Team Accelerated Instruction: A Cooperative Approach to Volume

Introduction

When I was in middle school, my mathematics teacher used to say that, as a house will not stand without a foundation, an understanding of mathematics requires a strong foundation on which to build. In this curriculum, I hope to explain a method of promoting an understanding of volume, to strengthen the mathematical competency of students in preparation for their studies in Algebra, an area which is considered by many to be a crucial skill considering current society's technological advancement. Maybe one of the children who gains understanding of mathematical concepts with the help of this curriculum will become an architect or an engineer, and make buildings of his or her own—a fitting development.

Goals

The primary goal of this project is to find a way to make mathematical inquiry fun and engaging for young people who may or may not understand its value in their future success. The framework of the curriculum, however, addresses three secondary objectives. First, this particular curriculum will encourage students to work together on group projects. Second, students will be expected to explore mathematical concepts in a concrete manner. Third, students will be encouraged to utilize their findings in developing their own hypotheses about concepts. Ultimately, then, this curriculum will aim to present the material in a way that fosters students' understanding of difficult mathematical subjects.

Methodology

Student Team Learning

This curriculum is heavily oriented around the learning method called student team learning. These organizational techniques, largely developed by Robert Slavin and his colleagues at Johns Hopkins University, group students into teams, who work together as a unit. Ensuring that students are learning is thus the responsibility not only of the teacher but also of that each of his or her teammates. This system gives teachers the option of rewarding the group as a whole and, as individual achievement would reflect well on the team, even turns rewards for individual success into a virtual "pat on the back" for the entire team. Furthermore, as the rewards would be based on progress, rather than achievement, students of all abilities would be able to bring these back to its team.

The advantage of rewarding progress, according to Slavin, is that this makes success "neither too difficult nor too easy for students to achieve."[1] A challenge of this arrangement is that the most competent student would do most of the work of the team; this feature of group work is kept in check by denying rewards to groups when not all students have met specified standards of improvement. In general, however, group work of this kind will prove to be an effective motivational tool in encouraging understanding.

Team Accelerated Instruction

The first distinction among kinds of student team learning is Student Teams – Achievement Divisions, or STAD. Aspects of Team Accelerated Instruction, which is closest to the method used in this curriculum, are taken from this standard. First, the class is divided up

[1] Slavin, p. 5

into teams of four that are mixed "in performance level, gender, and ethnicity."[2] Then, each team works as a unit to master concepts from lecture; "high-performing teams"[3] will subsequently receive certificates of achievement for their work.

Where STAD focuses on assessment in the form of quizzes, however, TAI uses a series of worksheets in student evaluation. The use of worksheets allows for faster advancement through subjects, as they can be administered in succession independent of other members of the class. Students still work together, however, to "check each other's work,"[4] among other things. Tests, taken at the end of a unit, are done solo, but group rewards will be awarded based on the how fast all students progress. Another difference from STAD is that, as "students are responsible for checking each other's work and managing the flow of materials,"[5] the teacher will be able to instruct small groups of students, called briefly out of their study group, who are working on the same lesson. Team Accelerated Instruction, clearly, is a great method of teaching for a subject, such as Math, that allows for modular building of one conceptual unit onto another.

The Algebra Project Curriculum

The Algebra Project is an extracurricular effort to broaden the mathematical ability of students using concrete examples to think about theoretical ideas. While most people have some understanding of arithmetic, this project works with students to aid in "a conceptual shift from arithmetic to algebraic thinking,"[6] a critical task, especially for teachers of students already disadvantaged in some way, as "a broad range of mathematical skills"[7] will soon supplant basic

[2] Slavin, p. 5
[3] Slavin, p. 7.
[4] Slavin, p. 7.
[5] Slavin, p. 7.
[6] "The Algebra Project Curriculum."
[7] "The Algebra Project Origins."

concepts as the requirements even in non-technical fields and everyday living. As a starting point, The Algebra Project takes "the concrete experiences of children,"[8] and extends them by "asking increasingly sophisticated questions"[9] about their findings. As this curriculum does, the project sets as a goal the standards put forth by the National Council of Teachers of Mathematics (NCTM). Clearly, the methods of The Algebra Project are a cohesive element in engaging student involvement.

National Council of Teachers of Mathematics Standards

The National Council of Teachers of Mathematics is an independent organization dedicated to the quality of education in students from all nations. To achieve the raising of standards throughout the world, this body of professional instructors produces, among other things, produces resources on theoretical curricular matters. The NCTM identifies the middle school years as a time where students will gain their perceptions of mathematics, and thus need "both challenge and support in the mathematics classroom."[10] A curriculum for middle school aged children must foster, furthermore, their nascent abilities in "finding and imposing structure, conjecturing and verifying, thinking hypothetically, comprehending cause and effect, and abstracting and generalizing."[11] The NCTM sets these goals as the starting point for its curricular guidelines.

