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Sustainable by Design: An education program on the science and economics of green design

Evaluation Report

Introduction

In 2008, Creative Change Educational Solutions was awarded a \$30,000 grant to support teacher education and classroom implementation of *Sustainable by Design*. The 15-month project provided 35 middle school teachers in Michigan and New York with ready-made curriculum, training, and support to integrate ecological economics into their science and economics courses. This report details the outcomes of this program on student learning and teacher practice.

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Note: For an overview the program, including a curriculum tour and overview of professional development packages, please see the Sustainable by Design section of our website:

http://www.creativechange.net/programs/sustainable_design/

Evaluation outcomes and methods

Participant background

The teachers who participated in the Science of Green Design training were mainly secondary science, technology or social studies teachers. As revealed in participant applications and pre-tests, most educators came into the program with moderate understanding of green design and/or sustainability, but a strong interest in these issues.

Goals

The project aimed to 1) increase teachers' knowledge of product life cycles and the links between the economy and the environment, 2) increase teachers' confidence in delivering instructions on these topics, 3) increase students' knowledge of these topics, 4) improve students' attitudes toward environmental consumer choices, and 5) ensure that the program continues beyond grant funding (addressed previously).

Assessment methods

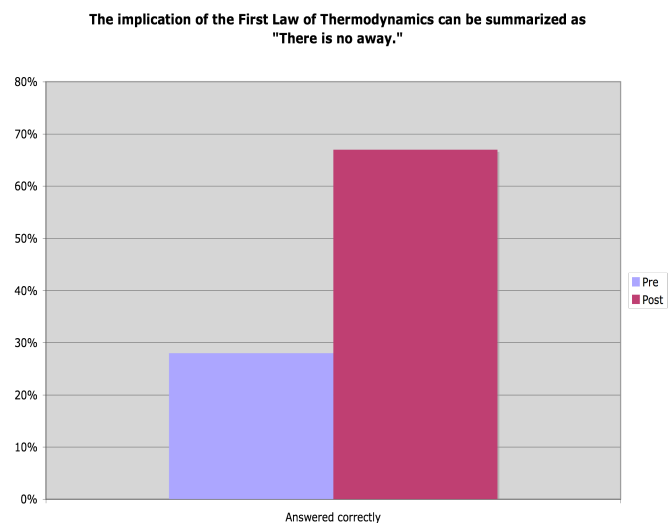
Creative Change conducted multiple assessments to measure the project's outcomes:

- First, we administered student and teacher pre-and post-tests online using Survey Monkey, allowing us to collect both quantitative and qualitative data from all teachers and over 350 students
- We held focus groups (supplemented with on-line evaluation) with teachers and administrators to identify core barriers to interdisciplinary teaching and learning, and additional needs and interests in the areas of green design and ecological economics
- Classroom observations and analysis of student work provided further insights of the impacts on student learning as well as common pitfalls and student misconceptions.
- A graduate student at Eastern Michigan University worked with CCES to conduct in-depth interviews focused on how and why a teacher adopts sustainability curriculum. Insights and quotes from her research were used to inform our quantitative data from the teacher pre-and post-tests and surveys.

Outcomes for Teachers by goal

Goal 1. Increase teachers' knowledge about product life cycles and the links between the economy and the environment.

Outcome: Post-test answers showed strengthened content knowledge and an increased ability to integrate the content knowledge into their teaching. For example, the percentage who could identify the First Law of Thermodynamics and its implications for the economy (i.e., "There is no away") increased from 28% to 67%.



Likewise, the percentage of teachers who could describe the difference between the conventional and ecological economic model, and who could identify that the environment is the biophysical basis for the economy, increased from 28% to 50%.

On similar questions, the percentage of teachers who knew that economic activities occur within (as opposed to separate from) the environment increased by 20%, and knowledge of the core principle behind cyclical life cycles (“waste=food”) more than doubled between pre and post-testing.

