QUANTIFYING SUCCESS:

FACTORS CORRELATED WITH ENERGY CONSERVATION

IN A K-12 ENERGY CONTEST MODEL

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ABSTRACT

As the United States electric grid converts to clean energy sources like solar and wind, individuals can also help mitigate climate change through personal energy conservation behaviors. As a strategy to encourage energy conservation, energy contests that pit groups against each other have become common. Participants attempt to save the most of a particular resource (electricity, water, etc.) within a given timeframe, ideally establishing energy-saving habits in the process. Through connection with such a contest and personal electricity usage data via a dashboard platform, K-12 schools may be an ideal place to teach and practice energy conservation behaviors. This study used the Pearson's correlation coefficient to explore the relationships between the energy actions taken by classrooms and the school's electricity savings. Activities involving the interactive feedback of a dashboard, as well as traditional classroom lessons were most strongly correlated with electricity savings (r = .485, p = .002 and r = .469, p = .002, respectfully). This study also examined how the activities aligned with components of the Theory of Planned Behavior (attitude, subjective norms, and perceived behavioral control) and how meeting the components might correlate with electricity savings via an independent samples t-test. Although such a relationship did not exist (t(38) = -0.768, p = .439), coding the actions highlighted the importance of providing detailed, goal-oriented descriptions for each of them. These results may provide insight for best practices for energy contests and other energy education endeavors such as adjusting motivation to participate in particular types of activities and/or fostering post-contest participant interaction.

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CHAPTER 1:

INTRODUCTION

In a time when climate change is widely accepted by scientists and the public is increasingly aware and concerned about its effects, environmental education is more pertinent than ever. From its inception, environmental education has acknowledged that human resource usage must be consciously and responsibly managed to be sustainable. Policies are largely decided by governments and corporations, but this does not mean individuals are helpless or inculpable. Small actions enacted on an individual scale create ripples of compounding results. When people ask the question of what they can do to mitigate their effects on the planet, environmental educators should be prepared with an arsenal of feasible suggestions.

Humanity's pressures on the earth's finite resources continue to increase in two major ways. First, approximately 214,500 people are added to the global population each day, each with a complicated set of needs to be met daily until their death (Central Intelligence Agency, 2019). Happening simultaneously is an increase in the average citizen's standard of living. In the Human Development Index, the United Nations defines the standard of living of a country by its gross national income (GNI) per capita (United Nations Development Programme, 2019). This definition of the prosperity of a country and its people is reliant on their production and consumption of goods. All people deserve to lead safe, healthy lives, but it is the increasing materialism evident in sectors such as fast fashion and cheap electronics that create a feverish cycle of consumption and subsequent waste.

As the average standard of living envelopes more technology for more people, resource use continues to climb. Many of the tools that make life more convenient like automobiles, washing machines, and refrigerators require intensive energy loads to be produced and used.

Since electricity became widespread in the mid-20th century, the array of products that have been introduced, adopted, and subsequently become ubiquitous in middle class life continues to grow. For example, in 2002, 62% of Americans owned a cell phone which has steadily climbed to 95% in 2019 (Pew Research Center, 2019). The combined effects of population growth and increased energy usage in all facets of life can be demonstrated by the United States' total energy consumption which has almost tripled from 1950 to 2018 (U.S. Energy Information Administration, 2020a).

Saving electricity can be achieved in many ways. One method that has demonstrated success in turning intentions into action is an energy contest. An energy contest challenges participants to reduce their consumption of household resources such as electricity compared to other groups. This study will examine a K-12 energy contest model that encourages electricity conservation via student explorations and successive behavior modifications. Classrooms can track their efforts to save electricity on an online platform called a dashboard. Together the contest framework and dashboard technology provide a unique perspective for energy education. This study will explore factors correlated with electricity savings within the contest model in order to make recommendations that potentially increase the program's impact.

Statement of Problem

The problem of increasing energy needs can be met in two ways. The first way to reduce the impact of the average American lifestyle is to change the way energy is produced. Moving from carbon-intensive coal and petroleum to renewable sources like solar and wind reduces the ecological cost of using each kilowatt of energy. The state of Wisconsin, for example, has made steady strides in this sector, increasing its generation of electricity from renewable sources from 2.1 billion kWh in 1990 to six billion kWh in 2015 (Durant et al., 2018). However, this represented only 3.26% of Wisconsin's electrical energy usage at the time (2018). There is significant work to be done to reach the goal of zero carbon emissions by 2050 outlined by Wisconsin's Executive Order #58 (2019).

The other strategy, to be used in tandem with the transition to renewable energy, is to increase energy efficiency and conservation. Energy efficiency refers to the transition to technologies that require less energy to complete the same targeted function. For instance, LED bulbs are recommended as a replacement for traditional incandescent bulbs which waste 90% of their needed energy as heat (Center for Nanoscale Science, 2018). Consumers are encouraged to buy Energy Star® appliances and fuel-efficient cars for the same reason. However, these technologies are not a priority for many Americans who may lack the time, money, or motivation to invest in them. Energy conservation, in contrast, is free, instantaneous, and can be done by adults and children alike. It is described as a reduction in energy consumption. Individuals are persuaded to engage in energy conservation behaviors for the benefits both to the planet and their wallets. Often, the excised energy is not even missed. However, it can be difficult to transition from suggesting change to enacting it.

Energy has been described as an "invisible" commodity because it can be easy for the average citizen to underestimate their energy consumption or not consider it at all (iNudgeyou, n.d.). Energy education programming highlights the numerous ways that humans use energy both directly and indirectly and illustrates that this energy has environmental costs. If possible, programming should also suggest ways to save energy such as carpooling and unplugging infrequently used appliances. These strategies should ideally be easy to complete and require only a small level of personal sacrifice to enact them. However, even equipped with the strategies to conserve, people often struggle to turn intentions into behavior. For energy consumption, if individuals do not believe that their usage matters, they are unlikely to be compelled to change it (Ajzen, 1991). Feedback, afforded by utility monitoring hardware and a user-facing dashboard, may therefore increase connection with energy usage.

Visualization technology in the form of data displayed on an online dashboard allows individuals to track otherwise ignored usage and the effect a change in behavior has on overall usage. Research on household water and electricity monitoring to impact behavior has been undertaken with positive results of utility reduction (Buchanan et al., 2014; Oltra et al., 2013; Willis et al., 2010). Likewise, efficient use of personal vehicles increased in three-fourths of participants in response to a dashboard with ecologically minded feedback (Stillwater & Kurani, 2013). From the research, dashboards may be powerful because people want tangible outcomes for their efforts, which the technology can provide.

