Action Research: Tiered Instruction in a High School Physics Course

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Abstract:

(Purpose) This article describes the use of tiered instruction, a specific form of differentiation, within the author's high school Physics classroom. A background and discussion on the nature of tiered instruction is also included. **(Findings)** Topics addressed in this paper include: (1) the necessity of differentiation within the classroom; (2) the basis of differentiation within educational theory; (3) tiered instruction as a form of differentiation; (4) methods of tiered instruction; (5) existing research on tiered instruction's impact on academic parameters; (6) a justification for tiered instruction within a general Physics course; (7) application of tiered instruction in the context of a laboratory exercise; (8) results of student surveys regarding learning and motivation from tiered instruction. **(Conclusions)** Trends emerged from student surveys showing small, but positive trends in learning and motivation due to the unique grouping of tiered instruction. Further research, with greater depth, sample size, and longitude, should be undertaken to show statistically significant results.

Differentiation: A Fundamental Background

To begin our discussion of differentiation we must first select an appropriate definition of differentiation that explains both its theoretical basis and its practical use within the classroom. Tomlinson (2000) provides us with such a definition when she declares:

At its most basic level, differentiation consists of the efforts of teachers to respond to variance among learners in the classroom. Whenever a teacher reaches out to an individual or small group to vary his or her teaching in order to create the best learning experience possible, that teacher is differentiating instruction. (p. 2)

Thus we immediately should understand differentiation as an accommodation of heterogeneity within our classroom. While one manner of instructional design may, given the best of circumstances, benefit the majority of students , there will always be situations where individuals in the class would have their learning experience enhanced by the altering of instruction. Through differentiation, specifically by allowing for variety in instruction and assessment, all students have an opportunity for maximizing their experience in regard to numerous aspects of education such as content mastery, rate of learning, motivation towards learning, and overall enjoyment. When speaking of differentiation in general, there is a variety of methods that may be employed in order to alter material, its delivery, and any assessments or products based on that content (Tomlinson, 2000). Tiered instruction is one particular method of differentiation.

Tiered Instruction: Methods and Use

While tiered instruction is a form of differentiation, it takes a different methodological approach from other means of diversifying content delivery. Richards and Omdal (2007) detail tiered instruction as, "the use of the same curriculum material for all learners, but adjusted for depth of content, the learning activity process, and/or the type of product developed by the student" (p. 2). Therefore tiered instruction's uniqueness as an instructional technique is the criteria for differentiation. Instead of only focusing on learning styles for alteration of content delivery, tiered instruction maintains the integrity of the content and its learning objectives and instead focuses on using prior knowledge and/or expertise in a field as a means to group students before content delivery. Based on their group identity, students can expect to experience different levels of content in terms of difficulty and depth. By using prior knowledge as a criteria, tiered instruction aims to give all learners an appropriate challenge for their abilities and experience. Rakow (2007) recommends tiered instruction for students with low versus high content knowledge in order to provide each group with an appropriate learning experience before bringing both groups together for class discussions or other whole class work.

If students are appropriately challenged and are not struggling from difficulty or bored from a lack of challenge, then it is often assumed that students will be more engaged, master a greater degree of material, and be able to produce novel products evident of their newfound mastery (Danzi, Reul, & Smith, 2008). Given that tiered instruction aims to provide all students a challenging learning experience, proponents would hypothesize that this technique can improve a number of learning based parameters in students.

The Necessity of Tiered Instruction

In terms of the classroom described in this action research study, it is a standard high school Physics course taught in a four by four block schedule, consisting of thirty-three students, and taught in a rural high school in southeastern Louisiana. While the high school consists of over one-thousand students, there is only one course in Physics offered each semester. Even though all of these students can be considered as academic achievers in comparison to their peers, there is a large degree of heterogeneity in the classroom in terms of interest, expertise, prior knowledge, and academic achievement of the students in regards to science. The most striking source of variation is that many students, particularly those interested in attending college for Humanities, are required to take Physics as a course requirement for admission to higher ranked universities such as Louisiana State University's main campus. While it could be argued that high school seniors aiming to go to college for majors such as English need a different class from those seniors going into Mathematics or Civil Engineering, no such class exists. Thus, considering the reasons for the heterogeneity within this classroom, the implementation of a differentiated assignment might not only be justified, but beneficial to the class as a whole.

Implementation Methods

Given the large volume of work and the risk of implementing a differentiated unit or content that may have poor academic results in this classroom, a more appropriate scope for an initial action research project was chosen. Tiered instruction was implemented in the context of a single day's laboratory exercise during a unit on sound waves. Two lectures, which delivered the content in a standard non-differentiated manner, preceded the laboratory exercise. Before the laboratory, students were given a brief survey of their intended college major and which of the laboratory groups in which they would feel most comfortable and motivated.

In terms of the differentiation within this laboratory, two aspects of the assignment were altered to accommodate tiered instruction: grouping and product. First, the grouping of the laboratory was designed to target the specific expertise, aptitude, and interest of the students in relation to the subject matter. First, students were grouped into three broad categories: science and engineering, performing arts, and humanities. Within these three broad categories, students were placed into one of two specific areas, leading to a total group number of six. The secondary grouping was designed to lower group size by increasing categories, as well as further separate areas of expertise. Details are given within Table 1.

