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It Does Matter How We Teach Math

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Abstract

This paper describes application of innovative practice and procedures in relationship to recognized principles and theory of adult education used in college math instruction. Adult learning principles provide the theoretical constructs and foundation of the practice supporting a learner-centered approach to learning. The purpose was to explore the needs of learners and the learning contexts that would help them achieve higher dimensions of critical thinking and cognitive development. Based on Knowles' six assumptions of andragogy, curriculum was designed to provide college math students meaningful learning experiences, critical thinking skills, and application within the context of the classroom. Creativity and hands-on learning proved to be beneficial not only to tactile and kinesthetic learners but to others in the classrooms as well. Additionally, math anxiety is addressed and how such anxiety can and does have a debilitating impact on learning math in the classroom. Using adult learning principles and best practices in undergraduate math education, keys to opening the door for student success are application, recognizing math anxiety in students, creativity, hands on learning, and incorporating characteristics of effective teachers.

Introduction

Adult learning theory and the use of concepts of andragogy, based on Malcolm Knowles' assumptions, were applied while teaching Concepts of Mathematics courses at Oklahoma Wesleyan University and Algebra at Brown Mackie College. There were approximately 200 students enrolled in the courses over a period of over one year. Malcolm Knowles has given us a guide with his concept of andragogy. Knowles originally proposed 4 assumptions about how adults learn. Later, he added two more.

Andragogy

Malcolm Knowles defined andragogy as "the art and science of helping adults learn." This concept was contrasted with pedagogy, the art and science of helping children learn (Knowles, 1980, p. 43). Knowles' (1980) andragogical model was originally based on four assumptions of adult learners and how they develop. Knowles proposed a program planning model for the design, implementation, and evaluation of adult educational experiences from these assumptions. Adults, unlike children, have their own unique learning

needs (Knowles, et al, 2005). The needs of adult learners can be addressed with Knowles' assumptions (Knowles, et al, 2005).

- First, adults learn what they need to know. Learners must be aware of this essential need and those facilitating adult learning should take this principle into account in the design of adult learning programs (Gregson & Sturko, 2007).

Students must be advised of specific requirements to pass the class but are encouraged to select assignments they feel will be more beneficial to their overall learning outcomes.

- The second assumption is that adults are responsible for their own leaning.

Based on the assumption adults have their own concept of self that is responsible for the direction of their own lives (Knowles, et al., 2005). Self-directed learning is more aligned with an adult's sense of autonomy (Knowles, et al., 2005). Students should be active contributors in the learning process for learning to be meaningful.

- The third assumption is the role of the learners' experiences is also very important in the process of adult learning (Knowles, et al, 2005).

"Adults have a wide range of diverse experiences from which to draw upon" (Gregson & Sturko, 2007, p. 4). Knowles, et al. (2005) point out that learners will have many different backgrounds, learning styles, motivation, and needs that must be considered in the learning process. One example is to provide a classroom environment where learners can share their experiences with each other through collaboration and scaffolding.

Learning styles were determined after administering Kolb's Learning Style Inventory and learning strategy preferences were determined by administering ATLAS (Assessing the Learning Strategies of AdultS) to each student. Peer introductions provided insight into learner needs and expectations as well as backgrounds and goals. For example, in the first week of each class students' learning styles and learning strategies were identified. After each learning style and learning strategy preference were identified, students were accommodated accordingly with curriculum infused with material including lecture for auditory learners, power points for visual learners, student participation and application for kinesthetic or tactile learners. Additionally, students were asked to group with their matching learning strategy preference members, i.e., Problem Solver, Navigator, and Engager. Inclusion was quickly recognized, so students felt a sense of belonging and fitting in the classroom.

- The fourth assumption is that adult learners must be ready to learn.

Thus, it is important to schedule learning experiences to coincide with periods of readiness to learn (Knowles et al., 2005). For example, learners need to be ready to make a commitment to attending classes and completing all assignments.

- The fifth assumption is that adult learners are problem centered in their orientation to learning.

Learners are motivated to learn if they perceive what they learn will be immediately applicable to their lives and work situations (Knowles, et al., 2005). A classroom example was designing curriculum to help learners connect a concept or theory to their work place or in their home. A few examples of applied learning in the classroom included introducing the class to applying math in architecture, cooking, film, and art.

- The sixth assumption is that adult learners respond to external motivators, but internal motivation is more powerful (Knowles et al., 2005).

External motivators could include obtaining academic credit, a diploma, a better job, a salary increase or a promotion. Examples of internal

motivators include a desire to grow, improved self-esteem, and quality of life. However, barriers such as time constraints and programs that ignore adult learning principles and attitudes toward learning may have a propensity to block internal motivators (Knowles et al., 2005).

Using Concepts of Andragogy

Concept of Learner

A learners' self-concept moves from one of being a dependent person to one who is self-directed. In other words, students move from being dependent on the teacher and learning environment to being independent. Some adults have a high need to be self-directed (Woodard, 2007), therefore time should be provided for learners to focus on areas they feel they need to work on the most. It is important to consider a learners' preferences for direction, so time spent teaching both preferences, for the most part, was equal.

