AC 2012-3740: ENGINEERING IN SUMMER CAMPS: TAPPING THE POTENTIAL

Dr. Thomas Shepard, University of Saint Thomas
Mr. Colton Thomas Altobell, Camp Olson YMCA

Exchange - Engineering in Summer Camps: Tapping the Potential

Abstract: The traditional summer camp provides a rich learning environment in which hands-on learning activities may be easily incorporated. This paper describes one such activity involving hand-powered electricity generation which allows users to see, and more importantly feel the differences between incandescent, compact fluorescent and LED lights. A detailed description of the apparatus is provided and feedback is given from its implementation during the past summer in which it was used at a YMCA summer camp by people from age 4-78. The demonstration was implemented during a carnival-like evening in which campers could wander about enjoying any and all of the roughly 20 different activities and games. The activity exceeded expectations based on both the number and enthusiasm of participants. This paper further discusses the outreach possibilities, including the potential audience numbers available at summer camps for educating people of all ages.

Introduction

There is a growing push to introduce STEM topics to students at an early age. This fact is seen in the regular reporting in the ASEE *First Bell* daily news briefings of high schools, middle schools, and even elementary schools adopting and developing STEM curricula and hosting STEM events. In addition to the focus on introducing students to STEM during the school year the number of STEM summer camps is also increasing. This is evident based on the number ASEE conference proceedings on “STEM Summer Camps” one finds when doing a search based on year as displayed in Fig. 1.

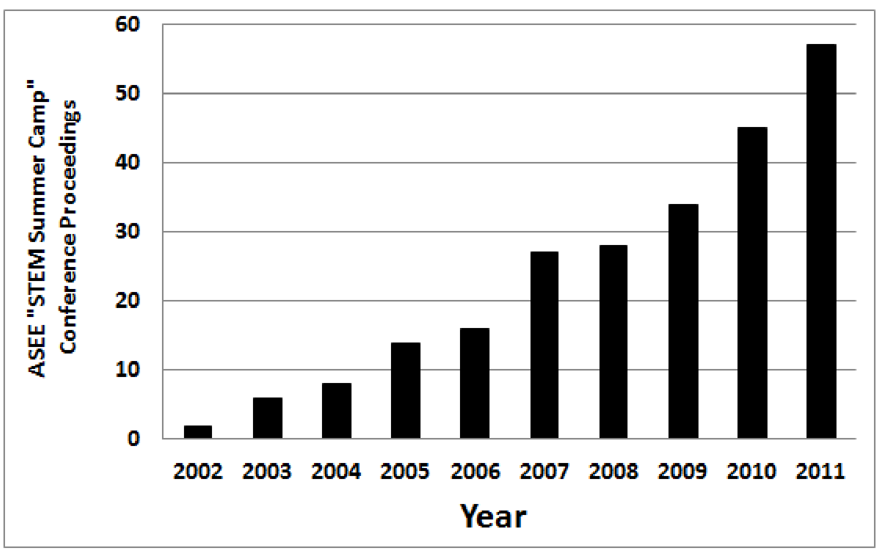

Figure 1. Yearly growth in the number of STEM Summer Camp papers presented at ASEE Annual Conferences (based on searches at www.asee.org/search/proceedings)

STEM summer camps may also be seen as a measure in addressing the growing concern over summer learning loss for children, a problem which has been known for over 100 years[1]. A study by Cooper et al.[2] integrated 39 studies examining the effects of summer vacation on standardized achievement test scores. It was concluded that on average children's tests scores were at least one month lower when they returned to school in fall than scores were when students left in spring. When measured in terms of mathematical and computation skills, most students lost about two months of grade level equivalency over summer vacation. According to Cooper et al., more than half of the achievement gap between lower and higher income youth can be attributed to an unequal access to structured summer learning opportunities; this gap grows each year of a child's development. Consequently, low-income youth are less likely to graduate from high school or enter college[3].