The programming evaluated in this study, coordinated by a youth engagement program based in Colorado called Renew Our Schools (ROS), uses the visualization tool of a real-time electricity dashboard as part of its K-12 energy-saving contests. Schools compete to save the most electricity within a given time-period and utilize classroom activities to develop motivation to do energy conservation behaviors and plan enactment strategies to complete them. At the same time, the dashboard serves as a method of observing said change in electricity usage (or lack thereof). Learn more about ROS at https://resourcecentral.org/renew-our-schools/ or by emailing renew@resourcecentral.org. Energy contests, due to their ability to directly quantify success of programming (in terms of energy savings) via the dashboard, are in a unique position to evaluate energy conservation programming styles and content.

Purpose of Study

This study sought to explore factors of a K-12 schoolwide energy contest that correlate with success in terms of building-wide energy savings. It evaluated the programming by uncovering relationships between participation in different activities and kilowatt savings tabulated through the electricity monitoring hardware. Trends uncovered in this research were used to make recommendations to improve ROS's contest iterations, moving forward to better inspire classrooms to enact energy conservation behaviors. Such data involving best practices may also be useful for other existing or potential energy contest hosts throughout the country.

Importance of Study

Although energy contests have been conducted in a variety of settings, conducting experiments has not been their main goal. Instead, energy contests tend to focus on numerical kilowatt savings as the metrics of success. Although important, this reporting does not examine which practices motivate behavior change resulting in the energy savings within the contest model. A review of twenty energy contests provided general recommendations based on the self-described success of the contest organizers, but the researchers also recommended future contests should examine "causal links between program activities and outcomes" (Vine & Jones, 2016, p. 171). Of note is that none of the contests examined by Vine and Jones (2016) centered exclusively on K-12 audiences or within K-12 school buildings.

When preparing Chapter 2, the researcher found no peer-reviewed articles on K-12 contest-based experiments, perhaps because of the relative scarcity of organizations hosting K-12 contests in contrast to university, community, and home-based initiatives. This study examines which activities classrooms engaged in during past ROS energy-saving contests and how these activities in turn correlated with the schools' energy savings and the components of the Theory of Planned Behavior. ROS can use the recommendations made from this study's analyses to format their contest requirements to continually improve student engagement with energy conservation. Locally, the Wisconsin K-12 Energy Education Program (KEEP) can use the results of the study to inform future decisions about energy efficiency and conservation programming and whether to invest in the energy contest model moving forward. On a broader scale, this study used energy monitoring to assess energy behavior change in response to a contest and its various educational activities, including electricity dashboard engagement. The results may inform further studies on using contests and/or dashboards for classroom learning.

Theoretical Framework

This research was informed by two major frameworks surrounding behavior change. The first, the Theory of Planned Behavior (TPB), provides a general theory of what guides human behavior (Ajzen, 1991). It proposes that a behavior hinges upon an individual's intentions to do it which, in turn, can be influenced by attitudes, subjective norms, and perceived behavioral control. In this study, the TPB was used as a way to code ROS's activity offerings to attempt to describe which ones were most strongly correlated with schools' electricity savings.

The second, the Model of Actionable Feedback (MAF), describes the situational conditions for optimal behavioral feedback: timely, individualized, non-punitive, and customizable (Hysong, et al., 2006). This study asserts that an electricity dashboard meets all four criteria and is thus an ideal platform to inspire energy conservation behavior change. This study also postulates that high-quality feedback afforded by a real-time electricity dashboard influences perceived behavioral control as students can observe the results of their energy-saving actions. The two theories justified the direction of this study's analysis and provided proposed explanations for the anticipated results.

Research Questions

RQ 1. How were ROS's School Energy Action (SEA) categories implemented by participating schools?

a. How many SEA categories did each school, on average, participate in?

b. How popular was the implementation of each of the SEA categories among participating schools?

Hypothesis 1: Because SEAs are at the discretion of each participating school, there will be a wide range in the number of SEAs completed. Since the SEAs *School Audit* and *Final Presentation or Video* were required, they will be the most commonly completed SEA categories.

RQ 2. How did schools' participation in School Energy Action (SEA) categories relate to School Measured Savings (SMS)?

a. Did the number of SEA categories completed correlate with SMS?

b. Were schools' SMS correlated with participation in a particular SEA category (or categories)?

c. How did the SEA category that focuses on dashboard use (*Energy Savings*) correlate with SMS?

Hypothesis 2: Completion of more SEAs is predicted to be aligned with higher SMS. The SEA category *Energy Savings*, because it encourages interaction with a dashboard featuring real-time data and feedback, is predicted to correlate most strongly with SMS.

RQ 3. (How) do School Energy Action (SEA) categories foster the components of the Theory of Planned Behavior (TPB) – attitudes, subjective norms, and perceived behavioral control – regarding energy conservation behaviors?

a. (How) are the three components of the TPB represented by the SEA categories regarding energy conservation behaviors?

b. Was the average school engaging in all three of the components of the TPB?

c. Was there a relationship between engaging the components of the TPB and SMS?

Hypothesis 3: SEAs were designed to provide context and strategies for enacting energy conservation behaviors. This fact combined with the various options of SEAs available indicates multiple activities are anticipated to meet each of the components of the TPB. Participating schools are predicted to have met all three components of the TPB through SEAs due to the scoring incentive to complete multiple SEAs and the SEAs' objectives. Because attitudes, subjective norms, and perceived behavioral control are described as impacting behavior, SEA categories that encourage energy conservation via these components of the TPB are predicted to correlate most strongly with SMS.

Research Design and Methods

Due to COVID-19 restrictions placed on visitors at many K-12 schools and the subsequent burden of teachers to create socially distanced and/or remote classroom environments in Spring 2020, the researcher opted to not conduct a quasi-experiment in schools in Fall 2020 as initially planned. Instead, the researcher explored potential relationships between energy conservation teaching techniques and energy savings achieved by K-12 schools as part of an energy-saving contest. Conducting a secondary data analysis eliminated the concern of further COVID-19 interference. Data was compiled into a single Excel sheet, coded as necessary to address the research questions described above, and statistical tests (Pearson's correlation coefficient and independent samples t-tests) were run to uncover relationships between School Energy Actions (SEAs) and School Measured Savings (SMS) as described in detail in Chapter 3.

Assumptions

The following conditions are assumed to be true for the purpose of this study:

1. Electricity data (provided by ROS through monitoring hardware and described as SMS) was collected and normalized accurately to represent electricity reductions caused by schoolwide behavioral change. This, in turn, assumes building-wide electricity usage is comparable across the studied timeframe (pre-contest vs contest)

and that significant fluctuations due to air conditioning usage, daylength, etc. were accounted for. Contact ROS for details concerning normalization calculations.

