The 2009 International Conference on Frontiers in Education: Computer Science and Computer Engineering (FECS'09)
July 13-16, 2009, Las Vegas, Nevada, USA.

Pair-teaching a course on Grid computing from two campuses on NCREN

Clayton S. Ferner[1] **and A. Barry Wilkinson**[2]
[1]Department of Computer Science, University of North Carolina Wilmington, Wilmington, NC, USA
[2] Department of Computer Science, University of North Carolina Charlotte, Charlotte, NC, USA

Abstract - *Since Fall 2004, we have been co-teaching a class on Grid computing to several NC institutions using the North Carolina Research and Education Network (NCREN). In this paper, we focus on a new teaching approach. In Fall 2008, we introduced a more integrated co-teaching or "pair-teaching" approach to the course. Our experiences are particularly relevant for a course taught in a distributed fashion, but it is also relevant for any co-taught course.*

Keywords: Grid computing, distance learning, collaborative teaching.

1 Introduction

Since Fall 2004, we have been co-teaching a class on Grid computing to several NC institutions using the North Carolina Research and Education Network (NCREN). This course has been taught four different times (Fall 2004, Fall 2005, Spring 2007, and Fall 2008) and included 15 North Carolina institutions at different times (see Figure 1). As far as we know, this is the only course that has actually uses a Grid to teach Grid computing. This has resulted in national attention [1], [2].

Grid computing takes advantage of the Internet by using geographically distributed computers for collaborative problem solving. In Grid computing, different organizations can supply resources and personnel, and the Grid infrastructure can cross organizational boundaries. Grid computing has become an important concept for high performance computing and has found its way into the permanent Computer Science curriculum at many schools in the country.

The technical content of the course has been developed over the period 2004-2008 to mirror the developments in Grid computing and also to enhance the special hands-on nature of the course. We now have seven assignments involving distributed computing resources. The technical details of the course are described elsewhere [3], [4], [5]. In this paper, we focus on a new teaching approach. In Fall 2008, we introduced a more integrated co-teaching or "pair-teaching" approach to the course. Our experiences are particularly relevant for a course taught in a distributed fashion, but it is also relevant for any co-taught course.

Figure 1: Map showing schools that have participated in Grid course

2 What we did differently

In this section, we describe some of these things we did differently than previous offerings. In the previous offerings (Fall 2004, Fall 2005, and Spring 2007), the course was primarily taught by one instructor with the other instructor playing a supporting role. In Fall 2008, we modified the structure of the course so that the responsibilities were fairly evenly split between the two instructors. In addition to the lectures being delivered by two instructors, we had to make a few modifications to make this work. This approach required close collaboration, including a telephone discussion before each class. The more salient differences are described below.

2.1 Put the web page in mutually accessible location

Since the course is a distributed course, it is imperative that the course materials are available on the web. Figure 2 shows the main class web page with links for other resources. With two instructors maintaining the pages, the web site needs to be in a location that is accessible to both. If only one of us can modify or publish the pages, then the other will need to email any changes. That is a very poor model for collaboration. It works much better if all instructors can make changes and publish the changes. However, this introduces a new problem: the critical section problem. We experienced the difficulty of both of us modifying the same web page simultaneously and thus losing the other's changes. Another problem was when one of us would modify a local, outdated copy of a web page, publish it, and consequently lose changes

