**Students’ Questions in Higher Education Chemistry Classes According to Their Gender**

Mariana Matias Martinho1

1 Research Centre for Didactics and Technology in Teacher Education (CIDTFF)

Department of Education, University of Aveiro, Portugal

marianamartinho@ua.pt

1. **Abstract**

This paper presents an ongoing Multimedia in Education PhD research (2011-2014) focused on the relevance of students’ questioning habits in the teaching, learning and assessment processes.

Focusing on undergraduate Chemistry students, in particular the first year students, at the University of Aveiro, in Portugal, it is our intention to investigate and characterize feminine and masculine students’ questioning profiles, in different situations, such as traditional classes and online interactions.

Throughout this project a set of teaching, learning and assessment strategies will be conceived and implemented, in order to foster students questioning and to create a welcoming setting for the raise of questions by students of both genders. It is, thus, our intention to contribute to greater gender equity in the learning, teaching and assessment processes.

1. **Framework**

Research on science education sustains the need for new emphasis on teaching and learning, particularly in higher education. Among the essential skills that every higher education student should achieve, we focus on what is described as 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 *et al* (2005) support that a teaching practice oriented to the development of this skill favors a learner-centered teaching and learning and promotes higher cognitive level capacities, such as those of critical analysis and problem resolution.

Regarding gender studies, 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 math and sciences.

1. **Objectives**

The aim of this study is to contribute to a better understanding of students questioning in higher education focusing on the gender gap. It is our intention to concieve and implement strategies, which will make higher education Chemistry classes more gender balanced.

This study arises over a sequence of other questioning centered projects, mainly focusing on 1st year university students, developed on the Research Centre for Didactics and Technology in Teacher Education (CIDTFF), Department of Education, University of Aveiro (Almeida, 2007; Moreira, 2006; Neri de Souza, 2006; Pedrosa de Jesus *et al*, 2003; Teixeira-Dias *et al*, 2005).

The specific objectives of this study are as follows:

(i) To investigate and characterize feminine and masculine students’ questioning profiles in higher education, both in traditional classes and in online environments;

(ii) To investigate and characterize feminine and masculine students’ learning approaches in higher education, both in traditional classes and in online environments;

(iii) To investigate feminine and masculine students’ understanding of the role of questioning in the learning, teaching and assessment processes.

(iv) To investigate and characterize the relations between feminine and masculine students’ questioning profiles and the role of questioning in the learning, teaching and assessment processes.

(v) To analyze the relation between feminine and masculine students’ questioning profiles and the classification obtained in Chemistry.

(vi) To conceive and implement strategies to promote students questioning in the different environments provided by the subject (classes and online interactions), according to the specificity of each gender.

(vii) To analyze the implications of the implemented questioning fostering strategies on the learning approaches of students of both genders.

1. **Research Questions**

The following research questions emerged upon a profound and critical literature review and relate to the previously defined objectives.

The main research questions are:

1. What are the differences between feminine and masculine students’ questioning profiles in first year university Chemistry classes?
2. Which strategies and teaching practices can promote students questioning, attending to their gender, in order to optimize Chemistry learning in university teaching?

The previous bear four secondary research questions:

1. How are the feminine and the masculine understandings of the role of questioning in the teaching, learning and assessment processes affecting their questioning profiles?
2. What influence do different learning environments (such as traditional classes and online interactions) have on feminine and masculine students’ questioning profiles?
3. How does the implementation of strategies to foster students’ questioning reflects on the learning approaches of feminine and masculine students?
4. To what extent are the students (feminine and masculine) classification results influenced by their questioning profiles?

**4. Framework**

**4.1. Questionning**

Research in science education highlights the need for new emphasis on teaching and learning, in particular in higher education. Several authors (Pedrosa de Jesus *et al*, 2003; Biggs & Tang, 2007; Cuccio-Schirripa & Steiner, 2000) highlight the key-skills and competencies every student should develop. Among these competencies, Teixeira-Dias *et al* (2009) underline the capacity for lifelong learning, which comprises the questioning skill.

