Andragogy in a Web Technologies Course
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Abstract
The face of the student body in post-secondary degree programs in the United States is changing as an increasing number of students work full-time while attaining an advanced degree [13]. As the student population includes greater numbers of working professionals, a corresponding change in the instructional approaches used to educate the maturing student population is required. Knowles' theory of andragogy [9] is a set of principles that can be used to guide adult learning. This paper describes an application of andragogy to a graduate-level Web Technologies course comprised of working professional students. In this paper, the working professional is characterized and an educational philosophy based on the theory of andragogy is presented. The application of andragogy to a Web Technologies course is described and the results are discussed.

1. Introduction
A recent report from the National Center for Postsecondary Improvement [13] indicates that increasing numbers of students are working full-time as they study towards a bachelor's, master's or Ph.D. degree. In addition, the demand for technologically educated workers, especially in the area of Information Technology (IT), is greater than the number of available skilled employees [7,14]. As a result, the face of post-secondary education is becoming more mature as more students are working full-time while attaining an advanced degree on a part-time basis. Academic institutions are responding to the changing student population by providing a wider range of educational opportunities [1,12]. This paper describes an approach to educating these working professional students based on Knowles' theory of andragogy [9] as demonstrated in a graduate-level Web Technologies course.

The rest of this paper is organized as follows: Section 2 explains the educational philosophy by describing the Rensselaer at Hartford environment, characterizing the working professional student and outlining Knowles' theory of andragogy. Section 3 describes the Web Technologies course. The application of the theory of andragogy to the Web Technologies course is discussed in Section 4, including instructor and student perspectives of the course. Section 5 outlines areas of future work.

2. Educational Philosophy
The educational philosophy used in the Web Technologies course is driven by the characteristics of the population of working professionals, as observed in the student population at Rensselaer at Hartford.

2.1 Rensselaer At Hartford
Rensselaer at Hartford (RH), a branch of Rensselaer Polytechnic Institute (RPI) located in Hartford Connecticut (www.rh.edu), has a forty-four year history of educating the working professional. RH's primary mission is to provide application-oriented master's degrees in Computer Science, Engineering, and Management to working professionals. RH has a student enrollment of around 2000 graduate students, approximately 285 of which are enrolled in the MS in CS as of Fall 2001. A typical student at RH is employed full-time in a diverse array of companies ranging from engineering institutions like the United Technology Corporation's family to insurance and financial services organizations like Actena. Student ages range from middle twenties into the fifties and students enter the Computer Science program with a spectrum of backgrounds that include undergraduate degrees in computer science, accounting, mathematics, and engineering. Students attend classes on a part-time basis and classes are held one day a week from 5:30 to 8:30 p.m.

2.2 Characteristics of Working Professionals
One obvious characteristic of a working professional student (WPS) is their background of work experience. This practical knowledge impacts the educational process of the WPS in two ways. First, experience provides students with a store of learning upon which to base decisions. Second, this knowledge is a valuable learning resource and should be distributed among all members of the class.

The WPS is a very motivated, goal-directed student, bringing a focus of purpose into the classroom. The WPS is a self-directed learner where student inspiration comes from their own desire to enhance their employment situation or to change professions. The WPS desires a direct application of
in-class learning to work situations. This highly motivated, goal-driven characteristic requires that education for the WPS include hands-on application of material, as well as the incorporation of real-world examples, case studies, work-related projects, etc.

In addition to being highly motivated, the WPS brings a maturity into the classroom as a result of their work experience. The impact of this maturity on the educational process is twofold. First, the WPS is careful to complete assignments that fulfill the requirements within the specified time frame and frequently go beyond assignment requirements. Second, the WPS is capable of clearly assessing their progress, resulting in few late drops and few complaints about grades.

Another characteristic of the WPS is a well-developed set of ethics. Due to their work experience, the WPS understands the implications of ethical choices in business and has a clear grasp of the pressures of the business environment. One impact of the developed ethics of the WPS is a very low occurrence of cheating.

Due to work experience, the WPS typically has refined communication skills. Correspondingly, the WPS frequently also has developed negotiation skills and is familiar with working in teams. The WPS is an active collaborator with classmates during the learning process. In addition, the WPS understands the value of working in teams and little if any instructor facilitation is required for teams to function efficiently.

There are several other characteristics of working professionals that have a direct impact on their learning process. The WPS population’s age span is wide with students ranging from their mid-twenties into their fifties. In addition to work-related time requirements, the WPS frequently has a family which further decreases time available to be spent on education. The WPS is geographically dispersed from classmates, and some travel over an hour one-way to attend class. These constraints require that learning for the WPS be a focused, efficient process with clearly identifiable goals.