One may see the potential of STEM summer camps as one opportunity for not only promoting STEM through fun hands-on activities but also learning and/or reducing learning losses in a child during the summer. STEM camps have many positive attributes: they promote STEM in the summer time, they can be made to target specific groups such as girls or minorities, they allow for significant learning due to their length and focus on learning, and many of the camps can be made affordable with grants, scholarships, and financial assistance.

Traditional summer camps are very different than STEM camps. They are often more focused on skills building and fun, but they also provide a unique opportunity for children to learn in a non-traditional environment during a critical time for students to stay mentally active. Traditional summer camps are rich with hands-on activities; the lessons are not only learned but experienced, and thus more likely to make impact. Indeed, according to Dale[4], students retain "90% of what they say or discuss while engaged in an activity." Further, in a study on science field trips Rudman describes marked gains in cognitive and affective achievement for student as a whole when they participate in learning outside the classroom[5]. Gains were most significant amongst those who are categorized as "at-risk". While students may not see the similarity between summer camp and a school field trip an educator would recognize that at many times the summer camp performs similar functions as common field trip destinations such as a nature center or museum of natural history. Additionally, in a book by Gordon et al.[6] on the need for supplemental learning, it is suggested that camps offer non-classroom mental stimulation in the form of outdoor adventures in arts, nature, and athletics with a hands-on approach. Thus, the learning that occurs during the school year is not simply deactivated during the interim summer. Gordon et al. contend that at camp youth are encouraged to explore, discover, and learn in a way that equates to great knowledge retention. The traditional summer camp learning environment further provides a number of distinct advantages including the staff of role models whom campers look up to, an interaction between children of many ages and diverse backgrounds, and the possibility to implement short, hands-on activities which can serve the dual purpose of promoting a camp's mission as well as engineering and technical knowledge.

The American Camp Association (ACA) is an organization which helps to educate camps and regularly inspects them to ensure that their policies, procedures and practices provide quality programs while ensuring the health and safety of campers and camp staff. According to the ACA more than 11 million children and adults attend camp each year[7] and there are more than 12,000 day and resident camps in the U.S. Of these, non-profit groups including youth agencies and religious organizations operate approximately 8,000 camps while 4,000 are privately owned for-profit operators. Of the estimated 12,000 camps in the U.S. roughly 7,000 are resident camps at which campers stay over a number of days and 5,000 are day camps. The ACA has accredited approximately 2400 summer camps, a number it intends on growing, and is making an effort to attract a more ethnically diverse camper population[8, 9]. In an effort to make camp accessible to all those who wish to attend, 90% of ACA accredited camps offer some form of financial assistance to over one million children who are from economically deprived families, have special medical needs, or special situations that might preclude them from attending camp[7]. Fees to attend camp can vary anywhere from $100 to $800+ per week and there is a camp for every child and every budget.

This data exposes an incredibly large opportunity for promoting STEM in an environment which is conducive to learning and which appears to be untapped to any significant degree. Not only is the population large, it is both economically and ethnically diverse. Perhaps most importantly, the opportunity exists in the summer when it is important for all students to be stimulated to learn thus limiting loss from the previous school year. It is important to point out that the learning activities which can be incorporated into a traditional summer camp will likely look slightly different from activities which are common at STEM camps. This is due to the fact that STEM camps are often conducted at schools which have readily available equipment such as computers and lab supplies. Also, it is important to note that the mindset of a summer camper will likely make some of them resistant to a time consuming learning activity which feels like school in the summer, unless it is in an area in which they are particularly interested. Despite these challenges it is noted that the inclusion of STEM activities in a traditional summer camp is logistically quite simple as one does not need to reserve space, find volunteers or attract participants as these are readily available at most camps. Also one must not worry about writing grants to ensure accessibility to a diverse population and the only funds which must be secured would be for the materials needed for the activity. Finally, it is easy to find a nearby camp through the ACA website (www.acacamps.org/) and most if not all camp directors will be glad to help determine how best to incorporate a given activity into their regular program.