The ability to raise questions that involve higher order thinking enhances an active learning (Chin & Osborne, 2008; Scholl, 2010). A teaching practice oriented for the development of que questioning skill favours a student-centered learning, enhancing other higher cognitive level capacities, such as those of critical thinking and problem solving (Teixeira-Dias *et al*, 2009; Hofstein *et al*, 2005). Students questioning competency is claimed by numerous researchers (Almeida *et al*, 2010; Pedrosa de Jesus *et al*, 2003; Zoller, 1987) as the most significant indicator of students most critical and highest order thinking.

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.

Several studies (Pedrosa de Jesus *et al*, 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 Comission’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.

**4.2. Online questioning**

In light of the numerous advantageous features of network technology (independence of time, place, device and platform, vast storage capacity, high processing speed, multimedia facilities, instant data retrieval and management, customizable design, ease of updating and upgrading, anonymity), there has been a growing number of projects focused on the design and development of web-based student question-generation learning systems (Yu, 2011: 485), many of which in higher education.

Results provided by Barak and Rafaeli sustain that web-based activities, which require students to generate questions, can serve as both learning and assessment enhancers in higher education by promoting active learning, constructive criticism and knowledge sharing (Barak & Rafaeli, 2004: 84).

On his turn, Wilson highlights that when students were asked to write exam questions and evaluate other student’s responses they improved their ability to communicate, critical thinking skills, ability to integrate facts, and motivation to do additional readings (Wilson, 2004: 89).

Similarly, Yu *et al* (2005) remarked the importance of fostering students questioning through multimedia tools available online and noticed that by enabling students to compose questions, and criticize and adapt other students questions, they perceived their learning as more motivating and cognitively-enhanced.

**4.3. Questioning according to gender**

Few studies have focused on gender differences on students questioning and even fewer have concentrated on higher education. Despite the recognition of the existence of gender differences in verbal communication for a long time (Wood, 2009; Tannen, 1990), the few existing studies are not consensual. On one hand Pearson *et al* (1995) stated that it is not clear which gender raises more questions. On the other hand, Jones *et al* (2000) observed that boys are less frightened than girls to pose questions.

In an attempt to identify the existing barriers to an equitative participation of both genders, either in class or online, Blum (1999) undertook an investigation to compare the questioning patters of boys and girls, both in class and online. With this study Blum concluded that girls ask more questions than boys in class, while boys ask more and answer more questions than girls in online environments.

Despite the fact that educational institutions have the capacity to produce or reinforce gender bias and stereotypes, they can also resist to those bias and raise other values and attitudes, such as that related to students understanding of the meaning of feminine and masculine (Vianna e Ridenti, 1998: 103).

According to Johnson (2010), universities should pay a special attention to the first year experience, which justifies our decision to focus on this first year. The same author recommends that 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.

Regarding gender differences in communication patters and considering the great importance of students questions in the process 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 immerse (such as classes or online environments). It is expected that this investigation will contribute to the enhancement of the learning, teaching and assessment processes, through the development and implementation of strategies, which will foster both questioning and gender equity.

**5.Methodology**

On this study, methodology is understood as “a study of methods, a study in which we lay bare our choices of method and define the way these choices fit our research problem” (Dobbert, 1990: 286). Accordingly, this section comprises three parts. On the first part, the nature of this investigation is classified. On the second part, the techniques and methods to be apllied are described and systematized. The third part consists of a description of the activities to be developed, which were organized in three stages.

**5.1. Nature of the investigation**

This study follows a naturalist-ethnographic approach. Naturalism assumes that there is an objective social reality ‘out there’, ready to be naturally observed and reported by the researcher as it ‘really is’ (Babbie, 2008: 321). Additionally, the researcher interacts naturally, and above all discretely, with those that are being observed until he/she understands a certain situation. By mingling with those who are being observed the researcher minimizes the effects that he/she might provoke on them (Carmo & Ferreira, 1998: 180).

