A post participation review of the North Carolina State University's online graduate credit physics course for teachers PY610C: Special Topics – Matter & Interactions II for Secondary School Teachers

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*A high school physics teacher reviews PY610C – Special Topics: Matter & Interactions II for Secondary School Teachers, an online graduate credit course offered by the North Carolina State University. Some aspects of this course that enhanced my learning experience included the videotaped classes, the hands-on lab experiments, and the online teleconferences. While the teleconferences were helpful, one of the negative aspects was that participation was not mandatory and therefore many students did not attend them. Another difficult aspect of the course were those lab assignments using the VPython computer modeling software -- while the programs were useful visual aids, creating the computer programs was difficult. Overall, the course was enjoyable and a worthwhile learning experience for teachers who want to improve their knowledge of electricity and magnetism. There are some minor credit transfer caveats. **

Introduction:

The North Carolina State University (NCSU) Physics Department offers several on-line graduate credit courses for teachers who want to improve their conceptual understanding of physics as part of professional development. Here I present a post participation review of PY610C - Special Topics: Matter & Interactions II for Secondary School Teachers, which I took in Fall 2006 for credit toward my M.S.Ed. (Physics) degree from Buffalo State College (Buffalo State College, 2008). I found PY610C to be a worthwhile investment. PY610C improved my conceptual understanding of electricity and magnetism, made it easier to understand the abstract concepts in E&M, and helped me see how the fundamental principles of physics apply to the array of problems one encounters in E&M.

Literature:

In recent years, online courses have gained in popularity. However, there are still many questions about them. In a letter to the editor of *The Physics Teacher*, James O'Connell (2001) asked several questions about the logistics of teaching an online course, including how to handle student questions, how to have students perform laboratory activities, and whether students learn as much in this medium. These are some issues that professors need to consider when deciding whether to teach a physics course online and how to design the course if they do decide to teach it.

The online environment is very different than the traditional classroom, and physics teachers need to modify their current classes in order to meet the needs of students in this environment. The traditional method of lecturing does not lend itself to the online format as well as it does to the regular classroom (Abdelraheem, 2003). In the online environment, students have a great deal of responsibility for their learning, Therefore, course expectations need to be clearly defined so that students know the amount of work they need to complete on a daily/weekly basis (Radnofsky & Bobrowsky, 2005). Teachers also need to facilitate discussion among students in an online class and "promote active learning" (Boada, 2001).

There are many advantages to taking a physics course online. Online courses allow access to a greater number of people. Many students who take online courses work, have families, or live far away from the college where the course is being offered (Radnofsky & Bobrowsky, 2005). In addition, online courses might increase a student's level of participation. In a normal classroom, students learn how to avoid participation. However, many online courses include participation as a portion of the grade and therefore can encourage greater participation than traditional classes. In Chester & Gwynne's (1998) study, two thirds of students indicated that they were more likely to participate in an online class than in a traditional class. Anonymity may allow some students who do not ordinarily feel comfortable sharing their ideas in front of others to feel more comfortable with doing so. Howard Rheingold (1994 as cited in Chester & Gwynne, 1998) commented that people find "virtual communities treat them as they always wanted to be treated – as thinkers and transmitters of ideas and feeling beings."

Another advantage (particularly to working teachers) of online physics courses is that there is a great deal of schedule flexibility to the student. Physics students can do the coursework when it is convenient, at any time of the day or night, instead of being confined to the classroom for three hours every week (Smith & Taylor, 1995). Online courses also allow students to ask questions at any time instead of having to wait until they are in the class or for the professor's office hours (Merrill, 2001). The use of discussion boards is also an advantage that online courses have over traditional classroom course. Discussion boards offer a place where students can reflect on their learning. This allows

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teachers to keep a running tab on how students are achieving their learning goals for the course (web logs and online discussions as tools to promote reflective practice).

