

Moodle as a strategy to foster student questioning: is it effective?

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INTRODUCTION

The purposes of this chapter are to (i) describe several aspects reported in the literature that should be taken into consideration when developing strategies to foster students' questioning through a forum on Moodle, (ii) describe the strategies to foster student questioning developed in a first year chemistry broad foundation class at the University of Aveiro (Portugal), (iii) reflect on to what extent Moodle was an effective tool to foster the questioning of university students of both genders compared to the other strategies implemented in class, (iv) analyze the perceptions of four selected students and their suggestions about the strategies implemented on Moodle and (v) discuss what changes can be made in future studies to foster student questioning through the Moodle. Strategies were applied both in traditional higher education (HE) chemistry classes, such as lectures, practical laboratory classes, supplementary tutorial guidance classes and mini-research projects; and through two forums created on Moodle, which is the course management system (CMS) provided by the University of Aveiro, in Portugal, to all courses.

REVIEW OF THE LITERATURE

a. Student-Generated Questions

Research on science education sustains the need for new emphasis on teaching and learning, particularly in HE. Among the essential skills that every HE student should achieve, emerges the most significant indicator of the highest and most critical level of students reasoning - the questioning skill (Almeida, Teixeira-Dias & Martinho, 2010; Pedrosa de Jesus, Teixeira-Dias & Watts, 2003; Zoller, 1987). Hofstein, Navon, Kipnis & Mamlok-Naaman (2005) support that a teaching practice oriented to the development of such skill favors a learner-centered teaching and learning and promotes higher cognitive level capacities, such as those of critical analysis and problem resolution.

Several studies (Pedrosa de Jesus, Almeida, Teixeira-Dias & Watts, 2007; Chin & Osborne, 2008; Hofstein *et al.*,

2005) have revealed that fostering a true questioning spirit of students can result in an improvement on the quality of teaching and, accordingly, on the quality of learning. For this reason, the Boyer Commission's report (Boyer Commission on Education Undergraduates in the Research University, 1998) highlights the importance of promoting the questioning skill from the first year of university studies. Universities thus need to offer students a first year wherein their learning experiences assure the development of the necessary skills, such as that of questioning, to empower them for lifelong learning (Johnston, 2010).

Even when the teachers are aware of, and sensitive to, the benefits of fostering student questioning, as the number of students that attend first year broad foundation courses at public universities is so high, only a small number of students manage to interact with the teacher and clarify their doubts. This has been happening to such an extent, that students understand that there is not much room for their questions and they gradually pose fewer questions (Mayer, Stull, DeLeeuw, Almeroth, Bimber, Chun, Bulger, Campbell, Knight & Zhang, 2009). Facing such an inconvenient scenario, educators need to reinvent their strategies in order to give an opportunity to all their students to clarify their doubts.

b. Questioning Through Online Learning Technologies

In light of the numerous advantageous features of network technology, there has been a growing number of projects focused on the design and development of web-based student question-generation learning systems (Yu, 2011), many of which in HE.

Regarding the advantages of online tools for educational purposes, it is known that students who participate in online activities are more likely to be higher achievers in their educational performance than those who don't (Davies & Graff, 2005; Sivapalan & Cregan, 2005). Results provided by Barak and Rafaeli (2004) sustain that web-based activities, which require student generated questions, can serve as both learning and assessment enhancers in HE by promoting active learning, constructive criticism and knowledge sharing. On his turn, Wilson (2004) highlights that when students write exam questions and evaluate other students' responses they improve their ability to communicate and integrate facts, their critical thinking skills and their motivation to do additional readings. Similarly, Yu, Liu and Chan (2005) remarked the importance of fostering student questioning through online multimedia tools and noticed that by enabling students to compose questions, criticize and adapt other students'

questions, they perceived their learning as more motivating and cognitively-enhanced.

c. Important Features Of Online Forums To Foster Student Questioning

As emphasized by Lonn, Teasle and Krumm (2011), tools themselves do not determine whether learning happens and Moodle is not an exception. The Moodle, a CMS that educators can use to create effective online learning sites, includes diverse tools and features that can be customized and used effectively in a wide variety of ways. Despite that most teachers use it exclusively or predominantly as a content management system to deliver worksheets, presentations or assessment grids to students, according to Hamuy and Galaz (2010) course management systems are more than just spaces to gain access to and place information and the dominant use that is being made in clearly insufficient. CMS should be used as places to communicate interactively and to build knowledge. As the two mentioned authors have emphasized, if teachers' have the aim of fostering learning through the CMS then it is essential that they adopt a strategy that generates interaction and communication between the participants. A smart customization and implementation of Moodle's tools must be therefore made by teachers to successfully accomplish their purposes and make the use of those tools advantageous in comparison to other strategies implemented in class.

Being aware that large format classes, such as first year broad foundations courses are not ideal learning environments and can create obstacles to students' intention to ask questions to clarify their doubts, online technologies can be used to engage students and to provide a safe place where students can pose their questions (Colbert, Olson & Clough, 2007).

Having in mind the optimization of the use of the tools and features of Moodle's to foster student engagement and questioning in HE chemistry, there was the necessity to identify and have in mind successful teaching practices, interventions and pedagogical innovations addressed in the literature, which benefited from such tools and features to encourage student questioning. From the analysis of such studies emerged a few essential aspects to consider when designing course mediated through asynchronous online tools, which we will henceforward present.

Evaluating Moodle's usability Kakasevski, Mihajlov, Arsenovski & Chungurski (2008) suggest that if teachers use every available feature both teachers and students can become confused and student's end up not having enough time to concentrate on the learning process. Tools that enable asynchronous communication, such as forums, can promote students' reflection and time for adequate formulation of their doubts by words, which should lie behind

every posed question. Besides, Colbert *et al.* (2007) have verified that providing an online forum in which students are encouraged to ask questions about course content, although time-consuming, is helpful in students learning the material, and students readily participate in it. Therefore, for this study we have decided to focus only on online forums. As most studies that have used the forums on Moodle haven't specified the use of Moodle itself, but referred mainly to forums in online platforms, or as online forums, we have also considered those studies that do not necessarily mention Moodle.

As a starting point, an effective interface design is a crucial tool for the optimal use of discussion forums in online learning (Nor, Hamat & Embi (2012). Being effective depends a lot on the circumstances, on the purposes for using the discussion forum and on the use that is made. First of all, students should be aware of the objectives of the use of the forum.

