

“Integrating innovative techniques in library science and guided inquiry based Science learning through undergraduate student self-directed primary research: A new approach.”

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Resumen. *We have introduced an inquiry based, student centered mode of instruction in a general Science introductory course of first year Odontology. We present here the definitive results and conclusions from a two years research experience about the integration of new techniques to teach different science subjects. Students have acquired course’s competencies by designing and carrying out their own primary research in a dentistry topic of their choice conducting a cross sectional statistical study. 80% of students report that having English as the medium of instruction is positive; 75 % of students describe to have grown academically by doing independent research and 85 % emphasize that being able to choose their own topic has been an important aspect of their research; 80% of students report to have grown academically after this course. Our results can be applied in other courses, particularly in those that include a student planned project such as master degree final projects, and particularly next year in different courses of Medicine and Odontology.*

Palabras clave: Inquiry based learning; student centered instruction; primary research

INTRODUCTION (CONTEXTUALIZATION/ RATIONALE)

The USA National Science Educational Standards focus on the development of scientific literacy in students and promote Inquiry as the “central strategy for teaching science” (National Research Council, 1996). Inquiry forms part of a quality Science experience. “Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work” (Singer, 2006). Effective Science-Inquiry programs have the potential to prepare both teacher and student in a way of learning that promotes scientific literacy and critical thinking habits of mind. (National Science Teachers Association (NSTA), 2007).

The main three competencies or performance skills to be developed in any undergraduate science introductory course can be summarized as follows:

1. Skills related to documentation and library science. Students should be able to gather, evaluate and use appropriate (level wise and topic wise) sources of information. When using these sources, agreed upon referencing rules should be used consistently.
2. Students should be able to use the Scientific Method.
3. Students should be able to identify and implement the Scientific Publication steps and the scientific article.

Generally these courses are taught following a traditional lecture based method. There has been an overall observation of the following issues:

- Students are unable to critically evaluate sources of information and end up working with many low quality secondary research types of work, from mainly inappropriate websites and non-scientific magazines.
- There is a worrisome level of plagiarism.
- Students are not able to apply and work with the scientific method.
- Students are not able to manage working with scientific journals within their field of work.

These findings are not uncommon within Science teaching in university circles. Researchers advocate for a more student centered approach which includes, especially amongst others, inquiry based activities within science topics based on the fact that there is a considerable number of students that do not perform well following traditional teaching methods (Brew, 1995). In spite of these findings, there are not many instances where science introductory courses at the university level encourage true student led research or that go beyond a few instances of cooperative learning activities and a few isolated case studies. However, true undergraduate research is widely considered an effective tool for enhancing the overall undergraduate experience (Lopatto, 2004). Many benefits are described in different studies such as increased interest in a career in science, increased levels of pursuit of graduate education and an overall increased ability to gather information, carry out research and speak efficiently (Bauer, 2003).

On the other hand, Science students currently find themselves with unprecedented access to information (Flaspohler, 2007). Different studies show that many times students struggle to locate and use reputable sources of information and use them to write research papers (which is a common requirement for all Science undergraduates) (Flaspohler, 2007).

Following these findings, we propose to integrate innovative techniques in library science and guided inquiry based Science learning through undergraduate student self-directed primary research. We have been using different educational techniques in "Documentation and Introduction to Research Methods in Odontology" which is a mandatory course for all Odontology students at the UEM, currently taught in English in the first semester. Continuous techniques, results and findings developed along this research study, will be also applied in "Fundamentos Bioquímicos, Biológicos y Fisiológicos", a mandatory annual course, currently taught in Medicine Degree first course.

Our working hypothesis is that enhanced library science instruction integrated as part of a student led primary investigation (following the guided inquiry mode of instruction), within one of the content subjects that students are currently studying, effectively leads to true acquisition basic competencies and higher student satisfaction. Our project lies within the priority lines of this University as we are moving from Innovation to Research in Education. We have implemented the inquiry based model of teaching during the first semester of 2010-2011 in Documentation and Introduction to the Scientific Method in Odontology. Based on our findings during this semester we will introduce changes in the same course the following year and in "Fundamentos", a first year Medicine course.

