



Cypriot Journal of Educational Sciences



Volume 7, Issue 4 (2012) 334-347

<http://www.awer-center.org/cjes/>

Student questioning in higher education: Does gender make a difference?

Mariana Martinho ^{a*}, Patrícia Albergaria Almeida ^a, José Teixeira-Dias ^b

^a CIDTFF-Research Centre for Didactics and Technology in Teacher Education, Department of Education, University of Aveiro, 3810-193, Aveiro, Portugal

^b Department of Chemistry, University of Aveiro, Aveiro, Portugal

Abstract

Considering the relevance of student questioning in the teaching, learning and assessment processes, this research proposal was developed to investigate and characterize female and male students' questioning profiles in higher education settings in different situations, such as traditional classes and online interactions. It is our intention to conceive and implement strategies to promote student questioning, according to the specificity of each gender, in order to contribute to the optimization of the teaching, learning and assessment processes in higher education. The project is being developed within first year chemistry classes at the University of Aveiro (Portugal), following a mixed (qualitative and quantitative) methodology. Data is being collected through observation, interviews, focus groups, one inventory aiming to identify students' learning approaches, and by means of an online forum. Preliminary findings suggest that a small number of oral and written questions are formulated by students of both genders, though males pose more questions in class than girls; by the end of the semester students pose more questions online than during the beginning or middle of the semester, but those questions are mainly referring to the evaluation procedures rather than chemistry content; more questions are asked in-class than through the online tool (Moodle) provided for the course, students ask more questions in chemistry practical laboratory classes than in lectures.

Keywords: Questioning, gender, higher education, chemistry, learning environments;

Selection and/or peer review under responsibility of Assist. Prof. Dr. Çiğdem Hürsen

©2012 Academic World Education & Research Center. All rights reserved.

1. Introduction

Recent data from the World Bank report on gender equality and development (The World Bank, 2011) highlights that currently girls participate equally (or more) than males at all education levels,

* ADDRESS FOR CORRESPONDENCE: Mariana Martinho, University of Aveiro, Research Centre for Didactics and Technology in Teacher Education, Aveiro, Portugal
E-mail address: marianabcn@gmail.com

including higher education (HE). Although women perform better at every levels of education and earn more and higher degrees than males do, women still face biases and barriers in particular fields, namely mathematics and sciences (Wood, 2009).

Despite the fact that educational institutions have the capacity to produce or reinforce gender biases and stereotypes, they can also resist to those biases and promote other values and attitudes, such as that related to students' understanding of the meaning of being a female or a male (Vianna & Ridenti, 1998).

As the questioning skill is the most significant indicator of the highest and most critical level of students' reasoning (Almeida, Teixeira-Dias & Martinho, 2010; Pedrosa de Jesus, Teixeira-Dias & Watts, 2003; Zoller, 1987), this study is aimed at contributing to a better understanding of student questioning in the teaching, learning and assessment processes in HE, focusing on the gender gap.

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). It is, thus, important to clarify to what extent strategies implemented though online environments can foster a gender-balanced student questioning compared to strategies implemented in class.

The study is being conducted with first year chemistry students at the University of Aveiro, in Portugal. It is our intention to investigate and characterize female and male students' questioning profiles in different situations, such as traditional classes and online interactions, and to conceive and implement strategies that foster student questioning and create a welcoming setting for the raise of questions by students of both genders. We look forward to contributing to greater gender equity in the learning, teaching and assessment processes, in particular in HE chemistry classes.

1.1. Review of the Literature: 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 higher education student should achieve emerges the most significant indicator of the highest and most critical level of students reasoning – the questioning skill (Almeida et al., 2010; Pedrosa de Jesus et al., 2003; Zoller, 1987). Hofstein, Navon, Kipnis and 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 in the quality of teaching and, accordingly, in 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. Furthermore, universities 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).