The nature of the task set by a teacher in an online forum is another aspect to have in mind, as it could be one possible factor that leads to different questioning behaviors among the students. In fact, as the nature of a task becomes more open-ended and demands more justification, it affords more space for students to engage in a wider range of questioning behaviors (Tan & Seah, 2010).

Online facilitators such as teachers should be aware that misunderstandings are more frequent in online communication, as online tools do not include non-verbal interaction, gesture, and facial expressions, not to mention the usual impossibility to hear the tone of voice when expressing sarcasm or humor (Calongne, 2002). As each student may interpret the requirements differently, it is important to clarify any lack of face-to-face interaction and define the objectives of each task as clearly as possible (Calongne, 2002). As the two courses we are focusing on combine online and face-to-face learning, any doubt that students had was promptly clarified during classes.

Compared to discussion in class, asynchronous online discussions usually require a longer time frame to process because participants need more time to read and reflect, prepare responses and type in the responses in written texts (Wang & Woo, 2007). However, this need for more time, shouldn't be seen as an inconvenience, but rather as an opportunity. As Meyer (2003) highlighted, among the advantages for students in taking the time necessary to construct knowledge is an improved retention of learned material.

Despite that online forums do not require attendees to be present, learners and facilitators are required to review

the discussions and respond to them in a timely fashion (Calongne, 2002; Chu, Hwang, Tsai & Chen, 2009). Students want answers from the teacher as soon as possible (Calongne, 2002), so short time for response is another aspect to take into consideration. So, managing time is another requirement for online facilitators. As teachers are unlikely to be able to pay attention to the online forum all the time, the chosen system should provide automatic notifications in order to catch the teacher's attention (Lin, Hsieh, Chuang, 2009). The Moodle meets this requirement.

An obvious feature that was emphasized by Colbert *et al.* (2007) was that it is absolutely necessary to answer all the questions that students pose online. That is very respectful to students and they feel that any questions that they may pose will be answered, which gives students' an incentive to keep on asking through the discussion forums and makes the time the teachers devote to answer students' questions worthwhile. At the same time, as giving feedback to student questions in a short period of time demands a substantial time from the teacher, it is important to check if students actually read the teachers answer (Colbert *et al.*, 2007).

The facilitator must monitor the discussion forum from time to time in order to maintain the quality of a discussion (Lin *et al.*, 2009). Still, whether the instructor should be more active and assume a visible part in the forum discussions to increase student involvement and participation in the course, or if he/she doesn't need to respond to every student post but instead should determine the appropriate time to jump in, make a comment, ask another question, or redirect the discussion is debatable (Mazzolini & Maddison, 2007).

Being aware that students rarely ask questions related to course content in large-format introductory classes, Colbert *et al.* (2007) investigated the use of an online discussion forum as a mechanism for encouraging student-generated questions about course content in an introductory biology course and they attributed an extra credit, for those students who have used the online forum to pose at least 4 or 5 meaningful questions during each semester. At the beginning of each semester students had been told what meaningful questions are.

Another important aspect to have in mind if the students' participation involves teamwork is the role of the instructor or assistant in helping the students to solve problems as well as encouraging them to work cooperatively (Chu *et al.*, 2009). However, encouragement may not be enough. In a similar study conducted in HE Biology classes in Portugal, Lopes, Moreira and Pedrosa de Jesus (2012) concluded that formative assessment moments, such as

continuous teacher feedback in order to stimulate and sometimes focus students' reasoning, are very important for students' learning.

THE STUDY CONTEXT

This project is based within a programme for 1st year students in sciences and engineering, at the University of Aveiro, in Portugal. This work relies upon the belief that it is possible to:

- promote active, integrated and deep learning in chemistry through student-centred teaching approaches, namely by the encouragement of question-asking between teachers and students, and between students;
- create a questioning-friendly learning environment that equally fosters the questioning spirit of students of both genders.

With this in mind, an action research project aiming to promote student-centered teaching approaches, mainly through the encouragement of student questioning in-class and online, was developed with 175 chemistry students, being 114 (65%) boys and 61 (35%) girls, in full collaboration between two educational researchers from the Education Department, and a professor from the Chemistry Department.

Setting The Scene: The 1st Year Chemistry Course At The University Of Aveiro

Having in mind the promotion of students' higher-order skills, the construction of the curriculum of the 1st year chemistry course, at the University of Aveiro, in Portugal, aims at meeting the learners and societal demands.

Our major concern is to develop a curriculum that has a sound reflection of the nature and methods of chemistry as discipline, with its important place in a modern society. We also aim to equip students with transversal skills and competences, which will enable them to contribute to society within and beyond chemistry. These skills should be seen in generic terms (like verbal and written communication of chemical ideas, team working) as well as in cognitive terms (such as objectivity, creativity, conceptual understanding, reflective, critical and logical thought).

Following the suggestions of Mbajjorgu and Reid (2006) and Johnston (2010), and in an attempt to foster student questioning, the subsequent strategies were implemented.

Lectures, laboratory classes and tutorials

The chemistry course for 1st year students is divided into two foundation chemistry courses: Elements of Physical Chemistry (EPC) (first semester) and General Chemistry (GC) (second semester). Each one of these courses comprises three kinds of classes: lectures, laboratory classes and tutorials.

Students should attend a 2 hour-*lecture* per week (not compulsory). Lectures should provide the students the understanding of the contents approached. These classes have a crucial importance to students' academic success in chemistry. Lectures should be seen as hours of active study.

During lectures students are stimulated to ask questions orally or in a written format. In the first lecture, the teacher explained the benefits of questioning and encouraged students to pose their questions any time they felt the need to, whether it was in the classroom or using the online forums.

The main aim of the *laboratory classes* is to initiate the student in the research process in chemistry. Simultaneously, it is expected that the students learn to appreciate chemistry as an experimental science. To accomplish this aim all the laboratory works are planned and performed individually. During laboratory classes the teacher acts as a facilitator, assisting the students to overcome their difficulties. Each student must attend a 2 hour laboratory class per week. Practical classes are compulsory.

Tutorials provide the student with pedagogical guidance about learning methods. Students should use these classes to clarify their doubts and ask questions about the contents taught in lectures and also about the practical tasks. Each student should attend a 2 hour-tutorial per week. These are not compulsory classes.

Innovative teaching and learning strategies

Besides the formal classes described earlier, the following strategies were also implemented:

(1) *small pauses during lectures* to encourage students' oral questions. The teacher regularly made 2-3 minutes pauses in the middle of each lecture so that students had time to think about what had been said, to formulate a proper question and had a privileged opportunity to express their doubts through the articulation of questions orally to the lecturer.