This paper describes the implementation of a hands-on activity in which participants at YMCA Camp Olson, a northern Minnesota residential summer camp, powered incandescent, light emitting diode (LED) and compact fluorescent lights (CFL) using a human-powered generator. The apparatus is described as well as the setting and manner in which it was used and the lessons learned are discussed.

Demonstration Apparatus

A schematic of the apparatus is shown in Fig. 2 and the individual components are listed in Table 1. The total cost of the components is $756.

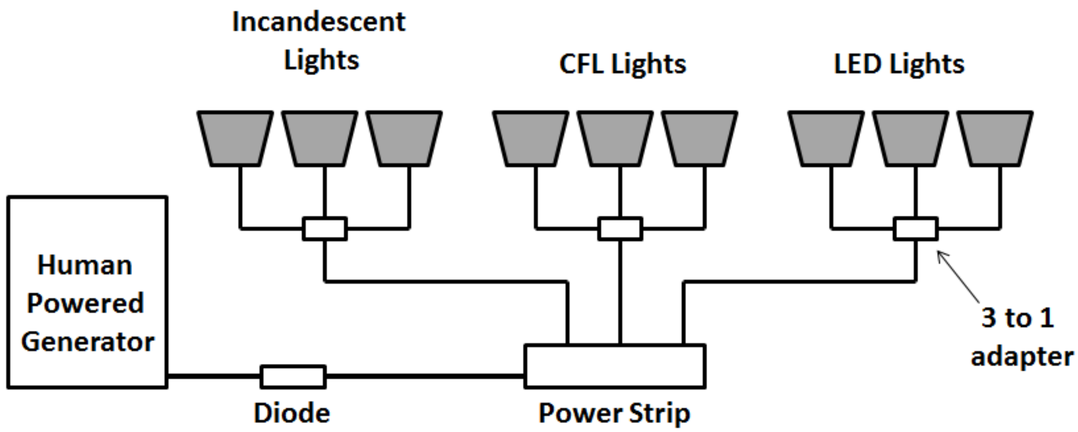

Figure 2. Human-powered lights demonstration set-up

The human-powered generator was operated with a hand crank which would turn a generator via a chain drive. The generator has a power cord coming from it which incorporates a diode and then ends in a positive and negative lead. The diode ensures that electricity cannot be fed to the generator thus causing it to act like a motor which spins the hand cranks. The positive and negative leads are then connected to the power strip. For each type of light bulb there are three lamps which are all plugged into a 3 to 1 outlet adapter. This adapter is for convenience, allowing all three lamps to be plugged in or unplugged from the power strip simultaneously.

Table 1. Components of demonstration unit

Component (number)	Supplier	Cost
Human Power Generator (1)	Windstreampower.com	$550
75 W Incandescent Bulbs (3)	Home Depot	$0.37/bulb
18 W Soft White CFL Bulbs (3)	Home Depot	$2.87/bulb
15 W LED Flood Light Bulbs (3)	Home Depot	$36.97/bulb
Clamp Light (9)	Home Depot	$8.47/light
3 to 1 Outlet Adapter (3)	Home Depot	$1.99/adapter
Power Strip (1)	Home Depot	$2.87

In developing the apparatus there were two main reasons for choosing the light bulbs which were selected. The decision to use three 75 Watt incandescent bulbs was made so that there was a noticeable resistance when operating the generator. Lower power bulbs could work just as well but then the number of bulbs used would need to be increased to match the total power. The other reason motivating the choice in bulbs was to pick bulbs that produced a similar amount of lumens. Table 2 shows the number of lumens for each specific bulb. The specifications for each bulb type listed in Table 2 come from the bulb manufacturers. It must be mentioned that the LED bulbs were flood lights, not standard light bulbs, as 15 W standard LED bulbs were not available. It is also noted that the choice of "soft white" CFL bulbs is important as "daylight" bulbs produce a harsher, whiter light while the soft white bulbs produce a color similar to an incandescent bulb.

