Using Innovative Pedagogical Practices in Disciplines of Engineering and Computing Graduation in Brazil

Alberto Sampaio Lima
Information Systems and Software Engineering
Federal University of Ceará
Quixadá, Brazil
albertosampaio@ufc.br

Wagner Bandeira Andriola
Education Department
Federal University of Ceará
Fortaleza, Brazil
w_andriola@ufc.br

***Abstract*—The use of innovative teaching practices has helped professors in universities, thus contributing to the improvement of undergraduate education. Within the engineering and computing areas of undergraduate courses, there is a more specific challenge to professors when ministering information technology management disciplines. This paper presents a study concerning the difficulties faced by IT management professors. We proceed with a review of innovative teaching practices used to improve the results of an IT governance discipline within a graduation course undertaken at the Federal University of Ceará (UFC), Brazil. Results taken from an interview and an assessment of the professor by students in the discipline were proven to be quite promising.**

Keywords—pedagogical practices; innovation; teaching graduate; professor´s evaluation.

I. INTRODUCTION

In Brazil, some engineering graduation courses, such as teleinformatic engineering, computing engineering and software engineering, need IT management as an important discipline in the engineering professional formation. IT Management disciplines in engineering and computer graduation courses involve the thresholds of knowledge in information technology and business administration. We proceeded with a survey and subsequently identified some of the difficulties faced by professors when teaching IT management disciplines:

- Difficulties in motivating students in IT management disciplines when facing competition from other technical disciplines of graduation;
- Students found difficulty in linking the knowledge and skills acquired in management disciplines with their future professional work;
- Theoretical traditional focus related to management disciplines.

Because of these historical difficulties, in addition to professor effort to act in two knowledge areas (computing engineering and administration), there are many professors in computing and engineering areas in Brazil that are not interested in focusing their actions in IT management. It hinders their performance when faced with the challenge of administering discipline in the area of IT management for any reason.

Another motivation for this research arose from empirical observation and analysis of IT management discipline results in undergraduate courses during the period 2007 to 2011. This was coupled with one researcher´s experience as an IT management professor (undergraduate and postgraduate) with 10 years in academic administration of graduate programmes in the computing area.

Our main objective was to experience a mixed innovative pedagogical strategy, trying to get better student learning results when teaching undergraduate IT management disciplines.

In this work, we presented and evaluated, from a student prospective view, an innovative classroom practice that was tested in an IT management discipline within the information systems graduation course at the Federal University of Ceará (UFC), Brazil. As a consequence, the promising results can be used in engineering and computing education.

II. RELATED WORK

This section relates the research reported in this paper to other published work. We organized the discussion by concept, going from general to more specific concepts. At a high conceptual level, our work deals with education evaluation and performance, and as such, it derives ideas from several other researchers working in pedagogical innovative practices to improve professor and student performance.

Peres-dos-Santos and Laros [8] showed the process of developing an instrument to assess professor's teaching practice in Brazilian university education. Their work result analysis revealed the existence of important factors that influence professor performance, such as "teacher-student relationship" and "teaching practice". This instrument has proven to be a promising element to improve teaching quality in the classroom.

Carvalho [11] conducted a study evaluating Brazilian professors in the communication area, showing the difficulties inherent in the pedagogical training vision of being a teacher and analysis of teaching activities, among others.

Pedagogical practices in health care laboratory disciplines in Brazil were assessed in [13]. The work identified the need to

This research has been partially supported by CAPES (Observatório da Educação – Edital 038/2010).

seek to change the classroom routine and the reality, where positive results will come only with education being integrated into the student's reality, with the knowledge systemization, ability to transform experience into knowledge and the formalization of a professional knowledge reference. The author argues that a better targeted pedagogical practice can create training programmes that complement teaching learning, in order to establish that knowledge starts from the assumption that intelligence, or any other name given to mental activity, is a faculty able to accumulate information even outside the classroom.