2. Schools were truthful regarding which energy conservation activities (SEAs) their classes chose to enact.

3. Schools were not explicitly implementing contest behaviors prior to the contest timeframe when ROS was collecting baseline energy usage.

Limitations

ROS school data was collected in the context of a programmatic initiative, not a research project. However, within its limits, the study provides recommendations on which measures to focus future research based on the strongest correlations. The following conditions are outside the control of this study due to external forces and are acknowledged by the researcher:

1. ROS runs their program as an education outreach initiative and not a research project. Critical differences may exist between iterations of the contest (or between contest participants) that are not noted and described.

2. School demographic information was collected by ROS and the researcher of this study was not involved. The researcher must rely on the accuracy from its original creators and handlers.

3. The study's schools are comprised of those with a willingness of the administration, building managers and teachers. These schools may be fundamentally different from non-participants in some way beyond the scope of this study that limit the general application of results and recommendations.

4. Contest data was collected by ROS and the researcher of this study was not involved. The researcher must rely on the accuracy of the energy data and its normalization within the contest period from its original creators and handlers.

5. SEAs are presented with limited instructions and are subject to the constraints, creativity, and interpretation of the participating schools/classrooms. There may be fundamental differences in the same activity between schools.

6. The scoring of SEAs is not conducted with a rubric. Human variability is present within the scoring and thus the associated results.

Summary

This chapter served to introduce and describe the topic of study. It provided an overview by highlighting the statement of problem, purpose of study, theoretical framework, research design and methods, research questions, assumptions, and limitations. Rationale and background information for the direction of the research will be discussed in Chapter 2.

CHAPTER 2:

LITERATURE REVIEW

The following chapter reviews background literature that provided a framework for this study. The literature informed decisions about rationale, methods, and instrumentation for exploring the topic. Relevant terms are compiled in Appendix A for reference. Three major themes will be discussed as follows: Environmental Education, Behavior Change Strategies, and Making Energy Education Relevant. The themes explored in this chapter culminate in the arguments described below that guided the researcher in the direction of this study:

1. Energy education, as a subset of environmental education, can be a method for introducing individual-level behavior strategies to combat intensive resource use by modern society.
2. Visualization technology has been used as a technique for encouraging behavior change by making otherwise obscured outcomes evident to the individual.
3. The K-12 school setting serves as a platform to make energy education and its behavioral strategies local and relevant for students.
4. By complementing energy education with the visually oriented technology of an electricity dashboard, students may be inspired to enact change in their school and beyond.

Environmental Education

History and Goals of Environmental Education

Environmental education, since it was first directly articulated, has maintained the same fundamental goals in response to a situation that looms larger and larger. Stapp and his colleagues (1969) described a country that was disconnected from its resources because as people moved into cities and suburbs, they no longer directly saw the requirements needed to fuel their lifestyles. Food came from the grocery store, water from the tap, and electricity from the switch – all was from the elusive "elsewhere." Stapp and associates (1969) realized that a lifestyle in a vacuum is dangerous because it removes the consequences from decision-making. They sought to emphasize both the natural and cultural systems at work necessary to run a community. Connecting people with their surroundings, they reasoned, was as important as any subject traditionally taught in school.

However, simply knowing how the world works is not enough. Stapp et al. (1969) reasoned that those who understood the interdependence of systems would realize that many practices of the modern world are unsustainable. Environmental education could also serve as a platform for inspiring people to make decisions as conscientious citizens of a global system. Environmental education, then, should offer solutions and strategies for reducing the impact of everyday tasks. Therefore, the original overarching aim of environmental education was to foster informed, responsible relationships between people and their environment.

The short essay, which Stapp and his cohort published in their first issue of *The Journal of Environmental Education* resonated with a larger audience. Within six years, the United Nations adopted a framework describing environmental education and its goals, highlighting it as an urgent mission for the entire world (UNESCO-UNEP, 1976). This document, dubbed the Belgrade Charter, encouraged both formal and non-formal teachers to instruct about environmental concepts and supported action-oriented critical thinking in the classroom. In this way, the Belgrade Charter extended the missions of the initial definition of environmental education to a larger audience without altering them. The following year, a mirroring text that recommended goals for governments of the world to implement concerning environmental education was adopted (UNESCO-UNEP, 1977). After all, creating a sustainable world cannot be an isolated act. It requires the cooperation of communities and countries alike.

To achieve its goals, environmental education often attempts to protect humanity from itself and its creations. Modern civilization has created substances like CFCs and DDT, stripped mountains for coal, and dumped factory biproducts in water systems without fully comprehending the implications of any of these actions. It has taken observant scientists to sound the alarm and the subsequent backing of the public to pressure governments for policy change. Environmental educators become a liaison between the environmental impacts of capitalism and the people's welfare. In no instance is this more evident than the increasingly urgent issue of climate change. Fortunately, through awareness and action, individuals can help initiate the transformation they want to see.

The Importance of Environmental Education in the Face of Climate Change

Although the missions of environmental education have remained relatively constant since their inception, the attitudes of the public regarding environmental issues have not. This is illustrated by a yearly Gallup (2019) public poll question concerning the prioritization of either environment or economic growth where the answers undulate considerably over time. In 1985, the environment was more important to the majority of sampled participants (61%), and this trend reached a peak in 1990 (71%). Then, the edge generally declined over time until 2009, when the majority reversed (with approximately 55% in favor of the economy). Flipflopping and/or close tallies continued until 2013 in which environmental concern has been climbing since, reporting 65% support in 2019 (2019).

Resources may feel endless, but with increasing population and industrialization, conservation is ever more important. Unfortunately, it often takes a crisis to spur action because the status quo is easier and more comfortable. The Cuyahoga River caught fire before laws were passed to protect waterways. Environmentalists must continually combat skepticism, hostility, and competing agendas like job creation. Researchers and educators alike must promote pro-environmental behaviors that resonate with their audiences in an ever-changing political and cultural realm.

In more recent times, environmental knowledge has become disseminated and democratized efficiently thanks to the internet. The average citizen can find reports about the number of acres of rainforest harvested every day or the amount of water necessary to produce a cotton T-shirt. Even though scientists and activists have been touting reform for decades, the public is finally becoming privy to what “global warming” really entails for humanity’s future. Partially thanks to publicity surrounding activists like Greta Thunburg and catastrophic natural disasters like wildfires and hurricanes, a majority of Americans – 69% in a 2019 nationwide poll conducted by the George Mason University Center for Climate Change Communication – “think global warming is happening” (Leiserowitz et al., 2019, p. 4).