Even though there are many advantages to online courses, there are also several disadvantages. In this environment, students have a great deal of ownership over their own learning. Students need to be self-motivated and self-disciplined while taking an online course. Radnofsky and Bobrowsky (2005) found that several of the students that took their online course commented that it was more difficult to meet the high standards of an online course than a traditional course. There are many reasons why online courses can be difficult for students who are not self-disciplined. If deadlines are not strictly enforced, it is easy to let work pile up and become insurmountable (ibid; Pearson 2006). Also, in this environment, there is minimal interaction with classmates. When solving problems or working on a lab activity, there are minimal opportunities to see how others solve problems (Merrill, 2001). One final disadvantage of online courses is that one must not only have regular access to a computer but must also be good with computers (ibid; Pearson 2006). While taking an online course, many different types of technical issues can arise, either with accessing materials online, viewing a course lecture, or completing or submitting homework.

My Experiences:

During the summer of 2006, I was working towards my M.S.Ed. (Physics) degree from SUNY-Buffalo State College (Buffalo State College, 2008; MacIsaac, Henry, Zawicki, Beery & Falconer, 2004). Because I live in Southern New York State, about six hours by car from Buffalo, I had to look at online course options for the fall semester in order to complete my degree. I had recently taken an intensive three-week summer academy course in electricity and magnetism at Buffalo State called PHY622 that included some brief readings from the first edition of the *Matter and Interactions II* text (Chabay & Sherwood, 2007). Because I have always struggled with electricity and magnetism, I felt taking another course on this topic would be a good idea. I had several different courses to choose from; I decided to take *Matter and Interactions II* for Secondary School Teachers. I had heard many good things about the course and about the instructor from Buffalo State faculty and colleagues, and I felt it would be a worthwhile endeavor.

The North Carolina State University Department of Physics course PY 610C: Special Topics: Matter & Interactions II for Secondary School Teachers is described in the department online literature as:

> *"This calculus-based course provides a deeper and broader understanding of the fundamental physics underlying the electricity and magnetism taught in regular and AP high school physics courses. Atomic nature of matter; emphasis on fundamental principles; computational physics (no prior) programming experience required; modeling messy real-world problems. Participants engage in reflections on the pedagogical consequences of the modern view of the subject. The course will assist teachers in helping their students understand current scientific research and discoveries." (NCSUa-c, 2006).*
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> *Course prerequisites are a teaching certificate in science or mathematics, or permission of the instructor. Information on how to register for the course can be found on the distance learning website (NCSUa-c, 2006).*

In order to take the course, I needed to fill out an online lifelong education application. After this was completed, I was able to register for the course. The total cost for the three credit PHY 610C course as an out of state student in Fall 2006 was $1239 (in state students pay approximately $600 less). After signing up for the course, I had to sign up for WebAssign (an online homework system) (WebAssign, 2006), which was an additional $10. As a participant in the course, I was given access to the weekly teleconference sessions and access to the discussion forum. The textbook for the course, *Matter and Interactions II: Electric and Magnetic Interactions* (Chabay and Shwerwood, 2006a) cost approximately $85. There is also an optional experiment kit available for $45 (NCSU 2006c). The kit makes it possible to do several of the labs required for the class. It is possible to assemble the kit contents yourself; however, some of them are difficult to obtain. In order to complete the computer modeling labs, I also had to download and install the free VPython computer programming software (VPython, 2006). After registering for the course, I received a set of 4 CDs with interactive video lectures by Prof. Chabay, though Prof. Sherwood was the actual instructor of record.

In order to succeed in the course, a modern computer with internet access, an e-mail account, *Adobe Acrobat Reader* (freely available), and *RealPlayer* (freely available) was required in order to view the lectures. In order to participate in the online teleconference, DSL or a cable modem is necessary. Also, working speakers are necessary, and a microphone is suggested. Other information necessary for success in the course were available on the course website and individually from the instructor. The interactive video lectures were sent out immediately after registration for the course.