Catapan et al. [2] identified key attributes and practices of accounting professors that have been successful in the classroom, from the standpoint of students in Brazilian public and private universities in Curitiba (PR) and Joinville (SC). They evaluated 5 Brazilian universities (UFPR, PUC / PR, FACINTER, FAESP and OPET).

The use of digital technologies as support to calculus discipline classes has been evaluated in [14]. The author cited that the use of digital technologies assist in the learning process, allowing greater content organization, greater motivation among teachers and students, increased interaction and communication, and new dynamic creation in the discipline activities. The school and classroom contexts in which pedagogical innovations employing technology were successfully sustained are shown in [15]. The authors cited that the essential conditions for the sustainability of classroom innovation were teacher and student support of the innovation, teacher perceived value of the innovation, teacher professional development, and principal approval. Contributing factors for sustainability were supportive plans and policies, funding, innovation champions, and internal and external recognition and support. Technology-supported innovative classroom practices in many countries around the world have many qualities in common [16]. Teachers in many countries are beginning to use information and communication technologies (ICT) to help change classroom teaching and learning, and are integrating technology into the curriculum.

In [17], a pedagogical training strategy has been evaluated into the student´s graduate experience in biology, with good results.

There was a project-oriented framework proposal for engineering schools in [18], which combined pedagogical methods such as project-based learning, active pedagogy and traditional teaching paradigms. The authors cited that although comparisons between various pedagogical methods are difficult and sensitive, numerous internal signals confirm the validity of several aspects of their mixed pedagogical proposal.

To meet the need of engineering graduates who can function comfortably in an increasingly distributed team context which crosses country and cultural boundaries, the work shown in [19] evaluated an Open Ended Group Project Framework (OEGP) as a pedagogical strategy, whereby using collaboration.

The feedback about the pedagogical practices of graduate teaching assistants was proposed in [20]. The evaluation tool called G-RATE allowed various stakeholders, for example: classroom observers, administrators, graduate teaching assistants, undergraduates, and students), in order to provide feedback about their pedagogical practices within a laboratory session.

III. INNOVATIVE CLASSROOM PRACTICES

Bolzan [1] cites that when we seek to understand the reciprocal relations between the knowledge domain (scientific knowledge) and the know-how domain (knowledge), we subsequently obtain advancement concerning pedagogical issues. The professors thinking and their ways of design and development of education explain how personal conception systems unfold, becoming shared pedagogical knowledge. As teachers discuss about their actions, explaining their views about teaching and learning process, they demonstrate a reflective attitude about their pedagogical knowledge and practices, contributing to their formation.

A systematic look at the procedures used in education and quality of education contributes to promoting change and development in society [2]. Among the characteristics of a good professor identified by Gomes et. al. [3], it can be stated with respect to intellectual stimulation dimension that professors need to be prepared and to have clear discussion amongst themselves. In the interpersonal dimension, the survey indicated the need for available, attentive, interested and helpful professors with the ability to motivate their students.

Slomski and Martins [4] state that when questioning the graduated professional performance, we are evaluating specifically, the education quality. We need to reflect on the professor role, on the university education practice and the teaching project construction to materialize the university goals as a scientific knowledge production institution.

Constructivism has lately been the more theoretical approach when used to guide teaching materials development, especially for multimedia learning environments [5]. The fact that the constructivist approach is predominant means not only a trend reflected in textbooks, because even the idea of constructing knowledge is present in the work of various authors and depending on which one is the elected benchmark, sets up a pedagogical practice somewhat differently.

There are fundamental common elements, despite the differences between the theoretical concepts of constructivism researches. The consideration of the individual as an active agent of his own knowledge displaces concern from the education process (traditional view) to the learning process. In the constructivist view, the students builds representations through their interaction with the reality, which will constitute their knowledge, an irreplaceable process, incompatible with the idea that knowledge can be acquired or transmitted. Taking these assumptions means changing some core aspects of the teaching-learning process in relation to the traditional view [5]. Table 1 shows a comparison between traditional and constructivist approaches.

Rezende [5] cites that in constructivism, authors consider important learning assessment that has been inserted within a context. Traditional professors have also recognized that

important skills are not covered in tests unrelated to the learning context.