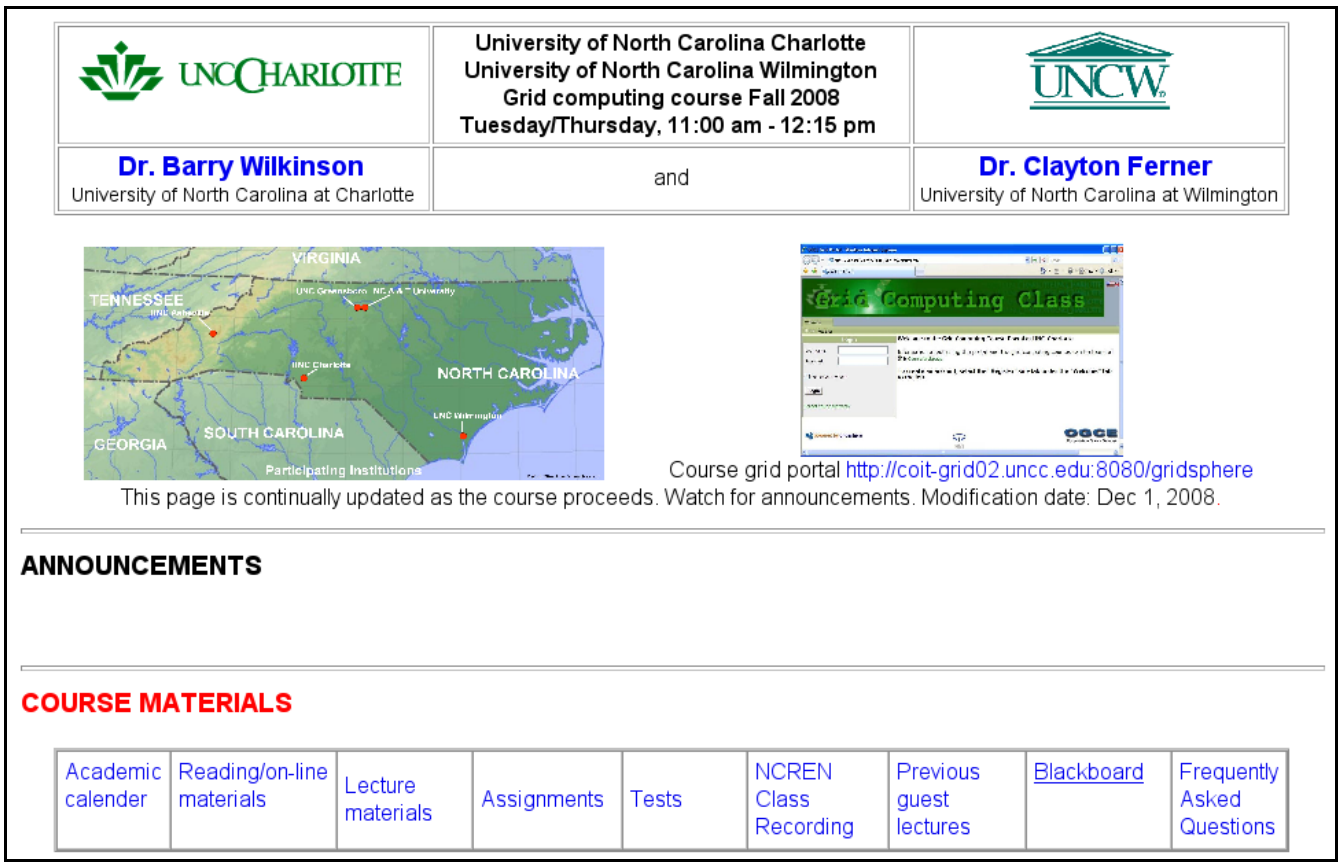

Figure 2: Class web page accessible by all instructors

made by the other instructor. So with multiple professors maintaining the web pages, two classic computer science problems need to be addressed: the critical section problem and the cache coherence problem.

The cache coherence problem is easy to address. Whenever one of us wished to modify a web page, he must first download a fresh copy from the server and modify that. The critical section problem is also fairly easy to address. We addressed the problem with a pseudo implementation of Peterson's solution to the critical section problem. Whenever one of us wished to modify a web page, he would need to send the other an email indicating his desire to modify the page and which page he wanted to modify. If his own email inbox was absent of an email from the other instructor wishing to modify that same page, he could then proceed. After saving, uploading, and publishing that page, the instructor would send an email to the other indicating its completion.

2.2 Split lectures

We tried to have each of us lecture approximately the same amount. This can be done in two ways: each lecture is divided into two halves or we simply alternate lectures. We actually used a combination of these two methods because breaks in lecture topics would naturally occurs at varying intervals and instructors are better informed, knowledgeable, prepared, or suited for different topics. Some days, one of us would lecture for approximately half of the period, and then the other would lecture for the remaining period. Other times, one instructor would lecture for the entire period or several days, and then the other instructor would take over for about the same length of time. The subject matter dictated this division. This alternating of lecturer helped to break the monotony of listening to one person speak. It is best if the speaker is lecturing from slides he or she authored, but this is not always possible. Figure 3 shows a picture of video transmission with instructors and other classrooms.

2.3 Split assignments

Each instructor wrote a different assignment. We tried to have the number of assignments written by each instructor be the same, but with seven assignments, this was not perfectly balanced. The choice of assignments was done to align with who gave the lecture on that material covered by the assignment. Also, the instructor who wrote an assignment had responsibility for grading it. This certainly makes sense from an instructor's view point. The downside to this is the potential for different grading standards or process for different assignments.