An ethnographic study involves an extensive collection of data, through a long period of time – this will take one year – during which the researcher may not interfeer in the situation that is being studied. Despite that in an ethnographic study observation is priviledged, through the investigation the researcher usually complements the data collection with other techniques, such as interviews, questionnaires, document analysis, among others (Carmo & Ferreira, 1998: 220).

On this particular investigation, the unit of analysis will be a university class. The researcher will try to immerse on the organization of the class and try to understand the student’s behaviours, not on his/her own point of view, but on the perspective of the students that are being observed.

Concerning the methodology to be followed, this study will encompass both qualitative and quantitative methods, thus it consists in a mixed methods research. Besides observations, semi-structured interviews and focus goups, it is also predicted the application of questionnaires, a technique commonly associated to quantitative studies. On one hand, the focus groups, the records of the online interactions, the researchers diary and the interviews made to students and to teachers will be qualitatively analysed. On the other hand, the observation grids, the questionnaires and the classification grids will be statistically analysed.

**5.2. Methods and Techniques**

Having into account the aim, the objectives and the research questions, several techniques will be applied, such as inquiries, observations and document analysis. The corresponding intruments to be developed and fulfilled will be semi-structured interview scripts, focus groups scripts, observation grids for classes, observation grids for online interactions, audio and video records and the researchers’ diary.

It is also forecast the application of one questionaire already developed and translated and validated to the Portuguese context (Approaches and Study Skills Inventory for Students - ASSIST; Valadas *et al*, 2010) to identify the students learning approaches.

Table 1 was outlined in order to systematize the techniques and instruments to be used in this investigation, as well as the corresponding purposes.

**TABLE 1:** Systematization of Techniques and Instruments

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Main Research Questions** | **Secondary Research Questions** | **Objectives (\*)** | **Techniques** | **Instruments/**  **Data sources** | **Participants** | **Purpose** |
| What are the differences between feminine and masculine students’ questioning profiles in first year university Chemistry classes? | How are the feminine and masculine understandings of the role of questioning in the teaching, learning and assessment processes affecting their questioning profiles? | (i), (iii), (iv), (v) | Non-participant Classes Observation | Observation Grids, Audio transcripts | Students | Characterize feminine and masculine students’ questioning habits (number, cognitive level and function of questions) in traditional classes. |
| Researcher’s diary | Researcher | Keep a record of data, which clarifies the way the study was conducted.  Register unforeseen situations and reflections. |
| Document analysis | Records of online interactions | Students | Collect information concerning questioning gender differences in online learning environments. |
| Inquiry | *Focus* group script, audio transcripts | Students | Characterize feminine and masculine students’ questioning profiles, in a more intimate environment, constituted by a limited number of people.  Identify feminine and masculine students’ understandings of the role of questioning in the learning, teaching and assessment processes. |
| Semi-strutured interview script, audio transcripts | Students | Characterize feminine and masculine students’ questioning profiles.  Identify feminine and masculine students’ concepts of the role of questioning in the learning, teaching and assessment processes.  Investigate feminine and masculine students’ opinion concerning the implemented strategies.  Investigate the reasons behind feminine and masculine students’ asking (or not) questions. |
| Records of debates and shared reflections, audio transcripts | Teachers | Discuss/analyze students’ questioning observed both in classes and online.  Interpretate the consequences of the promoted activities on the learning processes, considering gender equity.  Strengthen and deepen the trust relation and the collaboration spirit with the researcher. |
| What influence do different learning environments (such as traditional classes and online interactions) have on feminine and masculine students’ questioning profiles? | (i), (v) | Non-participant Classes Observation | Observation grids, audio transcripts | Students | Characterize feminine and masculine students’ questioning habits (number, cognitive level and function of questions) in traditional classes. |
| Researcher’s diary | Researcher | Keep a record of data, which clarifies the way the study was conducted.  Register unforeseen situations and reflections. |
| Document analysis | Records of online interactions | Students | To collect information concerning questioning gender differences in online learning environments. |
| Which strategies and teaching practices can promote students questioning, attending to their gender, in order to optimize Chemistry learning in university teaching? | How does the implementation of strategies to foster students’ questioning reflects on the learning approaches of feminine and masculine students? | (ii), (iv), (vi), (vii) | Inquiry | ASSIST Questionnaire | Students | Identify feminine and masculine students’ learning approaches. |
| Semi-strutured interview script, audio transcripts | Teachers | Investigate the teachers’ opinion about the efficacy of the implemented strategies on the promotion of students questioning. |
| Records of debates and shared reflections, audio transcripts | Teachers | Discuss/analyze students’ questioning observed both in classes and online.  Interpretate the consequences of the promoted activities on the learning processes, considering gender equity.  Strengthen and deepen the trust relation and the collaboration spirit with the researcher. |
| Document analysis | Records of online interactions | Students | To collect information concerning questioning gender differences in online learning environments. |
| To what extent are the students (feminine and masculine) classification results influenced by their questioning profiles? | (v), (vii) | Non-participant Classes Observation | Observation grids, audio transcripts | Students | Characterize feminine and masculine students’ questioning habits (number, cognitive level and function of questions) in traditional classes. |
| Document analysis | Records of online interactions | Students | To collect information concerning questioning gender differences in online learning environments. |
| Document analysis | Classification grids |  | Analyze the selected Chemistry curricular units classifications obtained by students of both genders. |