A silver lining of the climate crisis is that it provides rationale for implementing personal and governmental change. Young people, in particular, are alarmed about current climate projections and approximately 46% surveyed were willing to allow the government to mitigate human effects on the environment at the expense of the economy – up approximately 14% from 2015 (Harvard Kennedy School Institute of Politics, 2019). These individuals recognize that the current model of the United States’ economy is detrimental to our air, water, and land and that infinite economic growth is a pipe dream. Increased awareness about environmental issues like plastic pollution and industrial agriculture have made people reevaluate their lifestyle choices, but they may be unsure how to address these large, systemic issues.

At the heart of environmental education is the goal of creating harmony between people and the rest of the environment. However, almost half of people surveyed by the Center for Climate Change Communication believe that they do not need to make significant lifestyle changes in response to climate change (Leiserowitz et al., 2019). Instead, they plan to rely on new technologies to fix any impending environmental issues. This is a dangerous philosophy because it shifts responsibility from the individual to external entities. People should not expect others to fix climate change when it involves and affects everyone on the planet. Carbon-capturing robots are not a replacement for personal responsibility. However, sustainable living flies directly in the face of many habits of modern life. From a reliance on fossil fuels to disposable packaging, convenience and consumerism drive the current economic model. Asking people to give up their luxuries – which are often thought of as essential – like long hot showers is typically a difficult process with significant barriers. The benefits of the sacrifice must be apparent and outweigh the short-term loss.

The Role of Energy Education

Energy is a pervasive issue for conservationists because all aspects of life require energy which in turn often requires intensive use of resources. In 2016, the U.S. Energy Information Administration (EIA) (2019a) estimated America's carbon dioxide emissions per capita to be 16 metric tons. Although the United States continues towards its goals to use renewable energy, it is a slow journey. In 2019, the EIA (2020b) assessed that only 11.5% of the United States' total energy consumption came from renewable sources. In the meantime, to reduce the consumption of coal, petroleum, and other carbon-intensive fuels, society can use energy more efficiently and use less energy through conservation.

Energy efficiency is attractive because it allows individuals to continue their current lifestyle while using less energy. For example, the ecological cost of driving has decreased as the average fuel efficiency of cars has risen over ten miles per gallon since 1975 (U.S. Environmental Protection Agency, 2020). Similarly, Energy Star® appliances allow individuals to run dishwashers and clothes dryers with less impact on their electric bills and the planet. The EIA (2020a) partially credits increased efficiency standards for new equipment for the relatively modest 2% increase in the United States' total electricity usage between 2008 and 2018. Unfortunately, upgrading cars and appliances requires an investment which many people may be unable or unwilling to prioritize. The flipside to using energy more efficiently is to simply use less of it.

Energy conservation, the act of reducing consumption, is powerful because it typically requires little to no special equipment. Energy is often wasted without an individual's knowledge, and it would not be missed if the situation was rectified. This is referred to as a phantom load. For example, many appliances in the average home are continuously plugged in, using electricity while sitting idle. Televisions, modems, and other gadgets together were continuously wasting an average of 212 watts in one California home auditing study (Delforge et al., 2015). This equated to approximately 17% of the total daily usage of an American home according to the average of 30 kWh per day (U.S. Energy Information Administration, 2019b). The researchers recommended that if all households could get below an 80-watt phantom load per 1000 square feet, Americans could reduce their electricity usage by 64 billion kilowatt hours each year (Delforge et al., 2015). At an average cost of 13.01 cents per kilowatt hour (national rate in December 2019), this could save the country over 8.32 billion dollars per year (U.S. Energy Information Administration, 2021). The act of unplugging is not difficult, but it requires a conscious choice on the part of the individual, which in turn requires educators to understand how to inspire pro-environmental motivation and habits.

Behavior Change

The Theory of Planned Behavior

Awareness is touted as the first step toward behavior change. For example, if someone does not think about the impact of his daily plastic water bottle, he will feel no need to alter the behavior of using it. However, turning awareness into action has been a stumbling block for companies and conservationists alike. Knowing about an issue does not necessarily translate into behavior change. Ajzen (1991) proposed, in his Theory of Planned Behavior (TPB), that intentions are a powerful indicator of completing a specific behavior where the stronger the intention to do the behavior, the more likely the behavior will be done.

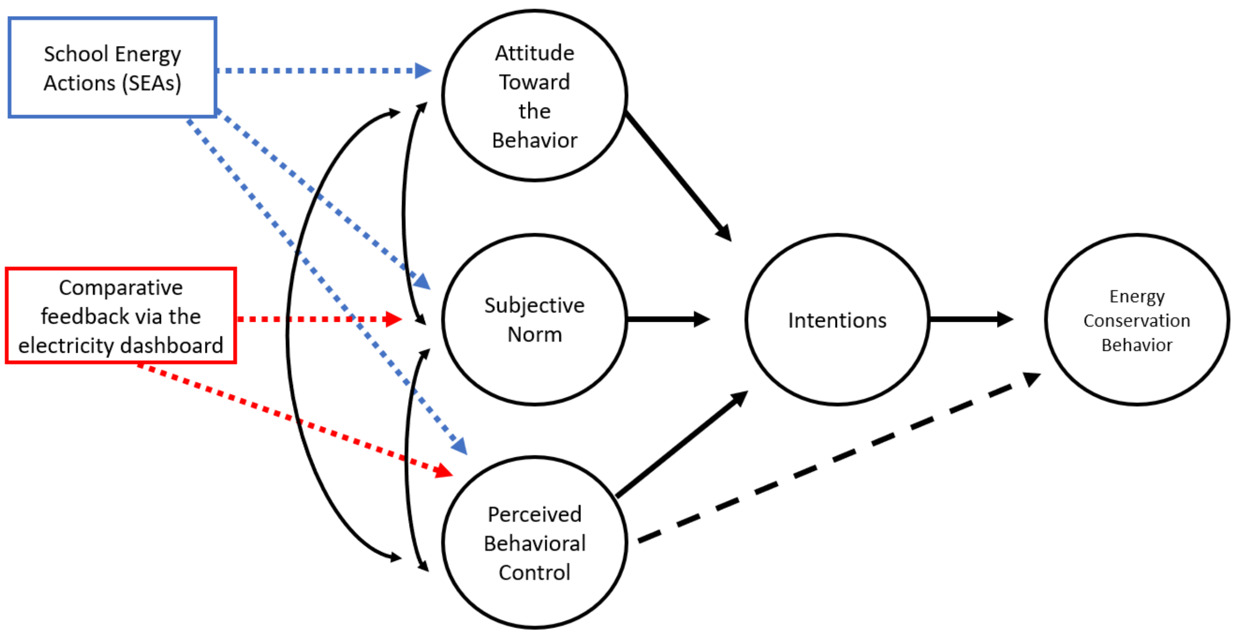
Ajzen (1991) described how intentions are impacted by three distinct spheres: attitudes about a particular behavior, subjective norms surrounding the behavior compared to its alternatives, and perceived behavioral control of achieving the desired results. The attitude surrounding a behavior is essentially the desire to do it based on whether the individual thinks the given behavior is viewed in a positive or negative light. For example, if the behavior does not align with an individual's belief system or self-concept, he will be unlikely to do said behavior. Recommending that the individual simply reduce his water consumption to decrease bottle usage will not work if he is more dedicated to health and hydration than reducing plastic waste. Therefore, an energy conservation activity should give context and rationale for participating in conservation actions for participants to see (or reinforce seeing) the actions as good or even noble behaviors to strive to complete.

