different topics. According to Özmen (p.147) *'research has shown that children bring to lessons a lot of pre-existing conceptions about scientific phenomena' ...This understanding has caused science educators to be increasingly concerned about revealing students' difficulties prior to, during, or after the instruction...*' This somewhat dated illumination of classroom interactions means that little further has been developed. So, while Özmen lists ten conceptual areas in which most of these studies have been conducted to then explore their implications for teaching in chemistry, there is no discussion of how group work might enable this. Almost in passing Özmen does cite Teichert and Stacy (2002) as recognising that *'many instructors agree that one of the best ways to measure student understanding is to assess how well they can explain a concept to someone else'*. As in many papers, the use of the term 'student' here refers to secondary school pupils rather than undergraduates, requiring Taber (2000) to point out that enabling teachers and students to be aware of the each others' ideas, a *sine qua non* of constructivism, *'could also pay dividends in university teaching'* (p.69). Strategies used with undergraduate's students will be different to those employed with younger people and the case we use here illustrates how small group working, where questions have a central role, is an excellent approach within university chemistry to enabling students and teachers to become aware of their current knowledge, and help in the construction of new conceptual understanding.

### **Question-based learning**

This paper is based upon a growing body of work shaped by the 'Questions in Chemistry' project at the University of Aveiro, Portugal (Pedrosa de Jesus, Teixeira-Dias & Watts, 2003; Teixeira-Dias, *et al.*, 2004). The central strand relates to the nature and quality of students' questions during the process of learning chemistry, and the ways in which lecturers can manage the processes of teaching in response to these. Our studies have augmented a growing emphasis on students' questions as these relate to conceptualising and structuring learning matters (Graesser & Olde, 2003; Marbach-AD & Sokolove, 2000; Maskill & Pedrosa de Jesus, 1997; Otero & Graesser, 2001; Pedrosa de Jesus *et al.*, 2003; Watts *et al.*, 1997). In this paper, however, we follow a different tack. Rather than explore the content of students' knowledge and understanding from the questions they ask, we examine instead their procedural knowledge in the context of project-based learning. We focus upon ways that university students use questions to organise and structure small group activities, tasks undertaken as part of their study of chemistry. Procedural knowledge concerns the techniques and procedures for

acquiring, validating and evaluating knowledge. *Procedural – or ‘organisational’ - questions* can be thought of as those that marshal, and lead to, procedural knowledge, the ‘*Knowing how to ...?*’ rather than the ‘*Knowing what ...?*’ of learning. The term ‘procedural questions’ has legalistic overtones and we choose to use the expression ‘organisational questions’ to better suit this educational context.

Holcomb's (1996) work shows that questions can be used as efficient guides to the performance of groups in the preparation, focus, diagnosis, development, implementation and evaluation of their work. Specific questions can be used to guide these group processes so that, for example in the ‘focus’ stage, the question might be: *Where do we want to go?* While implementing, monitoring, and evaluating on the other hand, the questions might be: *How will we know we have got there?* Both Pearson (1999, p28) and McGill and Brockbank (2004, p62) suggests that some broad questions of this kind might be:

*Where are we now?*

*Where do we want to get to?*

*How shall we get there?*

Once in progress:

*How well are we doing?*

*Are we keeping to time?*

*How do we move things along?*

And, towards the end:

*Where have we got to?*

*What have we gained?*

*What happens next?*

More specifically, Jones et al (1992) illustrate how both teachers’ and students’ organisational questions can be used to develop ‘open’ investigations in science. Teachers can pose questions to students that suggest areas for investigation, but that then leave the process and content of the work open for the students to pursue. The students are encouraged to ask themselves a series of questions that help in the structuring and management of their work. For example:

*What are we going to find out about?*

*What do we already know about this?*

*What do we think will happen?*

*What equipment will we need?*

*What will make it a fair test?*

*What have I found out I did not know before?*

In the work described by Jones et al (1992), teachers too are encouraged to ask themselves questions in order to evaluate this kind of classroom work, for example:

*Does this kind of open investigative work meet curriculum needs?*

*How much initiative am I prepared to give the students?*

*What changes are required to carry out this kind of work?*

We use our case study below to illuminate this use of students' group questions because, as Wloderhold & Kagan (1992, p.206) say:

Students' question can be the focus of cooperative lessons, allowing time to think critically: first in constructing questions, second in asking them, third in responding, and again in paraphrasing, praising, and augmenting them.