Recognizing "learned helplessness" and students lacking critical thinking skills is integral to understanding how best to work with these types of learners. Since I as well as my colleagues spend more time facilitating learning in the classroom, these learners sometimes complain that we are not teaching, i.e. a student asks a question of the facilitator and the facilitator directs them to a resource to solve the problem. This methodology clearly applies to crystallized learning, critical thinking skills, problem solving skills, and metacognition. Unfortunately, the student is not pleased with the response or that the teacher will not directly answer the question. Teaching math requires more than facilitation in the classroom. Specifically, breaking down barriers and providing a "safe environment", scaffolding and collaboration, motivators, and a clear sense of why and where the student is going on the path of learning is needed.

Role of the Learner's Experience

As individuals grow they accumulate a reservoir of experience that becomes an increasingly rich resource for learning. Most students came into the math class with a limited knowledge of algebra. However, students with a more comprehensive knowledge of algebra and various other mathematical concepts were encouraged to mentor those who needed help. For example, teams of three or four were created thus allowing collaboration. All teams participated in answering questions and scaffolding continuously throughout the courses. Students were encouraged to reflect on their experiences and occasionally journal writing was required.

Readiness to Learn

Learners see education as a process for achieving their full potential in life. Adult learners must be ready to learn; thus, it is important to schedule learning experiences to coincide with periods of readiness to learn (Knowles et al, 2005). Many students come into the classroom without a working knowledge of math. In order for students to get ready to learn, a commitment was made by the students to come to class and participate. Additionally, an evaluation of students' abilities and knowledge helped determine what areas needed to be addressed to get the students ready for the actual class assignments. For example, many non-traditional students, who were returning to school after 10-20 years, did not how to use a calculator. A review of how to use a calculator was incorporated into the course content. Secondly, many of the students did not remember or know how to calculate percentages, to use exponents or fractions, or even the basics of adding, subtracting, multiplying, and dividing. Instructional strategies were developed to provide remedial tutorials to allow students to optimize their learning experience.

Orientation to Learning

As real life problems occur, some learning situations require immediate attention, i.e. remedial math, tutoring, and building self-confidence in students. Since many students knew very little about the concepts of

math or algebra, it was the instructor's goal to work with the students to get them from the point of knowing (Zone of Proximal Development) a very limited amount about math to becoming confident in the classroom. This allowed students to achieve a higher cognitive level of comprehension and ability in solving problems.

Motivation

Adults tend to be more motivated to learn things that help them solve problems in their lives or that will result in internal or external rewards. By providing continuous feedback, positive reinforcement, and corrections with alternative solutions into every class session, students were motivated to learn.

Some of the internal motivators identified included students overcoming math anxiety and building self-esteem. All students were praised even when they arrived at incorrect solutions. Positive reinforcement was very beneficial to the students in building their self-esteem and self-confidence. Some external motivators students identified included making an "A" in the class. To accomplish this, each student was informed they would start out with an "A" and simply by attending every class and participating, turning in all required assignments, and making a "C" or better on all quizzes and exams they could maintain their "A" grade. Students were reminded why they were taking this math class and encouraged to remember to keep their eye on the goal so that they could get their degree, that better paying job, or a raise.

The class was able to connect learning experiences to real-life needs. This was accomplished by taking students on field trips; both virtual and real field trips to discover math in every day elements. Trips to art museums and tours of architectural wonders, gardens, and movies were part of the learning experience. Reflection papers of students' learning experiences were submitted in APA format and tests over application of concepts to real-life elements were administered.

Barriers such as time constraints, programs ignoring adult learning principles, and attitudes towards learning can block internal motivators (Knowles et al., 2005). Sufficient time was provided for students to complete learning objectives every week in class. Negative attitudes, including fear of math and fear of being able to do the work, were discussed at the beginning of the course. Fears from each student were written by a designated "team leader" on the white board. Additionally, a recording secretary wrote them on a piece of paper to save until the last week of class at which time most of the fears identified at the beginning of the course were no longer a reality.

Adults Need to Know Why

Adults need to know why they need to learn before learning it. Knowing why an adult needs to learn something is the key to giving them a sense of volition about their learning (Knowles et al., 2005, p. 149). At the beginning of each class session, learning objectives were explained, desired outcomes for the session were explained, questions about previous sessions were discussed, and concepts were reinforced. Students were reminded of the importance of math in everyday life. Some examples included cooking with the use of measuring cups, building a deck using intersect and x and y coordinates, and measuring the circumference of an object.

Conclusion

Because of the design and delivery of this course, based on adult learning principles, students were able to reflect on their learning, construct their own knowledge with the help of their peers and facilitation of the teacher, and develop more collaborative relationships with them. The teacher, or facilitator of the learning process, was able to engage students in the learning process and help them apply math concepts to their everyday lives.

Knowles' adult learning principles were applied to the curriculum design of the Concepts of Math class and were administered effectively to students. The results were as the facilitator expected; every student engaged

in the learning process who met the criteria of course requirements did earn an "A" while others did not earn below a "C" grade overall. Only students who did not participate or meet the course requirements were dropped from the class with a grade of "F". As future math courses are developed, it is recommended the principles of adult learning that guided the successful design and development of these courses be considered by others teaching similar courses.

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