(2) *teacher's written questions* during lectures to facilitate the organisation of teaching and learning and to serve as a role model to students. For instance, throughout the “Water and aqueous solutions” topic, the teacher presented seventeen written questions. These had diverse degrees of difficulty and served different functions.

(3) *'Questions and answers in Chemistry' online forum* to encourage and facilitate students' questioning. Students could use this tool to ask written questions related to the topics taught during lectures and/or practical laboratory sessions. Questions related to everyday phenomena with a chemical background were also welcomed. All questions and answers were online available to all chemistry students.

(4) *"Brainteasers" online forum* to encourage students to ask questions and suggest possible explanations for the phenomena proposed by the teacher. This kind of activity also aimed to encourage collaboration and enhance the discussion among students. All the problem-based cases proposed to students, designated by brainteasers or challenges were based on real life situations with a social, ecological or technological impact on society, such as that presented on Figure 1. Students were invited to analyse these situations through the eyes of a scientifically informed citizen.

Problem-based case “Acid rain”

Having in mind your knowledge about acids and basis, ask questions or propose possible explanations for the following phenomenon:

Marble and limestone are the most used materials in the construction of buildings and monuments. Both marble and limestone are composed by calcium carbonate ($CaCO_3$), *differing only in the crystalline structure*. Even if both are known by their high durability, buildings and monuments build with marble and limestone are gradually eroded through the action of acid rain. *How can we explain this phenomenon?*

(More information about acid rain available in: Atkins, P., & Loretta, J. (2005). *Chemical Principles – The Quest for Insight* (3rd ed.). New York: W. H. Freeman and Company. p. 396)



Figure 1. Problem-based case about acid rain

(5) *chemistry mini research projects (MRP)* where the students were given the opportunity to creatively develop a small group project on a chemistry topic. Some instances of these topics are: "How should chemists think?", "The ice of life", and "Melting below zero".

Assessment strategies

In order to promote the alignment between teaching, learning and assessment (Biggs & Tang, 2007), the following assessment strategies were considered:

(1) *a multiple-choice test* due to the large number of students in the chemistry course.

(2) *performance in practical laboratory work* considering both students' performance in practical classes and the content of the lab book;

(3) *participation in the mini-projects* considering the development of the project, the quality of the poster, the quality of the poster presentation, and the questions asked during the mini-projects presentation session.

METHODOLOGY

Participants

The main sample was composed of 175 first year undergraduate students (61 girls, 114 boys; mean age 19 years old) attending two broad foundation courses - Elements of Physical Chemistry (EPC) (1st semester) and General Chemistry (GC) (2nd semester) - of several science and technology degrees, such as Physics, Meteorology and Oceanography, Environmental Engineering and Materials Engineering. For this particular research, 4 chemistry students (2 female and 2 male) were selected and then analysed in a deeper way. The criteria used to select the mentioned students will be later detailed on this paper.

Data-Gathering

Data were gathered by means of observation and audio recording of Chemistry classes (lectures, laboratory classes, tutorials, mini research projects sessions), semi-structured interviews to students, focus groups conducted with students, records of the online interactions and the Approaches and Study Skills Inventory for Students

(ASSIST; Tait, Entwistle & McCune, 1998).

Non-participant observation

Throughout one academic year, 2011/2012, from September 2011 to June 2012, all the Chemistry classes (lectures, laboratory classes and tutorials) were audio-recorded. An educational researcher, who attended all classes, filled observation grids for every class and kept a researcher's diary to retain extra information or unforeseen aspects of data collection. This way, all the interactions between the students and the teacher were registered. Gillham (2000) stresses the importance of observation by mentioning that through observation it is possible to observe what people actually do, and not what they say they do.

Interviews

Students were interviewed individually in a quiet, private room within the building dedicated to the teaching of first year students of Science and Technology or at the Department of Education. During the interviews students were asked to reflect on their experience of the course (teaching and learning strategies, chemistry contents, assessment methods, study habits). All interviews were semi-structured and audio-recorded. Afterwards, the interviews were transcribed verbatim and content analysis was carried out.

Focus groups conducted with students

Focus groups were conducted with students to characterize student-questioning profiles, in a more intimate environment, to understand their perceptions about the implemented strategies and identify student understandings of the role of questioning in the learning, teaching and assessment processes. Students were invited to participate on a voluntary basis and all agreed to participate. All the focus groups were tape-recorded with student's agreement.

Records of online interactions

Online interactions were collected concerning the two developed forums: "Questions and answers in Chemistry" forum and the "Brainteasers" forum.

ASSIST inventory

An inventory aiming to identify students' approaches to learning (Approaches and Study Skills Inventory for

Students) (Tait *et al.*, 1998), which had previously been developed, translated and validated to the Portuguese context (Valadas, Gonçalves & Faísca, 2010), was also applied. This inventory consists of statements describing what university students usually do when they learn. Respondents indicate their agreement by setting a mark on a five-point scale (1 = disagree, 5 = agree). As a result, ASSIST allows us to measure individual differences in approaches to learning in HE students and assess students' study approaches according to three different dimensions: surface, strategic and deep. According to Tait *et al.* (1998), surface learning is associated with the idea that learning is about acquiring facts and memorizing; such students prefer to be told what to read and what notes to make. Strategic learning involves those who are trying to get a good mark on the exam and thus concentrate their effort on the precise conditions that, in their opinion, need to be fulfilled to accomplish their goal. Deep learning occurs when students are more concerned with their personal development and looking for meaning in what they study rather than trying to memorize it, they are curious and questioning and are constantly examining whether what they are told makes sense in the light of their past experience.

Data Analysis

Data from multiple sources (transcripts of classroom discourse from audio-recordings, transcripts of audio recorded interviews and focus groups, field notes, course assessments, and records of students' participation in online forums) were analysed in relation to each other; this served to triangulate the data and to help improve the credibility of the findings and affirmations made (Lincoln & Guba 1985).

RESULTS

Main Characteristics And Questioning Behavior Of The Four Selected Students

Not all the students equally embraced the same questioning strategies. As we believe that paying attention to, and understanding, students' perceptions about pedagogical approaches are vital to improve the forthcoming researches, we conducted interviews and focus groups with students. This paper discusses the results of case studies, looking in depth at 4 of the students. Before proceeding to the description of student's opinions about the strategies

implemented on the Moodle, we will report 4 students' questioning behavior in the different learning environments provided during the course. As the interviews were conducted during the 2nd semester, the students here described were selected according to their grades during the 1st semester – we chose students with better grades. Of those, we privileged those who have agreed to participate on the interviews and focus groups and were, thus, involved in further data collection. Additionally, we selected only those that had attended the first class, during which the benefits of questioning were thoroughly presented to students. Of this selection resulted 2 of the most successful male students and 2 of the most successful female students.