The course included weekly readings, labs, interactive lectures, homework assignments, three exams and a final. The exams were all short answer, including material from all aspects of the course. We were also required to make a weekly post in the discussion forum, and there was an optional Sunday night teleconference.

There was approximately ten hours of work required for the class each week. There were three classes per week, which were each approximately one hour. The lectures were unique since there are approximately three to five breaks during the lecture during which you are prompted to answer a question (either multiple choice or short answer). After you answer, the instructor displays a histogram of the original class responses, and a discussion of the correct answer ensues. These breaks provide you with an opportunity to check your understanding and reflect on the material in the lesson.

In addition to watching the lessons each week, there was weekly textbook reading, a lab activity and an assignment on *WebAssign*. The assignments on *WebAssign* reviewed the content of the lesson and the textbook reading. The homework assignments were often thought provoking. If homework assignments were done incorrectly, students had the opportunity to resubmit them up to four times for full credit. There was also a weekly lab that needed to be completed. The lab activities consisted of either experiments or computer modeling. The experiments involved investigating phenomena that were being studied in class. The computer modeling involved writing short computer programs in the *VPython* programming language that represented the phenomenon studied in 3-D in the class lecture. Prior knowledge of *VPython* was not required. The first computer modeling lab was an introduction to programming in *VPython*, and the subsequent labs included the programming knowledge necessary to complete the program.

Along with the above activities, students were required to make a weekly post on the discussion board. The post could either be a question or reflection on the recent work (which could include how it might potentially affect your teaching). You could either start your own thread on the discussion board or add to a thread that was already started.

Finally, there was a weekly teleconference every Sunday night. Here students were able to ask questions and clear up any misconceptions from the week. The instructor would take part of the time to ask an extension question and have us work together in small groups on the problem.

Findings:

Overall, I had a great experience in this course. My experiences as both a student and teacher of physics have taught me that many physics students lack a good conceptual understanding of electricity and magnetism. The course was focused on presenting a strong conceptual understanding of the fundamental concepts underlying electricity and magnetism and helped improve my understanding. The text authors and instructors are well-known scholars in Physics Education Research (PER) and curriculum development and are amongst the leading figures in the field for introductory electricity and magnetism teaching in particular (Chabay & Sherwood, 2007c).

Although it is an online course, the instructor made many different learning experiences available that went beyond many of the experiences in other online courses. The videotaped classes were a major strength of the course. They reinforced the readings and gave the experience of being in the classroom. I felt the breaks in the lectures gave the opportunity for a great deal of feedback during each lesson. I always had an opportunity to answer the questions presented to the class, and I was provided with feedback on both the correct and incorrect answers.

The online teleconferences were another advantage of the course. There was a great deal of interaction in these sessions. Students could either use the microphone or the keyboard to ask or respond to questions. All of the participants also had access to a virtual whiteboard. Many times the instructor would ask an application question, then break us up into small groups where we could discuss it on our own, then report back to the whole group. During the course of the week, I would often have questions about the topic we were studying and the online teleconferences provided me with an opportunity to get these questions answered. Although the instructor preferred questions relating the prior week's content, he was also willing to answer any questions students had. The teleconferences were like having built in office hours every week! Along with the teleconferences, students also had the opportunity to ask questions on the discussion board. Questions were often responded to by both other students and the instructor. Responses were often posted within a day, and the answers were often thorough. The instructor was also available via e-mail for any course related questions.

When studying electricity and magnetism, it is important to have concrete experiences in order to reinforce the learning from class. An advantage of this course is that it has hands-on lab experiments. The labs were not only measurement based. Students were asked to make predictions, give the reasoning for the prediction, perform the experiment, then go back to the original prediction and explain whether the results confirm or contradict your original thinking. The labs involved a balanced amount of thinking, experimentation, and reflection on the experiment. They helped build a conceptual understanding of the course material.

Another strength of this course was that technical issues were resolved immediately. At the beginning of the course, there was an issue with a defective course CD. Since the interactive video lectures were an integral part of the course, this was a significant problem. This issue was resolved immediately by the instructor; new CDs were shipped out to all of the course participants on the day that the problem was discovered.