OBJECTIVES

- Generating student centered activities which we are able to evaluate using rubrics in order to lead students towards a better assessment of resources

available to students and application of citation regulations.

- Planning curriculum following inquiry based model where students plan and conduct primary scientific research accurately.
- Doing an internal university publication of student scientific papers, following the publication requirements as presented by the ICMJE (International Committee of Medical Journal Editors) and all format requirements of Scientific Journals. In this process second year students will be recruited to serve as part of an editorial board, as well as faculty members of subjects involved (Epidemiology, Pharmacology and Biochemistry, where other inquiry and research-based learning experiences have been successfully achieved (Knutson, 2010)).
- Increasing collaboration with Library staff at UEM in order to improve bibliography management by students and to reduce plagiarism.

METHODOLOGY

The technique we followed to structure the course falls under the structure of what is considered a guided inquiry structured mode of instruction. We can highlight the following strategies which were applied sequentially:

Initially, small scale activities were developed to introduce certain skills that would be needed by each group of students to later on carry out their independent research projects.

- Introduction to the concept of Research in Odontology.
- Introduction to sources of information thorough a workshop done with UEM Library staff to start students on research strategies.
- Activities to learn how to evaluate appropriate vs. inappropriate web sources.
- Extensive work on Medical data bases like Medline and other resources available through the Library's website.
- Primary vs. secondary sources of information.
- Cooperative learning activity to develop secondary research project on a Scientist of their choice focusing on the Scientist's position and influence in the history of Science. The objective of this activity was to have students work in teams in order to develop work strategies following rubric specifications. During this project Vancouver method of citations was introduced. Evaluation of this project served to establish rigour standards in terms of plagiarism, adherence to work specifications and in particular referencing and citation regulations.

“Paper project” was introduced following the sequence below:

- Students were advised to group themselves in research teams following certain criteria: interest in the same odontology topic, ability to work together in terms of logistics and work style and academic objectives.
- In their groups, students picked an Odontology topic of their choice and conducted an extensive Literature review which needed to include at least three relevant, current scientific articles and college level books on the topic chosen. Students, this way gained background knowledge to facilitate the planning of their primary investigation.
- Students were handed a “Proposal Outline” designed by the professor, in order to guide the steps of their investigation plan. First year Odontology students also study Epidemiology during the first semester. Considering the time frame and financial and practical possibilities of the students a set mode of research was set for all projects: *a cross sectional survey*. This was given to them as they would be able to plan a rigorous investigation question that would be answered either thorough population surveys or through data from their parents’ dental clinics (in this case it was strictly requested that they present original evidence of patient consent to use their information). In the proposal outline, students needed to include summaries of the literature review process, the objective of their investigation, the original survey they were planning to perform or the data they were planning to collect from the clinics. In addition, they were asked to think about and outline how they were going to organize the data collected and how it would be analysed in terms of statistical analysis.
- A strict deadline was fixed to hand in the proposal and several feedback sessions and tutorials were set up to guide students through the process. An approved proposal granted *permission* to start with the survey, analyse the data and write the paper. Making sure that there is evidence of a continuous and monitored process (through logs of team progress maintained by the professor) guaranteed the authenticity of the study.
- Once the proposal was approved, students conducted their research, surveys and analysed their data. In this process they were informally advised by their epidemiology professors through individual tutorials. This constituted a multidisciplinary effort.
- In order to write the final paper a very specific rubric was developed summarizing the requirements of the ICMJE (International Committee of Medical Journal Editors) and we worked with model scientific papers several sessions.
- Students wrote their papers independently but were encouraged to email and discuss drafts through communications with the professor and a team leader per group.

- UEM Library staff collaborated with class professor to introduce the program *Refworks and write and cite* to manage citations in a more effective and accurate manner.
- Students communicated their findings both through very structured oral presentations to be developed in the class and through written *papers*.