- Marcela – Physics student; got 15 (out of 20) in the 1st semester and 16 in the 2nd semester; usually attended lectures and raised several questions during lectures and lab classes; never left any written question on the pieces of paper provided in lectures; didn't attend any supplementary tutorial guidance class; didn't participate in any of the online forums; participated on the MRP and accomplished all the tasks, except the presentation, because her colleague didn't attend the presentation session and the presence of both elements of each group was a precondition for the conclusion of the MRP; didn't participate in the challenging experiments; regarding approaches to study, she is predominantly strategic, with a slight combination of deep approach to learning, Marcela is a confident student.

- Joanna – Environmental engineering student; got 13 (out of 20) in the 1st semester and 16 in the 2nd semester; always attended lectures but only asked one question to the lecturer in class, although she asked many questions to the teacher during lab classes; never left any written question on the pieces of paper provided in lectures; only attended one supplementary tutorial guidance class; didn't participate in any of the Moodle forums; didn't participate in the MRP; and although she participated in the challenging experiments, hardly ever raised any questions; regarding approaches to study she is predominantly strategic with a slight combination of deep approach to study; Joanna is very shy, very hard worker and assumed to avoid her exposure in big classes, such as lectures. She was conscious that if she posed a question, other students would have to patiently wait until the teacher answered her question, so she preferred not to pose any questions.

- Daniel – Physics student; got 15 (out of 20) in the 1st semester and 14 in the 2nd semester; always attended lectures and raised several questions both during lectures and lab classes; never left any written question on the pieces of paper provided in lectures; only attended one supplementary tutorial guidance class, to try to understand

the scientific explanation for what was presented in the challenging experiment; didn't participate in any of the forums on Moodle; participated in MRP and accomplished all the tasks; during the presentation session he didn't raise any questions to his colleagues, but answered some of his colleagues questions; he participated in the challenging experiments and had a very active role, asking many questions to his colleagues; regarding approaches to study, Daniel adopts a combination of a deep and a strategic approaches. He is over 10 years older than his colleagues; he was previously graduated as an architect and he is taking Physics as his second degree; he is very confident and talkative.

- Raphael – Materials engineering; got 16 (out of 20) in the 1st semester and 17 in the 2nd semester; always attended lectures, but posed only a few questions; he posed and answered many questions during lab classes, both to the teacher and his colleagues; never left any written question on the pieces of paper provided in lectures; only attended two supplementary tutorial guidance classes; only participated once in the "Brainteasers" online forum of EPC to pose the question "Is there a rearrangement of the O and H atoms of the molecule, so that the density of ice is smaller than that of water? Are there new chemical bonds formed with a different character than those that exist on liquid water? If yes, the new bonds/rearrangements could explain the lower density of ice, as if there were loopholes in between the water molecules on ice.", in response to the challenge "Why does ice fluctuates on water, being the same substance in both cases (water)? Why is ice less dense than water?", but never participated in the "Brainteasers" online forum of GC, nor either of the "Questions and answers in Chemistry" online forums; participated in MRP and accomplished all the tasks; during the presentation session of MRP, although he answered to the questions the teacher posed to his group, the only question he posed was referred to assessment: "Will the evaluation of the MRP be published together with the final evaluation grid is?"; he participated in the challenging experiments and had a very active role, asking many questions to his colleagues; regarding approaches to study, he is predominantly strategic with a slight combination of deep approach. His Materials engineering colleagues see him as a very wise person. He assumes a very discrete position before the lecturer but a differentiated position before the lab class teacher, because on those classes he asked many questions. In fact, he was the student who got higher grades on both semesters.

As it is remarked, of the selected students only Raphael ever posted a question on Moodle, and it happened only once. Such shortage of these students' participation on the forums on Moodle reflects the overall stance of the class. Of the 175 students enrolled in the two courses, only 18 participated on either of the forums, during both semesters.

Students' Voice About The Implemented Strategies

Despite that students' voice is noticeably often absent from the majority of academic research and practice (McMahon & Zyngier, 2009), we believe it is important to hear them when designing and implementing new teaching strategies. Furthermore, research findings highlight that it is important to involve students in their own learning and give them freedom to express the motivating factors for their learning (Fielding, 2001; Mitra, 2003; Zyngier, 2007). So, for this study we have considered the perspectives of four students about the implemented strategies on Moodle, which arise from the interviews and focus groups conducted with students.

Feedback from students centered on the following 8 aspects. Each of these aspects is exemplified with quotations from the interviews and focus groups and further discussed.

- i) Time for response in classes was faster to get an answer than through the Moodle.

Joanna: *When I have a doubt I prefer that the teachers explain it directly, rather than having to wait.*

Raphael: *I think it is easier to pose our questions orally in class, to get an answer immediately, and the issue be solved straight away.*

- ii) Receiving an answer orally gives students the possibility to clarify any aspect, which isn't clear at first.

Marcela: *I prefer to ask my questions orally in large class lectures, rather than writing them, because I think that it is easier... If the teacher is explaining and talking to us, and if his answer arouses another question, it will be easier for him to clarify everything in a simpler and more efficient way. If it is written, misunderstandings can occur.*

Marcela: *As I previously mentioned, I prefer to get an answer orally, than written on the Moodle, because orally it is more personal... It is easier to understand, if another question emerges immediately after getting a response. It is easier to clarify us.*

- iii) Rejection of visibility before the class.

Raphael: *I think that students are influenced by the fact that whatever is written on Moodle is sent to everyone's e-mail. I don't know why, but I believe that there is that influence. (...) Well, I prefer to send an e-mail directly to the teacher. Maybe there is that unconscious notion of the group's opinion.*

Raphael: *Possibly, if everything that is written on the Moodle wasn't sent for everyone's e-mail and was only accessible for who visited Moodle, it would be easier for students to pose their questions there.*

iv) Receiving regular e-mails with every new interaction on Moodle keep students alert.