### **Questions in chemistry**

The 'Questions in Chemistry' project is based within a programme for Year 1 students in sciences and engineering at University of Aveiro. This work rests upon the conviction that it is possible to promote active question-based learning in chemistry through promoting question-asking between teachers and students. With this in mind, patterns of teaching have been developed to encourage students to ask questions of their teachers, within two modules (Chemistry I and Chemistry II) in the academic year 2002-2003 (~100 students). Many of these approaches were developed during a prior investigative phase (Teixeira-Dias et al., 2004) in cooperation with the staff of the Department of Chemistry at Aveiro. The main approaches are:

1. Tutorial lectures, centred in the resolution of particular case studies in chemistry
2. 'Questions in Chemistry' lectures, call 'Q/Q' lectures, based on students' questions on a specific theme
3. Conference-lectures, based on themes of high scientific, technological and social interest
4. Laboratory lectures, reconstructed to enable questioning and to promote student autonomy
5. Mini-projects, small group work to initiate investigations on themes chosen by the students.

These approaches to teaching have been supported by systems to promote the asking of oral questions, and the collection of written questions through, for example, a software programme installed upon select computers distributed throughout the Chemistry Department buildings. This software programme includes Internet access for entries to be posted off-campus. A simpler, physical, system

has entailed Question Boxes, prominently positioned in classrooms and in laboratories, where students could post written questions anonymously.

Within the lectures, tutorials and laboratory sessions, students have been asked to undertake 'mini-projects', relatively short investigations on topics in chemistry. Students choose from a list of 28 suggested themes such as: 'Electric vehicles', 'Fuel cells', 'Greenhouse gases', and 'Terra-forming Mars'. Participation in this mini-project work was voluntary and existed in parallel with these students' more routine studies. It enabled students to enhance their grades by a small margin where they felt this additional work might benefit their overall assessment. In the event, some 50 students formed a total of 13 groups of three, four or five students each. The groups met in and around their normal timetable over a period of some six weeks. The 'grande finale' to this work comprised an oral 'poster presentation' by each group in turn to the teachers and other students, followed by questions from the audience.

The teacher invited groups to work together by theme, clustered around the suggested titles. At the start he led the sessions to set out the overall parameters and provide some options for ways of working and then stood back to allow the groups to organise their own work, facilitating only where appropriate. The balance between being lecturer and facilitator in this initial phase of a project can often define the successful active involvement of the students. In this instance, the teacher led in asking the groups to nominate roles, choose themes and agree rules, and then handed the initiative over and retreated to a 'facilitative role' only.

In this paper we discuss the cooperative teamwork of one group of three students who developed a project on the 'Thermochemistry of fitness'. Our data consists of participant observation of the group, their own meetings and their meetings with the tutor. It is a case study augmented by semi-structured interviews with each member of the group and the group as a whole, along with an analysis of the questions asked by the group in the development of their project. Case studies are both illuminating and obfuscating in equal measure so that the extent to which one can generalise from a case, for example, is an open question. Moreover, they can run the risk of presenting impressionistic speculations about causes and consequences based upon learners' imprecise accounts of attitudes and behaviours and, in doing so, ignore the need for reliable and valid measurement.

Our response here is to reject attempts at broad generalisations, put individual learners at the centre of the picture and so concentrate on questions such as: what connections do we see here between learning intentions and the actuality as it happens; what are the gaps between learner independence and interdependence in this instance and, importantly, what use is made of questions in this experience of learning. We work between Walker's (1985) definition of a case study as 'the examination of an instance in action' and Cohen, Manion and Morrison's (2003) description of cases as 'steps to action',



in that they are drawn from real world circumstances and can, in return, contribute to them. The present case study was undertaken as part of our wider research studies and here the case is intended to ‘test’ the ideas we have discussed against data collected from these students and teachers. The case works well – as we discuss in the final section.