A well referenced method in literature, is the problem-based learning (PBL). Hmelo-Silver [6] cites that in PBL, students work in small collaborative groups and learn what they deem necessary to solve a problem. The professor acts as a facilitator to guide the student through the learning cycle.

Table 1. Traditional and constructivist learning approaches

Traditional Approach	**Constructivist Approach**
Focus on professor	Focus on student
Focus on discipline programme	Focus on individual significance construction
Student mind is a blank paper	Learning is construction upon previous knowledge
Student is a passive knowledge receptor	Student controls the learning process
Memorization of knowledge	Skills and knowledge will be developed in the context where they will be used

In the PBL learning cycle as show in Figure 1, also known as the PBL tutorial process, students are introduced to the problem scenario. The problem is formulated and analyzed through the identification of scenario relevant facts, helping students to represent the problem. To the extent that the problem is best understood by students, the possible solutions hypotheses are generated. An important point in the cycle is to identify the knowledge gaps in relation to the problem, called learning issues that will be studied during their self-directed learning (SDL). Students then use their new gained knowledge by assessing their hypotheses based on what was learned. At the end of each solved problem, students reflect on the acquired knowledge. The professor helps students learn the cognitive profile needed for problem solving and collaboration. One of cited limitations for this method use, is the amount of people necessary to facilitate learning in large classes.

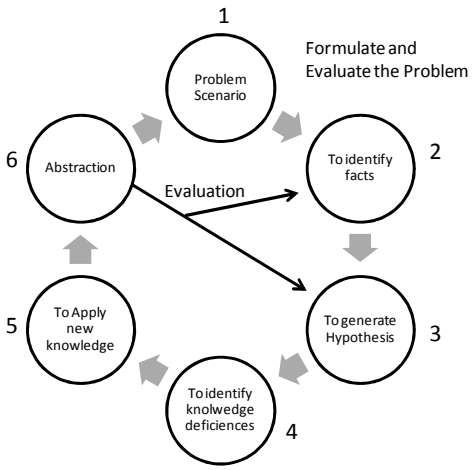

Figure 1. Problem-based learning cycle

The use of PBL to improve the curriculum of an undergraduate mechanical engineering course was addressed in Henry et al. [7]. The author states that a new course was proposed, more based on troubleshooting than topics, solved by small students groups, with the facilitators help. The paper describes the impressions and experiences of the students in the course, and how the final problem was solved.

When addressing the need for new pedagogical practices, it is important to know the problems professors faced when teaching in their daily lives. University professors in the communication area said that they faced the pedagogical problems as soon as they appeared, according to a survey reported by Carvalho [11]. Table 2 illustrates the identified main problems and pedagogical solutions encountered by professors [11].

Table 2. Pedagogical problems and solutions encountered by professors

Pedagogical problems faced by professors	**Solutions encountered by professors**
Student unmotivated and listless to continue the course. When the student starts the course he/she will already be getting discouraged. They are such a quick gratification generation.	We're professors, we need to be there giving them motivation to continue. I talk about their future profession, and show some texts about it.
Disinterest, academic failures.	I try to motivate students through case studies and practical projects.
Very heterogeneous student profiles in the classroom. Lack of student motivation. Lack of integration with other disciplines in the course.	-
Relatively rapid and radical change of the students profile and interests, perhaps due to the ongoing technological transition.	I try to confront the issue by talking with students and avoiding hasty conclusions, whilst maintaining a commitment to ethics and critique education.
Students' disinterested in reading area texts and papers.	Each semester I seek creative ways to attract the interest of students.
Keep relationships with students as subjects and not as teaching objects.	Read specialized books and talk with others professors.
Lack of time to hone skills and implement educational updates.	Read books, search internet and talk with others professors.
Pedagogical issues are not discussed in the course coordination meetings of the professors.	I make my own self-assessments with students, including the issue of discipline.