Joanna: *Yes, I would regularly read what appeared in my e-mail account, but I didn't visit the Moodle.*

Daniel: *I wouldn't access the Moodle, but the Moodle would access me. (Laugh) Sometimes a "shower of" e-mails would appear in my e-mail account of people asking ridiculous things, such as tow days before the exam, trying to know which chapters would be evaluated. Students sometimes misuse it. (...) I was forced to follow the challenges that were being inserted on the Moodle's forum, because they were immediately sent to my e-mail.*

Raphael: *Whenever I received any update of the Moodle on my email, I would see it. I mean, when someone added something I would go there.*

v) Lacking technical skills to interact with Moodle was rejected by most students

Marcela: *The Moodle is easy to use.*

Raphael: *It is a platform very easy to accede, easy to understand how it works and I believe it had many advantages, such as enabling question posing, download of materials, download od exercises....*

vi) If the Moodle was used to post regular activities, students would use it regularly and interact more

Joanna: *I checked the Moodle many times for other courses. Regarding EPC, I didn't go there very frequently, because I knew that not many things were posted there. On the other courses many things would show up, so I checked their Moodle often.*

Marcela: *I didn't go the EPC Moodle as many times as I did for other courses, because other courses have all the material on Moodle. We (students) have to go there to upload the experimental protocol to do in the following lab class, to upload the exercises worksheet, to upload the class notes... So the Moodle is useful for those purposes. Regarding GC and EPC, the material that we need is included in the book and in the guidebook. The teacher doesn't include any other materials on the Moodle. So, the reason why we regularly check the Moodle of other*

courses, but not the Moodle from EPC or GC is that on the other courses there are constantly new files being inserted, so we need to catch up.

Daniel: I went there (to the Moodle) more often in other courses, because all the contents were there.

Raphael: I accessed more (the Moodle of) other courses essentially to get the exercises; the contents that teachers give us are generally made available through the Moodle.

vii) Moodle is an advantage for students to get a succinct answer.

Joanna: On Moodle the answers we get are perhaps more succinct than those we get orally in class, because the answers in class are frequently... they usually include a lot of information and we end up losing the content of the question that had been initially asked. So, perhaps the Moodle was sometimes an advantage.

viii) Online participation not being considered for assessment.

Joanna (FG): I wouldn't participate more if the participation on the Moodle was considered for evaluation purposes. If it was considered for evaluation (...), that would go on the wrong direction. The number of questions would increase dramatically, only to see who had posted more questions, to get the highest grade and those questions would be useless. (...) Students would start posting questions and they wouldn't go back there to see the answers. I believe it would become nonsense.

ANALYSIS AND DISCUSSION

If we judge the effectiveness of the implemented strategies by the number of questions that students have formulated, we can consider that, except MRP, during which 26 questions were posed on Moodle, 49 were posed to the lecturer when each group attended the MRP's meetings with the lecturer and 7 other were posed to other students during the presentation sessions of the MRP; and to some extent lectures, the other strategies were flawed. Students didn't ask many questions during lectures and wrote even fewer on the pieces of paper provided in class. Besides, the two forums implemented on the Moodle, "*Questions and answers in Chemistry*" online forum and "*Brainteasers*" online forum, weren't an exception. Students asked even fewer questions through the Moodle's forums, than in-class. As a result from this research emerges that the way the two forums on Moodle were designed and implemented need to be improved to effectively foster student questioning. Such result reinforces the need for

further researches on the development of innovative strategies to foster student questioning through the use of the forums on Moodle.

Having in mind the improvement of the strategies implemented on Moodle, we observed the questioning behavior of four responsible and well succeeded students in the different environments provided by the two courses; we interviewed them and conducted focus groups to understand their perceptions on the strategies and comprehend the reasons for their low, or null, participation on the two forums. Students' perceptions and valuable suggestions were found to be very pertinent and arose some ideas for improvements that are very likely to be taken into consideration in future studies.

The four students involved in this research have their own inherent characteristics, which vary from one to another. However, they have all proved to be very responsible and committed to their duties as students and all of them have demonstrated to be predominantly strategic with a slight combination of deep approaches to study.

Regarding their perceptions about the implemented strategies, despite that each student has his/her own particular opinion, common aspects surfaced. From here on we will emphasize and discuss those common opinions revealed by the four students.

In what concerns time for response, students have highlighted that they preferred to pose a question personally to the lecturer, because they would get an answer much faster than if they posted it online and had to wait for the teacher to be notified of it and answer it.

We believe that this aspect could be, to a certain extent, overcome, if there was at least one teacher permanently online to answer students as fast as possible. Then, the teachers could have a more permanent participation on the forum and students would more promptly notice the usefulness of the forums. Obviously this would result in an increasing demand of teachers' time dedication for each course, which we recognize that would not be easy to accomplish. An alternative could be to arrange a daily online meeting on the forum, or in a chat, during which students could pose their questions to the teacher.

In Portugal, not all students have ubiquitous access to Internet, which partially justifies Joanna's comment. The shy female student mentioned that if questions were written on the forums, that would mean that the student were

accessing their computers at home some hours after the class, and so could easily have forgotten exactly what their questions were to correctly formulate them and post them on Moodle.

As emphasized by Marcela, the way the two forums on Moodle were implemented didn't allow the possibility to clarify any aspect of the teachers' answer, which wasn't clear at first. On the contrary, receiving an oral answer, allowed further questioning. Sometimes one answer given by the teacher may not be enough to clarify the students' original questions and other questions arise, which could result in a series of subsequent questions, rather than a discrete question. This situation can evolve into a "questioning interaction episode", previously described in the literature (Pedrosa de Jesus & Lopes, 2008; Pedrosa de Jesus & Lopes, 2011).

If the second alternative proposed to overcome the "time for response" issue was implemented, during the daily online meeting on the forum, or chat, the teacher could also clarify all the students' questions, and subsequent questions.

Concerning the rejection of visibility before the class, when students posted a question on either of the two forums on Moodle, all the students enrolled in the course would receive an e-mail with the name of that student and the corresponding question. In fact, Colbert *et al.* (2007) in a similar study conducted with biology students noticed that almost three fourths of all the students enrolled in the course (those who did and did not pose questions of their own) reported looking at questions posted by their peers. As previously noticed by Yu & Liu (2009), it is important to create a psychologically safe online learning space for learners engaged in question-posing related activities. Considering the students' rejection of visibility before the class, we may conclude that as students' had their identity revealed, they interpreted the Moodle as a psychologically unsafe environment. In previous studies conducted with 1st year chemistry students at the UA and other studies described in the literature (Tan *et al.*, 2011), it was noticed that students misused the online forums as another social chat tool, ignoring that the teacher could read their posts and comments. Such a situation resulted in embarrassing situations, which lead the forthcoming studies to force every comment to be seen by everyone (students, teachers and researchers). In an attempt to overcome these psychological constrain, we considered the possibility of making students identity visible to the teachers and

researcher, but invisible to their peers. However, the technical department of the university guaranteed that it was an impossible customization to make on the forums.