**(\*) Objectives**

(i) To investigate and characterize feminine and masculine students’ questioning profiles in higher education, both in traditional classes and in online environments.

(ii) To investigate and characterize feminine and masculine students’ learning approaches in higher education, both in traditional classes and in online environments.

(iii) To investigate feminine and masculine students’ concepts of the role of questioning in the learning, teaching and assessment processes.

(iv) To investigate and characterize the relations between feminine and masculine students’ questioning profiles and the role of questioning in the learning, teaching and assessment processes.

(v) To analyze the relation between feminine and masculine students’ questioning profiles and the classification obtained in Chemistry.

(vi) To conceive and implement strategies to promote students questioning in the different environments provided by the subject (classes and online interactions), according to the specificity of each gender.

(vii) To analyze the implications of the implemented questioning fostering strategies on the learning approaches of students of both genders.

**5.3. Detailed description of the study’s activities**

The present investigation will be developed throughout three stages, as represented in the chronogram presented further on.

**1st stage** (March – September 2011):

The first stage of this investigation consists in a critical literature review to understand what has already been studied regarding female and male students questioning. At the same time, data collection instruments will de prepared. Besides observation grids, interview scripts and focus groups scripts, will also be conceived learning, teaching and assessment strategies to be applied in the academic year 2011/12.

Under the premise that student question generation activities in big classes are better supported in a timely, flexible and logistically feasible manner, if they are mediated by online technologies (Yu, 2009), besides conceiving strategies to be applied in class, we will also conceive strategies mediated by online technologies (for instance, through a forum). It is, accordingly, our intention to understand the questioning differences between the two genders in diverse learning environments.

**2nd stage** (September 2011 – January 2013):

During the academic year 2011/12, the instruments previously conceived will be applied in first year university Chemistry classes. During the first semester a pilot-study will be conducted, followed by the main study to be carried through the second semester.

Students who attend these Chemistry classes are undergraduates of science and technologies degrees, such as Chemistry, Chemical Engineering, Physics, Physical Engineering, Materials Engineering, Environmental Engineering, Metheorology and Oceanography, Biology, Biochemistry, Biotechnology or Geology, among many others.