In the same work, when asked about the activities development by professors, students in the two evaluated universities answered in the manner as summarized in Table 3. From presented information, we found that some professors searched for innovative classroom teaching practices, but this activity is not usual. The authors observed that there is often a difference between what was planned and what is implemented in practice by professors. During the evaluated lesson study, the following observations were made: purely expository presentations, indifference, inattention, lack of interaction between professors and students, and sometimes the difference between what was presented and the real world.

Table 3. Student answers about professor's classroom activities.

How the activities should be executed by professors	**How the activities are executed by professors**
Knowing how to align the market with academics. Respecting the	They make presentations using powerpoint. He has pleasure with the execution of activities. He motivates the students.

student. Following the discipline curriculum.	He *brings* the market to students.
Being more relaxed. Being dynamic. Promoting debates.	We feel like we're at home. We invent products. He does not use alternative strategies. We have to read a text and discuss it in the classroom. He asks the question and tells us what we need to research. However, the lesson is always the same subject..

IV. TEACHING AND LEARNING EXPERICENCE RELATED TO ENGINEERING AND COMPUTER GRADUATION

To evaluate the problem complexity and to try to list possible solutions that make teaching of IT management disciplines in engineering and computing courses much easier, we conducted a study of the Bachelor of Information Systems (IS) course at the Federal University of Ceará.

A. Professors evaluation in UFC

When thinking about teaching quality evaluation, as well as representing an almost universal concern, which is present in many debates on education, we reveal important information concerning an operation that is considered a very complex task [8, 9]. Pavan [10] argues that education assessment can be a powerful tool for decision making, redirection of actions, re-thinking of the curriculum and the formulation of educational policies. Teachers are periodically evaluated by students on the UFC campus in Quixadá. Evaluations are conducted by means of an institutional assessment system, currently under test at the institution named SAVI [9]. Table 4 shows the 29 questions answered by students to evaluate the professor in their relative discipline course.

At the end of an evaluation process, the professors can view results of their evaluations by students, either generally or tabulated by discipline. The system also allows partial assessments that can be made during the discipline course, allowing the teacher to identify problems during the planning execution, and to correct them as required.

Table 4. Questions answered by students in professor evaluation at UFC.

Q1) Professor presented the discipline teaching plan upon commencement of course?
Q2) Professor discussed the discipline teaching plan upon commencement of course?
Q3) Professor clarified the meaning and importance of discipline for the course?
Q4) Does the discipline teaching plan contain the programme ?
Q5) Does the discipline teaching plan contain the general and specific objectives?
Q6) Does the discipline teaching plan contain a description of the contents / units?
Q7) Does the discipline teaching plan contain the teaching methodology?
Q8) Does the discipline teaching plan contain the forms and rules of learning assessment?
Q9) Does the discipline teaching plan contain the basic and complementary bibliography?
Q10) Professor demonstrates organization and logical sequence to teach the discipline programme.
Q11) Professor uses plain language to improve content understanding by students.
Q12) Professor utilizes appropriate didactic procedures to meet the discipline objectives.
Q13) Professor streamlines the classroom, promoting activities that encourage student participation.
Q14) Professor clearly guides the requested work solution.
Q15) Professor establishes the relationship between theory and practice, respecting the specific course..
Q16) Professor encourages student´s critical thinking.
Q17) Professor knows the discipline content components area.
Q18) Professor highlights cross-cutting issues (social, environmental, cultural, ethical, scientific, etc.), related to course content.
Q19) Professor maintained adequate ethical and professional attitude in the classroom.
Q20) Professor encourages students to obtain high performances.
Q21) Professor respects any student´s limitations or failures.
Q22) Professor arrives punctually in class.
Q23) Professor is assiduous.
Q24) Professor maintains good relationship with students.
Q25) Professor establishes clearly, the criteria for assessment of student learning.
Q26) Professor uses assessment practices that value reflection and problem solving issues.
Q27) Professor uses evaluation forms compatible with the goals and teaching content.
Q28) Professor uses evaluation forms that capture effectively, the actual student learning.
Q29) Professor uses evaluation results for feedback and consolidates student learning.