Others have observed similar characteristics of the WPS. Hofinger and Feldmann [6] describe characteristics of adult learners that include a foundation of work experience, family and job constraints, high incentive to learn, and maturity and focus of purpose. Depew et al [1], indicate that the learning process for the WPS is impacted by career goals and professional responsibilities, and state that student profiles must be considered when constructing and executing a successful education program for the WPS.

2.3 Andragogy
Malcolm Knowles published his theory of andragogy in his 1973 book The Adult Learner: A Neglected Species [10] (updated in 1998 [11]). The term andragogy currently refers to a model of self-directed learning primarily used in adult learning. The main theme of Knowles’ theory is that adults are independent, self-directed learners and that adults expect to be held accountable for their learning. Knowles’ theory is based on five tenets:

1. Effective adult learning must be relevancy-oriented. Adults want to understand the importance of the subject matter and learning should be applicable to their work or other responsibilities. Education for the WPS needs to be solidly motivated, typically through demonstration of the benefits of the correct application of the material. In addition, theories and abstract concepts need to be concretely connected to a familiar domain.

2. Adults are self-directed learners and need to be free to control their learning experience. The major educational impact of this principle is that the course instructor is no longer in the position of leader, but must take the position of facilitator who guides the WPS in the knowledge discovery process rather than providing the knowledge directly. Instructors must allow the WPS to take responsibility for their own learning by eliciting WPS perspectives about course material and project domain and approaches.

3. Experience is the main foundation for learning activities for adults. Adults have accumulated a knowledge base of experience from work, previous education, and life which must be recognized by the instructor. The sharing of this experience with all class members builds a common foundation of learning for the class as a whole. In addition, the WPS prefers a learn-by-doing educational approach.

4. Adults are practically-oriented learners. Due to the time and resource constraints on the WPS, they are most interested in learning material that is directly relevant to their employment or personal lives.

5. Adult learners are goal-oriented. The WPS approaches education with a set of goals. Therefore, an educational program for the WPS must contain well defined elements and the achievement of these goals must be clearly outlined. Adult education structured in the form of questions to be answered and problems to be solved is highly effective.

3. The Web Technologies Course
CISH-696X Web Technologies was first introduced in the Fall of 2000 and is an introductory graduate-level course. The only formal prerequisite is CISH-4020 Object Structures, an object-oriented data structures course. However a working knowledge of Java including interfaces, exceptions, and threads is also assumed.

The underlying idea behind Web Technologies is to educate students in the practices and key technologies used to develop and support a commercial-grade web site from client side through to server. Students begin by learning about internet protocols, browsers, server technology, and security, and then progress to learning individual technologies. The course investigates the most current technologies including DHTML, XML, Servlets, Java Server Pages, and JDBC. Emphasis is placed on hands-on application of the
technologies both within the class via workshops and outside of class via assignments. On-line references are used for background material and Hall's books Core Web Programming [5] and Java Servlets and JavaServer Pages [4] are used to provide material on web programming. Hunter's book Beginning XML [8] is used as an XML reference.

The Web Technologies class is held in a computer classroom one evening a week. Enrollment is limited by classroom size and varies between 24 and 34. Grading is based on a semester-long project broken into five cumulating assignments (50%), and four quizzes (50%). The course is supported by a complete web site and a listserv in which all students are required to participate.

4. Andragogy in the Web Technologies Course

Other educators have reported success in employing Knowles' theory of andragogy. Dick, et al, [2] indicate that the application of andragogy can have a positive impact on an undergraduate software engineering practice course. Goodnight et al, [3] describe the use of andragogy to maximize adult learning at Purdue. In this section, the application of Knowles' theory of andragogy to the Web Technologies course is described and instructor observations on the results are provided. This discussion is based on two semester offerings of Web Technologies with a total enrollment of 58 working professionals.

Support for Knowles' first principle of relevancy-oriented education is easily supported in the Web Technologies course through the subject matter content. Students are accustomed to using the web either to accomplish tasks at work or to fulfill personal goals on a daily basis. Students usually enter the course with a high interest in understanding how their favorite web page is constructed. In addition, the web is a very visual medium and examples showing the utility of most concepts are presented in class.

The most effective step taken to support Knowles' second principle of self-directed learning is that the instructor steps out of the role of leader both inside and outside of the classroom. The first class meeting is begun by informing students that the instructor is not an expert but the instructor would provide initial information and direction, which clearly puts the burden of learning on the students. It is also stated that students' learning objectives will be accommodated as long as they can be incorporated into the academic framework of sufficient scholarly content and grading. Students are warned that it is the individual student's responsibility to independently learn the subject matter in sufficient depth to be able to complete the project and the need for collaborative learning from peers is stressed.

