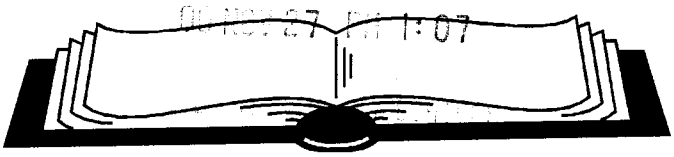
Code # 340
(office use only)

# NEW JERSEY

## 2000-2001 Guidelines and Application



# BEST PRACTICES

**Deadline for Application to County Office: NOVEMBER 27, 2000**

The Best Practices application is a public document. The information that you provide will serve as the official record. Review the application prior to submission to ensure accuracy and adherence to the guidelines. Type or keyboard information requested on this page and page 2, if applicable.

**Category** Mathematics (Application is limited to one category. See page 3 for details.)
**Practice Name** Dome Tent Calculus Project
**Number of Schools with Practice** 1 (If more than one school or district, read and complete information on page 2.)

| | |
|---|---|
| **County** | Union County |
| **District** (Proper Name) | Union County Vocational Technical Schools |
| Address | 1776 Raritan Road<br>Street/P. O. Box<br>Scotch Plains 07076-2997<br>City Zip Code |
| Telephone | (908)-889-8288 Fax (908)-889-4336 Email bistocch@ucvts.tec.nj.us |
| Chief School Administrator | Dr. Thomas J. Bistocchi |
| **Nominated School #1** (Proper Name) | Union County Magnet High School |
| Address | 1776 Raritan Road<br>Street/P. O. Box<br>City Scotch Plains 07076-2997 Zip Code |
| Telephone | (908)-889-3800 Fax (908)-889-3196 Email gzoeller@ucvts.tec.nj.us |
| Principal | Geoffrey W. Zoeller Jr. |
| Program Developer(s) | Gwendolyn S. Kubis |
| Application Prepared By | Gwendolyn S. Kubis |
| **Chief School Administrator's or Charter School Lead Person's Signature** | Thom. Bistocchi |

**FOR USE BY COUNTY SUPERINTENDENT OF SCHOOLS ONLY**

**Approved:** ✓ Yes ___ No **County Superintendent's Signature** James Dol

**NEW JERSEY STATE DEPARTMENT OF EDUCATION**

Code # _____
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# NEW JERSEY
# BEST PRACTICES
# 2000-2001 APPLICATION

**Application Requirements: Failure to comply with the procedures for submission of the application will result in the elimination of the application.**

1. **RESPONSES to the information and the statements below must be ANONYMOUS and ACCURATE.** No reference should be made to the names of the district, the school(s) or community. Use the words "the school" or "the schools" in referring to the applicant in responding to the statements
2. **USE ONLY THE SPACE PROVIDED ON THE APPLICATION FORM on pages 1, 2 (if applicable), and 4.** Do not include any additional materials, as they will not be reviewed in the selection process.
3. Application must be **keyboarded on 8 ½" x 11" white paper, portrait** format. **Twelve-point or larger computer font** or **fourteen-pitch or larger typewritten font** must be used. (This sentence is in twelve-point Times New Roman.)
4. **KEYBOARDED RESPONSES** to all the statements below must be **no more than a total of four pages. Keyboard and number the statement followed by the response.** Format your response for accuracy and clarity.
5. **The information on page 4 and the responses** to statements must be copied **on one side of the page. The information on pages 1 and 2 (if applicable)** must be copied **on one side of the page.** Staple pages 1, 2 (if applicable), 4, and the keyboarded responses together, in that same order.
6. **The original application must be signed by the district chief school administrator or charter school lead person, indicating his/her approval.**
7. **The original and seven copies of the application** must be submitted to the county superintendent of schools by **November 27, 2000**, with the **Itemized List of District Applications** form. Keep the seven copies of each application together with the original containing the signature of the district chief school administrator or charter school lead person on the top of each set.