Subjective norms are intertwined with awareness and require a facet of responsibility. By observing the behavior of others, individuals create descriptive norms (Ajzen, 1991). Essentially, using others as a gauge, an individual determines what behavior is standard. An individual's social circle may also directly expect him to conduct behaviors that follow their ideals, overriding the larger descriptive norm. This is known as injunctive efficacy (1991). The plastic water bottle user may be shamed into utilizing a reusable bottle if they find themselves surrounded by others who do so. While peer pressure is not condoned in many circumstances, ecologically centered subjective norms prompt behavior in individuals that might otherwise be ambivalent or reluctant. The contest model may create an environment that promotes new descriptive norms of electricity conservation led by self-motivated, championing students, teachers, and/or classrooms. Additionally, by giving a concrete, numerical value to their school's electricity usage and then being able to compare their usage with other schools, students may establish new norms of what consumption values should look like. They may be more motivated to participate in electricity conservation to match (or beat) other schools' totals.

Perceived behavioral control is a unique facet of the TPB because it can impact both intentions and behavior (Ajzen, 1991). If individuals feel that their actions do not make a difference, they will be reluctant to perform them especially if doing so requires personal sacrifice or extended effort. To successfully instill an alternative behavior for conservation, people need the proper "resources and opportunities" (Ajzen, 1991, p. 196). If there is nowhere to refill his metal water bottle, the hypothetical individual described above may give up and revert to his plastic habit. In general, changes that are too expensive, time consuming, or otherwise impractical will have a low success rate. By depicting local electricity usage and its changes over time, participants become aware of their consumption and can watch it change in response to their energy conservation endeavors. Students can feel in control of school building electricity usage by observing changes as a direct result of their behavior. This study predicted that the perceived behavior control of participants was increased by activities that emphasized visualized which in turn may have increased the likelihood and/or sustainability of the enactment of energy conservation behaviors. Figure 1 describes how Renew Our Schools' (ROS's) School Energy Actions (SEAs), and dashboard engagement may impact the facets of the TPB, thus increasing the likelihood of completing energy conservation behaviors through an energy contest.

Figure 1

Potential Effects of the Energy Contest Model on Energy Conservation Behavior



Note. Adapted from "The theory of planned behavior" by Ajzen, I. 1991. *Organizational behavior and human decision processes*, *50*(2), p. 182.

The Importance of Visualization

One of the largest barriers to energy-efficient behaviors is the innately hidden nature of energy usage. People do not use electricity as an end-goal, but as a means of accomplishing other tasks. They, therefore, often do not pay attention to the "costs" of running appliances. Participants of a study by Chen et al. (2014) wrongly predicted that their room's electricity usage for lighting was equivalent to the energy needed to run the room's HVAC system. In reality, the HVAC used, on average, approximately 14.5 times as much energy as the lights (2014). Even when individuals are motivated to save energy, without accurate plug-load information, their actions may not have the impact they envision.

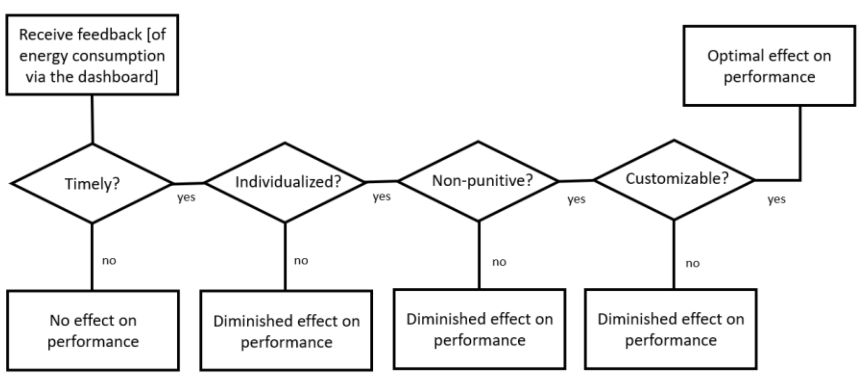
Encouraging energy-saving behaviors can also be hindered when participants do not see an immediate impact from their actions. Visualization has been proposed as a way to make both theoretical concepts and the results of collective behaviors more relatable. For example, dramatic images depicting the potential effects of climate change may spark more concern and understanding than scientific reports (Sheppard, 2005). In a similar vein, participants who were shown thermal images of the (in)efficiency of their homes – or even houses similar to their own – were more likely to be motivated to take insulation measures than those who were told their houses' carbon footprints (Pahl et al., 2016). Interviews from these participants noted that the pictures remained in their minds, demonstrating the powerful and potentially lasting impact of effective images to drive change.

Dashboards and Feedback as a Visualization Tool

Visualization of energy, particularly electricity, can be achieved by engaging an online software platform, known as a dashboard, connected to data-monitoring hardware through products like eGauge. After being installed in the targeted building, the eGauge hardware collects the building's usage data and displays it on the dashboard which can then be accessed by any computer's internet browser. This type of technology is used to monitor total electricity (or other targeted utility like water or natural gas) in a system. The dashboard also displays resource usage graphs which can be compared in response to behavior modifications – sometimes in real-time – serving as a type of feedback.

Feedback describes an environmental response to a behavior and can aid individuals in the decision-making process. A lack of feedback is one reason energy usage is often a mystery. According to Hysong et al. (2006), feedback is most salient when it is timely, individualized, non-punitive, and customizable as described by their Model of Actionable Feedback (MAF) as shown in Figure 2. In this study, the schools' dashboards adhered to all four recommendations. They displayed real-time data where students could observe changes in consumption via demonstrations like turning on and off the gym's lights. Each school's dashboard displayed its own usage, making it relatable to its students. The platform gave no opinions about the amount of usage, and there were no penalties concerning usage change (or lack thereof). Finally, the dashboard software allowed graphs to be manipulated to display different time intervals. Students could focus on the period of data that was most interesting or relevant to them. In this study, feedback via the dashboard was primarily used by participants to see if and how energy conservation behaviors were effective and may have served as a motivator to continue them.