To reinforce students' perception of the instructor's role as facilitator, guidance and direction is provided throughout the entire course via several mechanisms outside of the classroom. An extensive list of references is supplied (http://www.rh.edu/~heidic/webtech/links.html) that provides a broad base of sources from which students can learn. At least one on-line reference for each topic in the syllabus is provided (http://www.rh.edu/~heidic/webtech/syllabus). A collaborative environment of mutual respect is created within the class by frequently turning questions asked in class back to the class to be answered and the instructor asking their own questions of the class. This further supports the stance of the instructor as a guide rather than a leader. Items that the instructor learns from students are highlighted, and individual students are encouraged to become subject-matter experts by the instructor asking them to provide a summary of their experience with a topic. Input on future assignments is elicited by asking students for direction and the class often decides the due date of assignments.

Knowles' third principle of experience-based learning is supported in two ways. First the experiences brought to the class by the students are utilized, which provides a fertile foundation in which to base learning. At the beginning of the course, the value of experience is emphasized and reports where students relate how they have used course material to solve business problems are encouraged. For instance, one student polled his classmates for the usefulness of storing data in XML and received several real-life experience stories. Students from past offerings of Web Technologies are also invited to subscribe to the current listserv, allowing experience from past semesters to be carried over to the current group of students. Second, as much hands-on application of the subject material is provided as possible. Each class meeting is organized around a series of short presentations of subject material followed by hands-on workshops which allow students to immediately employ the knowledge. In addition, when a student has a question in class that question is answered by applying the technology whenever possible.

Knowles' fourth principle of practically-oriented learning is supported with the same ease as Knowles' first principle of relevancy-oriented learning. Examples that show how material has been applied in work situations are employed. Students are eager to relate work-related experiences to the class and frequently bring work-related problems to the class for solutions. For instance, one student's request for guidance in constructing an architecture for a new web application led naturally into a discussion of servlet-centric versus page-centric architectures. The impact of not applying some topics (e.g., security, SSL, etc.) is also discussed and examples showing the result of lack of application of the material are supplied.

Knowles' fifth principle of goal-oriented learning is fulfilled through a variety of mechanisms. The overarching goal is the construction of a project which covers the development of a commercial-grade web site from HTML through to database access. The project is broken into five cumulating assignments which provide a set of sub-goals and milestones by which students can measure their learning progress, and students are encouraged to set their own
pace in fulfilling milestones. The in-class workshops are in the form of problems to be solved, providing a question-oriented environment. Students provide an additional set of objectives when they bring their work-related problems into the classroom.

4.1 Instructor Observations
After teaching two consecutive semesters of Web Technologies to the WPS, the application of Knowles' theory of andragogy to the course was a success as measured by student learning and student satisfaction. By employing a self-directed, independent approach to learning, students gained far more knowledge and experience than expected. The opportunity to learn independently removed the artificial boundaries that define the prescribed amount of learning that should occur. Students were very motivated and frequently went beyond assignment requirements. In addition, the problem-oriented approach allowed students to absorb more material in a shorter period of time. Many students were observed exploring the technologies and sharing their experiences in ways unrelated to assignments or workshops. A discussion of student satisfaction is included in Section 4.2.

The instructor was successful in fulfilling the role of facilitator for the Web Technologies course, as evidenced by one student's comment: "It's good to have an instructor learning along with the students." More evidence in support of the instructor as facilitator role is the fact that students posed questions primarily to the listserv rather than to the instructor. Many questions were posed and solved by students without any input from the instructor. The independent style of learning was reinforced by students as their answers to questions were usually directive in nature (e.g., URL, suggestion of approach, etc.) rather than prescriptive (e.g., you solve that problem by doing X).

The use of workshops was an effective mechanism for supporting Knowles' fifth principle of goal-oriented and problem-oriented learning. Verbal comments by students indicated that they liked the immediate reinforcement of subject material provided by the workshops. Workshops served as an ideal time for students to collaborate to solve problems. In addition, the use of the computer and direct application of technology to dynamically answer student questions provides a long-lasting learning experience.

Although the overall application of Knowles' theory of andragogy to the Web Technology course was a success, students that recently graduated from college were least likely to have a positive experience in this course. These students appear to desire a more structured learning process and are not as comfortable in exploring topics independent of direct leadership from the instructor. This fact may be due to their frequent lack of on-the-job experience as experience provides both the practical foundation upon which learning can be built as well as supplying maturity and independence of thought. One other negative factor that was observed is that students frequently find independent learning more frustrating as they must expend more effort to obtain the desired information (i.e., there is no expert that can immediately answer all questions).