### **Phases in questioning**

As we observed this particular group, it became clear to us that their questions performed several important functions in the structure of their work in, for example, organising ideas, delimiting the scale of the theme, identifying and discussing on the many strands and sources of information available to them, and in their reflections on the whole theme. We identified seven distinct phases to their work:

1. Team organization
2. Accumulation of ideas
3. Divergence of ideas
4. Structure and Production
5. Writing
6. Oral presentations and exhibition of the poster and
7. Assessment and evaluation of the overall process.

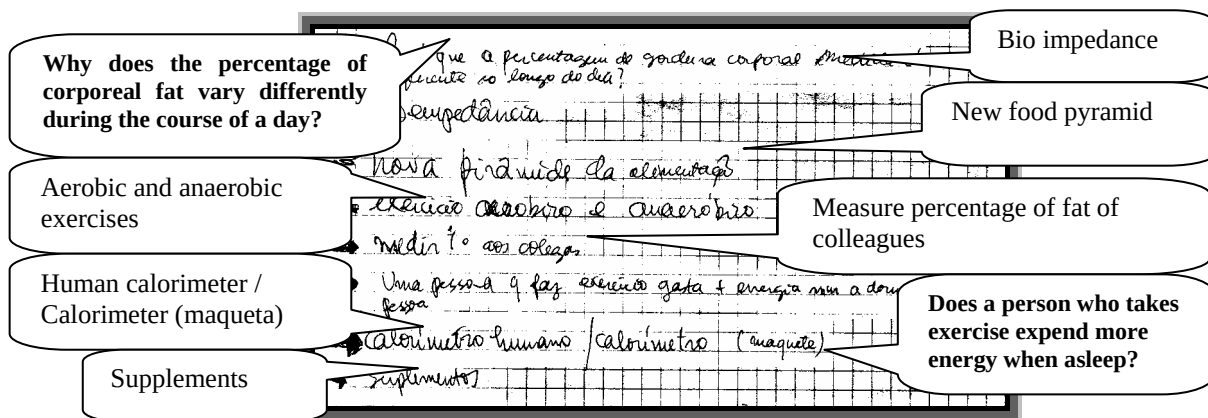
Needless to say, these phases are not rigidly marked by a sequence of occurrences, rather they were present to a smaller or larger degree in successive meetings as the group recapped and then made progress towards their aims.

The **first phase** was characterized by group organization and the initial choice of theme for the mini-project. At this point the three participants were not part of a friendship group and so there was a period of ‘getting to know each other’. *Paula* had come from another classroom and was asked to join two established friends who had been together during the first semester. She joined *Inês* and *Cidália* to make this a more viable group of three people. The initial lack of immediate rapport within the group meant that each stage in the progress of the project was more drawn out and prolonged than for other groups based on established friendships. This feature enabled us to examine their processes in greater detail because each stage had to be explicitly and clearly articulated between themselves, rather than the group moving forward quickly on more implicitly and tacitly understood assumptions.

We call the **second phase** the ‘accumulation of ideas’ and, in our case study group, a great number of ideas was generated, mostly by *Inês*. The other two treated these ideas very seriously and enlarged upon them with their own suggestions. In Figure 1, we show a student’s draft notes (in Portuguese) to illustrate some of this accumulation of ideas. We have added our translation of this in the

accompanying ‘bubble’ notes. In the figure are two questions in bold. The ‘content’ question: “Why is the percentage of corporeal fat different during the course of a day?” was stimulated by the instructions manual of a balance, brought by Inês, to measure the fat percentage through bio impedance. This indicated that percentages of fat could vary along the course of a day. Figure 1 does not represent all of the group’s ideas - many were introduced along the phases but not recorded in this way. Inês’s natural leadership in this phase was characterized by her many suggestions for sub-themes.