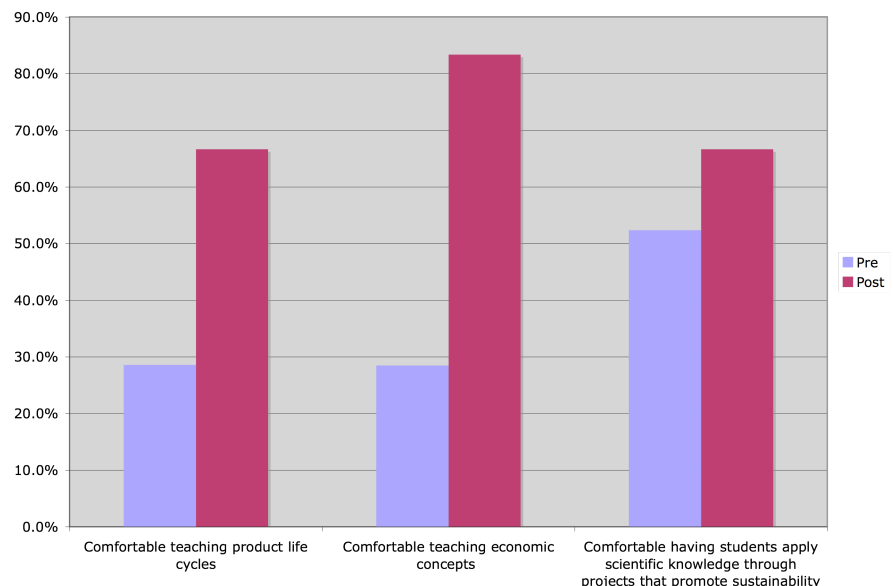
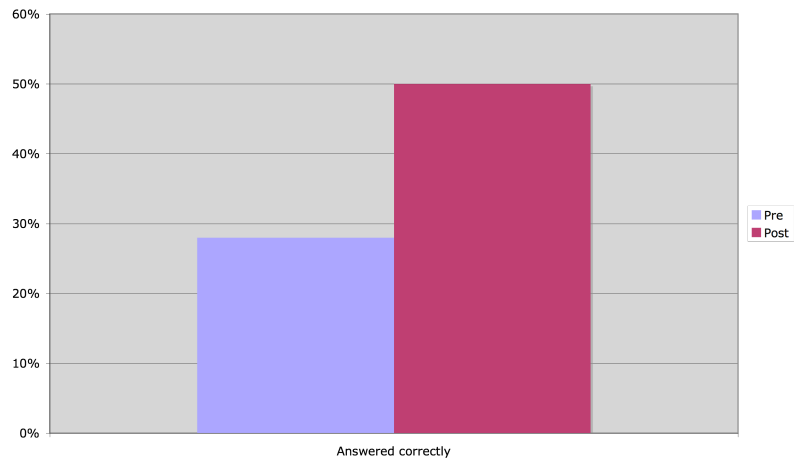
We modeled multiple activities to teach the connection between the environment and the economy, and provided these lessons to teachers. To teach the science behind life cycles, for example, participants used a worm bin to complete a lab on decomposition; and analyzed the “life story” of common foods and products to identify inputs, outputs and the role of the ecosystem in supporting economic activity (i.e., forests and oceans absorb carbon emissions, a common “output” of energy use). These activities provided a basis for understanding the Ecological Footprint, another core topic addressed.

We also used a deceptively simple demonstration to explore energy transformations and thermodynamics: Teachers burned a nut set up under a beaker with water and measured heat generated. This simple but memorable activity (provided as part of a lesson) is an excellent way to demonstrate the conservation of matter (First Law of Thermodynamics, aka, “There is no away”). As the activity shows, the energy (calories) in the nut do not ‘disappear,’ when they are burned, but are converted to heat energy.

Goal 2. Increase teachers’ confidence in delivering instruction on these topics.

Outcome: Teachers showed a significant increase in confidence and comfort in teaching the targeted content as shown in the graph. The greatest gains were in increased comfort in teaching economic concepts (a true interdisciplinary victory for a program that drew mostly science teachers). Also, the number of teachers who reported being familiar with and having taught the Ecological Footprint increased by 60% between the pre and post-test (not shown in graph).

In the ecological macroeconomic model, the environment is viewed as the biophysical basis of the economy.



Goal 3. Increase students' knowledge of product life cycles and the links between the economy and the environment.

The pre-tests revealed that many of the students began the program with a good understanding of some of the core scientific concepts. This is most likely a reflection of the content students were previously exposed to and the teachers' greater experience in this area. Consequently, we saw higher gains in knowledge of social issues (economics and human impacts) than in the science content; specific increases were in knowledge of product life cycles, the link between the environment and the economy, and students' own roles as decision-makers and consumers.