Still, this wasn't a consensual issue among the students. Despite that some students rejected the visibility before the class that happened anytime any of them posted a question on the forums, such as Raphael, others, like Marcela and Daniel, admitted that it wasn't a problem for them. Marcela explicitly said *"I don't feel embarrassed, if my colleagues become aware of my doubts. The teacher even told us that every single question ever asked by any of his students was always useful, so I don't feel so bad (...) It doesn't affect me."*

So, although we are glad that we are aware of this not consensual issue and that it is an important aspect to consider, in further studies we plan to maintain the students' identity visible to all students. The stimulus of the raise of constructive discussions among students on the contents of the course was one of the objectives that we initially aspired for when we first implemented the forums. If students couldn't see each other's posts, they wouldn't be able to interact on the Moodle.

Besides, Joanna, Daniel and Raphael also admitted that they checked what was being posted on Moodle, because of the e-mails they received in their inboxes informing them about it. So receiving regular e-mails with every new interaction on Moodle kept them alert to each other's comments. Joanna even admitted that if e-mails weren't sent to her inbox every time someone posted anything on Moodle, she wouldn't check the Moodle regularly. Like her, many other students could have only relied on the information about interactions on Moodle that was being sent to their e-mail accounts. This e-mail notification that was sent to students every time anyone posted anything on the forums is a customization to uphold in further studies.

Not surprisingly most students, like Marcela and Raphael, unequivocally refused to admit that they were lacking technical skills to interact with Moodle and found it very intuitive, easy to use and recognized its advantageous features.

Lacking technical skills wasn't a problem for most students, as they have promptly accomplished the first task of the MRP, during which they had to formulate questions about the Scientific American article that they had read and post them on Moodle. Some of the questions posted by students were "Was this technology successful? Is it being

applied nowadays? How developed is this technology?” referring to “Thermophotovoltaics” (Coutts & Fitzgerald, 1998); “To what extent is the production of a Nano phase material influenced by pressure and temperature?” corresponding to the article entitled “Creating Nano phase Materials” (Siegel, 1996) or “How could have the organic compounds that have reached the earth been brought by comets, if they start decomposing as soon as they contact the earth surface?” posted by students who explored the article entitled “The Ice of Life” (Blake & Jenniskens, 2001). Besides, despite that the quality of the questions posed by students wasn’t the main focus of this study, generally the questions that students have posed to accomplish their MRP tasks were much more elaborate than those posed by other means, such as those posed on Moodle.

However, one of the interviewed students, Joanna, admitted her digital illiteracy by expressing that her insufficient technical skills were a barrier inhibiting her use of the forums to pose her questions, as she mentioned, *“Besides, I don’t know exactly how to use the Moodle to pose my questions.”*

As nowadays most students are digital natives, this wasn’t an aspect we expected to face. However, an explanation of the Moodle was presented to students on the first lecture. Still, we recognize that we could have been influenced by our belief that all undergraduates are proficient users of online tools. In the upcoming researches we suggest that more attention should be paid to those less digitally literate students, for whom the use of an online forum could be a problematic.

One aspect that was mentioned by all the four students was that if the Moodle was used to post regular activities, such as exercises, class presentations, assignments or evaluation grids, students would be forced to visit it regularly and consequently ended up interacting more in each task, and ultimately would interact more on the forums and pose more questions. Just like students, we recognize and have verified that we need to incite more students’ involvement to foster their participation on Moodle.

As Marcela mentioned *“I didn’t go the EPC Moodle as many times as I did for other courses, because other courses have all the material on Moodle. (...) Regarding GC and EPC, the material that we need is included in the book and in the guidebook.”*

Just as Marcela referred a guidebook was delivered to students at the beginning of the semester, in both courses where these strategies were implemented, EPC and GC. The guidebook included the lab classes' guidebook, the lectures guidebook, which comprised some resumes of the course contents, printed slides of the presentations to be made on each lecture, the evaluation criteria and procedures and some exercises. Students wouldn't need any other materials, except for sporadic occasions. So, in students' point of view, as they already possessed all the materials that they needed for classes, they didn't need to check Moodle regularly. Students think of Moodle primarily as a tool from where they can access and retrieve data and in fact Moodle has been worldwide used primarily for that purpose (Hamuy *et al.*, 2010). Students usually don't consider using Moodle for other purposes, because they're not used to. That's why we believe that they have stressed so much the need for regular activities being posted and why they have lacked spontaneity and posed so few questions on the "*Questions and answers in Chemistry*" online forum.

As mentioned in the interviews the "*Brainteasers*" forum was considered to be much more appealing and question triggering than the "*Questions and answers in Chemistry*" forum, which reinforces Graesser and Olde (2003) and Graesser, Lu, Olde, Cooper-Pye and Whitten (2005) theory that students need an external stimulus that triggers a cognitive disequilibrium to interact and to drive questions and inquiry, whereas ensuing answers are expected to restore equilibrium. According to Graesser *et al.* (2005), a cognitive disequilibrium happens when individuals are confronted with stimuli, problems, or situations that present obstacles to goals, anomalous events, contradictions, discrepancies, expectation violations, and obvious gaps that don't fit into their previous knowledge. As previously mentioned, the "*Brainteasers*" forum included problem-based cases based on real life situations related to the content being taught in lectures that attempted to provoke some kind of cognitive disequilibrium on students. These cases were regularly posted on Moodle by the researcher and the students were then expected to formulate questions that would help them understand the case. On the "*Brainteasers*" forum the students' interaction was provoked by an external factor, which was triggered when new challenges were posted on the forum. On the other hand the "*Questions and answers in Chemistry*" was used as a space where students could pose their questions, make comments to their colleagues' questions and read the corresponding answers that were given by the lecturer. Students would have to go there on their own, without any external stimulus to interact.

During the interviews students even recalled some of the problem-based cases presented on the "Brainteasers" forum, such as "Why do lakes get frozen from top to bottom?". Joanna even added "... that explanation about the lakes, for instance, I think was very useful when I studied for the exam. Mostly because the explanation of that 'brainteaser' was related to the content of the course and I copied that explanation and the full response posted on Moodle to my course guidebook".

This corroborates not only that students are more prone to read posts on the forums when they are provoked, but also that they remember better those posts. During the interviews students haven't shown evidences of remembering what had been written on the "Questions and answers in Chemistry". References were made only to the "Brainteasers" forum. This observation reinforces the need to incite more frequently students' interactions, which we will consider in further studies. Despite that the content of the guidebook should certainly be given to students in further studies, the means by which they are delivered can be modified. If students pose more questions on the forums, if they have to go to Moodle several times throughout the semester to download materials for the course, we can reformulate the way we deliver information to them, and subdivide it and post it on Moodle.