B. Classroom strategy development

We proposed a pedagogical practice in the IT Governance (information systems graduation) discipline, in order to address some natural problems inherent to IT management disciplines.

The discipline course was composed of fifteen students which in fact, facilitated our strategy implementation. This is because we didn`t have facilitators involved in the experience (to minimize limitations of many students in class). The university lecturer´s function does not exist in Brazilian universities. Importantly, the campus of the UFC in Quixadá has multimedia features in sufficient quantity for all disciplines, thus enabling the planning of lessons based on the use of software tools with additional internet access in the classroom.

Our objective was to improve student motivation in relation to discipline, to create an effective link between the discipline and the engineering/computing profession, and to acquire knowledge of collective construction. The pedagogical planning was presented and discussed with students throughout the rest of the course, adapting it as necessary. We listened to students suggestions and adapted the class planning during the whole experience.

Good students were found to be dissatisfied with unfair evaluation practices [5]. We elaborated individual evaluation to all students, according to the following criteria (objective and subjective):

- Attendance at activities in the classroom;
- Participation and interest in the process of collective construction knowledge ;
- Development of work / activities in the classroom;
- Summaries of articles or other topics at home;
- Classes targeted for market needs (procurement);
- Participation as author / speaker in the workshop at the end of the course.

During our material preparation and discipline planning, there was an effort by professor to obtain information covered within the programme, which had been the focus of public tendering evidence. There are issues of public tenders that are very well prepared, which attempt to capture important nuances of the theory. We used a PBL-based strategy [6] in some specific classes for this purpose. We had dynamic classes to improve student participation and involvement. Whenever possible, there was a market topic insertion related to what was being presented. In a complementary fashion, some works were executed in the classroom and others at home. These studies consisted of: studies on important topics, presentation of summary papers, resolution of public tender tests, and study of best IT governance guidance practices (ITIL and COBIT), which are considered to be the current industry standards. With these integrated actions, we established a link between discipline and the market, whereby there was a large increase in student interest. The research strategy in the classroom proposes linking teaching with the research faculty, becoming student partners in the search for knowledge, whereby combining theory and practice as partners in the educational process [12]. Aiming to meet the research goal in the discipline, we developed research on the identification and assessment of managing IT service problems, taking place during classes and as an external activity. Table 5 shows these activities.

Table 5. Some discipline activities

Classroom activities	Writing summaries of papers (classroom and homework)	Homework
PBL - IT governance problems - resolution of public tender problems	Business-driven IT Management (BDIM) workshop papers	Researches about ITIL and COBIT related topics
Short paper reviews in classroom (IT management activities, ITIL and COBIT related topics)	Some IM papers - IT service management	IT governance real case studies reviews
Search-based activities - identification and assessment of managing IT service problems.	Some NOMS papers - IT service management	

The discipline final evaluation (E_w) result was calculated as a weighted average of all used *evaluation criterion arithmetic media (M_i)* (as shown in Table 6):

$$E_w = \frac{\sum_{i=1}^{n}(M_i \cdot w_i)}{\sum_{i=1}^{n}(w_i)}$$

Table 6. Discipline final evaluation

Evaluated aspects	Measure (M_i)	Criterion	weight (w_i)
Classroom attendance	Presence % 0-10	Presence in classroom	0.1
Active participation in the activities carried out in the classroom	0-10	Participation and Interest Quality of work/activities results	0.3
Homework	0-10	Quality of results and written work	0.2
Writing summaries of articles	0-10	Writing quality	0.1
Participation as author/speaker in workshop	0-10	Presentation and written work	0.3

We established a public workshop on the campus called the 1st IT Governance Workshop of Central Hinterland, where authors and speakers were the students of the discipline. The students were responsible for all the programming and execution of the event, including result analysis.

