Learning stations in the higher education class : collaboration, differentiation and critical

Dianne McCarthy

Abstract

The use of active learning techniques and collaborative learning in higher education has been advocated in much research. Differentiated instruction has received much press at the K-12 level, but not as much in higher education. This article describes active and collaborative learning experiences in higher education that provide differentiated instruction in the college classroom. Learning stations are one way of differentiating. This instructional technique led to improved class discussions, and many aha experiences as students developed understanding, compared and contrasted new ideas, and illustrated principles they had previously learned.

Key Words: Active Learning, Differentiation, Learning Stations

Take a walk around an institute of higher education and what you will see in classrooms is much the same as it was thirty years ago. Professors lecture and students listen. Learning often consists of note taking, and preparing papers and exams. This illustrates one model and one way to present information and demonstrate learning. The lecture model, however, may not be best suited for developing individuals who can think critically, work collaboratively, and synthesize information. Skills better suited for success in the twenty-first century. Barr and Tagg (1995) discuss the need for teaching that elicits student discovery and construction of knowledge. They focus on a need in higher education to improve the quality of learning. McConnell and Steer (2001) compared traditional lectures and active learning approaches in large earth science classes finding better achievement in active learning classes. They report better achievement in many ways, but point out short answer test questions where scores were 7% higher for the students enrolled in the section that used active learning methods. Fewer students dropped the active learning course section as well. While 7% higher scores may not seem significant, they still illustrate that the active learning section was achieving better results. Chickering and Gamson (1987) recommend active learning that encourages cooperation among students in their article Seven Principles for Good Practice in Undergraduate Education. When students in higher education participate in active learning tasks rather than listen to lectures they think critically, synthesize ideas, and work collaboratively.

Differentiated Instruction

One challenge to active learning in the classroom is the various levels that students display. Students in higher education bring different learning styles as well as different background knowledge from their life and school experiences. While differentiated instruction has received much press at the K-12 level, less has been made of its importance at the higher education level. There is a need to discuss differentiation at the higher education level. Differentiation according to Tomlinson (2001) is doing things in the classroom so that learners have multiple ways to learn, multiple ways to express what they learn, and multiple ways to make sense of what they are learning. It is not a difference in what students learn, but a change in how students learn in the classroom by multiple methods. All students in a class have the same learning goals, but the journey to meet these goals would be different. Differentiation as defined by the researchers at the National Center on Accessing the General Curriculum is "to recognize students' varying background knowledge, readiness, language, preferences in learning and interests; and to react responsively." (from Hall, Strangman, and Meyer http://www.cast.org/publications/ncac/ncac_diffinstructudl.html retreived 24 May, 2010)

How does one differentiate in the college classroom? One theory used in K-12 education that may have a role in higher education is Universal Design for Learning. According to the web site for the Center for Applied Special Technology Universal Design for Learning (UDL), a theory based on architectural design, has the instructor create learning experiences that can accessed by all in the same way that an architect creates a building that can be accessed by all regardless of how they come to the building or what challenges they face entering it. Universal

Design does not mean one way for all, but addressing the needs of all when designing the lesson. Universal Design is a framework for designing curricula that enable all individuals to gain knowledge, skills, and enthusiasm for learning. UDL provides rich supports for learning and reduces barriers to the curriculum while maintaining high achievement standards for all. (Hall, Stangman and Meyer, 2009) Learning stations may provide a method for infusing universal design into the higher education classroom.

A Method to Differentiate Instruction and use Active Learning Strategies

One way of meeting the goals of active, collaborative learning experiences and differentiated instruction in higher education could be through the use of learning stations. A learning center in K-12 is often a computer based activity where a student completes a task alone or with a partner. Children from the classroom cycle through the centers spending a limited amount of time on a specific task. The term learning centers is often used in K-12 to describe activities done in small groups with students cycling through a number of stations one at a time. The term "center" in higher education often refers to a place, for example the learning center or the skills center. Students go to a center to receive a service. In order to avoid confusion this article will use the word "learning station" to mean a task that a student completes with a small group similar to the learning center in K-12. Students will cycle through a number of learning stations.