Figure 3: Picture of video transmission with instructors and other classrooms

2.4 FAQ

The nature of Grid computing is that there are many mistakes that can be made along the way. The error messages or results that one sees is not always indicative of the error. Computer Science students experience this when they are first learning to program. The error messages produced by the compiler are quite often different or in a different location than the actual error. It requires experience to interpret the error message in order to figure out the real problem. To help the students with this, we maintained a FAQ page on the course web site (shown in Figure 4). Although, this took some additional effort for us to maintain, it ended up being a time saver in the long term. Instead of answering the same question individually for more the 50 percent of the class, we would copy the question and answer to the FAQ for all students to access. It did not take long for the students to learn to look for the FAQ first before emailing their question.

FREQUENTLY ASKED QUESTIONS

Modification date: Oct 14, 2008

- Portal Errors

1. I cannot get a job to execute from the portal.
2. I cannot get a valid proxy.

- Command line Errors

3. I cannot login to torvalds.cis.uncw.edu.
4. When I try to run the globusrun-ws command, I'm getting an error that says "OpenSSL Error: pem_lib.c:401: in library: PEM routines, function PEM_do_header: bad password read"
5. When I try to run the globusrun-ws command, I'm getting an error that says "Fault string: org.globus.wsrf.impl.security.authorization.exceptions.AuthorizationException: '.....' is not authorized to use operation: {http://www.globus.org/08/2004/delegationService}requestSecurityToken on this service"
6. When I try to run the globusrun-ws command, I'm getting an error that says "Fault string: org.globus.wsrf.impl.security.authorization.exceptions.AuthorizationException: '.....' is not authorized to use operation: {http://www.globus.org/08/2004/delegationService}requestSecurityToken on this service"
7. When I try to run my java program, I'm getting an error that says "Exception in thread 'main' java.lang.NoClassDefFoundError: ....."
8. When I try to run my java program, I'm getting an error that says "Exception in thread 'main' java.lang.UnsupportedClassVersionError: Bad version number in .class file"
9. When I try to run a program, I'm getting an error that says "Invalid executable path '....."
10. When I try to run a java program, I can't find where the results.

Figure 4: Excerpt of Frequently Asked Questions

Table 1: End-of-the-semester survey results

	Statement	Mean (n=12)	SD
1	The course stimulated my thinking about Grid computing.	4.75	0.45
2	The course enriched my understanding of key concepts and principles.	4.67	0.49
3	The course materials enhanced my learning.	4.58	0.51
4	The lesson sequence supported my learning.	4.42	0.51
5	Course assignments were instrumental to my learning.	4.42	0.67
6	The instructional media (e.g. web pages, videos) enhanced my learning.	4.42	0.79
7	My questions were adequately addressed by the instructors.	4.33	0.65
8	The instructional methods used in the course facilitated my learning.	4.33	0.65
9	I was encourage to participate actively	4.33	0.65
10	I was encouraged to take responsibility for my own learning.	4.33	1.15
11	The course delivery method (remote lecture and online materials) was conducive to my learning.	4.17	0.94
12	The knowledge and competencies I developed in this course will contribute to my professional performance.	4.08	0.79
13	Interaction with classmates assisted my learning.	3.33	1.15
14	How would you rate the level at which the course material was presented?*	3.25	1.42

Scale: Strongly Disagree (0) – Strongly Agree (5)
* Too Easy (0) – Too Difficult (5)

The real benefit of the FAQ will probably be experienced the next time the course is taught. The FAQ was continually updated through the due date for each assignment. Even though we tried to anticipate student errors, there were still errors we could not anticipate and the FAQ page evolved throughout the semester.

3 Successes/Failures

The changes that we made to the course listed in the previous section all improved the experience of the students in the classroom. We consider those to be successes.

What did not work well and what needs improvement is the interaction with the students. Teaching a distance course, in which most of the students are watching a transmission of the instructor and material, is not conducive to student interaction. There is already an intrinsic reluctance by students to speak up and ask questions. When students are in an environment where their picture and voice is broadcast to other sites, they are even more reluctant to speak. Furthermore, the class was recorded and a video stream was available on the Internet.

We intended to have more time in class where we reviewed previous topics and asked the students questions to access their level of understanding as well as to facilitate more class discussion. We were not very successful with this idea. Having a review session and preparing questions adds to the preparation time for the course. Since this review material must take a lower priority than preparing lecture material, it was quite often neglected.

4 What we learned

An external evaluator administered an end-of-the-semester survey for the students to fill out. Of the 39 students eligible for the survey, only 12 (31%) responded. There were several Likert-style questions, where the students indicated a level of agreement with a statement, 0 meaning “Strongly Disagree” or “Too Easy” and 5 meaning “Strongly Agree” or “Too Difficult”. Table 1 shows the mean and standard deviations for the scores given on these questions.