Regarding learning approaches, Almeida (2007) verified that students who consistently pose low cognitive level questions tend to adopt more superficial learning approaches, while those who adopt deeper learning approaches have the capacity to formulate questions of higher cognitive level.

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 projects have been developed in HE.

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.

Concerning student questioning, few studies have focused on gender and even fewer have concentrated on gender differences on HE. However, Wood (2009) states that although women perform better at every levels of education and earn more and higher degrees than males do, women still face biases and barriers in particular fields, namely mathematics and sciences.

Despite the longstanding recognition of the existence of gender differences in verbal communication (Wood, 2009; Tannen, 1990), the few existing studies are not consensual. On the one hand, Pearson, West and Turner (1995) stated that it is not clear which gender raises more questions. On the other hand, Jones, Howe and Rua (2000) observed that boys are less frightened to pose questions than girls. Blum (1999) undertook an investigation to compare the questioning patters of boys and girls, either in class or online, and concluded that girls ask more questions than boys in class, while boys ask and answer more than girls in online environments.

Facing such a controversial issue and considering the great importance of students' questions in the processes of knowledge construction, it is important to investigate and characterize students' questioning profiles according to their gender and to the learning environment in which they are immersed (such as classes or online environments).

2.1. Aims, Objectives and Research Questions

The purpose of this ongoing study is to contribute to a better understanding of student questioning in university education focusing on gender differences, as well as in the design and implementation of strategies, to make university education in chemistry more equitable, taking into account the specificities of gender.

This study comes in the wake of other projects focused on questioning of students of the University year 1, developed in the Research Centre for Didactics and Technology in Teacher Education, at the University of Aveiro, in Portugal (Almeida, 2007; Albergaria-Almeida, Teixeira-Dias, Martinho & Balasooriya, 2010; Albergaria-Almeida, Teixeira-Dias, Martinho & Balasooriya, 2011; Martinho, Albergaria Almeida & Teixeira-Dias, 2012a, 2012b; Moreira, 2006; Pedrosa de Jesus et al., 2003; Souza, 2006; Teixeira-Dias, Pedrosa de Jesus, Neri de Souza & Watts, 2005).

The option of carrying out this study with students of chemistry deals with the recognized impact and centrality that this discipline currently has. Chemistry provides a contextualized learning in everyday situations, encouraging interaction, discussion and debate between teacher and students (Teixeira-Dias, Pedrosa de Jesus, Souza, Almeida & Moreira, 2009).

Thus, the objectives of this project are to:

1. identify and characterize the questioning profiles (number and type of questions) of boys and girls in the learning of chemistry in the 1st year of university in different contexts (face-to-face and online environments);
2. identify and characterize the approaches to learning of boys and girls in the learning of chemistry in the 1st year of university education;
3. identify the conceptions of boys and girls about the role of questioning in the teaching, learning and assessment processes;
4. identify and characterize relationships between the questioning profile of students (boys and girls) and its role in the process of constructing knowledge (teaching, learning and assessment processes);
5. examine the relationship between the questioning profiles of boys and girls and the grades obtained by these in the chemistry course;
6. conceive, produce, implement and evaluate teaching, learning and assessment strategies aimed at promoting student questioning and optimizing the learning of boys and girls in higher education;
7. analyze the implications of the teaching, learning and assessment strategies aiming to promote questioning in the approaches to learning of students of both genders.

The research questions presented below are based on a thorough and critical review of national and international literature and are related to the aims described above.

The main research questions of this project are:

1. What are the differences between female and male students' questioning profiles in first year university chemistry classes?
2. Which strategies and teaching practices can promote student questioning, attending to their gender, in order to optimize chemistry learning in university teaching?

There are a series of sub-research questions that can be addressed:

1. How do females' and males' understandings of the role of questioning in the teaching, learning and assessment processes affect their questioning profiles?
2. What influence do different learning environments (such as traditional classes and online interactions) have on female and male students' questioning profiles?
3. How does implementing strategies to foster student questioning reflect on the learning approaches of female and male students?
4. To what extent are the students' grades influenced by their questioning profiles?