Using Learning Stations to Develop Fraction Concepts

Learning stations designed around the topic of fractions were used to enhance understanding of fraction concepts for teacher candidates enrolled in a mathematics class for elementary teachers. The main objective of the class is to develop understanding of the mathematical concepts and develop proficiency with the mathematical skills taught in the elementary school. It is not collegiate math, but elementary mathematics. Many undergraduate elementary education teacher candidates lack comprehension of fraction concepts and suffer from anxiety about mathematics. Doing rote exercises with fractions is both boring and seldom produces understanding while doing nothing to build self-confidence. In the article The Mathematical Miseducation of America's Youth Battista discusses the problems with traditional methods and notes that for most US students math was an endless sequence of memorizing and forgetting procedures. The same topics are taught and are not learned (1999). This is often the case for the college students in this class who are to learn or relearn the math they will teach. Sometimes it is math they did not learn in elementary school. According to VanDeWalle (2007), researcher and writer of effective teaching methods for elementary school children, the following methods are essential for developing understanding of fractions: focusing on concepts not rules, especially the concepts of more, less and equal, discussion of fraction concepts, and the use of multiple models. Leonard and Tracy (1993) found that using games with children maximizes students' problem solving competence, ability to communicate and reason mathematically, and their self confidence. A teacher educator, instead of assigning exercises or homework, created learning stations for collaborative learning that included tasks and games such as one might use with elementary students to build fraction concepts. There was an emphasis on fun while encouraging discussion, building understanding and developing self confidence with fraction concepts regardless of the differences in background knowledge and skills of the participants.

Learning Station 1: Top It.

The first station was called Top it, because it is similar to the game of the same name found in the Everyday Mathematics Series published by The University of Chicago Mathematics Project. This game is like the card game war, but instead of using a deck of cards students used index cards with fractions written on them. Each member of the group flips a card; the one with the largest fraction wins and takes all the cards. One interesting feature about this station is that students needed to think about the value of fractions and use mathematical reasoning.

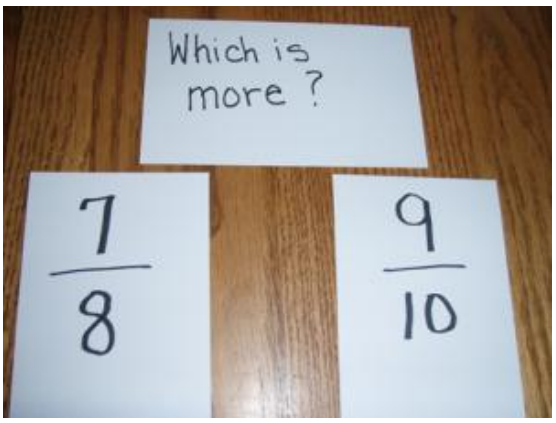

Figure 1 Fraction Top It Game

Learning Station 2: Dominoes.

The second station was dominoes. This game is played like a traditional dominoes game with each player taking about 7 cards and trying to match one of their cards to the others in play. The dominoes were made with index cards and contained either a written fraction like ½ or a picture illustrating a fraction of a set or region. It is interesting to note that one could place a card down next to an equivalent fraction. For example if you are holding a card with the picture of 4/8 you could place it next to a card with its equivalent, ½, written on it.

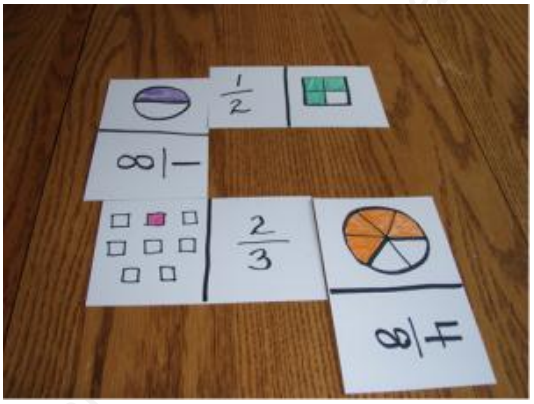

Figure 2 Fraction Dominoes

Learning Station 3: Quilt Squares.

The next station involved coloring fractions on a piece of graph paper which was called a quilt square. The students needed to follow a specific direction for coloring. For example, the square contained 100 boxes (10 by 10), the directions said ½ of the quilt square must be blue, therefore, 50 of the boxes must be blue. See figure 3 for a picture of a completed quilt square.