The following data is required to assist the panelists in the evaluation of the application:

| Type of School | Grade Levels | Practice Name Dome Tent Calculus Project |
|---|---|---|
| ____ Elementary School | _____ | Number of Schools with Practice 1 |
| ____ Middle School | _____ | **Number of Districts with Practice** 1 |
| ____ Junior High School | _____ | **Location** __ Urban/City __ Suburban With Urban Charcteristics |
| X High School | 9-12 | X Suburban __ Small City/Town __ Rural |
| ____ Other: _____ | _____ | |

**Check the ONE CATEGORY into which the practice best fits.**

| | | |
|---|---|---|
| ___ Arts (Visual and Performing Arts) | ___ Educational Technology | ___ Safe Learning Environment |
| ___ Assessment/Evaluation | ___ Gifted and Talented Programs | ___ School-to-Careers/Workplace Readiness |
| ___ Bilingual Education and Diversity | ___ Health and Physical Education | ___ Science |
| ___ Citizenship/Character Education | ___ Language Arts Literacy | ___ Social Studies |
| ___ Early Childhood Education Programs | X Mathematics | ___ Special Education |
| ___ Educational Support/Guidance and Counseling Programs | ___ Professional Development | ___ World Languages |
| | ___ Public Engagement (family involvement and partnerships with business, community, school districts, and/or higher education) | |

1. Describe the practice proposed for recognition, and list its objectives. Detail how the practice is innovative and how it promotes high student achievement.

2. List the specific *Core Curriculum Content Standards, including the Cross-Content Workplace Readiness Standards,** addressed by the practice and describe how the practice addresses those standard(s). Provide an example to substantiate your response.

3. Describe the educational needs of students that the practice addresses. Document the assessment measures used to determine the extent to which the objectives of the practice have been met. Provide assessments and data to show how the practice met these needs.

4. Describe how you would replicate the practice in another school and/or district.

*The 1996 edition of the ***Core Curriculum Content Standards*** published by the New Jersey State Department of Education was disseminated to all districts and charter schools and is available on line through the department's web site at http://www.state.nj.us/education.

1. **Describe the practice proposed for recognition, and list its objectives. Detail how the practice is innovative and how it promotes high student achievement.**

The proposed Best Practice provides a concrete learning activity that enables students to apply abstract calculus theory to a practical problem chosen from everyday life. A two-person dome tent is erected in the classroom. The challenge to students is to estimate the volume contained within the tent using calculus.

*Objectives for the proposed Best Practice:*

1. Students will be able to calculate the volume of solids of revolutions
2. Students will be able to visualize the three dimensional shape that results from revolving a two dimensional graph about a given axis.
3. Students will gain a conceptual understanding of revolution of solids.
4. Students will apply their knowledge of volumes of revolutions to estimate the volume of an actual three-dimensional dome tent.
5. Students will discuss how such integration techniques are important in solving problems that arise in real life.

The calculus approach to solving three-dimensional volume problems is to find a suitable equation, graph the equation, and then revolve the graph about a given axis to create the three dimensional object. This process is difficult for students to visualize and for instructors to sketch.

Advanced Placement Calculus AB and BC curricula include practical applications of integration. Students learn a variety of techniques to calculate volumes that are created by revolving graphs about a given axis. The proposed Best Practice utilizes graphing software to help students visualize solids of revolution. Students demonstrate their understanding of the mathematical theory by estimating the volume of a dome tent using calculus. Students are then challenged to validate their calculus solution by another means, chosen by the students.

The concept of solids of revolution is often difficult for students to grasp. Rotation of a two dimensional object about a line is necessary to create a three dimensional shape. In order to determine the volume of an object, students estimate the volume by filling the three-dimensional solid with many small shapes (e.g. disks) of calculable volume. The volume of the object is found by adding all of the small volumes. As the number of small disks increases, the better the estimate will be. Consequently, as the number of disks approaches infinity the calculation of the volume will be exact.

One of the problems with teaching this topic, is that it is very difficult for students to visualize the three dimensional shapes that are created. Furthermore, unless the teacher is particularly artistic, it is even more difficult to sketch the shapes on a board or transparency. Teachers and students are then limited to discussing only the hypothetical examples given in the text or other resource. Computer software is readily available that allows the user to graph a function, and visualize what three-dimensional solid would result if the graph of the function were revolved about a given axis. The software can also calculate an estimate of the volume of the resulting solid.