One of the disadvantages of the course was the lack of participation in the teleconferences by many students. At the beginning of the course, the instructor asked for feedback on the scheduled day and time of the online teleconference. There was little negative response about the day and time, so the teleconferences were kept on Sunday night at 8:00 pm EST. In the beginning, most of the class attended the teleconferences. However, attendance was not a mandatory part of the course and as the semester went on, fewer and fewer people attended the sessions. By the end of the course, only approximately four to five students would attend the sessions. I think that it would have been beneficial to all students for the teleconferences to be mandatory because having greater participation would have enhanced the effectiveness of this part of the course.

The final product of the *VPython* labs (3-D visualizations of the concepts), such as the electric field of a single charged particle, electric field of a dipole, and path of a proton in a magnetic field were useful 3-D animations, which are very helpful visual aides. However, this is one aspect of the course with which I struggled. During the course of the semester, we completed twelve labs. Five of the labs were computer modeling using the *VPython* software. These labs would generally take one to three hours. We were given detailed instructions on how to complete the labs. However, even with these instructions, I still struggled with several of the labs. These lab activities required both an understanding of vectors and knowledge of the *VPython* software. Because this programming software was new to me, I experienced difficulty when I was trying to translate the physics into a working *VPython* program. This is one aspect of the course that I found too difficult to complete via distance learning (even with the opportunity to send it to the instructor for assistance). Although the final products were useful, I felt the experimental labs were a much more worthwhile learning experience.

I found the lab experiments to be extremely worthwhile. However, I found that I was often in need of a second pair of hands in order to do the experiments well. There were also two labs that I had to modify, because I had errors with my initial calculations. Being on one's own to complete the labs properly seems to be an unavoidable consequence of a distance education course with a lab component.

In order to succeed in the course, participants should have prior experience with the concepts of electricity and magnetism. If possible, it makes sense to take the Matter and Interactions mechanics course first, as it provides a strong foundation in 3D vectors, *VPython* computation, electric forces, and electric potential energy. The electricity and magnetism course has built-in review, which allows students to succeed without first taking the mechanics course, but less effort would be required for students who have taken the prior M&I course.

It is also important to have a working knowledge of calculus, including familiarity with derivatives and 3-D vector analysis because it is used throughout the course. The first day of class and homework assignment is a review of vector analysis of vectors in 3-D. Familiarity with computers is also important. Although no prior computer programming is necessary, it can be difficult to independently write computer programs. Some of the computer programs were difficult. However, it was nice to see a 3-D model when the computer program was complete.

I did encounter an issue when transferring credit to my M.S.Ed. (Physics) program at SUNY- Buffalo State. The NCSU PY610C designation is for an experimental course, granting grades of either satisfactory or unsatisfactory (S/U). I had to petition the transfer of such a course to my degree program, due to a standard policy that S/U courses not be transferred. At Buffalo State, only grades of B and above are routinely transferred. Luckily, Dr. Sherwood provided a memo explaining the experimental nature of the course and provided me with a letter grade. NCSU Physics is moving PY610C to a standard course designation with real letter grades, so you may not have to make such a petition.

Summary:

I feel my experience in this class was comparable to a traditional university course. The online nature of the course is its major advantage – it can be taken from anywhere in the country. There were several weeks where I put more than 10 hours into the course. This can create difficulty for working professionals. Trying to balance homework, labs, readings, and video lectures can be difficult while teaching a full load. In order to get the most out of the course, some time should be dedicated a few days a week in order to complete the weekly assignments. I felt the benefits I received from the course were well worth the time I put into it. The technology associated with the course can be challenging for those not comfortable with significant use of computer video playing, conferencing, or *VPython* programming. I STRONGLY RECOMMEND this course to any physics teachers that want to enhance their conceptual understanding of electricity and magnetism by learning the fundamental principles that govern electrical and magnetic interactions.

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