**Figure 1:** Student’s draft during the ‘accumulation of ideas’.



Her’s was not an overt exercise of leadership, but nevertheless present in many of the phases we identified, as she herself admits in the interview:

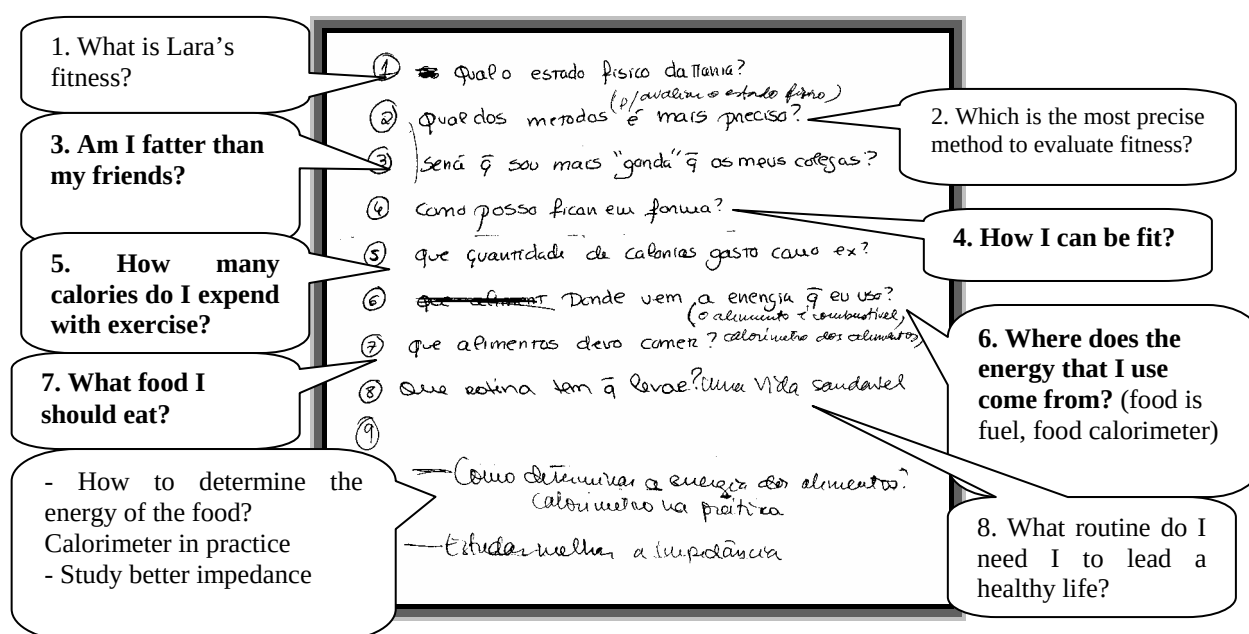
**Inês:** Things could have run a different way, if I had wanted them to, though I did not have the authority to ‘command’ anything to happen, right? Look, we would sent each other text (mobile phone) messages: “Are we going to meet somewhere?”, “Can you make this place?” and so on. It means everybody could take part in the same way - I did not have to order anybody around. They are both grown up people and each one knows what they have to do, don’t they? But, there has to be some initiative.

This interview took place at the end of the mini-project, where she reflected upon the process as a whole. She felt a little that she had been pressed into leadership, not so much by her own inclinations (although some of that was evident) but by her two colleagues’ dependence on her to make decisions. The **third phase** of the development of the mini-project was marked by a search for information through several sources, but mostly via the Internet. This information search brought a considerable number of further ideas and sub-themes that, although of being linked to the main theme, could not all be treated in the same mini-project. Here, the three discussed and diverged in the extent to which these, given the parameters in which they were working, could be treated in the time available. For example, the students gleaned through the teacher that to undertake a calorimeter measurement in a real calorimeter, something they thought they might do, is not routine process. Moreover, the three

also ran into comprehension difficulties with some of the texts, giving rise to a series of fact-finding questions. These questions were formulated so that Inês could represent the group in meetings with the teacher to generate some feedback and technical support. This ‘information overload’ contributed to a brief sense of loss in direction for the project. During an interview meeting with the researcher, Cidália relates how she challenged her colleagues with the prospect that they were losing sight of what they were trying to achieve because of the diversity of ideas and themes they were trying to develop.