The proposed Best Practice capitalizes on the power of the graphing software to provide an innovative way for students to estimate the volume of an actual three-dimensional solid. Students are required to examine the physical dome tent. They take measurements and try to fit a polynomial equation that will make a reasonable approximation of the shape of the tent when revolved about a given axis. The software helps the students to visualize the resulting solid and

to compare the estimate with the physical dome tent. Students are able to refine their initial estimate, visualize the results of the refinement, and test their estimate against the actual physical object. Through use of this software students gain a more conceptual understanding of the topic and rely less on memorization of related formulas.

Students work in small groups to take measurements, devise an accurate method to calculate the volume, and devise another method for testing the reasonableness of their findings. Students complete a detailed written report that includes the following:

1. States objective and includes clear descriptions of procedures used
2. A complete explanation of steps taken along with their rationale
3. A summary of all proposed methods discussed and why the group chose their resulting method
4. Includes data and calculations for the calculus solution, with explanations
5. An explanation, data and calculations for testing reasonableness of their findings
6. Discussion of potential disagreement between the calculus solution and the other estimate.
7. Conclusions made and a summary of what was learned from the activity
8. Suggestions for improvement of their calculations.

Finally groups compare the methods that they used for calculating the volume of the dome tent by formally presenting their findings to the class.

The proposed Best Practice is innovative in that it allows students the opportunity to solve an actual physical problem using calculus. It uses computer graphing software technology to greatly increase the conceptual understanding of a difficult concept. Students have the opportunity to compare theoretical results with physical estimates made by themselves and by other teams of students. While the cognitive outcome of the proposed Best Practice is significant, an important collateral outcome in the affective domain is also achieved. Students have a good time accomplishing this activity and learn that calculus can be both useful and fun!

**2. List the specific *Core Curriculum Content Standards, including the Cross-Content Workplace Readiness Standards,* addressed by the practice and describe how the practice addresses those standard(s). Provide an example to substantiate your response.**

- **Mathematics Standards 4.1.15 & 4.16.2:** Students are challenged to solve the problem of estimating the volume of the dome tent. Integration techniques are reinforced through discovery, and inquiry.
- **Mathematics Standard 4.2.9:** Students formulate conjectures to determine if their integration method is appropriate for finding an accurate volume of the dome tent.
- **Mathematics Standard 4.5.8:** Students use software to help visualize solids of revolution and use calculators to complete volume calculations.
- **Mathematics Standard 4.7.21:** Students use a real, three dimensional shape (the tent), to calculate its volume. Using calculus techniques, students must create two dimensional graphs and diagrams of the tent in order to find the volume.
- **Mathematics Standards 4.10.12, & 4.15.19:** Students assess the accuracy of their calculation methods by designing a non-calculus way of finding the volume. Students find a "reasonable" estimate using whatever tools are available to them. For example, some students may fill the tent with a measurable substance. Other students may

calculate the volume of the sphere encompassing the tent. Whatever the method of checking accuracy, students must then evaluate their calculus calculation (was the estimate to small or too large and why?).

- **Mathematics Standard 4.15.14:** Students calculate the volume by summing the number of shapes used to fill the tent (e.g. disks). As the number of these shapes increases the better the approximation will be, hence the concept of limits.
- **Workplace Readiness Standard 2.2:** Students select and utilize the tools they use for the actual measurement of parts of the tent. They use graphing calculators to perform computations and create graphs to aid them in their solution. They also use computer software to help visualize the actual 3-dimensional solid they used to estimate the volume of tent.
- **Workplace Readiness Standard 3.11:** Within their student groups, students usually have different methods of solution to the problem and will either test both methods and decide which is more accurate or use a combination of the methods. When each group presents their method of solution to the class, the other groups will be able to observe several alternative methods of solution.
- **Workplace Readiness Standards 3.13 & 3.14**: In their groups, students select and apply methods of their choice to determine the tent volume and are constantly evaluating and testing their methods. They examine the reasonableness of their volume estimations and discuss possible causes of error in their findings. Then they may change their method and recalculate, if they feel their volume estimation is not very accurate.
- **Workplace Readiness Standard 4.2**: This whole project is done in student groups working cooperatively together to determine the volume of the tent, as previously described.

