Socratic Seminars as a Tool for Inductive Learning

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Abstract. *Teaching a course with cross disciplinary graduated students is a trade-off between an overview and a technical approach. The inclusion of Distributed Systems in a postgraduate specialization course in telecommunications is an example. As the specialization course is focused in the management aspects, we decided to use an inductive learning approach using Socratic Seminars to elicit their participation. Socratic Seminars prevent students from adopting a surface learning approach. The seminars give an opportunity to deep oriented students to relate the course materials with their own interests. In our experience, some of the surface learners became enthusiastic when saw the deep learners performance.*

1. Introduction

Networks in the telecommunications industry became very large distributed computing systems. In the computer industry, as well as the computer science research community, the dominant model for general purpose computing became also distributed computing. Both the public and private sectors had experienced a dramatic increase in their requirements for highly skilled personnel that have a fundamental understanding of not only telecommunications and computer science but the resultant effects of the functional merging of these two interdisciplinary sectors [Jonest 1991].

Therefore, telecommunications is as an interdisciplinary academic subject that spans primarily the disciplines of electrical engineering, computer science and management. In our institution, postgraduate studies in telecommunications focused essentially on communications and management. Basic computer science concepts from operating systems and programming were introduced to support data networks protocols. A few years ago, the concepts of distributed systems were introduced when distributed system became ubiquitous. Since the total hours allotted to a particular study program are fixed, new subjects are framed as half semester mandatory courses.

Distributed systems related topics are appropriate mainly for advanced courses in computer science masters or PhD programs. Distributed systems is a complex subject that requires background knowledge in many computer science topics: operating systems, software engineering, parallel computing, object-oriented programming, network programming, security, and so on. We are teaching Distributed Systems in an undergraduate semester course for senior computer-science students (5th year of a six-year study program) since 2000 [Feldgen 2008]. Our undergraduate students meet the long list of background topics to be prerequisite knowledge. The graduate half semester course, on the other hand, is for students from different engineering fields and most of them have an introductory background in both computer science basics from their freshman course and operating systems.

To build the graduate course we focused on an interdisciplinary approach. The

advantage of a graduate course is that, having mastered the engineering fundamentals and being somewhat more mature than undergraduate, students are more able to appreciate the need for an interdisciplinary attitude. An interdisciplinary course has the same academic rigor as traditional courses, but the content is delivered through a more contextual hands-on approach. Students are encouraged to take an active role in the learning process and to use their new concepts, and conceptual understanding is valued. These type of courses, using a methodology also called inductive learning, focus on essentials and emphasizes comprehension of overarching principles and enhances skills in such areas as communication and teamwork, writing and presentation, argumentation and debating.

There are few distributed systems courses for students with limited computer science background. Several universities have recently initiated undergraduate courses with a basic background in operating systems and programming. Many of them focus on Grid computing [Petcu 2008]. Grid computing based systems are instances of distributed systems no matter their purpose is computation, collaboration, or information sharing, These courses focus on helping undergraduate computer science students acquire an understanding of Grid computing's implications for the software and hardware systems being built in academics and in industry [Mache 2005]. Grid development projects provide introductory or overview talks and short lectures, but hands-on training is unusual. However, a comprehensive training with hands-on experience, as in the university courses, helps people to understand the technology and to use it correctly and efficiently [Mache 2006] [Stockinger 2004].

This paper presents the interdisciplinary inductive learning approach with Student Seminars and Socratic dialogues we use. We present our students' feedback and their attitudes accordingly to their working experience not in computing but in problem solving. The results are based on data and investigator triangulation.

2. Socratic Seminars

The Socratic method of teaching is based on Socrates' theory that it is more important to enable students to think for themselves than to merely fill their heads with "right" answers. Therefore, he regularly engaged his pupils in dialogues by responding to their questions with questions, instead of answers. In Socratic dialogues, the main goal is to guide the learner toward an understanding of the concepts and the principles which underlie the domain learned. Some variations of Socratic dialogues are used in some automated learning environments [Pelle 2006].

