

A LEGS-ON APPROACH TO ENERGY EDUCATION THEN AND NOW: A LONGITUDINAL STUDY

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ABSTRACT

The energy bike is a bicycle-powered generator that students pedal to generate electricity to light a display panel of light bulbs and other appliances. As appliances are turned on and the energy draw increases, students feel the increased need for electricity. The Wisconsin Energy Cycle Education Program includes lessons that focus on basic energy concepts, renewable energy resources, and energy conservation. The energy bike was piloted in five Wisconsin nature and environmental education centers in the mid-90's. The study concluded that the program increased environmental literacy and positive attitudes regarding energy conservation. In the late 90's the energy bike model was improved based on pilot feedback and additional units were placed in educational settings throughout WI. Recently, the energy bike model has been improved again and sturdier models that are easier to transport are available. Follow-up interviews were conducted with participants involved in the pilot as well as those who became involved after the pilot. Although it clearly appeals to students and gets the message across, technical difficulties and educator discomfort with the complex nature of the lesson concepts cause some to question the future of this educational tool.

INTRODUCTION

Providing students with tangible experiences can help them explore their energy understandings and provide them with productive means to learn new concepts

(Lieberman and Hoody 2002; Resnick and Chi 1988; Rohwedder and Tourtillot 1992). Not having these resources is a commonly reported barrier to teaching about the environment, including energy (Ham and Sewing 1987; Lane 1993). Alternatively, teachers report that having access to resources would promote their interest and confidence in teaching environmental concepts (Dixon 2001; Lane 1993; Sivek 1987).

One program that attempted to fill the energy education gap is the Wisconsin Energy Cycle Education Program (WECEP). This program and pilot project, which operated from 1993 to 1995, combined the teaching resources of 5 regional environmental education centers with funding from the Wisconsin Demand-Side Demonstrations (WDSM).

The WECEP taught students about energy by having them pedal a stationary bicycle which generates electricity to power lights and other appliances. This interactive “legs-on” educational tool stimulates students’ curiosity as it teaches concepts of electricity, energy production, supply and demand, efficiency, and other related topics. Students can actually feel the difference in energy required to power an energy efficient appliance compared to its not-as-efficient counterpart. The Energy Cycle Education Program was originally developed by the North Carolina Alternative Energy Corporation in conjunction with SEASUN power systems to promote energy awareness and conservation.

This study reports on the results of the evaluation of the initial pilot program of the WECEP. It also provides more recent findings of a longitudinal follow-up study of those centers which participated in the pilot program and educators who acquired an energy bike after the pilot year.

METHODS

The Solomon Four-Group experimental design (Campbell and Stanley 1963) was chosen because of its strength in controlling both external and internal variables. The Experimental Treatment consisted of having students participate in the Energy Cycle lesson plan activities at the Central Wisconsin Environmental Station (CWES). Energy Cycle lessons were scheduled to last 1 – 1½ hours. Learning groups consisted of 10-15 students. To assure consistency, a training program was developed to educate instructors at CWES on how to use the Energy Cycle and teach the lesson.

A test was developed to measure changes in students' knowledge (Hungerford, Peyton and Wilke 1980), attitudes (Koballa 1984; Passineau 1975) and behavioral intention (Roggenbuck and Passineau 1986; Wilke 1993) regarding energy resources and conservation practices.

RESULTS

A comparison of simple mean pre- and post-test scores by school for the three factors (attitude, knowledge, and behavioral intention) suggests an obvious change in attitude and knowledge scores (Table 1). None of the schools, however, showed statistically significant changes in scores for behavioral intention.