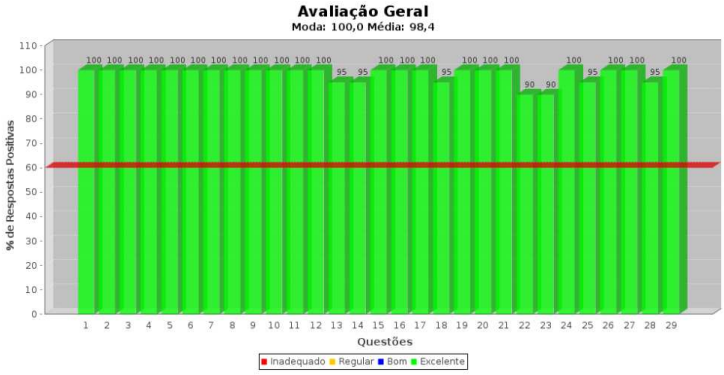

Figure 2. System general results of professor evaluation by students

We proceeded with interviews with all of the students in the discipline, where we identified that all of them preferred our adopted practice in relation to traditional practices experienced so far in the course. The collective construction knowledge strategy that has been adopted was very well praised. Our multicriteria-based evaluation strategy was cited by students as well as being fairer and more motivating than theoretical evaluations and work.

In a complementary way to the interview results, Figure 2 illustrates the overall professor evaluation using the university evaluation system. Positive indicators were verified in all evaluation dimensions, with percentages greater than or equal to 90% on all questions (evaluation performed by 53.33% of the students in the discipline).

We observed that discipline students issued and shared information about IT governance importance through means of social networks (ie Facebook). Final discipline results and our innovative strategy were announced in a positive manner among students, which in turn, generated a demand by a new offer for this specific discipline in graduation courses.

Results indicate that planning activities were considered very good in the students assessment, whereby classroom planning presentation and discussion clarified the importance of course discipline, programme information, objectives, content and bibliography. The innovative teaching methodology was also one of the strengths indicated in interviews. We implemented oriented works, research presentations, reading books and journal reviews. To improve final results in discipline course, we established a workshop which was totally organized and presented by students. An empirical result that strengthens our argument, is the fact that our strategy improved the student evaluation mean (8.9 in discipline), a very good result (student evaluation mean in previous disciplines during last two years was around 7.6).

Due to the positive results obtained during the discipline, student´s interest concerning the topic steadily grew, whereby suggesting the creation of a blog, where important information about IT governance could be available to students on the web.

V. CONCLUSION

This paper presented an innovative pedagogical practice in the classroom, applied in a graduation course at a Brazilian university. Using the principles related to professor assessment by students, the integration of discipline with the market and a knowledge collective construction approach, we obtained important results that can be used by professors in similar experiences.

Our strategy generated positive results in terms of increasing student motivation in discipline courses, with an improvement of final student results and a disclosure of the discipline importance between the other students. Another positive result was the suggestion of an IT governance blog created by students.

Because the evaluation was conducted specifically with one professor and one discipline, there may be some difficulty in generalizing the results to other disciplines. We didn't test our approach with many students in the classroom.

However, although just a preliminary experience, the results were important in that they show a differentiation innovative practice in the classroom which can improve discipline results. The overall results of the professor evaluation by students were solid and reliable.

In future work, we hope to evaluate the adoption of similar pedagogical practices in two other IT management disciplines with more registered students, whereby utilizing some facilitators in order to help the professor. Other work would be possible in order to evaluate these practices in other knowledge areas.

REFERENCES

[1] Bolzan, D. P. V., Isaia, S. M. A. Aprendizagem docente na educação superior: construções e tessituras da professoralidade. Educação, ano XXIX, n. 3 (60), p. 489 – 501, 2006.

[2] Catapan, A., Colauto R. D., Sillas E. P. Perception of students on good account professors in public and private universities. Revista de Informação Contábil, v. 6, n. 2, p. 63-82, 2012.

[3] Gomes, M. E. M., Albuquerque, L. S., Carvalho, J. R. M., Santiago, J. S.; Lucena, W. G. L., Rêgo, T. F. Attributes and pedagogical practices of accounting professor who has success in the classroom: student perception study in universities, In: ENC. DE PESQUISA EM ADMINISTRAÇÃO E CONTABILIDADE, 2009.