In its pure version, a group of participants with equal rights seek to answer questions or to examine statements. Participants engage in the exchange of views, information and reasons aiming at mutual understanding. The group is (almost always) guided by a facilitator whose role is to assist in the structuring of the dialog but does not intervene in the debate. Socratic Dialogs are suitable to be used with questions for which independent critical thinking and reflection about personal experience suffices. Questions that require exert knowledge or data collection cannot be answered in this way.[Saran 2004]

Four indispensable features have to be present in a Socratic Seminar:[Krohn]

1.Start with the concrete and remaining in contact with concrete experience.

2.Full understanding between participants.

3.Adherence to a subsidiary question until it is answered.

4.Strive for consensus

We tried to focus the dialog keeping always present these recommendations. In a cross disciplinary learning community as our course these goals proved to be very valuable for the participants. Dialogs allowed to understand each other lingos and uses of words and concepts. It also allowed some cross generations understanding.

3. Teaching methods and Course Structure

The main teaching method used in this course was Student seminars. A concept test was used at the beginning of the course to find out students background in computer science topics.

The courses had no more than 20 students and met once a week, for a total of nine times. The first six meetings were lectures with active participation of the students. The last three were devoted to students' seminars and debates. In the first lecture, goals of the course, seminar goals and rules, and assessment criteria were discussed. The information was available on the course's Internet pages, where all other relevant material was also posted as the course progresses. Every student had three weeks to choose a Grid computing application of his/her interest or knowledge from the list of Grid Computing Info Centre (GRID Infoware) [GRID]. Next, we formed teams of two students with the same interests and meeting timetable.

In the lectures we introduced the concepts and discussed the various types of distributed systems and their applications, maintaining focus on the goals that should be met to make building a distributed system worth the effort. A distributed system should make resources easily accessible; it should reasonably hide the fact that resources are distributed across a network; it should be open; and it should be scalable [Tanenbaum 2007]. We highlighted the underlying technology of computers, devices and telecommunications. We presented successful projects and pitfalls. The presentation of the material was complemented with related Internet links.

Every team had to hand-in a plan for the presentation of the team's seminar focused in finding-out how this particular grid meet the goals of a distributed system and their limitations. The presentation included also a brief description of the application, its scope and implementation issues. It finished with a few questions they consider relevant to dialogue. A dialogue is a collaborative activity, it means that multiple sides work toward shared understanding.

The seminars sessions ended with a debate about the criteria they apply to reveal which goals the grids met. A debate is an oppositional activity; it means that two opposing sides try to prove each other wrong. It implies to present arguments using the concepts of distributed systems, the course material and the links to Internet sources. These debates were developed following the rules of Socratic Dialogues.

4. Socratic Dialogues

Socratic dialogues [SOCR] or Socratic Seminars, are conversations based on difficult texts in which the leader's primary role is to ask questions. Socratic seminars improve critical thinking, self-respect, classroom community, initiative, originality, reading, writing, listening, and speaking skills, and may ultimately result in students who pursue knowledge for its own sake, regardless of the original cultural background or academic preparation of the students involved [Strong 1997].

For argumentation, the first step is a clear definition of the basis of the argument (e.g. what is under dispute) and of all the terms central to the argument. So an essential part of most arguments is clarifying exactly what the meaning is. It follows a logical process moving from something already everybody agrees to be true to the application of this general truth to a particular case. The persuasiveness of the argument is going to depend largely on the shared truth of that general principle. Finally, is the logical process proceeding from particular evidence to a conclusion, which on the basis of that evidence, everybody agrees to be true or probably true. It requires evidence (facts, data, measurement, observations, and so on) [Johnston].

A Socratic seminar begins with a question, students must have the assigned text in their minds and on the table in front of them, address is polite and responsive, all should participate and support their opinions with argument -when that has been said, all has been said-. There is no further method. The rest develops as living conversation [Wenning 2006].

M. Strong and C. J. Wennings, op cit, also recommended that for an effectively engaging of students in Socratic dialogues as questioners as well as responders, that student must be made aware of the nature of the question-generating process. Teachers can share what they know about the question formulation process with students. Even a small amount of instruction can be helpful in this area. We introduce our lectures focusing in the same type of questions we asked them to post for the grid computing applications.