With the purpose of finding answers to these research questions, the present study aims to contribute to the quality of university education through the design of strategies that can be implemented in other contexts (different courses, different disciplinary fields).

2. Research Design and Methods

This study follows a naturalistic ethnographic approach and the methodology is mixed (qualitative and quantitative). Several techniques are applied, such as one inventory, observation and documentary analysis. The corresponding research instruments used are semi-structured interview scripts, focus groups scripts, observation grids for classes and for online interactions, audio and video records and the researcher's diary. An inventory aiming to identify students' learning approaches is also applied (Tait, Entwistle & McCune, 1998). This inventory had previously been developed,

translated and validated to the Portuguese context (Approaches and Study Skills Inventory for Students - ASSIST; Valadas, Gonçalves & Faisca, 2010).

The focus groups, the records of the online interactions, the researcher's diary and the interviews conducted with students and to teachers will be qualitatively analyzed (content analysis). On the other hand, the observation grids, the inventory and the classification grids will be statistically analyzed.

The first stage of this investigation, fulfilled between March and September 2011, consisted in a critical literature review to understand what had already been studied regarding female and male students' questioning, and in the preparation of the data collection instruments. At the same time, strategies were developed to foster student questioning and create a welcoming setting for the raise of questions by students of both genders, either to be applied in class or through the online content management system that supports the curricular unit, the Moodle.

The students observed were first year undergraduates attending two broad foundation courses – Elements of Chemical Physics (1st semester) and General Chemistry (2nd semester) – of several science and technologies degrees, such as physics, meteorology and oceanography, environmental engineering and materials engineering. The total number of students was 175, 114 of which were boys and 61 were girls.

Following this initial stage we proceeded to the pilot study, which was carried out during the first semester of the academic year 2011/12 with students attending the Elements of Chemical Physics course. The pilot-study served as a testing study of the previously conceived techniques, instruments and learning, teaching and assessment strategies. The identified improvements and reformulations were made before the beginning of the main study. The empirical data for the pilot study was mainly gathered through a non-participant observation, audio recorded classes, administration of an inventory and records of online interactions.

Following data treatment and analysis and having in mind the lecturer's perspective, the necessary improvements were made before the main study carried through the second semester of 2011/12.

During the main study, besides class observation, analysis of online interactions, application of the ASSIST and implementation of learning, teaching and assessment strategies, focus groups and interviews were conducted with students. Furthermore, sessions of debates and shared reflections with the class's chemistry teacher were held throughout the two semesters.

By the end of the main study we proceeded to the transcriptions, treatment and analysis of the data collected. The final part of this study will be dedicated to an integrated analysis of the results retrieved during the pilot and the main study, and to the writing and presentation of the PhD thesis.

Throughout the timeframe of this project a deeper critical scientific backup is regularly being made through further readings and review of specific literature.

2.1. Course Description

This study was conducted with two classes of students attending two 1st year courses at the University of Aveiro (Portugal). The first course - Elements of Chemical Physics (ECP)- was taught during the first semester and included themes such as *Water and aqueous solutions*, *Molecular structure and shape*, and *Solids*.

On its turn, General Chemistry (GC) was taught during the second semester and comprised varied themes, such as *Chemical thermodynamics, Acids and bases, Redox reactions and Electrochemistry and Chemical kinetics*.

In both courses, besides large classroom lectures (2 hours per week), students had compulsory practical laboratory classes (2 hours per week) in groups of 10 to 12 students, and they could also attend supplementary tutorial guidance classes (2 hours per week).

2.2. Teaching, Learning and Assessment Strategies

In an attempt to foster student questioning several strategies were implemented. As some of these strategies had previously been developed, adaptations were made for them to meet the objectives of the current investigation. Other strategies were developed from scratch. Despite the fact that some of the implemented strategies did not have the intended result on encouraging student questioning, in this section all the implemented strategies will be listed and detailed, so that further studies could take advantage of such evidence.

