Integrating Practical Geometry and Statistics into Service Learning Activities:
Remediating Storm water Runoff with Community Rain Gardens

By
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Project Objectives

• The project combined both the statistics and geometry portion of the class to solve an environmental issue. Students had to design a rain garden to remediate runoff pollution. They analyzed precipitation statistics from the past 10 years and then used geometry to build a trapezoidal rain garden.

• The students then also taught basic geometry to disadvantaged youth at a local community center in Los Angeles, using their project as an example so that the participants at the center can build their own rain garden at the facility.

• Thus, not only were the students connecting mathematical concepts to real-world situations, but they were also learning how to incorporate such projects into their lesson plans and instructional models since they are pre-service teachers.
Integrating Practical Geometry and Statistics into Service Learning Activities: Remediating Stormwater Runoff with Community Rain Gardens

Eugene Allevato, Melissa Barclay and Melissa Munoz

Abstract

The purpose of this program is to raise awareness of environmental issues and engage students in practical applications of math and science in their everyday lives. This program is designed to promote critical thinking, problem-solving, and social responsibility skills in future educators. This paper will present an informational model that utilizes conceptual learning and geometry to address elementary school teachers from a practical and engaging perspective. Students already have knowledge of basic concepts through their own experiences with real-world phenomena. However, leading to coordinate projects that involve practical learning in the classroom to solve environmental issues is an encouraging initiative. This paper examines the impact of integrating practical applications of geometry and statistics into the context of current environmental issues. The model for this was developed in collaboration with a charter school where pre-service teachers explored fundamental concepts of geometry and implemented environmental solutions to reduce runoff pollution by engaging with the community around them. The model for this was developed through a series of educational activities centered around the concept of teaching students critical thinking skills that have been implemented previously but have not been fully implemented. The model is based on the educational development of the future elementary school teachers.

The pre-service teachers' assessment of learning outcomes was based on a questionnaire administered before and after instruction on the Charter School program. Analysis of the effectiveness of the active learning sessions focused on practical activities was evaluated based on the level of environmental consciousness and understanding of mathematical concepts that solve real-world problems. This instructional model emphasized the importance of pre-service teachers to implement systematic thinking to integrate subject content and real-world problems in order to develop critical thinking skills in their students to live each day of their lives with an environmental consciousness and become better decision-makers.

What Are Rain Gardens?
A rain garden is a landscaped depression that is designed to allow rainwater runoff to be absorbed to reduce runoff and erosion, water pollution, flooding, and recharge groundwater. Rain gardens can be downscaled to reduce erosion in the amount of pollution reaching waterways and oceans.

What are the Environmental Benefits?
- It provides habitat for insects and birds due to the increase of vegetation.
- It is aesthetically pleasing and will improve the neighborhood landscape.
- It will filter and increase the amount of groundwater recharge.
- Plants can provide shade and a light of noise screens.
- Reduce stream runoff volume and velocity.
- Reduce runoff pollution by trapping sediments and pollutants at the surface.
- Solve drainage problems and reduce erosion.

Community Service Activity

Conclusions and Recommendations

The instructional model utilized in this course emphasizes a transdisciplinary approach including concepts of geometry, statistics, and environmental science for pre-service education students to have the opportunity to develop critical thinking and problem-solving skills in respect to relevant environmental issues. The instructional model is designed to be real-world problem-solving. The conceptual and statistical concepts provide pre-service education students with the opportunity to develop critical thinking and problem-solving skills in respect to relevant environmental issues. The instructional model is designed to be real-world problem-solving. The conceptual and statistical concepts provide pre-service education students with the opportunity to develop critical thinking and problem-solving skills in respect to relevant environmental issues. The instructional model is designed to be real-world problem-solving.
Hydrologic data is typically skewed, meaning that data sets are not symmetric around the mean or median, with extreme values extending out longer in one direction. When data are skewed the mean is not expected to equal the median, but is pulled toward the tail of the distribution. Thus for positive skewness the mean exceeds more than 50 percent of the data. The standard deviation is also inflated by data in the tail. Therefore, tables of summary statistics which include only the mean and standard deviation or variance are of questionable value for water resources data.
What are Rain Gardens?
A rain garden is a planted depression that is designed to allow rainwater runoff the opportunity to be absorbed from impervious urban areas like parking lots, sidewalks and compacted lawn areas. This reduces rain runoff by which causes erosion, water pollution, flooding, and recharges groundwater. Rain gardens can cut down on the amount of pollution reaching waterways and ocean.