Figure 2
Model of Actionable Feedback



Hysong, S. J., Best, R. G., & Pugh, J. A. (2006). Audit and feedback and clinical practice guideline adherence: making feedback actionable. *Implementation Science, 1*(9), p 6.

Using real-time visualization data as feedback to instill behavior change is a relatively new technique, but studies have been encouraging. In a classroom study, students who were taught about electricity using a dashboard were better able to articulate “indirect consequences related to energy use” than those without it (Clark et al., 2017, p. 6). Although the quasi-experimental study was composed of fourth and fifth graders at a single school, those students who participated in active dashboard engagement also improved self-efficacy and group-efficacy in terms of describing ways to save energy as well as unit content retention (2017). In Golden Coast, Australia, when individuals were given live water usage information during a shower, their consumption dropped an average 27 percent (Willis et al., 2010). Some individuals are even curious and motivated enough to utilize utility information without external prompting when it is available in a digestible dashboard format. A study of Amazon reviews for household monitoring devices found that users described the benefit of the device’s visualization feature to “‘see’ electricity usage” in a more concrete way (Buchanan et al., 2014, p. 141). These individuals described their motivation to find the “culprits” of excessive energy usage and examine the necessity of their usage, thanks to the monitor (2014). Making the topic of energy relevant to students might then be bolstered by showing localized electricity usage in their own school using the dashboard interface.

Making Energy Education Relevant

Benefits of Place-based Education

Place-based education, at its core, is essentially using local examples to explain and explore concepts. It uses techniques like outdoor learning and community service projects to connect students with their surroundings and strengthen the understanding of material. It also allows students to be curious and ask questions to drive explorations that relate with their personal interests. Doing so has been demonstrated to aid in student understanding of ecological concepts even in urban settings (Endreny, 2009). Place-based learning also encourages place attachment by fostering opportunities for positive interactions in the space (Kudryavtsev et al., 2012). This, in turn, might support behaviors that protect the space, increasing sustainability (2012).

Place-based learning encourages students to consider practices like agriculture and urban development and “analyze [their] effects on local, regional, and global natural and cultural systems” (Wisconsin Department of Public Instruction, 2018, pg. 17). By making issues and their solutions local, students may better understand the needs for change and reap satisfaction from observing results done in response. Energy could be explored in this way, and the school building can be the backdrop for salient exploration of electricity consumption.

School as a Teaching Tool

School is where students learn, but the building itself can also provide a powerful model for environmentally conscious behavior. Orr (1997) argued that when a school is wasteful, this subtly teaches children that energy is an endless resource not worth conserving or even considering. When classroom concerns for the environment do not mesh with the school’s building features, the disparity may make the lessons ring hollow, undermining their importance (Orr, 1997; Titman, 1994).

Fortunately, schools with sustainable elements have been shown to have the opposite effect. Kellert (2005), echoing design principles of architects like Frank Lloyd Wright, postulated that building models that are both naturalistic and place-based are vital to “help heal modern society’s generally adversarial stance toward nature” (p. 98). Tucker and Izanpanahi (2017) found that students who attended schools with green features like gardens and rain barrels were more likely to hold pro-environmental beliefs and engage in energy-saving behaviors like recycling. The students already exposed to these environmentally friendly infrastructures were also more supportive of implementing additional sustainable features such as natural lighting

(Tucker & Izanpanahi, 2017). Thus, research suggests that students who are familiar with energy-efficient behaviors and technologies through their school's culture are more likely to recognize them as important and accept them as the norm (Cole, 2014). This makes schools a valuable site to promote energy conservation through channels like green design and behavior modeling.

Energy Contests

One way a school building can be harnessed as a platform for energy conservation is through an energy contest. In an energy contest, teams compete to save the most energy – typically electricity – in their space within a given period. The contest model encourages groups to contrast their efforts with competitors' and strive to be the best. Comparative feedback afforded by contests has been a promising way to bolster energy conservation efforts (Dixon et al., 2015). Feedback afforded by a real-time electricity dashboard may influence perceived behavioral control as students can observe the results of their energy-saving actions and see how their behavioral choices make an impact on total electricity use.

However, energy contests are varied in both audience and messaging which can make them difficult to generalize. A review of 20 energy competition programs throughout the United States described initiatives primarily targeting colleges, households, businesses, and public spaces (Vine & Jones, 2016). Interestingly, none of the described energy contests took place in K-12 schools, although children were likely involved in the household and community-based contests. Each energy contest was run by a different organization, but the researchers were able to find overarching trends in their energy contest models.

The average program in the review used 12 of the 20 described behavioral strategies to achieve energy savings. This may demonstrate the need for more targeted research on which strategies inspire energy savings within (and beyond) contests instead of having programs attempt various approaches with the hope that something will stick. Of particular note for this study is that 80% of the programs used comparative feedback, 65% used imagery, 30% used tailored feedback, and 30% used instantaneous feedback, presumably via a dashboard (Vine & Jones, 2016).

Dashboards and contests make for an ideal pairing because monitoring hardware is typically used to track changes pre/post contest to determine participant ranking. Because of the behavior change frameworks described above, it appears that dashboard interaction should be the forefront of participant learning and engagement of energy-saving contests. Doing so allows participants to accurately and impartially collect usage data in real-time, set realistic goals for energy reduction accordingly, and receive immediate and tailored feedback on their energy-saving efforts.

Little research has been done on energy contests conducted in a K-12 school setting, perhaps due to this model's relative rarity. No formal journal articles were found concerning energy contest research in K-12 schools when preparing Chapter 2. White papers have described some organizations' energy contest work, but typically as a general share-out of short-term success. Of note for this study is an evaluation of ROS's success in terms of teacher and student feedback. Staff from three school districts interviewed cited student engagement with energy topics as the top motivators for participating in an ROS contest, even above the potential prize money (Group 14 Engineering, 2016). Additionally, 91% of teachers agreed that "knowing what they know now, they would sign up for the [ROS] competition" (Group 14 Engineering, 2016, p. 17). From the perspective of a majority of participants, there is value in doing an energy contest, despite the large time commitment. The challenge for energy contest organizers is making the most of this limited time to engage and inspire schools.