The pilot study, to be carried out during the first semester, will serve as a testing study of the previously conceived techniques, instruments and learning, teaching and assessment strategies. The necessary changes and improvements will be made before the main study.

During the pilot study data will be collected through a non-participant observation, associated to audio taped classes (and following transcription), the application of questionnaires, the records of online interactions and through the conduction of focus groups.

This last method was followed particularly because it stimulates interaction, discussion, self and metacognition among participants. A major advantage of this qualitative methodology is that due to the “dynamic nature of the process” (Greenbaum, 2000:13) it “encourages the participants to think conceptually about the topic that is being discussed and to visualize ideas that are not well developed” (Greenbaum, 2000:35). Moreover, through the focus groups we will investigate and characterize feminine and masculine students’ questioning profiles, in a more intimate environment, constituted by a limited number of people and identify feminine and masculine students’ understanding of the role of questioning in the learning, teaching and assessment processes.

Classes will be audio taped and later transcribed in order to characterize feminine and masculine students’ questioning habits (number, cognitive level and function of questions) in traditional classes. On its turn, records of online interactions will be analysed in order to characterize both genders’ questioning habits in online environments.

Through the application of the ASSIST questionnaire (Valadas *et al*, 2010) we expect to identify feminine and masculine students’ learning approaches.

Still during the first semester’s we will have sessions of debates and shared reflections with the class’s Chemistry teacher, which will be audio taped and later transcribed. The purpose of these sessions will be to discuss/analyse the questioning observed in class and online and to interpret the consequences of the promoted activities on the learning processes, considering gender equity. Furthermore, we expect not only to strengthen and expand the trust relation established with the Chemistry teacher, but also to encourage the collaboration spirit with the researcher.

Following data treatment and analysis, and having in mind the teachers’ perspective, the necessary improvements will be made before the main study to be carried through the second semester of 2011/12.

During the main study besides class observation, focus groups conduction, analysis of online interactions, application of questionnaires and implementation of learning, teaching and assessment strategies, interviews will be made to students and teachers.

Furthermore, during this second semester we will proceed with the sessions of debates and shared reflections with the class’s Chemistry teacher, which were also done during the pilot study.

At the end of the second stage we will proceed with the treatment and analysis of the data collected during the main study.

**3rd stage** (January 2013 – December 2014):

This period will be dedicated to an integrated analysis of the results retrieved during the pilot and the main studies, and to the writing and presentation of the PhD thesis.

Throughout the three stages of the project, a deeper critical scientific backup will be made through the further readings and review of specific literature.

**6. Chronogram**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Academic Year | **10/11** | | **11/12** | | | | **12/13** | | | **13/14** | | **14/15** |
| Months  Activity | 3-6 | 7-8 | 9-11 | 12-2 | 3-5 | 6-8 | 9-11 | 12-2 | 1-6 | 7-12 | 1-6 | 7-12 |
| Critical literature review | **✓** | **✓** | **✓** | **✓** | **✓** |  |  |  |  |  |  |  |
| Literature review update |  |  |  |  |  | **✓** | **✓** | **✓** | **✓** | **✓** | **✓** | **✓** |
| **Pilot-Study:** preparation |  | **✓** | **✓** |  |  |  |  |  |  |  |  |  |
| **Pilot-Study:** data collection |  |  | **✓** | **✓** |  |  |  |  |  |  |  |  |
| **Pilot-Study:** data treatment and analysis |  |  | **✓** | **✓** |  |  |  |  |  |  |  |  |
| **Main-Study:** preparation |  |  |  |  | **✓** | **✓** |  |  |  |  |  |  |
| **Main-Study:** data collection |  |  |  |  | **✓** | **✓** |  |  |  |  |  |  |
| **Main-Study:** data treatment and analysis |  |  |  |  |  | **✓** | **✓** | **✓** |  |  |  |  |
| Integrated analysis of pilot and main studies results |  |  |  |  |  |  |  |  | **✓** | **✓** | **✓** |  |
| Writing and presenting PhD thesis |  |  |  |  |  |  |  |  |  |  | **✓** | **✓** |
| Articles/communications |  |  |  | **✓** |  |  |  | **✓** | **✓** | **✓** | **✓** | **✓** |

The previous description of the study’s activities can be systematized in a chronogram as follows.