Regarding the impression that the Moodle is an advantageous tool for students to get a succinct answer to their questions, it was surprising that only Joanna, the less digitally literate of the four, actually declared it. "On Moodle the answers we get are perhaps more succinct than those we get orally in class, because the answers in class are frequently... they usually include a lot of information and we end up losing the content of the question that had been initially asked. So, perhaps the Moodle was sometimes an advantage." As all the four students considered on this study have demonstrated to be predominantly strategic in their approaches to study, they are all driven by a common goal to get as better marks as they can. If they perceive the effectiveness of the forums on Moodle to get a succinct and reliable answer for their questions, in the sense that they would have access to an accurate and well-organized written answer from the lecturer, in such a quick manner and without having to look for other resources and combine the information provided in each one of them, they would consider its usefulness and would thus start using it more often. Perhaps more digitally literate students take that systematic answer for granted and don't contemplate the value of that aspect in such appreciative way.

Observing online participation not being considered for assessment, at first, the contribution of students' participation on the online forums for their evaluation seemed to be an interesting aspect to consider in further studies. Moreover, students were really attentive to evaluation procedures. This was disclosed by the increase in the number of questions that students posted on the "*Questions and answers in Chemistry*" online forum by the end of the semester. These questions, rather than focusing on the Chemistry content that would be assessed on the exam, were mainly referring to the evaluation procedures. This emphasizes an aspect previously noticed by Colbert *et al.* (2007) that when students do ask questions, they often address matters not related to deeply understanding science concepts (e.g., "What will be on the exam?", "How will the assignment be assessed?", "Would you repeat that?"). Consideration must be, thus, given to the selection criteria of the relevant questions for evaluation purposes. As Joanna highlighted, if the questions students posted on the forums on Moodle were considered for their evaluation in the course, "*the number of questions would increase dramatically, only to see who had posted more questions*" and that could result in a higher number of very low cognitive level questions, which would not have a constructive and relevant contribution to the students' improvement and learning growth. This aspect referred to by Joanna, had already been mentioned in the literature by Colbert *et al.* (2007), who have encouraged student-generated questions by offering students a small amount of "extra credit" of their final course grade, for those who posed questions related to the course material on an online discussion forum.

We realize that we are just taking the first steps to foster student questioning, not only in class, but above all in asynchronous learning environments. Students are not accustomed to pose questions to teachers through online forums and they are managing to situate themselves. They shouldn't be as informal as they usually are in common online forums, but they should be confident enough to pose any question that occurs to them. However, educators also need to reformulate their practices and teaching strategies for them to fit into any of the uncountable emerging new technologies. Despite that our strategies have resulted in very few spontaneous questions posted on either of the forums on Moodle, we fully understand students' perspectives and in the next researches we will have them in account when designing and implementing new strategies. The results of our study also confirm that there are still many possibilities of researches to be conducted to understand which strategies can effectively take advantage of the Moodle's tools and resources to foster student questioning.

On the basis of these findings, we believe that the study would benefit from the application of the same strategies in other courses and institutions to determine whether these findings can be generalized across HE. Moreover, a more profound insight into the variables affecting the students' usage of online environments for educational purposes could help to determine if they influence student questioning and if so, to what extent.

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REFERENCES

- Almeida, P., Teixeira-Dias, J. J., & Martinho, M. (2010). Teaching and Learning Chemistry: a new approach at the University of Aveiro, in Portugal. In N. Popov, C. Wolhuter, B. Leutwyler, M. Mihova & J. Ogunleye (Eds.), *Comparative Education, Teacher Training, Education Policy, School Leadership and Social Inclusion* (pp.357-362). Sofia, Bulgaria: Bureau for Educational Services.
- Atkins, P., & Loretta, J. (2005). *Chemical Principles – The Quest for Insight* (3rd ed.). New York: W. H. Freeman and Company. p. 396).
- Barak, M., & Rafaeli, S. (2004). On-line question-posing and peer-assessment as means for web-based knowledge sharing in learning. *International Journal of Human-Computer Studies*, 61(1), 84-103.
- Biggs, J., & Tang, C. (2007). *Teaching for quality learning at university* (5th ed.). The Society for research into Higher Education and Open University Press, Maidenhead, UK.
- Blake, D. F., & Jenniskens, P. (2001). The Ice of Life. *Scientific American*, 285(2), 44-47.
- Boyer Commission on Education Undergraduates in the Research University (1998). Reinventing undergraduate education: a blueprint for America's Research Universities. Retrieved from [http://naples.cc.sunysb.edu/pres/boyer.nsf/673918d46fbf653e852565ec0056ff3e/d955b61ffddd590a852565ec005717ae/\\$FILE/boyer.pdf](http://naples.cc.sunysb.edu/pres/boyer.nsf/673918d46fbf653e852565ec0056ff3e/d955b61ffddd590a852565ec005717ae/$FILE/boyer.pdf)
- Calongne, C.M. (2002). Promoting team interaction in the online classroom. *The Journal of Computing Sciences in Colleges*, 18(1), 218–227.
- Chin, C., & Osborne, J. (2008). Students questions: a potential resource for teaching and learning science. *Studies in Science Education*, 44(1), 1-39.
- Chu, H.-C., Hwang, G.-J., Tsai, C.-C., & Chen, N.-S. (2009). An innovative approach for promoting information exchanges and sharing in a Web 2.0-based learning environment. *Interactive Learning Environments*, 17(4), 311-323.
- Colbert, J.T., Olson, J. K., & Clough, M. P. (2007). Using the Web to Encourage Student-generated Questions in Large-format Introductory Biology Classes. *CBE Life Science Education*, 6, 42-48.
- Coutts, T. J., & Fitzgerald, M. C. (1998). Thermophotovoltaics. *Scientific American*, 279(3), 90-95.