This study focused on iterations of K-12 energy contests coordinated by ROS. By combining lessons with external incentives to follow through on the energy conservation behavior strategies described within them, contests may reinforce energy education messaging. Contests “engage, educate, motivate, and empower” participants to achieve energy conservation (Vine & Jones, 2016, p. 159). Learning how to maximize a contest’s potency only makes this immersive tool more valuable.

Summary

Energy conservation is a simple way for individuals to protect natural resources and participate in mitigating climate change. Because energy use is often ignored in modern life, bringing it to the forefront is a mission of energy contest organizer ROS. By referencing their school’s electricity dashboard, students can quantify their building’s usage and may become motivated to reduce its environmental impact. Making electricity usage visual and personal may increase the perceived control of reducing it which, in turn, may increase the likelihood of completing energy conservation behaviors. Nesting the potential of a dashboard within the energy competition model may strengthen both energy education strategies. This study will explore the relationships between different activities enacted by classrooms and the school’s measured energy savings due to the rationale described in this chapter. Doing so may provide insight on how to conduct future energy programming to maximize both student engagement and energy savings.

CHAPTER 3:

METHODS

The following chapter will describe Renew Our Schools' (ROS's) contest model, study approval, methodology, and research design, including breakdown of statistics addressing each research question. The methods were selected to answer the research questions listed below within the limits of secondary data.

Renew Our Schools' Contest Structure

Data used for this research originated from energy contest iterations conducted by ROS in Spring 2019 and Fall 2019 – one Colorado-based contest and one nationwide contest per season. Information has been accessed with the direct permission and support of ROS. Descriptions of the energy contest model were acquired through emails and video calls with ROS staff.

ROS is a programmatic initiative out of Boulder, Colorado, as part of Resource Central. ROS has been running since 2007, although their energy contest model has been adapted multiple times in response to program growth and teacher feedback. The contest iterations selected for this study reflect the most recent version of contest scoring. ROS hosts five-week energy contests that pit schools against one another to earn the most points. Measures are taken to create a relatively fair playing field including sub-dividing the contest into groups by age of participating classrooms representing the school and/or school population size. The winner of each contest iteration receives a cash prize – currently $2500 – for their school to spend on energy efficiency technology and a framed certificate. Points are earned in two ways: School Energy Actions (SEAs) and kilowatt savings of electricity, known as School Measured Savings (SMS).

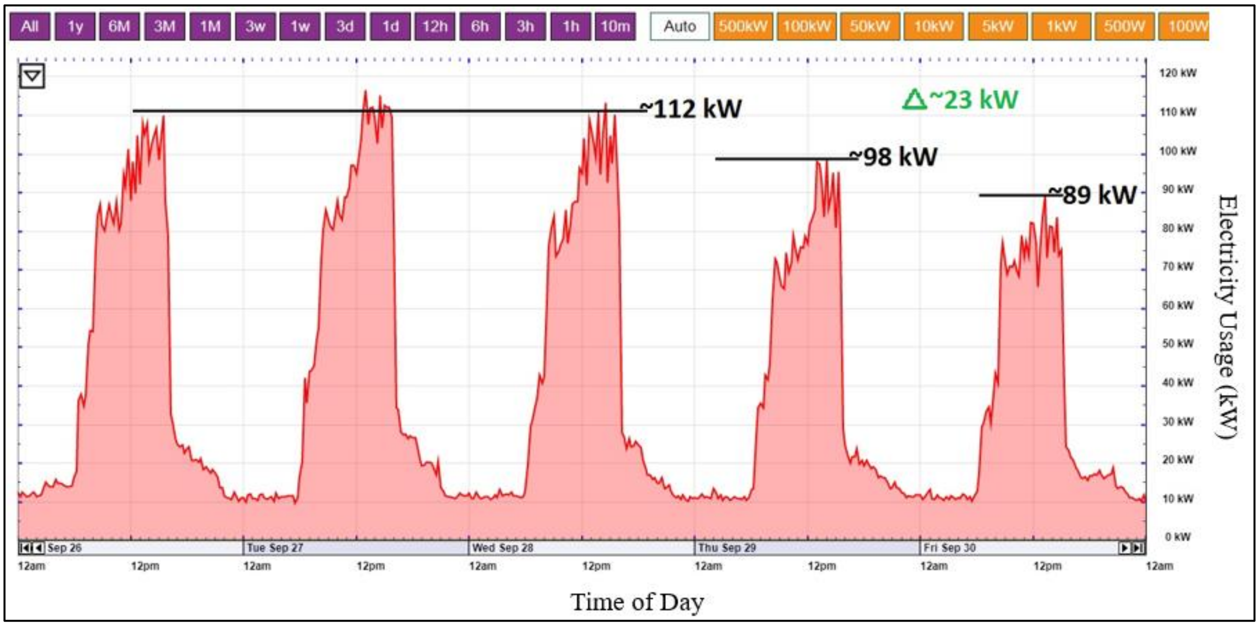
SEAs are interactive activities completed by classrooms to integrate energy education. During the contests analyzed in this study, there were 23 SEAs offered, sub-divided into seven categories (with maximum points possible listed in parentheses): *School Audit* (40), *Final Presentation or Video* (50), *Energy in the Classroom* (80), *Energy Savings* (85), Creative Campaign (55), *Students as Teachers* (80), and *Local Experts* (120) for a total of 510 base points. Differences in point value were intentional to compensate for activities with higher time commitments. The exact breakdown of each SEA's points is described in Appendix B. There is also an opportunity to earn additional points through an untitled create-you-own style category. According to ROS, this category is typically for bonus iterations of SEAs from the other categories (K. Croasdale, personal communication, August 27, 2020).

Schools report their SEAs by submitting the appropriate verification identified in the SEA list available to them (Appendix B). Scoring does not use a rubric, and according to ROS, is done generously (K. Croasdale, personal communication, August 27, 2020). Essentially, if the schools submitted the appropriate pieces, they received full points and if not, they received a partial credit as deemed appropriate. The tabulations are as follows, where x is the total number of SEA points earned:

$$\text{SEA raw score (\%)} = 100\left(\frac{x}{510}\right)$$

To determine the kilowatt-hour electricity savings of a school (SMS), monitoring hardware called an eGauge, available through eGauge Systems LLC, is installed in each school pre-contest by an electrician. Accessibility to the dashboard is confirmed and usage data is checked for accuracy. Electricity usage data is available to participants in line graphs as a function of time via eGauge's online portal as shown in Figure 3. ROS provides an onboarding video to instruct participating teachers on how to access and discuss the dashboard with their students. Classrooms can log-in to the school's account to access personalized eGauge data during the contest and beyond. By remaining in the building post-contest, the technology can also be referenced when making building management decisions.