Table 2. Light bulb comparison

Bulb Type	Power (W)	Lumens	Lifetime (hrs)	Lumens/Watt
Incandescent	75	1180	750	15.7
CFL	18	1250	12,000	69.4
LED	15	1100	25,000	73.3

Summer Camp Demonstration

The described set-up was used at YMCA Camp Olson during a session of family camp. During family camp the summer camp operates more like a resort, with families staying in the cabins and enjoying the many activities at the camp. It is not uncommon for family campers to be made up of three or four generations of a family. Each night of the week there is a different activity in which families are encouraged to participate. The human-powered light demonstration was used during a renaissance themed activity in which a number of games were set-up in a big field for children to enjoy. The different sets of light were clamped to a picnic table along with the generator and power strip and interested participants were welcome to come and generate their own electricity while subtly learning about different light bulbs and electricity generation.

When a contestant first stepped up to participate they would power just the three incandescent bulbs and see how spinning the generator faster would make the lights brighter. It is noted that to keep the three 75 Watt incandescent bulbs on requires a significant effort. Participants were asked how they would like to power their own lights with such a method and most acknowledged that their life would be much darker if they had to generate their electric power by hand. Next the incandescent bulbs were unplugged from the power strip and the three CFL bulbs were plugged in. The contestant would then generate electricity to power these lights and notice how much easier it was to turn the hand-cranks while producing light with the CFL bulbs. From Table 2 one can calculate that the CFL bulbs require only 24% of the power required by the incandescent bulbs. It is noted that CFL bulbs have a threshold voltage which must be reached in order to produce light and thus slowly turning the crank would not produce light. Then the

CFL bulbs were unplugged and the LED bulbs were plugged in allowing the contestant to also feel that LED bulbs are much easier to power than the incandescent, though there is not much difference between the CFL and LED bulbs' power requirements. Figure 3 shows one festive participant operating the hand-cranked generator and lighting up incandescent bulbs.

Figure 3. Human-powered generator in action

Not only did this exercise allow participants to experience the different power requirements needed for each bulb, but it also allowed them to see the difference in light quality from the various bulbs. This was important as the light quality of non-incandescent bulbs is often seen as an obstacle in the way of their more wide-spread adoption. Some of the more curious participants asked to have all 9 lights plugged in and tried to power them all at once, which was possible but only for a brief spell.

In addition to light demonstration two multimeters were hooked up to measure the voltage and amperage which were being generated. By monitoring these two measurements as a person cranked the generator it was possible to roughly determine the amount of power which was being generated. This information was then useful in letting a person know what other common devices they could power with the hand crank generator as a point of interest.

Placed in the field with roughly 20 or so other games participants would wander freely trying the different games. Throughout the roughly 90 minutes it was available roughly 200 people used the demonstration unit, many of them coming back for a second and third use. Participants included children as young as 4 (with the help of a parent), grandparents as old as 76 and everyone in between. As each person participated the demonstration facilitator was able to ask them questions to highlight some of the technical, and even societal, issues surrounding lights and electricity generation. Due to the large range in ages there was a large range in questions:

Do you know where electricity comes from?
Which light bulb do you think will be easier to power?
What kind of lights do you have in your home?
Do you see a big difference in the light quality of the different bulbs?

Do you think you could generate enough power to run your TV (or computer, or …..)?
Do you know what is actually moving inside the generator which is creating the electricity?
Did you know that there is legislation that will require light bulbs to meet an efficiency standard and most incandescent bulbs will not be able to meet the requirement?

Lessons Learned

The exercise exceeded the expectations of the authors and was considered a great success not only based on the number of participants but also the enthusiasm and curiosity displayed. It is judged that over 90% of the campers and staff present took part. At one point one of the fathers even asked if the authors knew of a similar apparatus in his town as he was interested in seeing it used at his children's parties.