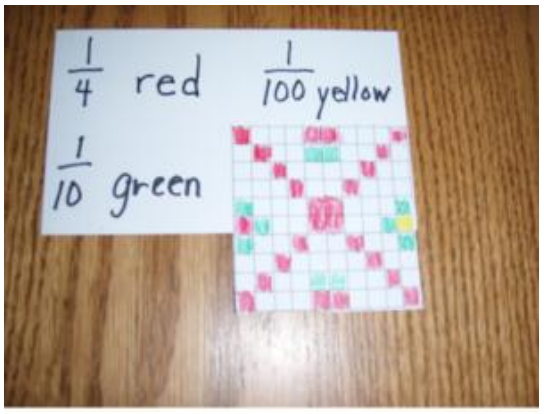

Figure 3 Fraction Quilt Squares

Learning Station 4: Restaurant.

The last station was called restaurant. Here students were given recipes that served 4 people. They needed to change the recipe so that it would serve more people such as 8 or 20. One of the recipes was for a large amount and required the students to change the recipe to a smaller amount.

Figure 4 Pre and Post test scores for students enrolled in Elementary Mathematics Methods Course. All names have been changed

Name	Pretest Score	Post Test Score
Alice	6	6
Johan	6	6
Chris	5	6
Chloe	3	5
Karen	3	6
Gregg	3	6
Annie	3	6
Sammy	3	6
Tonya	3	6
Carla	3	6
Mario	1	4
Tommy	1	3
Jorge	1	6

Procedures and Findings.

Students were placed in groups of 4 and rotated among the 4 stations spending about 15 minutes in each station. Talking, laughing and overall engagement was evident as students rotated through the stations. While some may read this and think what juvenile activities for college students, it was surprising to note how many students had never played war/ Top it or dominoes as children, enjoyed the problem solving, found the coloring interesting, and how cooking is a common experiences and that everyone has strategies for measuring. It is also important to note that a number of students learned new techniques for comparing and ordering fractions from classmates, developed new strategies for altering recipes, and exchanged their understandings of fraction concepts. It did not matter how strong or weak a students' understanding was, they engaged in the same activities. Students grew from wherever their understanding was before we started. One student remarked when leaving, "now that was a good class."

In subsequent classes students showed better understanding of fractions. Results on the fraction unit test and the final exam were also positive. This set of stations has also been used in an elementary education methods course for mathematics and in a graduate course on improving instruction in elementary mathematics with similar feedback and results.

These same learning stations were also used with a group of students enrolled in an elementary education mathematics and science methods class. This group had similar characteristics, lack of understanding and math anxiety. This group was given a pretest the class before the stations were used and a post test after the center experience. Note the

results below. All students either improved or remained at a high achieving level. Again students remarked about how much fun they had in class.

Using Learning Stations to Differentiate Instruction on Pedagogy: Inquiry, Problem Based and Direct Instruction

Methods courses in teacher education often describe various theories of teaching and learning. Sometimes teacher educators will model theories in lessons and sometimes they will show videos of elementary classrooms for students to compare and contrast. This collaborative activity required students in an elementary education methods course for mathematics and science to engage in three different stations invoking three different teaching theories for the purpose of helping students understand the theories and compare and contrast them. Based on ideas from the Exploratorium web site and the Institute for Inquiry (Exploratorium.edu) the teacher educator developed three stations all hands on activities involving foam that were implemented using 3 different theories of pedagogy; direct instruction, problem-based learning, and the explore stage of inquiry. Foam proved to be an interesting topic because students often had limited knowledge and experience that made the use of the particular method clear.

Learning Station 1: Direct Instruction.

Direct instruction is a methodology with the importance placed on teacher wording and then students doing (Kinder and Carnine, 2001). According to Stein, Carnine andDixonthe goal of direct instruction is to increase student learning by developing, applying, and connecting background knowledge to new knowledge. Key ideas are teaching explicit strategies, scaffolding instruction, integrating skills and concepts, and reviewing (1998). The student is more a passive receiver of knowledge in direct instruction and the teacher acts more as the authority, telling what to know and do.