For the ambitious mathematical curriculum that they pose to succeed, the NCTM sets a number of conceptual ground rules off of which to build. First, they strongly suggest that any lesson should incorporate algebraic and geometric concepts, such as "visual models of algebraic

[8] "The Algebra Project Curriculum."
[9] "The Algebra Project Curriculum."
[10] National Council of Teachers of Mathematics, p. 211.
[11] National Council of Teachers of Mathematics, p. 211.

identities […] and […] equations for lines represented on coordinate grids."[12] Second, the NCTM specifies that teachers must instruct students in "serious, substantive mathematics,"[13] at the middle school level in order for students to deal with whatever situation they encounter in the future, in high school or in life outside of school; this can only be met, of course, if teachers "develop a sound knowledge of mathematical ideas and excellent pedagogical practices and become aware of current research on students' mathematics learning."[14] The NCTM standard thus stresses that a well-devised curriculum in the hands of a professionally trained educator is the key to a rich middle school mathematics education.

NCTM Middle School Geometry Standard

The National Council of Teachers of Mathematics specifies additional requirements in the teaching of middle school level geometry. A student, who has explored the concept of volume, or the three dimensions of physical space, during these grades, as in the case of this curriculum, should be able to

> "precisely describe, classify, and understand relationships among types of two- and three-dimensional objects using their defining properties; […] use coordinate geometry to represent and examine the properties of geometric shapes; […] use two-dimensional representations of three-dimensional objects to visualize and solve problems such as those involving surface area and volume; […] use geometric models to represent and explain numerical and algebraic relationships; [and] recognize and apply geometric ideas and relationships in areas outside the mathematics classroom, such as art, science, and everyday life."[15]

The student, in this framework, is expected to enter with "informal knowledge about points, lines, planes , and a variety of two- and three-dimensional shapes; with experience in visualizing and drawing lines, angles, triangles, and other polygons; and with intuitive notions about shapes

[12] National Council of Teachers of Mathematics, p. 212.
[13] National Council of Teachers of Mathematics, p. 212.
[14] National Council of Teachers of Mathematics, p. 212.
[15] National Council of Teachers of Mathematics, p. 232

built from years of interacting with objects in their daily lives."[16] The NCTM sets strict criteria, here, if it expects a teacher to incorporate all of these elements, but such curricula would certainly satisfy the mathematical needs of all middle school students.

In this plan for a geometry education, the NCTM specifies a number of different specific examples of exercises for student enrichment. For example, a student could be given a computer program with which to draw a parallelogram and be asked to manipulate its angles and sides, paying close attention to "some of the characteristic features of each type,"[17] to help develop an understanding of both two-dimensional shapes and categorizing. These parallelograms could be used for "algebraic representations […] using coordinate geometry,"[18] by plotting them on a coordinate plane and evaluating the slopes of different parts in relation to each other. Over the course of a middle school geometry education, a student should also "build three-dimensional objects from two-dimensional representations; draw objects from a geometrical description; and write a description, including its geometric properties, for a given object,"[19] as well as explore, geometrically, "algebraic relationships, such as identities."[20] The NCTM also suggests areas beyond mathematics in which geometry can be observed: "[n]ature, art, and the sciences provide opportunities for the observation and the subsequent exploration of geometry concepts and patterns as well as for appreciating and understanding the beauty and utility of geometry."[21] Although they do not generally provide the terms of implementation, these standards and vignettes, set forth by the NCTM, thus provide the framework for a specific curriculum that potentially will transform the mathematical experience of students.

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[16] National Council of Teachers of Mathematics, p. 233.
[17] National Council of Teachers of Mathematics, p. 233.
[18] National Council of Teachers of Mathematics, p. 235.
[19] National Council of Teachers of Mathematics, p. 237.
[20] National Council of Teachers of Mathematics, p. 238.
[21] National Council of Teachers of Mathematics, p. 239.