What are the Environmental Benefits?
- It will provide habitat for insects and birds due to the increase of vegetation mixture.
- An aesthetic enhancement that will thereby improve the neighborhood landscape.
- It will filter and increase the amount of groundwater recharge.
- Plants can provide shade and a light or noise screen.
- Reduce stormwater runoff rates and volume.
- Reduce runoff pollution by keeping sediments and pollutants out of streams.
- Solve drainage problems and reduce erosion.
- Volume of a rectangular prism

\[ V_r = l \times w \times h = 6 \times 1 \times 2 = 12 \text{ ft}^3 \]

- Volume of a Triangular prism

\[ V_{\text{Tri}} = \frac{1}{2} h (b + B) h = \frac{1}{2} \times 1 (3 + 3) \times 1 = 4.5 \text{ ft}^3 \]

\[ V_{\text{Total}} = 12 + 4.5 = 16.5 \text{ ft}^3 \]

- Estimation of water retention: Consider a sphere inscribed in a one-inch cube

\[ V_{\text{Cube}} = l^3 = 1^3 = 1 \text{ in}^3 \]

\[ V_{\text{Sphere}} = \frac{4}{3} \pi r^3 = 0.52 \text{ in}^3 \]

Retention = 0.48 x \( V_{\text{Total}} = 0.48 \times 16.5 = 7.92 \text{ ft}^3 \]

- Run off from impervious surface.
  Sidewalk (2 x 20 yards) or (6 x 60 ft)

Based on precipitation data (0.35 in = 0.0275 ft)

Run off = 60 x 6 x 0.0275 = 9.9 ft\(^3\)

- As ponding depth more than 6 inches could lead to retention longer than 46 hours, piano to使者ers breaching so a design along the sidewalk was proposed.

\[ V = 60 \times 0.5 \times 1 = 20 \text{ ft}^3 \]

Water Retention = 0.48. \( V = 0.48 \times 30 = 14.4 \text{ ft}^3 \)

Cost of supplies

<table>
<thead>
<tr>
<th>Cost of supplies</th>
<th>1 yd(^3) = 27 ft(^3)</th>
<th>Price per yd(^3)</th>
<th>Cost per yd(^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>50% 15 ft(^3)</td>
<td>0.555</td>
<td>$4.16</td>
</tr>
<tr>
<td>Topsoil</td>
<td>25% 7.5 ft(^3)</td>
<td>0.277</td>
<td>$4.26</td>
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<tr>
<td>Compost</td>
<td>25% 7.5 ft(^3)</td>
<td>0.272</td>
<td>$4.32</td>
</tr>
<tr>
<td>N. Iron Plants</td>
<td>10 approx. 2-15/plant</td>
<td>$20-150</td>
<td></td>
</tr>
</tbody>
</table>

\[ $43 - 173 \]
Seasonal Precipitation Data: Runoff Forecasting

Hundredth of inch

Day
Giving Back to the Community
Learning Outcomes Assessment

• Assessment of learning outcomes was based on a questionnaire implemented before and after instruction at the Charter school.

• Analysis of the effectiveness in active learning linking lectures with a practical activity was evaluated based on the level of environmental consciousness and the understanding of mathematical processes to solve real world problems.

• This instructional model emphasized the importance of pre-service teachers to implement systemic thinking to integrate subject content and real world problems in order to develop creative and critical thinking skills in our children to live each day of their lives with an environmental consciousness and to become better decision-makers.
Questionnaire implemented before and after instruction at the Charter school.
Assessment of Learning Gain per Subject: Charter School Students
Knowledge Assessment Before and After the Course: Pre-service Students
Conclusion

• The instructional model utilized in this course emphasizes a transdisciplinary approach including concepts of geometry, statistics and environmental science where pre-service education students have the opportunity for civic engagement and to provide community service by teaching students from a local charter school.

• The concept of project-based learning of a real-world problem involving geometric and statistical concepts provides pre-service education students with the opportunity to develop critical thinking and decision-making skills in respect to the volume estimation and design of a rain garden based on the precipitation data and area of permeable surfaces of the site studied.

• Pre-service education students in this class learned concepts of geometry and statistics, and developed a lesson plan including statistical analysis of an assessment of learning gains that they formulated.

• Assessment of learning gains measured before and after teaching activity indicated that students, from the Charter school gained knowledge on concepts of symmetry, angles, calculation of area, and other basic geometry skills. However, the concepts of units of measurement were not completely understood.

• It seems that pre-service education students liked the idea of incorporating community service projects in their lessons’ plans and will be interested to implement this concept in the future.

• The environmental science project motivated students to study geometry and statistics since runoff pollution is a major issue that affects everyone. In addition, it reinforced the concept that in the real world problem solving requires the understanding of different disciplines and perspectives.