The beginning of **phase 4** is marked by the point where Cidália suggests the creation of a fictional girl character (Lara), who has worries about her fitness and voices this through a series of questions. These questions bring into play many of the sub-themes the students would like explore. ‘Lara’s’ questions are made to appear like a ‘brainstorming session’ (see Figure 2) that then serve to organize the group’s work into several sub-themes.

**Figure 2:** Some orientations questions formulated in the 4<sup>th</sup> phase



In the Figure 2, we highlight in bold the questions asked in the character's voice. These questions formulated by Lara give the group three key sub-themes they wanted to develop. For example, the questions “What food I should eat?” and “Where does the energy that I use come from?” are opportunities to talk about the calorimetry of food. In this context, the questions became a tool for the elaboration, organization and presentation of ideas and the importance of these and of other kinds of questions arose in Inês interview:

*Inês:* OK, we had a theme, right? This (showing a page of notes) was at the beginning and here (a second page) was for the meeting with the teacher. Then, we had this idea of Lara ... (leafing and placing pages of notes in order to give to the interviewer) ...

**Interviewer:** *Here, where you wrote ‘Orientation questions’. Is that because you were encouraged to ask questions or because ...*

**Inês:** *They’re useful ...*

**Interviewer:** *What do you mean “They’re useful”?*

**Inês** *(She continues leafing through her notes, slightly distracted) ...They are a useful way to guide. I don’t know! I don’t remember all my other work, but I do know that questions worked really well here.*

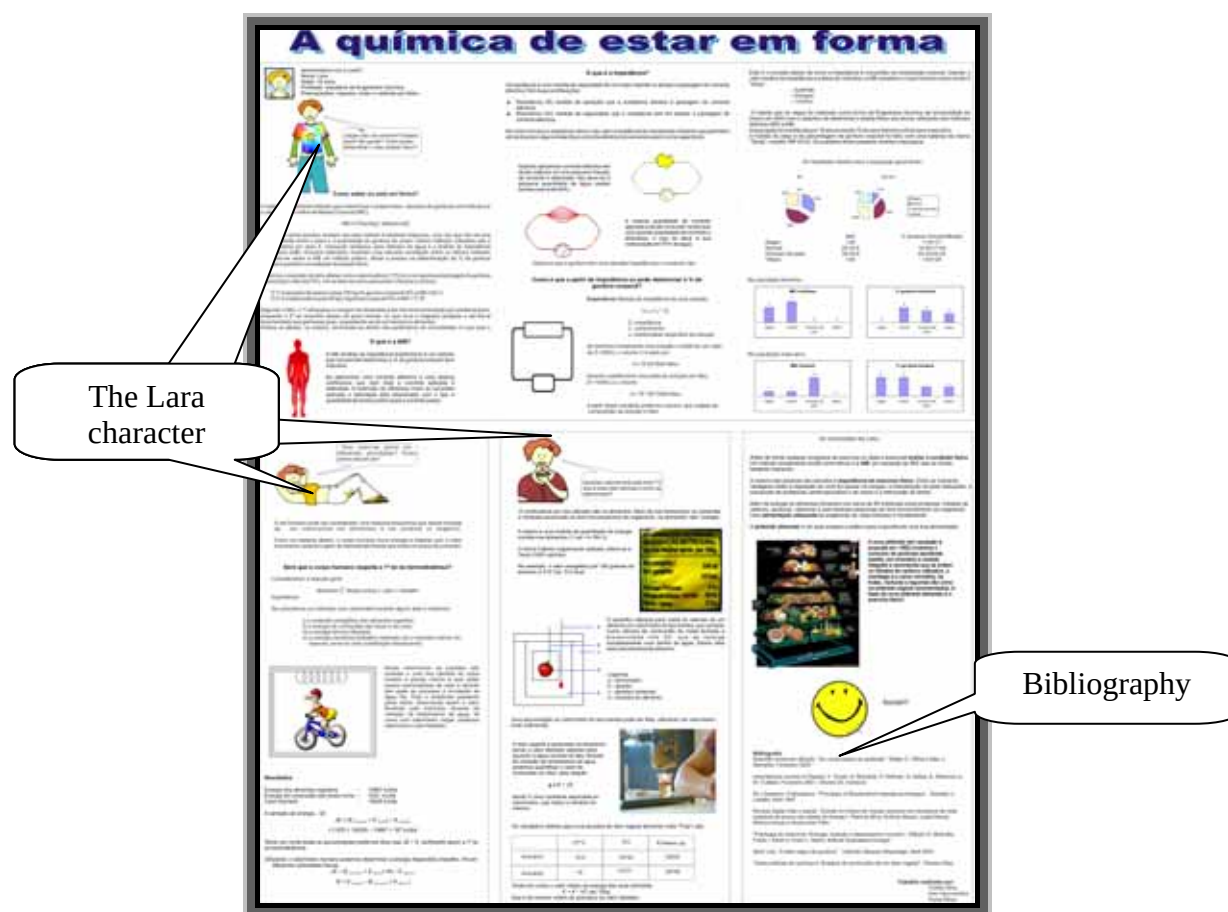
The two other students in this small group also saw that asking questions had advantages. For example, Cidália added at the end of her interview that she was now asking questions as an aid in studying for her final examinations in chemistry.