This center included the following materials: bowl, bucket, gallon of water, dish soap, whisk, paint stirring stick, measuring cups, ruler, paper plates and bowls. There were strict directions to follow regarding how much water, how much soap to mix in a bowl, how many times to stir, and what tools to use. Students were then asked questions about the foam such as which tools produced the most foam, what happens if you stir faster or slower, and does more soap or more water produce more foam. Students completed the tasks and worked through the questions needing little guidance from the teacher educator.

Learning Station 2: Problem-based Learning.

Problem-based learning is an instructional method where students are presented with a problem before any instruction takes place. Students take the role of scientists solving a problem and the teacher acts as coach. Learners develop higher order thinking skills and are actively engaged. Critics say it focuses too much on thinking skills and does not develop content knowledge (Drake and Long, 2009). Koray et. al. (2008) found this approach was better at helping pre-service teachers develop problem solving skills than traditional instruction. Pre-service teachers using problem-based learning also gained in communication skills, ability to work with others and knowledge (Koray et. al. 2008).When using this method students work in groups to solve a problem with teacher guidance provided as needed.

In this center students were given the same materials as in the first center and told to build a tower of foam 12 inches high. This was the only direction and students could decide how much soap, how much water, and what tools to use to meet the goal. The teacher educator offered suggestions as she circulated among the three stations.

Learning Station 3: Inquiry.

To teach using inquiry is to allow students to develop and investigate their own questions. Building on students' curiosities, science instruction is developed as students strive to answer their own questions. There are often 5 steps in inquiry based instruction. The second step is

exploration where students explore with materials, develop questions and strive to answer them. The teacher acts as a facilitator stimulating discussion and self reflection. According to the National Science Education Standards "Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results (NAP.edu June 5, 2009).

This center contained the same materials as the other two stations and also had shaving cream and root beer. Here the direction was to explore foam and write down questions or ideas that you would like to investigate about foam. The teacher educator was frequently at this center with questions and suggestions for the students.

Procedures and Findings.

Each of the stations was to simulate instruction in one of the three pedagogies described above. The purpose of this was to improve preservice teachers understanding of the three theories and their ability to discuss when and where each technique would be most useful and successful. Each group spent 20 minutes at a center and there were five students in each group. A rich discussion followed this collaborative learning experience that helped students: describe the pedagogical theories of direct instruction, problem-based learning, and inquiry based learning, explain the different educational objectives best achieved by each type of pedagogy, and analyze the role of the teacher when using each technique. While some students may have had a strong background in these theories based on the instructional methods they had experiences as student, others students did not have these experiences. In order to complete the tasks in each center a student did not need extensive knowledge of the methodology, but at the conclusion and with the discussion of the experiences, students constructed their understanding of the three methods. The various levels of understanding and experience that the students entered with did not matter the learning was maximized for all. This was illustrated in the discussions that followed. While studying foam was not the objective some content knowledge in this area also developed and the need to develop our own content knowledge before teaching a topic was also considered vital to successful teaching using any of the techniques. This insight while not a goal shows how the learning station activities encouraged individual development.

Using On-line Learning Stations to develop Background Knowledge about Poverty and Socioeconomic Status

Students often enter the college classroom with differing levels of understanding. Often times instructors expect that students can define and explain key vocabulary and important concepts. When students can not the instructor must teach it. Learning stations may be a way to build background knowledge that students are lacking. Constructing the learning stations on line using a classroom site such as ANGEL may help students develop background knowledge working thru web sites and discussions at their own pace. Teacher candidates enrolled in an elementary education methods course for mathematics and science lacked background knowledge in defining and describing poverty and socioeconomic status. Online learning stations were created to facilitate student learning of these concepts.

Learning Station 1: Defining Poverty.

Students were instructed to search the web and find at least 3 definitions of povery. They were to post them and include references. They were then instructed to visit the website ahaprocess.com. They were to discuss the site including such questions as who runs it? What information does it offer? What services are available to teachers? This site was established by Ruby Payne, author of Frameworks for Understanding Poverty. A drop box and a discussion forum were available for students to post, get feedback and read classmates work on this topic.

Learning Station 2: Understanding Socioeconomic Status and Learning.

This learning station required them to access an article, Poverty and Learning by Ron Renchler,.with a link provided by the instructor. This article described socioeconomic status and provided data. Students were then to discuss this via discussion board on ANGEL.