DESCRIPTION OF EXPERIENCE AND RESULTS

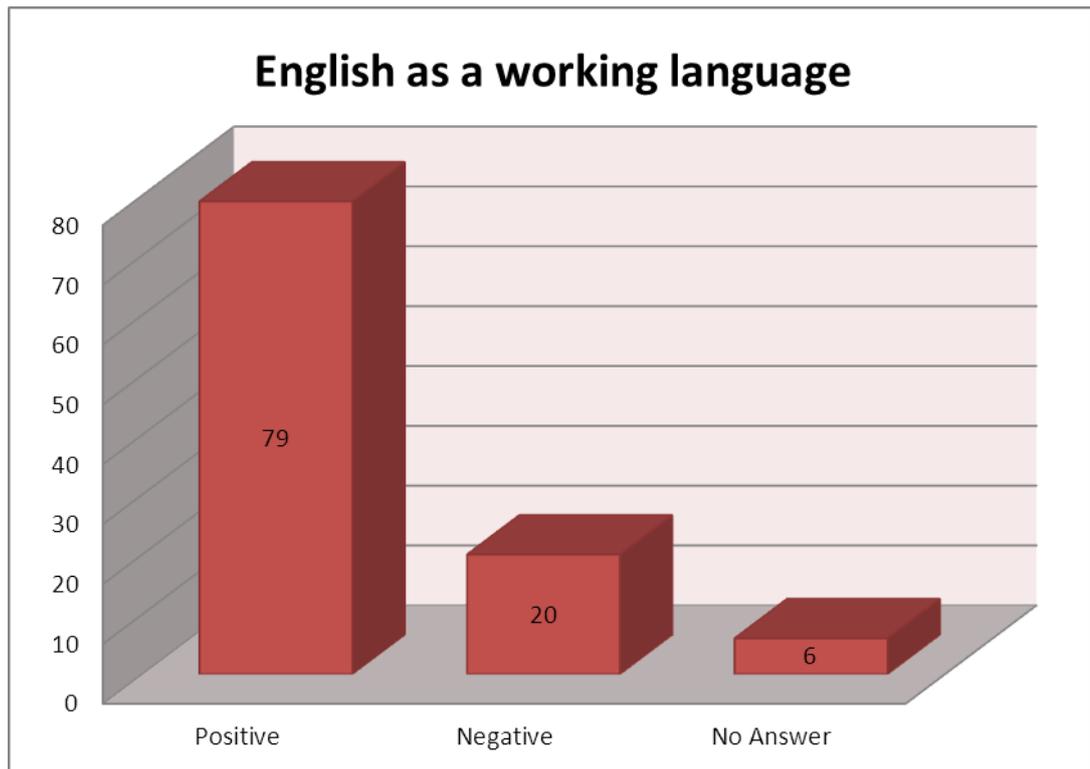


Figure 1: Student's perception of English as the class' working language

We can observe that in general the percentage of students viewing instruction in English as positive remains relatively high, the second year of the course's functioning on a 79%. As professors, we have also felt less stress in dealing with student resistance to having the course in English. We feel that students came more informed about the fact that the course was in English in all its components, probably with communication amongst students from the previous year. Believe it or not, this is a very important factor in working with a relatively young group of students, as being able to overcome the mental barrier of speaking in another language and perceiving it as an opportunity to learn represents half of the task, particularly in student centered environments. As previously specified both students

and professors feel that it is an idea to consider that for students with very low level of English there should be the option to course the class in Spanish and once a reasonable level is achieved (we feel this level should be a 10, as per the UEM lab), then future courses in English could be pursued. We also feel that as teachers, we have learned to deal with such heterogeneous groups from so many aspects and better understand the needs of our students. We have “adapted” and also manage the challenges of the class with a better understanding of teaching students with low proficiency of English.