2.3 1st Class: Presenting the Benefits of Questioning

A critical feature considered for the success of this research was to make sure that students felt free to ask questions and to encourage them to do so any time they felt the need to, whether it was in the classroom or when they were studying at home away from university. That is, we tried to create an inviting atmosphere in order to stimulate and encourage student-generated questions and ultimately enhance students' willingness to interact in the classroom. With this end in mind, a brief presentation was made to students on the first class explaining the advantages of student questioning for learning and the benefits of students' development of questioning habits.

2.4 Lectures

These are large classroom lectures traditionally centered on the teacher, where a very small number of students have the confidence to raise questions before such a big audience. In an attempt to provide better opportunities for interpersonal interactions with the students, besides asking students several questions to make sure that they had understood the content and to foster their curiosity, the teacher regularly encouraged students' oral questions on the subject matter and even made 2-3 minutes pauses in the middle of each lecture so that students had time to think about what had been said and managed to express their doubts through the formulation of questions. The teacher would then answer the questions formulated by students orally within the class.

2.5 Written Questions In-class

Students were given the possibility to deliver the questions that had emerged from the lectures, or from their study at home, in a written format through a piece of paper provided by the researcher. Those questions would then be collected by the researcher and typed on the "Questions and Answers" online forum, being anonymously exhibited to the whole class. Other students' comments and efforts to answer each posed question were welcomed. After giving time for student-to-student discussion about each question, the correct answers were given by the teacher through the content management system (Moodle). These more complete answers would provide students with more

individual answers, and the teacher would also give suggestions for further reading and encouragement to raise follow-up questions.

2.6. Practical Laboratory Classes

These 10-12 student weekly classes were planned so that students could develop practical works related to each of the topics explored at the lectures. At the beginning of the year students were given a laboratory work manual where they could verify which laboratory experiment would be done on each week of the semester. The manual included the objectives and some guidelines for each work. Instead of a commonly found “cooking recipe” type experiment protocol, the laboratory work manual was redesigned to promote student autonomy and foster critical thinking. It was expected that students would use this manual to prepare themselves before each practical laboratory class and to bring questions to class. At the beginning of each class, each of the teachers that were giving these laboratory classes would ask the students the objectives of the work and would make a brief explanation of what they should do. During the class, besides developing the practical experiment itself, students had to take their notes on their logbook, which would be used for their evaluation. These logbooks were kept in the lab during the entire semester so that students couldn't take their notes at home beforehand. It wasn't expected that students would make a formal report of the experimental activity on the logbook, but they had to record and discuss the results and observations, answer the questions raised in their laboratory work manual and, eventually, suggest practical alterations and improvements.

2.7 Supplementary Tutorial Guidance Classes

These voluntary classes were provided for small groups of students by the lecturer. This constituted an opportunity for students who wished to clarify doubts regarding not only the content of the lectures but also about the works developed in practical laboratory classes or even previously taught content or mathematics. These were run in the evenings after regular classes and would typically last 2 hours. Students of both genders hardly attended these classes.

2.8 Forums in Moodle

Two forums were developed on the content management system provided for all courses at the University of Aveiro (Portugal), the Moodle, to support the students' questioning interactions online. These forums were open to all ECP and GC students throughout each semester.

Having in mind that not all first year students are equally familiar with Moodle, on the first class students were taught how to use Moodle and where and how to pose their questions.