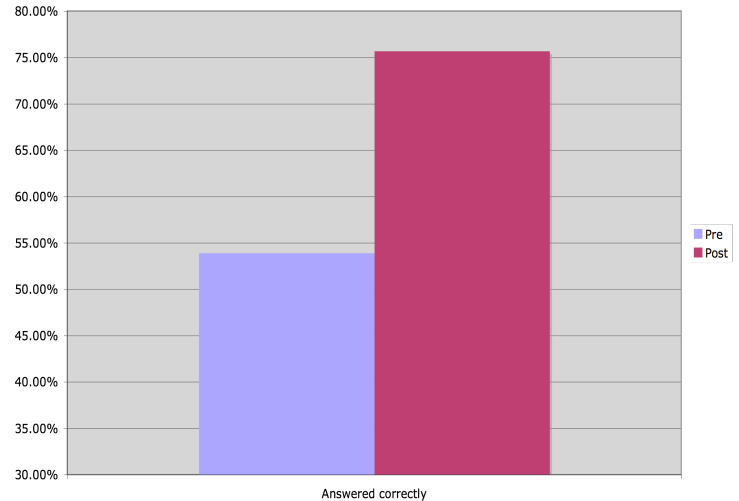
For example, there was an average 25% increase in students' ability to define and correctly identify components of product life cycles, including stages, sequence, and specific terms such as 'inputs' and 'outputs.' Opened-ended questions revealed additional learning, especially about the implications of disposal and students' choices as consumers. Comments such as this were typical: "I can choose the t-shirts that I buy or the strawberries. I can take that glass jelly jar that my teacher found in the garbage and I can recycle because it never ever decomposes."

Quotes and writing from the students revealed an emotional connection to the material. As one teacher noted, "The kids were into this unit with every cell of their bodies." Another teacher commented, "This curriculum is a perfect springboard for doing things that the kids could really relate to. This was a pretty serious unit. We had a lot of fun but they did a lot of deep thinking, and they loved it... [My students] have very heightened awareness now, which is nice. I think the ideas and concepts really permeate into just about everything that they do, from how they look at the world and how they look at their learning to how they recycle their scrap paper."

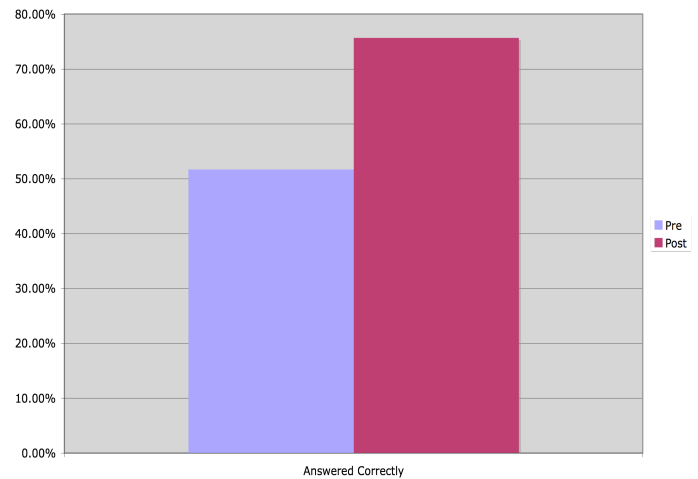
In follow up interviews, we specifically asked teachers if students' emotional connections manifested as feelings of dread or disempowerment (an unfortunate result of "the sky is falling" approach to environmental education, which is all too common). The teachers resoundingly said that the students were not despondent, but engaged and inspired. When we probed the teachers further as to why this was, they noted several factors inherent to the framing of the content in the lessons:

- The level of problem-posing was grade-appropriate, with a focus on issues that 10-14 year-old students could connect to and act upon.

Students who could describe the materials needed to make something



Students who could describe the wastes created when making something



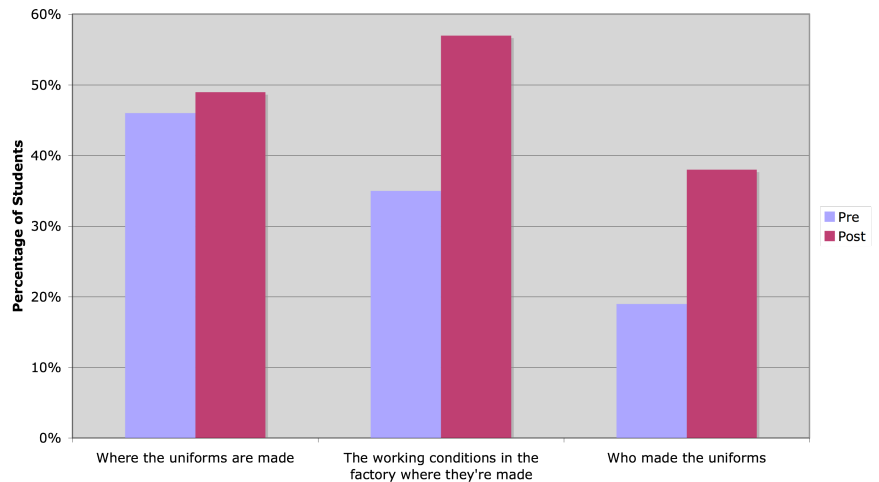
- The lessons provide many activities and opportunities for students to consider choices and make a difference.
- The lessons included decision-making issues at the policy and business levels; students learned how adults, businesses and public leaders are taking action. This approach is designed to relieve kids of the burden (and anxiety) that “saving the world” is all their job.