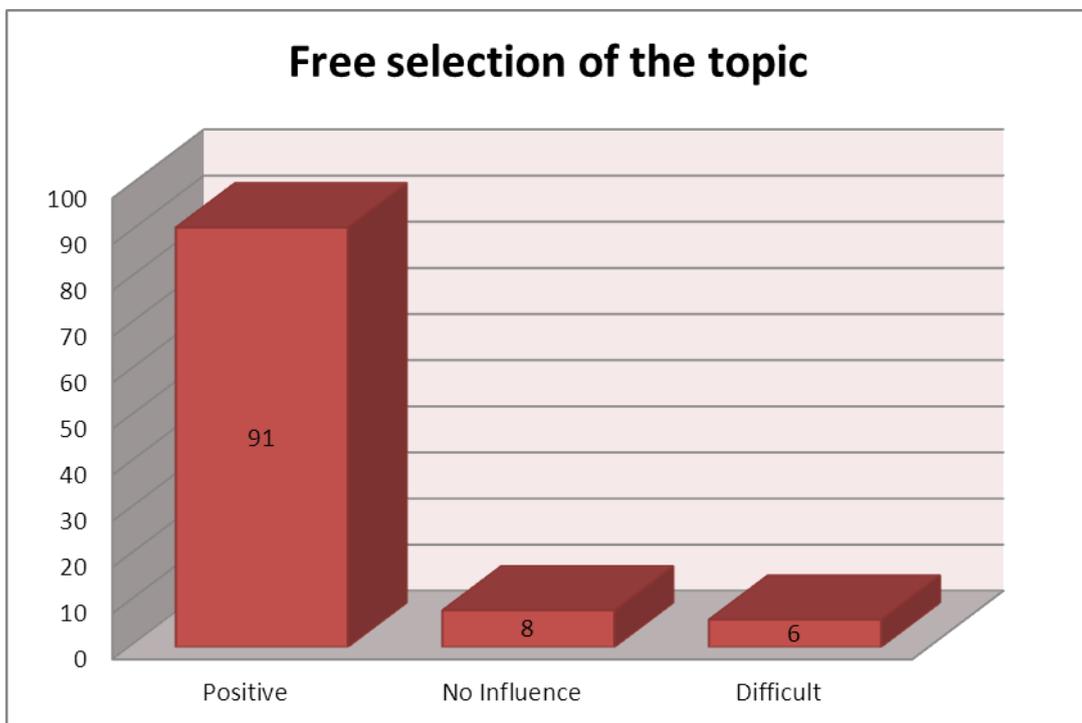


Figure 2: Student’s perception of choosing the topic for their papers themselves.

Students continue to view as very positive to be able to choose themselves the topic for their paper. In order to write their research paper, students choose within their groups a dentistry topic of their choice; many students choose implant surgery, others gum disease and also oral hygiene, are amongst the most popular topics. Students who are able have the possibility of using their family’s clinics patient’s data of different treatments to use as their results and main focus of the study. In all groups, we have observed that these students therefore perceive their clinics and see how the idea of research can have a direct application on their future professional lives. This is an important point to reflect on. Students generally have difficulty

understanding the relevance that this course has in their future professional career. Many of them do that a family clinic set up, and the ones that do not, view regular practice and particularly implant surgery as their future day to day activity. The idea of being involved in any type of research is a very alien and abstract concept and most students do not find it appealing at all. Those students who are able to collaborate with their family clinics, their future work place, begin to see research as part of their future career, even if it is involving a very simple study many times dealing with patient satisfaction. Rigorous patient consent forms are required from each patient when his/her information is used, therefore exercising another important aspect of the research process. Student's level of motivation when they are able to choose a topic of their interest has remained highly valued by students.