- a) “Questions and answers in Chemistry” forum was created to encourage and facilitate students' questioning when they were away from university, and to facilitate question posing for shy students. Students could use this tool to raise written questions related to the topics taught during lectures and practical laboratory sessions, to read the answers given by the teacher to the written questions left in class, to answer or comment other students' questions or simply to follow other students' questions. The teacher answered all of the questions in about 1-2 days.

b) *“Brainteasers” forum* was created to trigger students’ curiosity and foster higher level reasoning. Several challenges, perplexing situations, or questions were posted throughout each semester, usually not directly related to the content being taught in class. Students should analyse and reflect on the post and were expected to articulate their reflection through the raise of questions that would express their thoughts and doubts. Furthermore, when posting the question, students were expected to support their thoughts by justifying the reason why they had elaborated that question. All the questions were open to comments of other students.

2.9 Mini-research Projects

At the beginning of the semester the teacher explained to students the aims of mini-research projects (MRP) to be developed in groups of 2 students and entirely done outside formal classes. Participation in MRP was done on a voluntary basis. Despite the fact that students who enrolled in the MRP and succeeded could enhance their grades by a small margin (2 out of 20), only 34 out of the 175 students decided to enroll. Of these 34 students, 17 were boys and 17 were girls, organized in 7 mixed gender groups, 5 only female groups and 5 only male groups.

After the enrollment of all the groups, the teacher drew the topics to decide which group would develop each topic. The topics were based on articles published in several editions of *‘Scientific American’* that had been previously selected by the teacher.

The first task of the students was to acquire, read and analyse their corresponding paper from *‘Scientific American’* that was going to introduce them to the selected theme. During the time given for the accomplishment of the first task, each group of students had to raise two genuine questions that had emerged from the reading of the article but whose answer could not be found there. It was expected that this particular task would guide students along the development of the project. Only 12 groups formulated the questions, which corresponded to 24 students out of the 34 that had initially enrolled. Of these 24, 12 students were boys and 12 were girls, organized in 6 mixed gender groups, 3 only female groups and 3 only male groups.

To accomplish the second task, each group had one compulsory meeting with the teacher to discuss the work being developed. Of all the 34 students initially enrolled, only 30 (15 groups) attended this meeting. Of the 30 students that attended the meeting, 15 students were boys and 15 were girls, organized in 7 mixed gender groups, 4 only female groups and 4 only male groups.

The agenda for this meeting included moments for students’ questions on their topic, time for the teacher to answer their previously posed questions and other moments for appropriate orientation and guidance provided by the teacher regarding the topic and the development of the posters. As before reaching HE students had never been asked to develop a scientific poster, many of them revealed the need for further assistance. If at any time during the semester the group felt that they would benefit from other meetings with the teacher, they could ask the teacher to schedule them.

Finally, by the end of the semester, all the students who had enrolled in the MRP were asked to attend the presentation session. During this session each ‘project team’ presented their project orally, complemented with a poster presentation to the teacher and to the other students who had developed MRP. The presentations took place over a period of four hours, with each presentation being subject to numerous questions from both peers and teacher. Of all the 34 students initially enrolled, only 18 (9 groups) delivered the poster and only 12 (6 groups) attended the presentation session. Of the 12 students that had attended the presentation session, 6 students were boys and 7

were girls. One of these girls couldn't present because of the absence of her male colleague. These groups of students were organized in 3 mixed gender groups, 1 only female group and 2 only male groups. As this public presentation was a pre-requisite for finishing the mini-project, at this stage 22 students (11 groups) were eliminated.

2.10 Challenging Experiments

Challenging lab experiments were demonstrated to 3 groups of 4 students each. One of the groups was exclusively composed of male students, another exclusively composed of female students, and still another composed of two male and two female students. After the experiment demonstration made by the lab technician, students had to discuss among their group what was their interpretation of what had just happened, and together formulate the questions they would need to answer in order to propose an explanation for the challenging situation. At the same time, students were asked to support their thoughts by justifying the formulated questions and the explanations proposals. The time frame for these experiments was adjusted according to the needs of the group. Some groups asked the lab technician to make a few changes in the procedure, asked her simply to repeat the procedure or decided to make a mock up of their thoughts on the white board and engaged in discussions about a specific aspect of the experiment.