Table 1. Pre- and posttest mean scores by school

Knowledge		Pretest			Posttest		
Group	School	Mean	n	Std. Dev.	Mean	n	Std.Dev.
I (treatment)	Houdini	2.99	85	.53	3.43	85	.60*
I	Alexander	2.68	107	.65	3.16	101	.66*
I	Roosevelt	2.75	71	.64	3.25	71	.69*
II (control)	Read	2.55	40	.62	2.46	37	.77
II	Ap. Jefferson	2.56	46	.64	2.65	53	.62
II	St. Paul	2.72	13	.54	2.80	13	.59
II	Jackson	2.58	43	.64	2.66	43	.71
Attitude		Pretest			Posttest		
Group	School	Mean	n	Std. Dev.	Mean	n	Std.Dev.
I (treatment)	Houdini	3.73	85	.49	4.16	87	.43*
I	Alexander	3.63	109	.62	4.01	102	.59*
I	Roosevelt	3.62	74	.52	3.94	71	.55*
II (control)	Read	3.62	41	.44	3.54	37	.41
II	Ap. Jefferson	3.35	52	.44	3.46	53	.53
II	St. Paul	3.27	14	.68	3.37	14	.87
II	Jackson	3.52	45	.45	3.54	43	.50
Behavioral Intention		Pretest			Posttest		
Group	School	Mean	n	Std. Dev.	Mean	n	Std.Dev.
I (treatment)	Houdini	3.12	85	.81	3.21	87	.81
I	Alexander	2.80	109	.91	2.86	102	1.01
I	Roosevelt	3.04	72	.83	3.04	71	1.00
II (control)	Read	3.08	40	.76	3.13	37	.86
II	Ap. Jefferson	3.46	52	.75	3.61	52	.77
II	St. Paul	3.48	14	.77	3.29	14	.65
II	Jackson	3.15	45	.65	3.23	43	.76
* significant at 95%							

Regression analysis (Borg and Gall 1971) was also used to help determine if the treatment had a statistically significant effect on participating groups (Figure 1). In addition, the regression analysis helped clarify the influence of factors beyond the lesson (treatment) that might have caused the observed changes such as the influence of taking a pretest (pretest effect).

Figure 1. Regression Model

$$S_{post} = \beta_1 D_t + \beta_2 D_{pre} + \beta_3 D_t D_{pre} + \beta_4 + e$$

Where:

- S_{post} is the posttest score;
- D_t is a dummy variable for participation in the energy cycle unit (1=yes, 0=no)
- D_{pre} is a dummy variable for whether a pretest was administered (yes = 1, 0=no);
- e represents random error
- β₁=treatment effect
- β₂=practice effect
- β₃=sensitization effect
- β₄=constant

The result of running this regression model for the three indicators (Table 2) shows large, positive coefficients on the treatment variable for attitude (+0.37; 7.0) and knowledge (+0.52;7.6), along with highly significant (p<0.01)t statistics.

Table 2. Results of Evaluation Posttest Model (regression coefficient and t statistic)

	Attitude		Knowledge		Behavioral Intention	
	coeff.	t	coeff.	t	coeff.	t
β ₁ (energy cycle effect)	+0.37	7.0*	+0.52	7.6*	+0.09	1.1
β ₂ (pretest practice effect)	-0.05	0.8	+0.09	1.2	+0.25	2.6*
β ₃ (pretest sensitization effect)	+0.17	2.2*	+0.13	1.3	-0.41	3.3*
β ₄ (constant)	+3.55	84.5*	2.52	46.7*	+3.09	45.0*
Additional model statistics:						
N	822		809		817	
Adjusted r ²	0.15		0.16		0.01	
* = statistically significant at p<95%						

LONGITUDINAL FOLLOW-UP STUDY OF THE ENERGY CYCLE EDUCATION PROGRAM

Despite the effectiveness of the Wisconsin Energy Cycle Education Program, efforts to maintain and expand the program in Wisconsin failed. Program administration was challenged by problems with bike maintenance, finding replacement parts, and transporting the bikes around the state. We decided to conduct a follow-up study to see how the original SEASUN pilot Energy Cycle units fared and investigate issues with models that were disseminated after the pilot year.