- Davies, J., & Graff, M. O. (2005). Performance in e-learning: Online participation and student grades. *British Journal of Educational Technology*, 36(4), 657-663.
- Fielding, M. (2001). Students as Radical Agents of Change. *Journal of Educational Change*, 2, 123-141, <http://dx.doi.org/10.1023/A:1017949213447>
- Gillham, B. (2000). *Case study research methods*. London: Continuum.
- Graesser, A. C., Lu, S., Olde, B. A., Cooper-Pye, E., & Whitten, S. (2005). Question asking and eye tracking during cognitive disequilibrium: Comprehending illustrated texts on devices when the devices break down. *Memory and Cognition*, 33(7), 1235-1247.
- Graesser, A. C., & Olde, B. A. (2003). How does one know whether a person understands a device? the quality of the questions the person asks when the device breaks down. *Journal of Educational Psychology*, 95(3), 524-536.
- Hamuy, E., & Galaz, M. (2010). Information versus communication in course management system participation. *Computers & Education*, 54(1), 169-177.
- Hofstein, A., Navon, O., Kipnis, M., & Mamlok-Naaman, R. (2005). Developing students' ability to ask more and better questions resulting from inquiry-type chemistry laboratories. *Journal of Research in Science Teaching*, 42(7), 791-806.
- Kakasevski, G., Mihajlov, M., Arsenovski, S., & Chungurski S. (2008). Evaluating usability in learning management system Moodle. *Proceedings of the 30th International Conference ITI Cavtat/Dubrovnik, Croatia*, June 23-26, 2008, p.613-618.
- Lin, F. R., Hsieh, L. S., & Chuang, F. T. (2009). Discovering genres of online discussion threads via text mining. *Computers and Education*, 52, 481-495.
- Lincoln, Y.S., & Guba, E.G. (1985). *Naturalistic Inquiry*. Newbury Park, CA: Sage.
- Lonn, S., Teasley, S. D., & Krumm, A. E. (2011). Who Needs to Do What Where?: Using Learning Management Systems on Residential Vs. Commuter Campuses. *Computers and Education*, 56, 642-649.
- Lopes, B. S., Moreira, A. C., & Pedrosa de Jesus, M. H. (2012). «Questions in Biology» Designing an Online Discussion Forum for Promoting Active Learning about Evolution. In F. J. Gonçalves, R. Pereira, W. L. Filho, & U. M. Azeiteiro (Eds.), *Contributions to the UN Decade of Education for Sustainable Development* (pp.235-254). NY: Peter Lang. ISBN 978-3-631-61347-4
- Mayer, R. E., Stull, A., DeLeeuw, K., Almeroth, K., Bimber, B., Chun, D., Bulger, M., Campbell, J., Knight, A., & Zhang, H. (2009). Clickers in college classrooms: Fostering learning with questioning methods in large lecture classes. *Contemporary Educational Psychology*, 34(1), 51-57.
- Mazzolini, M., & Maddison, M. (2007). When to jump in: The role of the instructor in online discussion forums. *Computers & Education*, 49, 193-213.
- Mbajjorgu, N., & Reid, N. (2006). *Factors Influencing Curriculum Development in Chemistry*. Hull: Higher Education Academy Physical Sciences Centre.
- McMaohn, B. J., & Zyngier, D. (2009). Student Engagement: contested concepts in two continents. *Research in Comparative and International Education Volume*, 4(2), 164-181.

- Meyer, K. A. (2003). Face-to-face versus threaded discussions: the role of time and higher-order thinking. *Journal of Asynchronous Learning Networks*, 7(3), 55–65.
- Mitra, D. (2003). Student Voice in School Reform: reframing student–teacher relationships. *McGill Journal of Education*, 38(2), 279-304.
- Nor, F. M., Hamat, A., & Embi, M. A. (2012). Patterns of discourse in online interaction: seeking evidence of the collaborative learning process. *Computer Assisted Language Learning*, 25(3), 237-256.
- Pedrosa de Jesus, H., Almeida, P., Teixeira-Dias, J. J., & Watts, M. (2007). Where learners' questions meet modes of teaching. *Research in Education*, 78, 1-20.
- Pedrosa-de-Jesus, M. H., & Lopes, B. S. (2008). Questioning strategies and teaching approaches: A study in university biology. Proceedings of the 13th ELSIN Conference, Gent: Vlerick Leuven Gent Management School, 366–80.
- Pedrosa-de-Jesus, M. H., & Lopes, B. S. (2011). The relationship between teaching and learning conceptions, preferred teaching approaches and questioning practices. *Research Papers in Education*, 26(2), 223-243.
- Pedrosa de Jesus, H., Teixeira-Dias, J. J. C., & Watts, M. (2003). Questions of Chemistry. *International Journal of Science Education*, 25(8), 1015-1034.
- Siegel, R. W. (1996). Creating Nano phase Materials. *Scientific American*, 275(6), 74-79.
- Sivapalan, S., & Cregan, P. (2005). Value of online resources for learning by distance education. *CAL-laborate*, 14, 23-27.
- Tait, H., Entwistle, N. J., & McCune, V. S. (1998). ASSIST: A reconceptualisation of the approaches to studying inventory. In C. Rust (Ed.), *Improving student learning: Improving students as learners*. Oxford: Oxford Brookes University, Oxford Centre for Staff and Learning Development (pp. 262-271).
- Tan, S. C., & Seah, L. H. (2011). Exploring relationship between students' questioning behaviors and inquiry tasks in an online forum through analysis of ideational function of questions. *Computers & Education*, 57(2), 1675–1685.
- Valadas, S., Gonçalves, F., & Faisca, L. (2010). Approaches to studying in higher education Portuguese students: a Portuguese version of the approaches and study skills inventory for students. *Higher Education*, 59, 259-275.
- Wang, Q., & Woo, H. L. (2007). Comparing asynchronous online discussions and face-to-face discussions in a classroom setting. *British Journal of Educational Technology*, 38 (2), 272–286, doi:10.1111/j.1467-8535.2006.00621.x
- Wilson, E. V. (2004). ExamNet asynchronous learning network: augmenting face-to-face courses with student-developed exam questions. *Computers & Education*, 42(1), 87-107.
- Yu, F. (2011). Multiple peer-assessment modes to augment online student question-generation processes. *Computers & Education*, 56(2), 484-494.
- Yu, F., & Liu, Y. (2009). Creating a psychologically safe online space for a student-generated questions learning activity via different identity revelation modes. *British Journal of Educational Technology*, 40(6), 1109-1123, doi:10.1111/j.1467-8535.2008.00905.x
- Yu, F., Liu, Y., & Chan, T. (2005). A web-based learning system for question-posing and peer assessment. *Innovations in Education and Teaching International*, 42(4), 337-348.

- Zyngier, D. (2007). Listening to Teachers – listening to students: substantive conversations about resistance, empowerment and engagement. *Teachers and Teaching*, 13(4), 327-347.
- Zoller, U. (1987). The fostering of question - asking capability: A meaningful aspect of problem-solving in Chemistry. *Journal of Chemical Education*, 64(6), 510-512.