Before a lecture began, we led a summing-up discussion with some questions about the goals of the type of distributed system we were discussing the last lecture. Students had to argument and debate using the links in the handed-out material or he/she found by her/himself. We encouraged students' participation in this activity. As stated by experts in Socratic dialogues we allow students to present without interruption, promote peer questioning, show respect for student conclusions, get students to agree and maintain a positive atmosphere. When misunderstandings and preconceptions are identified, they must be confronted and resolved through questioning so that they might be overcome .

5. Results and discussion

The evaluation for the qualitative results is based on triangulation. The emphasis is on students learning, which includes both subject matter and general skills such as writing, presenting, debating and communicating. Results and data are based on our observations, before lecture and after lecture participation and questioning, peer assessment data, students' feedback reports and hand-ins and discussions with the students.

The student teams were asked to hand-in a plan for the seminar two weeks before the sessions. One week before the sessions, they must hand-in a report with the presentation of the seminar, arguments for their conclusions, and unanswered questions. After the sessions, a seminar's summary report was handed-in as a conclusion after the sessions. In the last report students evaluated the significance of the different activities, lectures, and other team seminars in their own seminar, doubts and learning. It must include comments about all the seminars.

Students' evaluations on how seminars and in-class discussions worked showed both the same data we gathered during the before and after lecture discussions and during the students seminars sessions.

5.1. Student Attitudes and Evaluation

Our students were mostly Electronic and Electrical Engineers and only a few Computer Science Engineers in the last three times we taught the course. We had foreign students from Colombia, Ecuador and Peru. They use different words to express their ideas and different vocabulary for technical terms in Spanish, but they had both the same introductory background and the same behavior than our students from Argentina.

Most of them were freshly graduated with no working experience, wanting to have a postgraduate degree in order to obtain their first job or a better wage. Their attitude was similar to undergraduate students, whose goal is the approving the course more than learning.

After the second meeting in class we observed two groups of students. The first group of students had Engineers with working experience; they arrived in time and participate actively in the Socratic dialogues. They enjoyed discussing about distributed systems technology and the challenges it imposed to the underlying network. They follow the links in the material we handed-out and used them during the debates to support their arguments. They were non computer-science Engineers. We classified them as "experts". We had learned from previous experiences in a Master course that this fact will lead to different learning strategies. The knowledge of experts will allow for effective use of sophisticated strategies, which will be not used by novices [Jacobson 2000]. The working experience not in computing but in problem solving makes the difference when covering complex issues [Feldgen 1999] [Clua 2004].

The in-class Socratic dialogues of the freshly graduated with no working experience were mostly of poor quality. It was difficult to engage them in debates and questioning. As each debate was highly correlated with previous one and we demanded for participation, these students came late and tried to leave early. We made Socratic dialogue sessions mandatory and it worked as a "pressure" system for many of them, but was seen as personalized attention by others. They belong to the second group.

The types of grid applications students chose were consistent with the group division, and it happened that none of the novices with undergraduate attitude joined an "experts" team. They all chose open grid computing projects, e.g. SETI@home project [SETI] to have a closer look to a distributed systems. Experts register in the grid community, installed the software and participate, analyzing the outcomes and statistics, distribution of the participants and source of the data and sink of the results, rewards, electronic devices suited for the processing, etc. The findings were shared and compared in the seminars debate. Novices restricted themselves to read the related material.

The results are plotted in Figure 1, where the students' summary reports indicates the significance of the different modes of working in their learning. For experts the preparation of the seminar, Socratic dialogues and the links had the greatest impact in their learning. Novices, on the other hand, complained that this learning method demanded to be up-to-date with the material discussed the class before and it took more out-of-class time that they had scheduled. It was very interesting they admitted they learned from their classmates' dialogues and conclusions. However, they declared they did not participated actively because they had not enough time to review the material of the class.