3. **Describe the educational needs of students that the practice addresses. Document the assessment measures used to determine the extent to which the objectives of the practice have been met. Provide assessments and data to show how the practice met these needs.**

All faculty and students at our school are introduced to the Gregoric Style Delineator as a way to identify their own favored learning style, and to become aware of the rich variety of cognitive styles used by other faculty and student body members.

The Gregoric Style Delineator is based on two major axes (the Abstract – Concrete dimension and the Random – Sequential dimension) and classifies cognitive styles into four broad classifications: AR or Abstract-Random; AS or Abstract – Sequential; CR or Concrete – Random; and CS or Concrete - Sequential. All the curricula used at our school identify activities for each unit that are designed to meet the special needs of students in each of these four groups. This best practice is no exception.

The AR learner is attuned to the subtleties of human behavior and sensitive to "vibrations" in group interactions. They like to gain information in less structured ways including group discussion, and they enjoy busy, free-wheeling environments. Since the best practice is a group activity and the teacher is not the center of attention, AR learners take active roles within the group based on their "read" of the fluid situation within the classroom.

The CR learner enjoys exploring, especially in unstructured situations. Their insightful, intuitive thought processes allow the group to identify novel solutions to open-ended

problems. Because the teacher gives only a minimum number of instructions at the beginning of the activity, CR learners have opportunities to be creative and steer the group in new directions as they deal with a problem very different from textbook examples assigned up to this point in the unit.

An AS learner is an excellent decoders of printed, verbal, and iconic symbols and favor pictorial representations of abstract concepts. The activity affords the AS learner chances to encode, tabulate, and analyze data in with different tools, and use of the graphing software plays to their cognitive strengths.

A CS learner favors gaining information by direct, hands-on experience with physical objects, following detailed instructions. With the dome-tent as a large-scale manipulative as part of this best practice, CS learners may not only manipulate a concrete object, but they can walk around it and even sit inside of it! This facilitates their devising alternative ways to obtain the measurements needed to solve the problem at hand. CS learners can rely on other members of the group to flesh out sketchy, initial indications that do not meet their personal needs for explicit and extension directions.

Finally, the open-ended nature of the problem allows a perceptive teacher to modify the activity to meet other cognitive needs accounted for when the activity was first planned for the four general types of learners named above.

Students are evaluated through use of a detailed rubric that is given ahead of time (see explanation in question 1 for further details). The rubric assesses student performance based upon their group work, formal presentations, and written laboratory reports. The most obvious measure of student understanding of the related material is through the formal project assessment based upon characteristics outlined in the rubric. Students who completed this project scored on average 89.3%. In addition, problems that utilize the material involved in this activity are annually seen on the Advanced Placement Calculus AB and BC exams. An indirect measurement of student performance can be ascertained from the following Advanced Placement Calculus scores for students who completed this activity.

| | 5 | 4 | 3 | <3 |
|---|---|---|---|---|
| AB | 1 | 1 | 1 | 0 |
| BC | 4 | 0 | 2 | 0 |

**4. Describe how you would replicate the process in another school and/or district.**

Replicating this activity in another school would be simple. A teacher would first need to purchase or borrow software that revolves two dimensional graphs about a line or axis, such as *Best Grapher* (produced by George W. Best). Access to graphing calculators will also help students fulfill the goals of the project. Teachers can receive software familiarization through inservice training conducted by the appropriate county Educational Technology Training Center (ETTC). Once teachers and students are familiar with the software and/or graphing calculators, completion of the dome tent project will run smoother because students are able to better visualize the revolution. Other materials necessary for replicating the project include a dome tent with a geometric shaped base, measuring tools such as a tape measure, and graphing calculators.