Most of the responses to the statements were between 4 (Agree) to 5 (Strongly Agree) with low standard deviations. Statements 6-8 and 11 are most relevant to this paper. These scores show us that the experience of learning in a distance classroom and our efforts to co-teach the course are largely

successes. We are please and perhaps a little surprised to get such a good response to feedback on the instructional media and delivery method. The response of 4.33 to the statement, "My questions were adequately addressed by the instructors" is probably a result of having the FAQ page.

There are high standard deviations for the responses to statements 10 and 14. This indicates that the students were marginally challenged by the content of the course, and we should step up the level in the next offering.

Finally, there is a relatively low score in response to the statement, "Interaction with classmates assisted my learning." Although this was not a primary goal for our course, this might be indicative of the low level of classroom interaction. In the section of the survey where the students may enter comments for suggestions, most of the comments related to specifics of the assignments or tests. There were, however, comments where students indicated their desire to have a session before or after class for them to ask questions. We allowed and encouraged students to ask questions during class. Although there were some students that felt comfortable asking questions during class, comments like these indicate that there is still a level of reluctance in speaking up during class in a distance-education environment. This is an issue that needs to be addressed. We have two suggestions we might try in the next offering of this course. First, we can try turning off the recording of the class for the video stream during a period when we allow and encourage student questions. Second, we can allow another method for questions to be presented, such as email or some anonymous transmission.

5 Previous Work

The concept of team teaching in which teachers collaborate on the curriculum is used extensively in elementary, middle and high schools. It has been explored in colleges and universities. Sample publications include [6] and [7]. Collaboration across institutions has also been reported [8]. Sometimes, the team is formed because of the interdisciplinary nature of the course and each instructor provides specific skills. Our work differs from previous work in that the course topic itself is about collaborative computing (Grid computing). Both instructors are capable of teaching the whole course and can support the other directly. Our course is co-taught mostly in each class period and not separate classes each. It uses the teleconferencing facilities and shared web sites. The motive of our work, as others, is to improve the teaching environment, but our case focuses on the distance learning environment and a highly technical computer science subject.

6 Summary

Our approach of "pair-teaching" has a number of distinct advantages:

- Shorter more focused lectures divided between the instructors
- Students are exposed in one class period to differing lecturing styles providing more interest
- The instructors complement each others' strengths for the benefit of the class
- As one instructor makes their presentation, the other instructor can assist in guiding discussions.

We have used our pair-teaching approach for a specific distributed computing course (Grid computing), but the approach is applicable to any Computer Science course taught at one site or taught in a distance learning environment. The actual subject matter is not significant. Our objective is to improve the delivery of course content and improve the learning environment.

We plan to offer this course again in Spring 2010 and use this style of pair-teaching again. We will try to address the shortcomings we experience. However, we feel that this pedagogy was largely a success and warrants its continued use.

7 Acknowledgements

Partial support for this work was provided by the National Science Foundation's Course, Curriculum, and Laboratory Improvement (CCLI) program under Award Nos. 0410667/533334 and 0737318/0737269/0737208. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Surveys were administered and results were collected and analyzed by East Main Education Consulting, LLC.

8 References

[1] K. Yurkewicz, "Distributed Classes For Distributed Computing," Science Grid This Week, December 14, 2005, repeated in GridToday, December 19, 2005.

[2] C. Ferner and B. Wilkinson, "Opinion - New Developments in Teaching Grid Computing Across North Carolina," International Science Grid This Week (iSGTW), March 26, 2008.

[3] M. A. Holliday, B. Wilkinson, J. House, S. Daoud, and C. Ferner, "A Geographically-Distributed, Assignment-Structured Undergraduate Grid Computing Course," SIGCSE 2005 Technical Symposium on Computer Science Education, St. Louis, Missouri, February 23 - 27, 2005.

[4] B. Wilkinson and C. Ferner, "Teaching Grid Computing across North Carolina" IEEE Distributed Systems Online, vol 7, no 6/7, 2006.

[5] B. Wilkinson and C. Ferner, "Towards a Top-Down Approach to Teaching an Undergraduate Grid Computing Course," SIGCSE 2008 Technical Symposium on Computer Science Education, March 12-15, 2008, Portland, Oregon.

[6] Francis J. Buckley, "Team teaching: what, why, and how?" 2nd ed., Sage Publications Inc, 1999.

[7] James R. Davis, "Interdisciplinary Courses and Team Teaching," American Council on Education/Oryx Press Series on Higher Education, 1995.

[8] B. Gatliff and F. Wendel, "Inter-institutional Collaboration and Team Teaching." The American Journal of Distance Education. Vol. 12, No. 1, pp. 26-37, 1988.