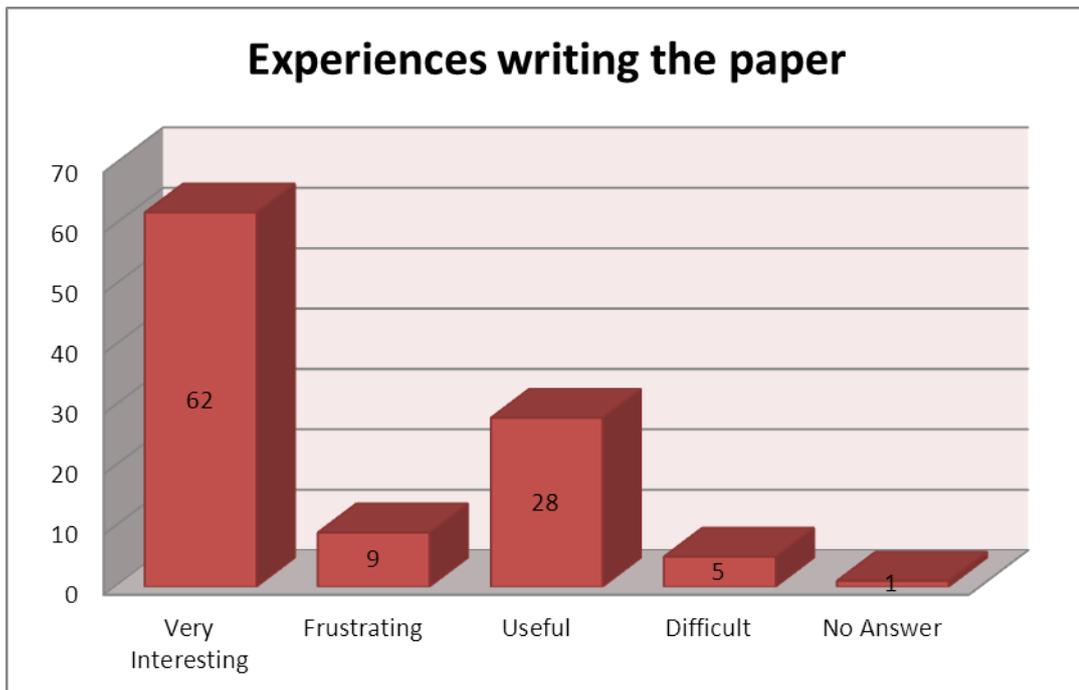


Figure 3: Student's reported experiences writing the paper.

Students continue to value writing the paper and rate it as a very interesting process.

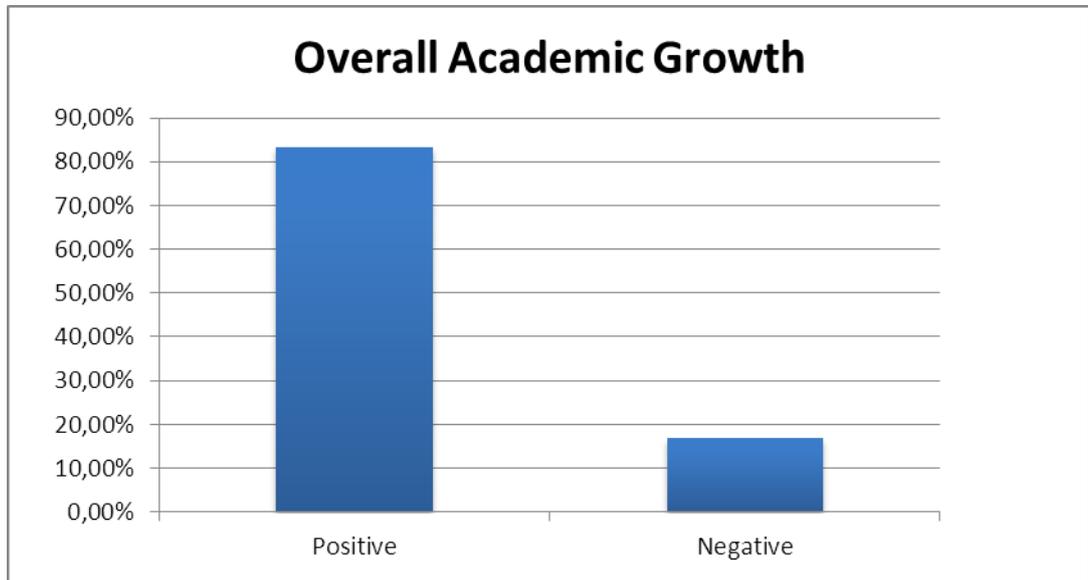


Figure 4: Student's perception of academic growth

Consistent with results from last year, students feel that they have grown academically as a result of this class. However, it is interesting to note that this year, in spite of having reported to have experienced an overall academic growth, students also report to prefer a more traditional approach of teaching with fewer student centered activities. We find this contradictory to the fact that students report to have grown academically as a result of the course. Maybe as a possible explanation we can propose that learners tend to feel more comfortable in familiar situations, and traditionally students are not involved in long term research projects of a primary nature. Furthermore, students recognize their learning when it comes to student centered activities but these prove to be challenging and uncomfortable, particularly when done in another language. It is however interesting that even though all parties, that is students and professors, should recognize, that if the objective is to learn and grow academically, then methods alternate to direct instruction should be preferred by all.