2.11 Assessment Strategies

Regarding assessment, both courses were evaluated through a multiple-choice exam at the end of the semester and by their logbooks developed in practical laboratory classes. Students who had enrolled in MRP had the additional opportunity to enhance their grades by a maximum of 2 values out of 20.

3. Preliminary Findings

Few studies have attempted to compare student questioning in higher education depending on gender and such studies have never been conducted in Portugal before.

Not all the 1st year students of the same gender equally embraced the same questioning strategies. Still, although the global results are not yet available for discussion, some findings that have already emerged show that:

a) Only a small number of oral questions were formulated either by male or female students during lectures. Interviewed students of both genders believe that this small number of questions may be a consequence of most students not being comfortable in exposing themselves before the class.

b) Even a smaller number of students' questions were written in the pieces of paper provided to students in class and collected after the end of each class. Student admitted that they wanted to get answers as soon as possible. Interviewed students, either individually or in focus groups, felt that a short answer given orally in class enables them to understand what is taught immediately after. Writing them down and having to wait for a response would make students loose a lot during the class when the question occurred to them.

c) Males pose more questions in class than girls.

d) By the end of the semester students pose more questions online than during the beginning or middle of the semester, but those questions are mainly referring to the evaluation procedures rather than Chemistry content. Online participation not being considered for assessment was the main aspect referred by female students to justify the lack of question-posing online.

e) Both male and female students ask more questions in-class than through the online tool (Moodle) provided for the course, as they feel that the time for response in classes is smaller than when posing their questions through the Moodle and furthermore receiving an answer orally gives them the possibility to clarify any aspect, which isn't clear at first.

f) Students ask more questions in chemistry practical laboratory classes than in lectures. Disregarding gender, some of the interviewed students admitted that this was due to the smaller size of classes, which made them feel more comfortable to pose their questions, while others attributed this increase in the number of questions posed to the teacher in practical lab classes to the fact that students were conscious of the continuous assessment made on every class, so they needed to make the best possible records on their logbooks.

g) Despite that the number of female students and male students that have enrolled the MRP were equal, if we notice that boys in the course outnumber girls, we can conclude that a bigger percentage of the total number of girls decided to take on a mini-project.

4. Discussions and Conclusion

The main purpose of this study is to investigate and characterize female and male students' questioning profiles in HE in different situations, such as traditional classes and online interactions. With this in mind, we have implemented a number of strategies to increase the opportunities provided for student questioning.

Some findings that have already emerged show that students prefer not to pose questions, which can be understood if we consider students' perception of HE classes as impersonal and intimidating (DeBourgh, 2008). Students tend to feel they are passive recipients of the instructor's lecture rather than active participants in a student-instructor interaction (Mayer *et al.*, 2009).

Despite that the importance of student questioning was emphasized from the first class, facing such a different setting from what they were used to, these first year students interacted very little with the lecturer. This shortage of student-teacher interaction is, according to DeBourgh (2008), due to the students' reluctance to express an unpopular opinion and fear to be identified as uninformed or unprepared.

Another aspect that emerged from the data collected was that a very small number of students' questions were written in the pieces of paper provided in class. As noticed during interviews and focus groups, most students prefer to pose questions orally to the teacher because that means that they will get an answer immediately. Of all the students that were interviewed, the few who recognized the advantages of written questions alleged that this way it was easier to pose questions to the teacher because of the reduced exposure before the colleagues.

It was also noticed that males pose more questions in class than females. According to Jaasma (1997), male students generally participate more than female students, which could imply that boys

would ask more questions to teachers than girls. On the other hand, it could also be due to the fact that on this class male students outnumber female students in class. As described earlier in this paper, of the 175 students enrolled in the courses, 114 (65%) were boys and only 61 (35%) were girls.