Experts use of analogies from their own field of engineering helped novices to understand complex issues and interactions. However, novices were not able to ask

questions during the Socratic dialogues.

Table 1 Activities in Figure 1

Activity	*Description*
A	Preparing my own seminar
B	Contribution of others' seminars
C	Seminar debates
D	Preparing for in-class Socratic Dialogues
E	In-class Socratic Dialogues
F	Argumentation using the links

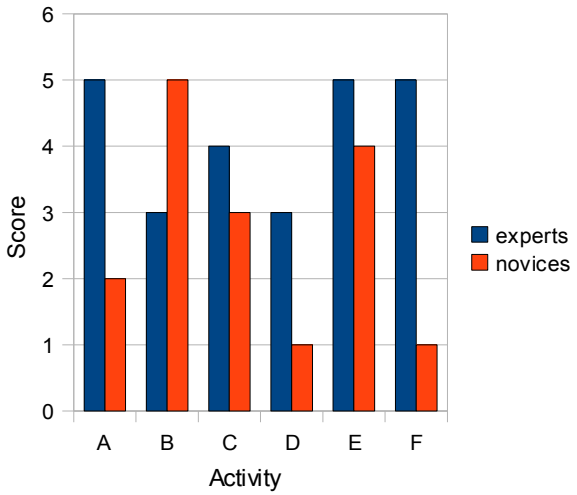

Figure 1. Student's evaluation of the significance of modes of working in their learning (Scale from 1=very little to 5= very much)

In Figure 2 we plotted the results of our data gathering about attendance, students participation and hands-in in time. We obtained a similar plot as in Figure 1. Experts had regular attendance, active participation and handed-in plans and reports in time. During their seminars they presented the application focusing and evaluating critically how it met the main goals of distributed systems. In many cases, they master to analyze complex software pieces. They posted questions and debated the alternatives. Novices, however, arrive late and remained passive, handed-in plans and reports late. They seminars focused on the application of the grid and it uses. The goals of distributed systems were left as questions for the debate.

Table 2 Attendance / participation in Figure 2

Type of Data	
A	After class sessions attendance and hand-in on time
B	Seminars attendance (mandatory)
C	Participation in seminar debates
D	Out-of-class assistance
E	Attendance to Socratic Dialogues (mandatory)

Type of Data	
F	References in the seminars reports

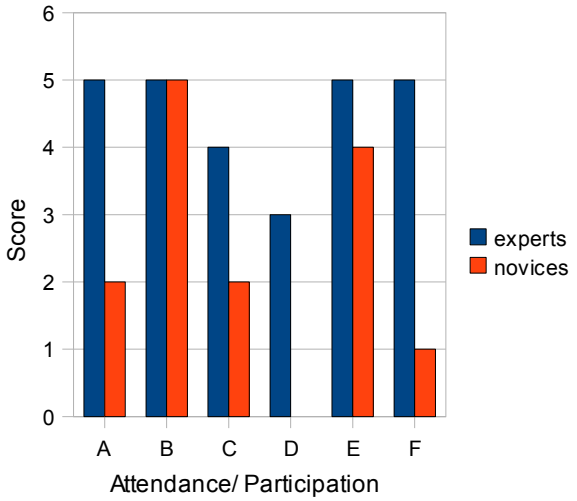

Figure 2 Students attendance / Participation in activities (scale from 1=very little to 5= very much)

The working proposal was successful. All the student teams presented and debated their seminars mastering the basic concepts and terminology of distributed systems.

The lack of expertise in computing was not a drawback at all.

6. Conclusion

Socratic dialogues and student seminars created a meaningful learning environment. Students prepared themselves by reviewing concepts and relating them to a real implementation of a distributed system. The hands-on experience with a real application was rewarding and motivating. Their interest increased during the course. Experts were more enthusiastic that novices and enjoyed the dialogues and seminars.

We noted that novices needed more time and more hints. The mandatory attendance to Socratic dialogues and seminars helped them to be up-to-date with the subject and to apply these concepts when they installed and began to "play" with the grid application.

Students enjoyed the experience, learnt about distributed systems and passed the exams.

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