In the **5<sup>th</sup> phase**, the group composed the poster and the slides for their presentation. This phase was accomplished in Paula's absence, who only came back to join in the group's processes for the next parts of the work. In this phase the written work was eased by the use of the questions that served in organizing the sequence of the presentation, and in reflections on the text. The meetings with the researchers at this time were marked by the writing of the final prose that would embellish the poster and slides as part of the oral presentation of the project. The learning in this phase was more intense for Inês and Cidália. For example, in one interview Inês noted that she had developed skills in working with the software used to make the poster and the slides for presentation, as shown in Figure 3. She noted, too, that the act of asking questions had served as a means to organize processes and procedures, and to connect their written ideas.

During the oral presentation (**6<sup>th</sup> phase**) each group had to present their work to the assembled class. Lemke (1993) argues that:

Learning sciences means learn to talk science. It also means learning to use this specialized conceptual language in reading and writing, in reasoning and problem solving, and in guiding practical action in the laboratory and in daily life. It means learning to communicate in the language of scientific and to act as member of the community of people who do so (p. 1).

**Figure 3:** Poster to presentation of the mini-project ‘thermochemistry of fitness’



To Lemke (1993) ‘talking science’ means observing, describing, comparing, classifying, analysing, discussing, hypothesizing, theorizing, **questioning**<sup>1</sup>, challenging and arguing. These oral presentations constituted such an opportunity for these first year students to do just this. Each group had 15 minutes of presentation and a further 5 minutes for questions and discussion.

While Paula had not taken part in the previous writing phase she returned to cooperate with Inês and Cidália, sharing the presentation into three parts and with the other two guiding and supporting Paula through the talk. Inês introduced for character ‘Lara’ and her questions. In the Figure 4 and 5, we show the two first slides she used.

<sup>1</sup> bold added to the original text

**Figures 4 and 5:** Two first slides used in the oral presentation



The first slide introduces the character and in, the second slide (Figure 5) shows Lara formulating the first question: “These trousers do not fit me!!! Am I so fat? How I can know how fit I am?” Questions such as this were used during all the presentation as means of introducing and connecting sub-themes to each other and serving as ‘organising’ sub-titles:

*How can I know my fitness?*

*What is impedance? And ‘How can I determine the % fat of a body from its impedance?’*

*How many calories are in this cake?*

*How many calories are expended in different physical activities?*

*How can I calculate this?*

*Does the human body obey the 1st law of the thermodynamics?*

The class reacted extremely well to these presentations – not least to this one by the group of three. A swell of questions - and debate - arose at the end of the presentation.