Learning Station 3: The Flat World and Education.

This station was to encourage students to read more about what is meant by the terms "the flat world." This was the concept being presented when the instructor realized many students lacked background knowledge on poverty and socioeconomic status. This station also included a discussion forum where it was hoped that students would connect the other two stations, their findings for this station and the class discussion.

Procedures and Findings.

The on line learning stations were not required of students enrolled in the methods class, but were highly encouraged because of the other assignments and tasks required in this course were extensive. Of the 16 students enrolled in the class, 6 participated in the on line learning stations. These stations were completed the following semester and 11 of 17 students participated. This is encouraging because students chose to build their background knowledge the task being a classroom exercise or a graded assignment. Simply setting up and providing the on line learning stations for students and having them successfully engage in them was a positive experience for both instructor and student. Offered to all and participated in by a few, the on line learning stations demonstrated the theory of universal design and encouraged collaboration, critical thinking, and synthesis of information.

Conclusions

The learning stations described above not only provide active learning experiences, but allow for differentiated instruction. As students work through the stations described above they activate background knowledge, complete the tasks entering into them at whatever level of understanding, and build knowledge and skills including higher level thinking. The learning goal for each individual is the same. In case one that is understanding fraction concepts to a level needed for teaching elementary students not just for personal use, in case two it is comparing and contrasting educational methodologies in order to evaluate when to use each in teaching, and in case three it is building background knowledge on concepts. This is accomplished through learning stations where each student's growth is maximized.
Positives of these experiences include achievement on tests and exams, higher level thinking as observed in class discussions including the ability to compare and contrast ideas. While these experiences may take more time then delivering a lecture the benefits of collaboration such as the ability to work with others, the development of critical thinking and the opportunity to provide active experiences far outweigh the loss of time. It will serve students better in the future to know how to work collaboratively and critically think than to be passive receptors of knowledge. It will serve students and faculty better to provide activities where students can begin where they are and maximize their learning.

Dianne S. McCarthy
mccartds@buffalostate.edu
Buffalo State College
1300 Elmwood Avenue
Buffalo, NY 14222
716-878-3693

References

Barr, R.B. & Tagg, J. (1995) From teaching to learning a new paradigm for undergraduate education. Learning from Change. Landmarks in Teaching and Learning in Higher Education from Change Magazine 1969-1999. 198

Battista, M.T.(1999). The mathematical miseducation of America's youth. Phi Delta Kappan, 80(6) 424-434.

Center for Science, Mathematics and Engineering Education (1996). National Science Education Standards. retrieved June 5, 2009. From http://www.nap.edu/openbook.php?record_id=4962&page=23

Chickering, A. & Gamson, S. (1987). Seven principles for good practice in undergraduate education. AAHE Bulletin, 39, March 1987. 3-7.

Comparing Approaches to Hands on Science. Institute for Inquiry retrieved March 2009. www.exploratorium.com

Drake, K. N. (2009) Rebecca's in the dark: a comparative study of problem-based learning and direct instruction/experiential learning in two 4th-grade classrooms. Journal of Elementary Science Education, 21(1) 1-16

Hall, T. Strangman N., and Meyer A. (2009) Differentiated Instruction and Implications for UDL Implementation. Center for Applied Special Technologies. retrieved May 2010. www.cast.org.
Kinder, D. & Carnine, D. (2001). Direct instruction: What it is and what it is becoming. Journal of Behavioral Education, 1(2), 193-213.

Leonard, L.M. and Tracy, D.M. (1993). Using games to meet the standards for middle school students. Arithmetic Teacher, 40(9). P. 499.

Stein, M., Carnine, D., &Dixon, R. (1998). Direct Instruction: Integrating curriculum and design and effective teaching practice. Intervention in School and Clinic, 33(4), 227-234.
Tomlinson, C. (2001). How to differentiate instruction in mixed ability classrooms. 2nd ed. Association of Curriculum Development. Alexandria, VA. p. 1-2.

VandeWalle, J.A. (2007). Elementary and Middle School Mathematics. TeachingDevelopmentally. 6th ed.Boston,MA Pearson.

Fonte: Academic Leadership, 30 Mar. 2012. [Base de dados]. Disponível em: <http://www.academicleadership.org>. Acesso em: 16 Apr. 2012.