Another evident aspect was that by the end of the semester students posed more questions online than during the beginning or middle of the semester, but those questions were mainly referring to the evaluation procedures rather than Chemistry content. It could be supposed that as the term was reaching an end, students were increasingly getting more worried with the course evaluation and that they were extremely interested in figuring out the best way to have good marks.

Regarding the higher number of questions students ask in chemistry practical laboratory classes in comparison to the questions asked during lectures, we consider that it happened because students had to prepare the lab experiment at home before the class, which meant that they would have time to think, compare, analyze and reflect on the work being developed. Moreover, during the interviews most students of both genders said that they felt more comfortable in posing questions in practical laboratory classes because classes were smaller and they really needed to ask everything they didn't know because they were evaluated in every class. Again, the preoccupation with evaluation was a reason for students' increased questioning.

Finally, students asked more questions in any kind of class than through the online tool (Moodle) provided during the course. In fact, during the interviews students indicated that they prefer traditional lectures or chemistry practical laboratory classes as a questioning learning environment, rather than one involving the content management system used during the course, the Moodle. It could be that the content management system available wasn't friendly enough to increase students questioning. Furthermore, as a content management system it is primarily purposed at the "storage" of content, rather than at the support of interactions. During the interviews and focus groups most students didn't recognize the advantages of question-posing through Moodle and alleged that it would take more time for them to have an answer or an explanation than in class.

5. Recommendation

On the basis of these preliminary findings and taking into account that boys posed more questions than girls and that the number of male students largely exceeded the number of female students, the study would benefit from the application of the same strategies in other courses where females students outnumbered males. It would also be interesting to conduct the same research in other institutions to determine whether these findings can be generalized across HE.

Besides, we argue that online courses need to be user-friendly so that no learners are disadvantaged and that other motivational strategies need to be built into the course. In future research it would be worth investigating other embedding questioning strategies in other online environments. Moreover, a more profound insight into the variables affecting the usage of online environments by students could help to determine whether they influence student questioning, and if so, to what extent.

Acknowledgements

We acknowledge the financial support of the Portuguese Foundation of Science and Technology (FCT; SFRH/BD/74511/2010) and of the Research Centre for Didactics and Technology in Teacher Education (CIDTFF), University of Aveiro, Portugal.

References

- Almeida, P. (2007). *As questões dos alunos e os estilos de aprendizagem – um estudo com um público de Ciências no ensino universitário* [Students' questions and learning styles: A study with a public of science in higher education] (Unpublished PhD thesis). Aveiro: University of Aveiro.
- 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: Bureau for Educational Services.
- Albergaria-Almeida, P., Teixeira-Dias, J.J., Martinho, M., & Balasooriya, C. (2010). Kolb's learning styles and approaches to learning: The case of chemistry undergraduates with better grades. *International Journal of Knowledge Society Research*, 1(3), 1-16.
- Albergaria-Almeida, P., Teixeira-Dias, J.J., Martinho, M. & Balasooriya, C. (2011). The interplay between students' perceptions of context and approaches to learning. *Research Papers in Education*, 26(2), 149-169.
- 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.
- Blum, K. (1999). Gender differences in asynchronous learning in higher education: Learning styles, participation barriers and communication patters. *Journal of Asynchronous Learning Networks*, 3(1), 44-66.
- 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)
- Chin, C., & Osborne, J. (2008). Students questions: A potential resource for teaching and learning science. *Studies in Science Education*, 44(1), 1-39.
- Davies, J., & Graff, M.O. (2005). Performance in e-learning: Online participation and student grades. *British Journal of Educational Technology*, 36(4), 657-663.
- DeBourgh, G.A. (2008). Use of classroom "clickers" to promote acquisition of advanced reasoning skills. *Nurse Education in Practice*, 8(2), 76-87.
- 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.
- Jaasma, M.A. (1997). Classroom communication apprehension: Does being male or female make a difference?. *Communication Reports*, 10(2), 219-228.
- Johnston, B. (2010). *The first year at university: Teaching students in transition*. Maidenhead: Open University Press.
- Jones, M.G., Howe, A., & Rua, M. (2000). Gender differences in students' experiences, interests, and attitudes toward science and scientists. *Science Education*, 84, 180-192.
- Martinho, M., Albergaria Almeida, P., & Teixeira-Dias, J. (2012a). A gender perspective on student questioning upon the transition to higher education. In N. Popov, C. Wolhuter, B. Leutwyler, G. Hilton, J. Ogunleye & P. Albergaria Almeida (Eds.), *International perspectives on education* (pp. 418-424). Sofia: Bulgarian Comparative Education Society.
- Martinho, M., Albergaria Almeida, P., & Teixeira-Dias, J. (2012b). Students' questions in Higher Education chemistry classes according to their gender. *Procedia – Social and Behavioral Sciences*, 47, 835-840.