There were many lessons learned from this initial trial with the human-powered lights demonstration. Future use of the generator will incorporate clamps to secure the base of the generator apparatus to a table to avoid wobbling when participants are vigorously cranking. Additionally it was noted that participation increased as the ambient light decreased (i.e. the sun was setting) thus making the lights stand out better. It is recommended that future use of this demonstration will be enhanced by taking measures to have the lights in a dimly lit setting. Also, while the 3 to 1 adapter plugs were convenient and allowed the users to see exactly what lights were plugged in, there was a small delay while lights were being unplugged and plugged in. It would likely not take too much effort to create a switch system which would control what lights were hooked up to the generator with the flip of a switch. This would be a more elegant set-up that would save time and make operation more convenient. It is also worth mentioning that some of the younger participants could not generate enough electricity to overcome the threshold voltage requirement of the CFL bulbs and thus the bulbs would not light up. This problem was not experienced with the incandescent and LED bulbs, thus one may consider not including CFL bulbs for children younger than ~8 years old. Finally, the use of two multimeters to measure the power being produced was a bit cumbersome and could be improved with a single digital power meter. Ideally the power meter would have functions to measure the average and peak power produced.

While the current paper is focused on the utilization at a summer camp one can see the opportunity to use this exact set-up in variety of ways depending on the setting and audience. If one wanted to focus on the power generation side they might also include a cutaway of a smaller generator and an electric motor which exposes their interiors and shows how they use the same components. Additionally, the use of some coils of copper wire and magnets would allow for demonstrating Faraday's law of induction with the appropriate measurement equipment to show that a current, voltage or power is being generated when the magnet is moved through the coiled wire. The set-up also helps demonstrate the difference between energy and power as a user must continually provide energy, i.e. provide power, to keep the generator working. Finally, there are many potential lessons based solely on the different light bulbs including a discussion of the pros and cons of each in terms of efficiency, economics or even life cycle analysis. While some of these lessons may not fit into a traditional summer camp setting they could be easily introduced in a classroom or at a STEM camp.

Conclusion

Traditional summer camps show great potential for utilizing hands-on activities to promote STEM and limit summer learning loss. They possess a population of millions of economically and ethnically diverse children, there are thousands of summer camps available and the literature suggests that camps produce an environment which is conducive to learning. A single instructor who develops a hands-on activity has the ability to interact with thousands of children in the summer without having to write grant proposals, schedule volunteers or reserve space at a school. By teaming up with the director of a camp, or camps, one can best determine how to fit an activity into the schedule of the camp. The implementation of a human-powered light demonstration is one such example. By participating in the demonstration one experiences the effort required to produce power and sees the differences between various light bulbs. The set-up is simple enough to be used by very young children and the use of age-appropriate guiding questions by a facilitator ensures that all participants walk away having learned something new.

References

1 White, W.S. (1906). Reviews before and after school vacation. *American Education*, 10, pp. 185-188.

2 Cooper, H., Nye, B., Charlton, K., Lindsay, J., Greathouse, S. (1996). The effects of summer vacation on achievement test scores: A narrative and meta-analytic review, *Review of Educational Research*. 66, pp. 227-268.

3 Alexander, K.L., Entwisle D.R., & Olson L. S. (2007). Summer learning and its implications: Insights from the Beginning School Study, *New Directions for Youth Development,* 114, pp. 11-32.

4 Dale, E. (1954). *Audio-visual methods in teaching.* New York,, Dryden Press

5 Rudman, C.L. (1994). A review of the use and implementation of science field trips. *School Science and Mathematics*, 94(3), pp.138-141.

6 Gordon, E.W., Bridglall, B.L., Meroe, A.S. et al. (2005). *Supplementary Education: The Hidden Curriculum of High Academic Achievement*, Lanham, Rowman & Littlefield Publishers.

7 http://www.acacamps.org/media-center/camp-trends/fact

8 http://www.acacampsblog.org/?page_id=18

9 http://www.acacamps.org/campmag/issues/0809/shelton