METHODS

One of the first steps of the follow-up study was to learn if and where the bikes in the original study existed. During this search, we learned the status of bikes the Energy Center of Wisconsin distributed after the pilot year as well. We also found that although SEASUN went out of business, other agencies such as A1 Cable Solutions (Pedal Power) and an individual in Illinois (Pedal 4 Power) had created and were distributing their own bikes.

In-depth, semi-structured interviews (McCracken 1988) were conducted with educators associated with units that were used in the pilot test. In addition, people who were involved after the pilot year were contacted to discuss their experiences with the Energy Cycle.

RESULTS

Of the five pilot units, only two are still used by the original owners, and those are being used at a reduced capacity. Of the remaining three units, one was sold to a local

utility, one has been sitting in a closet for four years and the other was passed on to two different owners before being disassembled for parts.

Of the 19 non-pilot year energy bike units identified in Wisconsin, 14 were acquired through participation in Energy Center of Wisconsin (ECW) workshops in 1998 and 1999 and five were purchased through other mechanisms, such as grant funding or general operating funds. Seventeen of these units were some version of the SEASUN model, one was a Pedal 4 Power model, and one was a Pedal Power unit. Five of these units are no longer in operation, 12 are still used to varying degrees, and two units were untraceable.

Pilot participants reported common problems with their units. Technical problems included a cracked display panel, broken generator and/or voltage regulator, loose wires and connections, broken or unstable bikes, and problems finding replacement parts. Respondents also agreed that transporting the unit was problematic because of its size and weight and the risk of damaging equipment or connections. Respondents either felt unqualified to manage repairs or that managing repairs took too much time away from their other responsibilities.

Caretakers of non-pilot units reported the same kinds of problems reported by caretakers of pilot units. The owners of the Pedal 4 Power and the Pedal Power units reported no problems.

DISCUSSION

Although the SEASUN models continued to present technical and other physical challenges, several of these units are still in use. Those that are still in use either 1) did

not experience the same level of break-down or 2) were owned by a caretaker who had the technical knowledge or access to resources to properly maintain their unit.

CONCLUSION

We found that the greatest predictor of success with the older energy bike models was a dedicated, handy caretaker who had time to maintain the unit. Minimizing travel with the older models also increased the likelihood of success. Most of the respondents who had the SEASUN models reported a plethora of problems. With the newer models (Pedal 4 Power and Pedal Power), however, it appears that these problems are minimized. These newer models, with their improved durability and greater portability, could result in greater success in a variety of settings even if owned by those with little skill in technical repair.

Two themes emerged that were common to both the pilot and the follow-up study. First, the issues of where to use the energy bike units and what criteria to use to measure success are closely linked. The original pilot study based program success partly on quantity. If the units are used in a setting where mass audiences pass through, large numbers of people are exposed to the unit. The drawback to using the energy bike for this kind of mass audience is participants are only exposed for a short period of time which only allows for the incandescent/compact fluorescent comparison. While this is a valuable lesson, the energy bike activities offer much more.

Quality is another criterion to measure program success. When the energy bike is used in a setting where one group of learners is exposed to a longer lesson, the instructor is able to cover the whole range of concepts, thus providing a richer educational experience. The drawback is that this type of lesson inevitably leads to a lower

participation rate. We conclude that perhaps the best situation is for the unit to be used in a mixture of settings to take advantage of both reach and depth.

The second theme that came out of the data was the need for a coordinating organization to provide support in the form of instruction, technical assistance, updated energy information, loan coordination, and finding replacement parts.

We have hope that the energy bike program will continue to grow, not just in Wisconsin but around the country as well. These newer models seem to have successfully resolved the technical problems reported by those using the original SEASUN models. As these newer models gain recognition and help dissolve the bad reputation that the earlier models earned, we anticipate that those who are charged with overseeing energy education programs will see fit to fund and support comprehensive energy bike programs.

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