- Mayer, R.E., Stull, A., DeLeeuw, K., Almeroth, K., Bimber, B., Chun, D., ... Zhang, H. (2009). Clickers in college classrooms: Fostering learning with questioning methods in large lecture classes. *Contemporary Educational Psychology*, 34(1), 51-57.
- Moreira, A. (2006). *As questões dos alunos na avaliação em Química*. [Students' questions in chemistry assessment] (Unpublished Master dissertation). Aveiro: University of Aveiro.
- Pearson, J., West, R., & Turner, L. (1995). *Gender and communication* (3rd ed.). Dubuque: Brown & Benchmark Publishers.
- 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, H., Teixeira-Dias, J.J.C., & Watts, M. (2003). Questions of chemistry. *International Journal of Science Education*, 25(8), 1015-1034.
- Sivapalan, S., & Cregan, P. (2005). Value of online resources for learning by distance education. *CAL-laborate*, 14, 23-27.
- Souza, F.N. (2006). *Perguntas na aprendizagem de química no ensino superior*. [Questions in Chemistry learning in higher education] (Unpublished PhD thesis). Aveiro: University of Aveiro.
- Tait, H., Entwistle, N.J., & McCune, V. (1998). ASSIST: A Re-conceptualization of the Approaches to Studying Inventory. In C. Rust (Ed.), *Improving students as learners*. Oxford: Oxford Brookes University.
- Tannen, D. (1990). *You just don't understand: Women and men in conversation*. New York: Ballantine.
- Teixeira-Dias, J.J.C., Pedrosa de Jesus, H., Neri de Souza, F., & Watts, D.M. (2005). Teaching for quality learning in chemistry. *International Journal of Science Education*, 27(9), 1123-1137.
- Teixeira-Dias, J., Pedrosa de Jesus, H., Souza, F., Almeida, P., & Moreira, A. (2009). Questões de estudantes universitários no primeiro ano: Como promover a aprendizagem activa em Química. [First year university students' questions: How to promote an active learning of chemistry] In I. Huet, N. Costa, J. Tavares, & A. Baptista (Eds.), *Docência no ensino superior – partilha de boas práticas* (pp. 61-78). Aveiro: Universidade de Aveiro.
- The World Bank (2011). *World development report 2012 – gender equality and development*.
- Valadas, S., Gonçalves, F., & Fáisca, 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.
- Vianna, C., & Ridenti, S. (1998). Relações de género e escola: Das diferenças ao preconceito. J. G. Aquino (Ed.), *Diferenças e preconceitos na escola: alternativas teóricas e práticas* (pp. 93-106). São Paulo: Summus.
- Wilson, E.V. (2004). ExamNet asynchronous learning network: Augmenting face-to-face courses with student-developed exam questions. *Computers & Education*, 42(1), 87-107.
- Wood, J.T. (2009). *Gendered lives: Communication, gender, and culture* (8th ed.). Belmont: Wadsworth.
- Yu, F. (2011). Multiple peer-assessment modes to augment online student question-generation processes. *Computers & Education*, 56(2), 484-494.
- 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.
- 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.