Table 1:

Group Number	**Primary Grouping**	**Secondary Grouping**
1	Science and Engineering	Science and Mathematical
2	Science and Engineering	Architectural/Design
3	Performing Arts	Visual
4	Performing Arts	Musical
5	Humanities	Social Sciences/Humanities
6	Humanities	Education

After being placed into their groupings, students were given an assignment with a time limit of forty-five minutes. Students were asked to develop a method of demonstrating three aspects, properties, phenomena, or laws pertaining to sound waves. A list of available topics was given to students which included harmonic resonance, Fourier analysis, constructive/destructive interference, Doppler effect, and changing the amplitude of a wave. After the initial planning, each group had to deliver a five to ten minute presentation to the class. Students were allowed to utilize supplies within the lab, which included tuning forks, glass cylinders, a snare drum, and a guitar.

While each group was allowed to choose which topics they would be presenting to the class, they were, however, required to present in the perspective of their area of expertise. Table 2 clarifies the group specific instructions given at the start of the assignment.

Table 2:

Group:	**Assignment Instructions:**
Science and Mathematical	Present mathematical theory and example problems illustrating concepts
Architectural/Design	Diagram sound wave interactions while demonstrating how the diagrams fit into mathematical definitions
Visual	Physically present examples of each situation, using materials provided
Musical	Utilize their musical instruments and expertise to perform musical examples of each situation
Social Sciences/Humanities	Work together to construct an essay explaining each concept
Education	Create a lesson appropriate for a younger grade (9^{th} grade Physical Science)

Teacher Observations

Students seemed genuinely motivated to engage in a laboratory that gave many more freedom to express themselves within the context of physics. In particular, three aspects of the laboratory contributed to increased student motivation and work efficiency. First, students were aware of their time limits during the planning stage and worked towards meeting their goal. Second, students had to take responsibility for their project in that they were presenting their results to their peers. Finally, students seemed to take particular pride in demonstrating their abilities in other areas not traditionally explored within the context of the class. For example, the musical performance group used a snare drum as a medium to explain the concept of musical beats in terms of constructive and destructive interference, as well as having members with experience in chorus demonstrate harmonics by singing in and out of tune.

Student Survey Results

Immediately following the presentations, students were given a seven question survey, specifically designed to relate topics relevant to tiered instruction to their experience within the laboratory. The general design of the survey aimed to compare aspects such as learning and motivation against the grouping of tiered instruction or the random grouping students had experienced in previous laboratories. Answers were formatted in terms of a Likert scale, ranging from "1" being strongly disagree and "5" being strongly agree. Table 3 gives a synopsis of each question as well as the average response of the students (n=33).

Table 3: Questions and Average Rating.

Question Number/Type	**Survey Statement**	**Average Rating**
1. Grouping vs. Learning	Grouping with those who have similar interest and abilities helped me learn more.	3.9
2. Grouping vs. Motivation	Grouping with those who have similar interest and abilities, increased my motivation to perform well in the laboratory.	3.4
3. Product vs. Learning	Creating and presenting a product that was based on my interests and abilities helped me learn more.	4.1
4. Product vs. Motivation	Creating and presenting a product that was based on my interests and abilities, motivated me to perform well in the laboratory.	3.5
5. Learning vs. Random Grouping	I have learned more in the tiered instruction lab compared to if this lab and its product would have been grouped randomly.	3.1
6. Motivation vs. Random Grouping	I have enjoyed the tiered instruction lab compared if this lab and its product would have been grouped randomly.	3.1
7. Overall Enjoyment	Overall, I prefer this method of laboratory grouping and product choice to standard lab set-ups.	3.3

Conclusions

While this survey is not of an appropriate design for statistically significant conclusions on tiered instruction as applied to other situations, it does provide for the demonstration of general trends within the context of our Physics classroom. When examining the student responses, several positively trending patterns emerged. First, regardless of the range, overall averages were neutral to positive, which gives the indication that as a whole tiered instruction was not detrimental to the student's learning and motivation, at least from their own perspective. Second, the highest scores for students were those scores pertaining to the questions regarding learning. Whether it was phrased in the context of grouping or product creation, students reported that they learned much more in a tiered instruction laboratory. Finally, motivation followed positive trends similar to that of learning, however, the magnitude of motivation increases was much less than that of the respective value of learning. However, it should also be noted that in terms of overall enjoyment, learning, and motivation of a tiered instruction lab compared to a standard Physics laboratory assignment with a method of random grouping, as such is the standard in previous assignments, students were nearly indifferent, expressing very minor preferences for tiered instruction.

In conclusion, this action research project into a single high school Physics class demonstrates previously researched trends regarding tired instruction as a means to increase learning and motivation in students. However, this work also gives rise to the need for more extensive research that both represents a broader sample size and presents data in statistically significant methods. If the resources were available, replicating this experiment with separate groups, such as a treatment and a control group, and using multiple sources of standardized measurements for learning increases, comparisons of tiered instruction with other methods of laboratory instruction could be completed in a manner that would allow for statistically valid conclusions.

References

Danzi, J., Reul, K., & Smith, R. (2008) *Improving Student Motivation in Mixed Ability Classrooms Using Differentiated Instruction*. Retrieved from ERIC database (ED500838).

Rakow, S. (2007) All Means All: Classrooms that Work for Advanced Learners. *Middle Ground*, 11(1), 10-12.

Richards, M.E. & Stuart N. Omdal (2007) Effects of Tiered Instruction on Academic Performance in a Secondary Science Course. *Journal of Advanced Academics*, 18(3), 424-453.

Tomlinson, C.A. (2000) *Differentiation of Instruction in Elementary Grades*. ERIC Clearinghouse on Elementary and Early Childhood Education, ERIC Database Number: ED443572