After the oral presentation the posters were gathered in by the teachers for a more detailed assessment (7<sup>th</sup> Phase). The department have inaugurated a complex arrangement for adding the assessment of the group’s work to other, more theoretical parts of the overall programme. A score for each person’s participation in the mini-project was added to the average of the theoretical components, taking into account each student's involvement, not only in the presentation of mini-project but in its full development. Using specified criteria related to the level of engagement of the students, the teacher’s assessment of the ‘Thermochemistry group’ placed Inês with the highest score, followed by Cidália and then Paula.

## Summary issues and questions

This particular strand of our work on organisational questions is in its infancy but has sparked a range of possible avenues for further exploration. The organisational questions asked by the students are very useful instruments in the self-management and organisation of group work. For example, in this short study, Phases 1, 2 and 3 of the project development were characterised by questions geared to the initial exploration and organisation of the group's theme. During the 4th phase, deeper questions were asked, such as: "What methods are the most precise for measuring physical states?" The 5th phase is characterised by the organisation of the final poster and oral outcomes.

We have seen that questions have contributed to students' engagement in their study of the discipline, bringing an increase in interaction between teacher and students, and an increase in the confidence and trust of the students in asking questions. For example, creating the character called Lara allowed them to ask (sometimes naïve) questions which were then used to organise the remainder of the work and their reflections as the group. One of the questions 'asked by Lara was: "Am I fatter than my friends?" and this was used later in the 6th phase. Their question structure, too, led them to experiment with a rudimentary calorimeter in the laboratory and then, later, measure (with Inês's balance) the fat percentages in a sample of students.

The collaboration of this small group fluctuated throughout the phases we have described. So, for example, while she began work as an 'outsider', by the last phase of the mini-project it was clear that Paula had become well integrated within this small group. Their use of organisational questions prompted a greater convergence and a more systematic approach to the mini-project. Shaping their work this way allowed the trio to stage their activities, providing sufficient structure to accommodate shifting participation and roles. To this extent, the advantages to using organisational questions noted by Holcomb (1996) and Wlederhold & Kagan (1992), in a more systematic way, were arrived at by these students quite spontaneously.

While 'Lara' was initially created by one member, Cidália, the character was quickly relinquished to the group and then co-constructed as the centrepiece of their work. It is praiseworthy that the group could share in this communal construction even though their individual contributions were to be subject to separate evaluations. In this case, their interdependence overcame their independence or, as Belenky, *et al.* (1986) would have it, their 'connectivity' overcame their 'separateness'. Interestingly, Belenky *et al.* based their work on an analysis of ways in which women work together to construct knowledge. Our research has not been designed to explore gender differences in question-based learning and so we have no comparative case to work with.

That said, the overall consensus of those that undertook the mini-projects was that these were enormously valuable, enjoyable and very well worth the time and effort invested in them, and that the

questions generated in-group, and by audience responses to the presentation, were highly formative of thinking and learning. In this sense, these organisational questions have been useful incentives to promote the active learning of chemistry. Designing inquiry-based-learning with, and for, university students has developed their problem-solving skills, logical reasoning as well as reflective thinking. It has involved working as a member of a team, questioning, being creative, and shaping the skills for continued intellectual development. For Light and Cox (2001), this is one of the most important learning experiences that a university can offer because it enables the exploration of theoretical ideas and conceptual change. This paper has presented some small ways in which students' questions can be used to shape these processes.

We end by presenting a range of further research questions, for example:

*How typical are these organisational questions across other groups?*

*Are these organisational questions general or are there more generic questions that can be used to guide this kind of student investigative work?*

*How effective is it to organize work in this way – does it suit different kinds of students, different teachers and different kinds of working practices?*

*Are there gender differences in the ways that learners use questions of this sort?*

*Is there value in teaching the use of organisational questions as a vehicle for promoting planning and strategic purposes?*

This, then, is 'work in progress' and the next phases of our research will take up some of these issues. Students need special training in asking questions and skills to use them in teamwork.



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