4.2 Student Feedback
While the instructor's observations support the positive outcome of applying andragogy to the Web Technologies course, student comments provide stronger and more descriptive arguments for success. Student opinion of the Web Technologies course has been excellent as evidenced by the results of student evaluations using the Individual Development Educational Assessment (IDEA) ratings (http://www.idea.ksu.edu) and based on students' written evaluations. Both modes of feedback strongly support the premise that the application of Knowles' theory of andragogy to the Web Technologies course has been a success.

Overall, students expressed a very high degree of satisfaction with the course with students stating: "I am very satisfied with the course..." and "Excellent course; best one I've taken here." Another student commented on the knowledge that they had gained: "Excellent, learned a lot."

Feedback on the instructor was also very positive: "Best instructor I've had at Rensselaer so far." Several students commented on the excellence of instruction: "[instructor] did an excellent job keeping the entire class 100% interested at all times," and "I thought that [instructor] was an exceptional instructor." One student's comments directly addressed the issue of learning style, reinforcing the belief that Knowles' theory of andragogy was successfully applied in Web Technologies: "[the instructor] employs the best strategy of instruction that I've encountered." These comments highlight the success that can be achieved through teaching the WPS in a manner that fits their learning style.

Feedback from students also directly supports most of the individual principles of andragogy. Comments like "Topic is red hot..." and "...challenging students to face real life of programming..." and "...very relevant..." support the principle of relevancy-oriented learning. One student commented directly on the relevancy of the course material: "I felt it gave me very practical, marketable skills which I could use in the workforce/real world."

No student feedback appeared to directly support Knowles' second principle of self-directed learning. However the fact that students were enjoying autonomy in their learning process can be inferred through comments like: "...supporting materials were helpful and good reference material," and "...expanded learning through other sources," which indicate that students were pursuing topics of individual interest. Perhaps the most convincing indicators of students' self-direction were the IDEA ratings of 4.9/5.0 for the category "I had a strong desire to take this course." and 4.5/5.0 in the area of "instructor expected students to take their share of responsibility for learning."
The hands-on experimentation included in the Web Technologies course to support Knowles’ third principle of andragogy was enthusiastically received by students. One student remarked that they enjoyed having “...chances to discuss and practice what we’ve learned in class.” Another commented positively on the project: “...provided opportunity for students to practise the knowledge learned from class through projects.” The response to experience-based learning was also supported by the IDEA scores of 4.8/5.0 in the category of “asked students to help each other understand ideas or concepts” and 4.6/5.0 in the category of “encouraged students to use multiple resources.”

Student comments that support Knowles’ fourth principle of practically-based learning frequently included the word “practical”: “This is one of the most practical courses....” “This is one of the most applicable real practical courses that have been offered....” and one student commented on the usefulness of the course: “I gained a tremendous amount of knowledge that I can apply to the real world.”

Students expressed their pleasure with the employment of Knowles’ fifth principle of goal-oriented learning. One student commented on the goals provided by assignments and quizzes: “I liked the way the handouts, lectures, quizzes and project were timed and complimented each other.” Another student commented on the cumulative nature of the assignments, saying they liked the: “...projects and how well concepts were learned through each additional assignment to build an ultimate application....”

Not all student feedback was positive. Students that entered the course with less web-related background were somewhat overwhelmed by the sheer volume of information to be learned. Comments such as “...change to four credit course....” indicate that some students found the workload too high. In addition, several other students suggested that the course material be divided into separate courses.

5. Future Directions

Overall, student feedback and instructor opinion on the application of Knowles’ theory of andragogy to the Web Technologies course have been strongly positive and the use of andragogy in future offerings of the course is planned.

In order to support Knowles’ second principle of self-directed learning, the individual assignments will be replaced with one large project in the Fall 2001 offering of the course. This will allow students more flexibility in constructing the project. Rather than providing concrete milestones with somewhat fixed requirements, students will be able to set their own milestones and will be able to define their own approach to completing the project. In addition, students will be allowed to select and define their own projects. This will further support Knowles’ fourth principle of relevancy of material.

In the Fall 2001 semester, support for Knowles’ first principle of involving adults in the execution of their instruction will be broadened to include self-grading by the students. While the instructor will provide a set of guidelines and minimal requirements for the project, students will define the exact project contents as well as prescribe the criteria for an A, B, and C grade. This definition will be a mutual process where students will craft initial criteria which will then be detailed and refined in conjunction with the instructor.

One further area of study is the application of Knowles’ theory of andragogy in a distance education environment. Web Technologies will be offered asynchronously via video streaming during the Spring 2002 semester. Future plans include the measurement and comparison of learning between an on-site section and a section comprised entirely of asynchronous students.

References