Finally, teachers cited activities that engaged the students in questioning their assumptions and beliefs consumption and what is “cool” or necessary for a good life. For example, in one activity, students interviewed older family members to learn about purchasing and disposal habits when the elder was young. As the students learned, practices such as mending, sharing and wearing hand-me-downs were not only common, they were respected; this contrasts to today’s messages that “new” and “more” are always better. (To support this, we provided teachers with a Powerpoint with images the next goal, changing students’ consumer attitudes.)

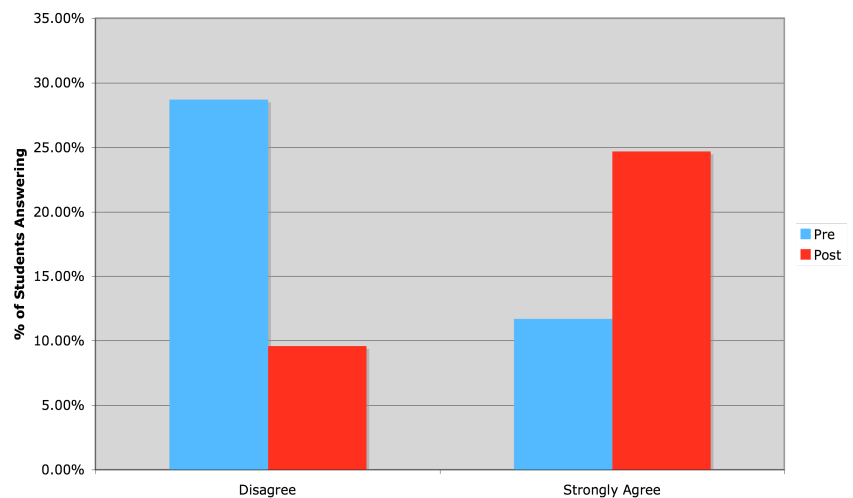
Goal 4. Improve students’ attitudes towards environmental consumer choices.

In the pre-and post-tests, students were asked to explain and identify what factors they considered when selecting clothing or other items for themselves. In the pre-test the majority of students listed color, brand name and price as the most popular factors that informed their purchase. The post-test answers showed that those things were still important; however, the majority of answers also considered the type of fabric, where the clothing was made and the working conditions of the factories. A similar question about purchasing plates and forks for a school party revealed similar increases in the percentage of students who considered life cycle factors.

Imagine you are choosing new uniforms for a school team and you have a choice between two companies; the uniforms are about the same price and look the same. What would you consider in your decision:



Imagine you are helping to plan a party at school and you have to buy plates and forks. Would you think about what the plates and forks are made of before you purchase them?



Conclusions

In both teachers and students, there was a greater increase in knowledge and awareness of social and economic issues compared to increases in scientific knowledge. We attribute this to the perhaps obvious fact that most of the teachers came in with strong interest and/or some experience teaching science or the environment, and that this reflected in their students' knowledge.

These results highlight several needs for the fields of environmental and sustainability education:

- Environmental education needs to move out of the science classroom only and become a focus for social studies. Likewise,
- Science teachers need greater understanding of the linkages among the environment, social issues, the economy, and public policies.
- Teacher education in *any* discipline should be cross-disciplinary so that teachers gain an understanding of the content and context of an issue simultaneously.

These conclusions reinforce the existing literature that shows students can better understand a social issue if they have a solid understanding of the science behind it, and that science is more meaningful when placed in a social/cultural context. Sustainability is the perfect context for achieving these goals.

As one middle school technology teacher noted “[Sustainability] is something that we will have to be teaching regardless. We can apply some critical thinking and really teach what it means to see a different way of doing things. [W]e will come to a time when there will not be another way of doing things besides operating in a sustainable manner.”