**7. References:**

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.

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. (ISBN: 978-954-9842-15-9).

Almeida, P. (2007). As questões dos alunos e os estilos de aprendizagem – um estudo com um público de Ciências no ensino universitário. Tese de doutoramento não publicada. Aveiro, Universidade de Aveiro.

Babbie, E. (2008). *The Basics of Social Research*. 4th Edition. Belmont: Thomson & Wadsworth Publishing.

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.

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. JALN, 3(1).

Boyer Commission on Education Undergraduates in the Research University (1998). Reinventing undergraduate education: a blueprint for America’s Research Universities. url: <http://naples.cc.sunysb.edu/pres/boyer.nsf/673918d46fbf653e852565ec0056ff3e/d955b61ffddd590a852565ec005717ae/$FILE/boyer.pdf> (acedido em 9 de Maio de 2011).

Carmo, H. & Ferreira, M. (1998). *Metodologia da investigação – Guia para Auto-aprendizagem*. Lisboa: Universidade Aberta.

Chin, C. & Osborne, J. (2008). Students questions: a potential resource for teaching and learning science. Studies in Science Education, 44(1), 1-39.

Cuccio-Schirripa, S. & Steiner, H. (2000). Enhancement and analysis of science question level for middle students. Journal of Research in Science Teaching, 37(2), 210-224.

Dobbert, M. L. (1990). Discussion on methodology. In Guba (Ed.), The paradigm dialog(pp. 286-290). London: Sage Publications.

Greenbaum, T. L. (2000). *Moderating Focus Group: A practical guide for group facilitation*. Thousand Oaks: Sage publications.

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.

Instituto Nacional de Estatística – http://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine\_indicadores&indOcorrCod=0002738&contexto=bd&selTab=tab2 (acedido em 28 de Agosto de 2010).

Johnston, B. (2010). The First Year at University: Teaching Students in Transition, The Society of Research into Higher Education and Open University Press, Maidenhead, UK.

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.

Moreira, A. (2006). *As questões dos alunos na avaliação em Química*. Dissertação de Mestrado não publicada. Aveiro: Universidade de Aveiro.

Martinho, M. (2007). Impacto dos centros interactivos de ciência, segundo o género do visitante. Dissertação de Mestrado não publicada. Aveiro: Universidade de Aveiro.

Neri de Souza, F. (2006). Perguntas na aprendizagem de química no ensino superior. Tese de doutoramento não publicada. Aveiro, Universidade de Aveiro.

Pearson, J., West, R., & Turner, L. (1995). *Gender and Communication* (3rd ed.). Dubuque, Brown & Benchmark Publishers.

Pedrosa de Jesus, H., Teixeira-Dias, J.J.C & Watts, M. (2003). Questions of Chemistry. *International Journal of Science Education, 25*(8), 1015-1034.

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.

Scholl, R. (2010). The Question Quadrant: A stimulus for a negotiated curriculum. [Primary & Middle Years Educator](javascript:__doLinkPostBack('','mdb%7E%7Ea9h%7C%7Cjdb%7E%7Ea9hjnh%7C%7Css%7E%7EJN%20%22Primary%20%26%20Middle%20Years%20Educator%22%7C%7Csl%7E%7Ejh','');), 8(2), p 3-16.

Tait, H., Entwistle, N. & McCune, V. (1998). ASSIST: A reconceptualisation of the approaches to studying inventory. In *Improving student learning: improving students as learners,* ed*.* C. Rust (pp. 262-271). 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. In Huet, I.; Costa, N.; Tavares, J. & Baptista, A. (Eds.), *Docência no ensino superior – partilha de boas práticas* (pp. 61-78). Universidade de Aveiro. (ISBN: 978-972-789-301-0).