It would be interesting to see if students who are further in their education have developed certain skills that are very relevant in these types of activities, such as being a reliable member of a team, feeling more comfortable with higher class participation, and carrying on in a responsible way long term independent assignments.

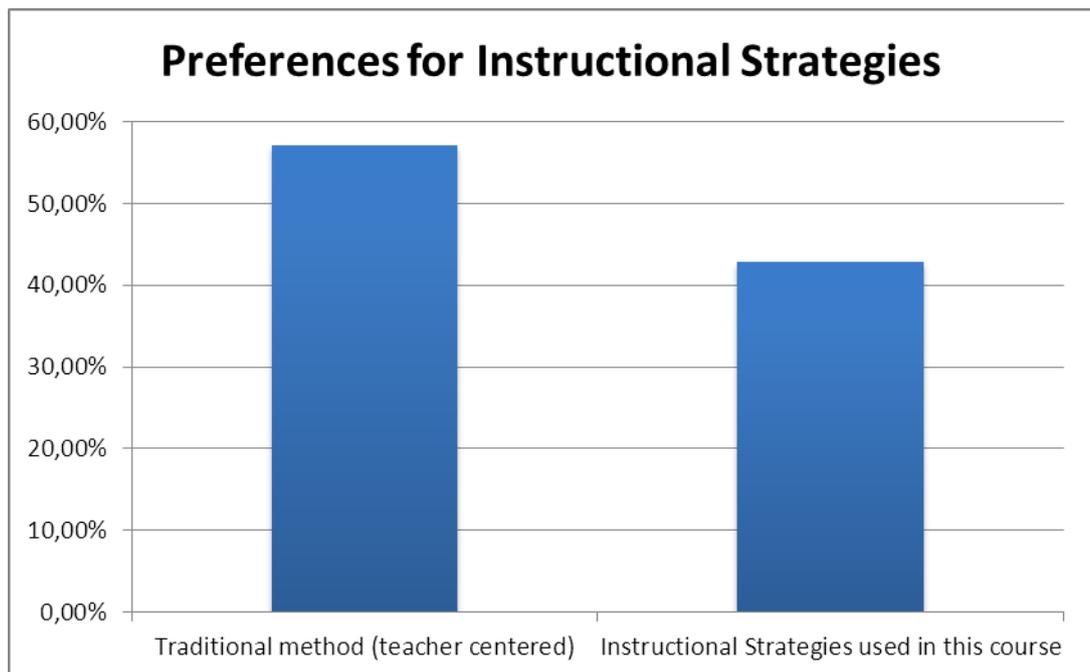


Figure 5: *Reported preference for type of class instruction*

CONCLUSIONS: 2011-12

- One of the most important factors in this year's work versus the previous one is that having one more hour per week has led to a closer motorization and more structured opportunities for feedback during the final writing of the paper. In the previous year students did not use the tutorial sessions as much as we would have liked and they would have needed. Having received feedback during different stages of the process; this includes the experimental design, results and analysis and the writing of the paper has made the whole process more accessible to students and increased the overall quality of the projects.
- We feel that reducing the number of students in a group from six to four has made it possible to ease logistical problems of group work. However, we would like to add a component of group work co evaluation done by students of each other's work to be able to also evaluate general competencies such as team work and responsibility.
- We would like to receive more training in appropriate methods to use CLIL (content and language integrated instruction). Initially the idea that was passed on to professors of documentation was that the course was to be delivered in English in all its components. With time, we have become aware that this is part of a European initiative to integrate content and language instruction. Since just to avoid the issue of such heterogeneous groups in terms of English knowledge

does not seem appropriate we plan to incorporate different strategies to support those learners with more language difficulty.

- In terms of the research component of this project we would like to add a qualitative analysis of the development of this course. We would like to do group interviews of key students and professors of the project and record in depth information of the process. We would also like to collect written reflections of several students about their experiences writing the paper.

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