[4] Slomski, V. G., Martoms, G. A. O conceito de professor investigador: os saberes e as competências necessárias à docência reflexiva na área contábil. Revista Universo Contábil, Blumenau, v. 4, n. 4, p. 06-21, 2008.

[5] Rezende F. New technologies in pedagogical practice in the constructivist perspective. Pesquisa em Educação em Ciência, v. 2 , n. 1, pp. 1-18, 2002.

[6] Hmelo-Silver C. E. Problem-Based Learning: What and How Do Students Learn? Educational Psychology Review, Vol. 16, No. 3, 2004.

[7] Henry H R;, Tawfik A. A., Jonassen D. H., Winholtz R. A., Khanna S. "I Know This is Supposed to be More Like the Real World, But . . .": Student Perceptions of a PBL Implementation in an Undergraduate Materials Science Course. Interdisciplinary Journal of Problem-based Learning, Vol. 6, Issue 1, Article 5, 2012.

[8] Peres-dos-Santos, L. F. B., Laros, J. A. Evaluation of teacher's pedagogic practice in graduation. Estudos em Avaliação Educacional, v. 18, n. 36, 2007.

[9] Andriola, W. B.; Andriola, C. G.; Lima, A. S.; Silva, J. C. Development of a prototype of a computerized system for the evaluationof the performance of the university teaching: presentation of partial results. Revista Iberoamericana de Evaluación Educativa, v. 5, p. 198-216, 2012.

[10] Pavan M. M., Fernandes M. C. S. G. Professional assessment and professor professional improvement in universities. ADM, Sicca NAL, organizadores. Currículo, história e poder. 1ª ed. Florianópolis: Insular, 2006; v.1, p. 149-165. in: <http://www.anped.org.br/reunioes/29ra/trabalhos/trabalho/GT04-2370--Int.pdf> in sep 24 2011.

[11] Carvalho, R. I. B. Pedagogical practice of professors in social communication area, PhD Thesis. Universidade de Brasília, 2012.

[12] Oliveira N. M., De Medeiros G. A. Research on classroom in environmental engineering graduation - CREUPI - A possible activity. Eng. ambiental, Espírito Santo do Pinhal, v.1, n.1, p.000-000, 2004.

[13] Pacheco, F. T. A importância das práticas pedagógicas em disciplinas laboratoriais em cursos de graduação, www.psicologia.com.br, 2008.

[14] Rodrigues, E. M., Bilessimo, S. M. S. Inovação na prática docente: uso das tecnologias digitais nas aulas de cálculo em uma IES catarinense. III Seminário de Ciências Sociais Aplicadas, Vol. 3, No 3, 2012.

[15] Owston R. Contextual factors that sustain innovative pedagogical practice using technology: an international study, Journal of Educational Change, Vol. 8, Issue 1, pp 61-77, 2007.

[16] Kozma R. B. Technology and Classroom Practices: An International Study, Journal of Research on Technology in Education, Vol. 36 Number 1, 2003.

[17] Tanner K., Allen D. Approaches to Biology Teaching and Learning: On Integrating Pedagogical Training into the Graduate Experiences of Future Science Faculty, CBE—Life Sciences Education Vol. 5, 1– 6, Spring, 2006.

[18] Rouvraisa S., Oormroda J., Landraca G., Malleta J., Gilliota J., Thepauta & Tremenberta A. A mixed project-based learning framework: preparing and developing student competencies in a French Grande Ecole, European Journal of Engineering Education, Vol. 31, Issue 1, 2006.

[19] Daniels M., Cajander A., Pears A. Engineering Education Research in Practice: Evolving Use of Open Ended Group Projects as a Pedagogical Strategy for Developing Skills in Global Collaboration, Int. J. Engng Ed. Vol. 26, No. 4, pp. 1–12, 2010.

[20] Cox M. F., Hahn J. , McNeill N., Cekic O., Zhu J., London J. Enhancing the Quality of Engineering Graduate Teaching Assistants through Multidimensional Feedback, Advances in Engineering Education, 2011.