Valadas, S., Gonçalves, F. & Faísca, 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. In Summus Editorial Ltda.

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; Liu, Y. & Chan, T. (2005). A web-based learning system for question- posing and peer assessment. Innovations in Education and Teaching International, 42(4), pp. 337–348.

Yu, F. (2009). Scaffolding student-generated questions: Design and development of a customizable online learning system. *Computers in Human Behavior, 25*, 1129-1138.

Yu, F. (2011). [Multiple Peer-Assessment Modes to Augment Online Student Question-Generation Processes](http://web.ebscohost.com/ehost/viewarticle?data=dGJyMPPp44rp2%2fdV0%2bnjisfk5Ie46bFJsa6uULekwn3k1%2fOE8qTreefkvk6tra1KrqevOLCwsk24qrU4zsOkjPDX7Ivf2fKB7eTnfLujsEuup7FQtaiyPurX7H%2b72%2bw%2b4ti7ffDf4T7y1%2bVVv8Skeeyzw2K3prJLs66kfu3o63nys%2bSN6uLyffbq&hid=19). Computers & Education, 56 (2), 484-494.

Zoller, U. (1987). The fostering of question - asking capability: A meaningful aspect of problem-solving in chemistry. Journal of Chemical Education, 64, 510-512.

**APPENDIX 1 - TABLE 1:** Systematization of Techniques and Instruments

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Main Research Questions** | **Secondary Research Questions** | **Objectives (\*)** | **Techniques** | **Instruments/**  **Data sources** | **Participants** | **Purpose** |
| What are the differences between feminine and masculine students’ questioning profiles in first year university Chemistry classes? | How are the feminine and masculine understandings of the role of questioning in the teaching, learning and assessment processes affecting their questioning profiles? | (i), (iii), (iv), (v) | Non-participant Classes Observation | Observation Grids, Audio transcripts | Students | Characterize feminine and masculine students’ questioning habits (number, cognitive level and function of questions) in traditional classes. |
| Researcher’s diary | Researcher | Keep a record of data, which clarifies the way the study was conducted.  Register unforeseen situations and reflections. |
| Document analysis | Records of online interactions | Students | Collect information concerning questioning gender differences in online learning environments. |
| Inquiry | *Focus* group script, audio transcripts | Students | Characterize feminine and masculine students’ questioning profiles, in a more intimate environment, constituted by a limited number of people.  Identify feminine and masculine students’ understandings of the role of questioning in the learning, teaching and assessment processes. |
| Semi-strutured interview script, audio transcripts | Students | Characterize feminine and masculine students’ questioning profiles.  Identify feminine and masculine students’ concepts of the role of questioning in the learning, teaching and assessment processes.  Investigate feminine and masculine students’ opinion concerning the implemented strategies.  Investigate the reasons behind feminine and masculine students’ asking (or not) questions. |
| Records of debates and shared reflections, audio transcripts | Teachers | Discuss/analyze students’ questioning observed both in classes and online.  Interpretate the consequences of the promoted activities on the learning processes, considering gender equity.  Strengthen and deepen the trust relation and the collaboration spirit with the researcher. |
| What influence do different learning environments (such as traditional classes and online interactions) have on feminine and masculine students’ questioning profiles? | (i), (v) | Non-participant Classes Observation | Observation grids, audio transcripts | Students | Characterize feminine and masculine students’ questioning habits (number, cognitive level and function of questions) in traditional classes. |
| Researcher’s diary | Researcher | Keep a record of data, which clarifies the way the study was conducted.  Register unforeseen situations and reflections. |
| Document analysis | Records of online interactions | Students | To collect information concerning questioning gender differences in online learning environments. |
| Which strategies and teaching practices can promote students questioning, attending to their gender, in order to optimize Chemistry learning in university teaching? | How does the implementation of strategies to foster students’ questioning reflects on the learning approaches of feminine and masculine students? | (ii), (iv), (vi), (vii) | Inquiry | ASSIST Questionnaire | Students | Identify feminine and masculine students’ learning approaches. |
| Semi-strutured interview script, audio transcripts | Teachers | Investigate the teachers’ opinion about the efficacy of the implemented strategies on the promotion of students questioning. |
| Records of debates and shared reflections, audio transcripts | Teachers | Discuss/analyze students’ questioning observed both in classes and online.  Interpretate the consequences of the promoted activities on the learning processes, considering gender equity.  Strengthen and deepen the trust relation and the collaboration spirit with the researcher. |
| Document analysis | Records of online interactions | Students | To collect information concerning questioning gender differences in online learning environments. |
| To what extent are the students (feminine and masculine) classification results influenced by their questioning profiles? | (v), (vii) | Non-participant Classes Observation | Observation grids, audio transcripts | Students | Characterize feminine and masculine students’ questioning habits (number, cognitive level and function of questions) in traditional classes. |
| Document analysis | Records of online interactions | Students | To collect information concerning questioning gender differences in online learning environments. |
| Document analysis | Classification grids |  | Analyze the selected Chemistry curricular units classifications obtained by students of both genders. |