Implementation

Overview

Under these goals and guiding principles, a curriculum that befits and rises to the level of young adults can now be assembled. I have chosen to focus on presenting the concepts of three-dimensions to a sixth grade classroom. To this end, I have used these sources as an inspiration to further each of my objectives. First, my classroom structure will be based around Team Accelerated Instruction, a strategy that makes the most effective use of teacher availability and to give all students the chance to work at their ability level, assuring that each student receives the education he or she requires to continue in mathematics. Second, in order to foster a practical understanding of mathematics and the ability to abstract mathematical concepts from a concrete situation, the tactics of The Algebra Project will be incorporated into the curriculum, thus personalizing students' connections to the field itself. Third, in following the NCTM's guidelines of what constitutes a quality education, this curriculum will challenge students to rise to its level in their explorations, ensuring, if not their immediate success, then their development of a way to approach mathematics that will guide their future endeavors in the field.

Classroom Activities and Homework

A number of different exercises are planned for the classroom to work on. The lesson will be built around laboratories in which students will "play" with different mathematical objects and homework assignments that ask them to go out into their community and evaluate different situations mathematically. In the case of this curriculum, a sample laboratory would be for students to be given an array of thin, square bricks and be asked to assemble them into different

three-dimensional objects. A sample homework assignment might be to go out and identify different 3-dimensional shapes in the world that they've studied about in class. Most of the time, students will be working on worksheets that ask them specific questions about their lab and homework assignments, ranging from "what different kinds of shapes did you make?" to "how would you think about volume in terms of the shapes you have been working with?" In addition to whatever tests that they might take, these worksheets would be used to measure student progress in the subject by evaluating them critically, if briefly, to make sure that students are able to draw mathematical understanding from the material being presented.

Classroom Organization

As its format most closely resembles TAI, for the purposes of this curriculum, it is assumed that the class can be divided into groups of four. Each one of these groups will be mixed in ability level, preferably with a lower performing student and a higher performing student in each. This will be the cohesive unit that will work together to accomplish most tasks of the classroom, from planning student presentations to filling out class worksheets. While each student will be expected to produce his or her work independently, this group will work together to give suggestions to one other in the case that difficulty arises, as will often be the case. The group will not work together on laboratories or be part of the same lectures, as students will be drawn at these times individually from the groups, depending on their progress. This organization will lead to an effective use of both teacher and student time, as students will be able to work at their own pace and will receive more personal instruction time with the teacher.

Conclusion

This paper represents a broad idea of what I would put into a classroom curriculum. Unfortunately, I have not been able to explain all of my ideas to the extent that I had hoped to be able to in this paper, but I have included (Appendix 1) my oral presentation slides to give some details of what I had planned for a curriculum on volume. That said, this curriculum, as it stands, does include some ideas of what a curriculum for middle school students should include: both concrete and abstract goals that will encourage students to extend their ideas about mathematics and reinforce their abilities to explore this world mathematically.

Appendix 1: Presentation Slides.

Team Accelerated Instruction:
A Cooperative Approach to Volume

Goals:

- *To promote mathematical activity at a concrete level*
- *To encourage students' derivation of mathematical theories*
- *To involve students in mutual education*

Day 1:	Day 2:	Day 3:	Day 4:
Introduction	Introduction	Introduction	Introduction
Worksheets & Discussion with Group 2. (Mid)	Worksheets & Discussion with Group 4. (Low)	Worksheets & Reinforcement with Group 2. (Mid)	Class Presentations Games
Worksheets & Discussion with Group 3. (Mid)	Laboratory: Difference (3D) Cylinders Cubes	Worksheets & Reinforcement with Group 3. (Mid)	Announcement of current progress and lesson enforcement
Laboratory: Cylinders Cubes Geometric Addition	Worksheets & Reinforcement with Group 1. (High)	Worksheets & Reinforcement with Group 4. (Low)	Conclusion
Conclusion	Conclusion	Conclusion	

A typical school week's lesson plan
Two days in a week

Day 2:

Introduction (10 minutes)
Brief overview of day's activities

Worksheets & discussion with group 4 (Low) (15 min)
Group 2 discusses their previous day's laboratory with teacher while others work.

Laboratories (30 min):
Concrete investigations of different subjects.

Difference (3D)
Try to understand how volume changes.

Cylinders
Try to derive the volume of a cylinder with discs as a tool

Cubes
Try to derive the volume of a cube using squares.

Worksheets & reinforcement with Group 1 (High) (15 min)
Group 3 discusses previous day's lab with teacher while others work.

Conclusion (10 min)
Evaluation of the day's activities.

Day 4:

Introduction (10 min)
Brief overview of day's activities.

Student Presentation (30 min)
Presentations of lab results to entire class

Games (20 min)
Encourage thinking about volume as fun by playing games that require an understanding of volume

Announcement of current progress and lesson enforcement (10 min)
Announce how each team is doing and go over some general volume questions.

Conclusion (10 min)
Evaluations of day's activities

Works Cited

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