**(\*) Objectives**

(i) To investigate and characterize feminine and masculine students’ questioning profiles in higher education, both in traditional classes and in online environments.

(ii) To investigate and characterize feminine and masculine students’ learning approaches in higher education, both in traditional classes and in online environments.

(iii) To investigate feminine and masculine students’ concepts of the role of questioning in the learning, teaching and assessment processes.

(iv) To investigate and characterize the relations between feminine and masculine students’ questioning profiles and the role of questioning in the learning, teaching and assessment processes.

(v) To analyze the relation between feminine and masculine students’ questioning profiles and the classification obtained in Chemistry.

(vi) To conceive and implement strategies to promote students questioning in the different environments provided by the subject (classes and online interactions), according to the specificity of each gender.

(vii) To analyze the implications of the implemented questioning fostering strategies on the learning approaches of students of both genders.

**APPENDIX 2 - Chronogram**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Academic Year | **10/11** | | **11/12** | | | | **12/13** | | | **13/14** | | **14/15** |
| Months  Activity | 3-6 | 7-8 | 9-11 | 12-2 | 3-5 | 6-8 | 9-11 | 12-2 | 1-6 | 7-12 | 1-6 | 7-12 |
| Critical literature review | **✓** | **✓** | **✓** | **✓** | **✓** |  |  |  |  |  |  |  |
| Literature review update |  |  |  |  |  | **✓** | **✓** | **✓** | **✓** | **✓** | **✓** | **✓** |
| **Pilot-Study:** preparation |  | **✓** | **✓** |  |  |  |  |  |  |  |  |  |
| **Pilot-Study:** data collection |  |  | **✓** | **✓** |  |  |  |  |  |  |  |  |
| **Pilot-Study:** data treatment and analysis |  |  | **✓** | **✓** |  |  |  |  |  |  |  |  |
| **Main-Study:** preparation |  |  |  |  | **✓** | **✓** |  |  |  |  |  |  |
| **Main-Study:** data collection |  |  |  |  | **✓** | **✓** |  |  |  |  |  |  |
| **Main-Study:** data treatment and analysis |  |  |  |  |  | **✓** | **✓** | **✓** |  |  |  |  |
| Integrated analysis of pilot and main studies results |  |  |  |  |  |  |  |  | **✓** | **✓** | **✓** |  |
| Writing and presenting PhD thesis |  |  |  |  |  |  |  |  |  |  | **✓** | **✓** |
| Articles/communications |  |  |  | **✓** |  |  |  | **✓** | **✓** | **✓** | **✓** | **✓** |