Figure 3
eGauge Electricity Dashboard Interface



Note. Retrieved from "Monitoring system serves as foundation for energy efficiency at little elementary" by eGauge Systems LLC. (2019). *eGauge Company Blog.* https://www.egauge.net/blog/2019/08/16/monitoring-system-serves-foundation-energy-efficiency-little-elementary/.

Pre-contest electricity usage data is collected via the eGauge for as long as possible, typically three to eight weeks. Pre-contest data is used to create a baseline average of electricity usage for each school. The average is meant to mimic a "typical" school day's electricity usage. Once the contest begins, classrooms gain access to their school's dashboard, learn how to enact energy savings via the SEAs, and may choose to follow-through with behavior modifications that support savings. Within the contest period, the 20 most successful, eligible school days (in terms of energy saved compared to the baseline) are tabulated to give a contest total. Non-eligible days are anomalies, such as snow days (unfairly low) and parent-teacher conferences (unusually high), that may occur during the contest period. Weekends are also excluded from the tabulation. The 20-day total is compared to 20 days of the baseline as follows:

$$\text{SMS raw score (\%)} = 100\left[\frac{(Total\ kWh\ of\ 20\ best\ contest\ eligible\ days) - (baseline\ kWh\ x\ 20)}{(baseline\ kWh\ x\ 20)}\right]$$

Therefore, the percentage score represents an average of the percentage of electricity saved. Savings were scored relative to the pre-contest baseline from their own building as opposed to total numerical savings which would be skewed in favor of larger school buildings. It should be noted that the schools who do not save electricity during the contest period are given a score of zero – even though they might have actually used more electricity during the contest period.

ROS calculates contest winners by multiplying the SMS value by two and dividing the SEA score by two. This creates a weighted score where the SMS score becomes worth four times as much as the SEA score. These final SEA and SMS scores are added together to give the total contest score; the school with the highest contest score is the winner. Note that this study used the raw percent scores instead of the weighted scores for analysis.

As stated above, this study used information collected by ROS regarding their contest participants' scores. Additional questions about contest data methodology should be directed to ROS staff and their affiliates. ROS had historically conducted their contests in Colorado, but they began offering nationwide iterations in Spring 2019. ROS worked to recruit schools, but ultimately schools must self-select participation in the contest. Because it costs approximately $1800 to purchase and install the hardware necessary to participate in a contest, ROS applied for and received grants from the All Points North Foundation to sponsor three schools within the study period. The Colorado Energy Office funded 17 additional Title 1 schools. Supplementary funds were also provided by Xcel Energy, a North American utility, through their Renewable

Energy Trust (RET) grant for schools within their territory. All but 12 (30%) schools within the study period were assisted financially in some way.

The study focuses on 40 schools who participated in the four selected iterations of ROS's energy contest (Table 1). Schools that were directly described by ROS as dropouts were removed from the study, as were those who completed no activities (which the researcher assumed were not invested in the initiative and savings observed were not intentional). Participating buildings varied in square footage, age, and capacity and included elementary, middle, and high schools. These variances were possible because the contest model compares schools against their own baseline rather than inter-school numerical savings. Contests were subdivided into groups based on grade-level to determine winners, but because winners are not considered in this study, sub-grouping was ignored.

Table 1
Schools Participating in 2019 Renew Our Schools Energy Contests

ROS Contest Iteration	Number of Participating Schools	Dropout Schools*	No Activities**
Spring 2019 National	10 (90.9%)	1	0
Spring 2019 Colorado	7 (87.5%)	0	1
Fall 2019 National	13 (59.1%)	3	6
Fall 2019 Colorado	10 (71.4%)	2	2
Total	**40 (74.5%)**	**6**	**9**

*****directly noted by ROS; excluded from analysis
**implied school dropout by researcher; excluded from analysis

Study Approval

According to human research policies set by the Institutional Review Board (IRB) of the University of Wisconsin – Stevens Point, the researcher did not need to obtain IRB approval to conduct the research within this study. This is because the researcher of this study did not directly interact with participants of the energy contest iterations studied. Instead, the researcher received previously collected data from ROS that was gathered on a school-building level. Individuals involved retained their anonymity to the researcher. Schools are not referenced by name in this study to further protect anonymity.

Methodology

This study primarily used quantitative data analysis to explore success of energy contests in a K-12 model. Success in this study was defined in terms of SMS because it involves relatively little interpretation from the researcher. The researcher could use the SMS percentage for each school to compare energy conservation efforts, despite being an outsider to the ROS energy contest iterations studied.

Quantitative data analysis was chosen for two primary reasons relating to the restrictive nature of secondary data. First, the researcher had no access to contest participants directly. Contests were run one to two years prior to the study and collecting qualitative data about participants' experiences would have been logistically difficult and potentially temporally compromised. This problem was confounded by the presence of COVID-19 and the disruption it had on both teachers' and students' time and schedules. Second, using secondary data inherently creates limitations surrounding the researcher's lack of involvement in its collection. Numerical data is generally less likely to be misinterpreted. Essentially, the researcher acknowledged that qualitative data would require making herself into a tool of the analysis, and as an uninvolved party of ROS energy contest iterations, the researcher assumed that quantitative analysis could provide more insight not previously explored by ROS.

Qualitative coding was also included to evaluate ROS's SEA offerings according to the TPB which was used as this study's framework. Coding was applied to SEA descriptions by three independent coders to increase reliability. Results were then tallied and analyzed quantitatively to look for a relationship between completing SEA categories that emphasize components of the TPB and SMS. Together, qualitative coding with subsequent quantitative analysis provided a more complete story concerning the energy contest model's potential for behavior change in relation to the TPB.

Research Design

Data used for this study originated from energy contest iterations conducted by ROS in Spring 2019 and Fall 2019 – one Colorado-based contest and one nationwide contest per season. As a result, the research questions were developed under the limitations of ROS's data documentation methods. Data was provided to the researcher via Google sheets for each contest iteration.

Data was compiled into a single Excel sheet, coded as necessary to address the research questions, and imported into IBM SPSS Statistics 25. The statistical test Pearson's correlation coefficient was run to determine relationships between School Energy Actions (SEAs) and school measured savings (SMS). The significance of *r* will follow the scale developed by Cohen (1988) as described by Pallant (2007). A summary of variables per research question are described in Appendix C. Details of the process for exploration of each research question are described as follows:

> **RQ 1.** How were Renew Our Schools' School Energy Action (SEA) categories implemented by participating schools?
>
> > **a.** How many SEA categories did each school, on average, participate in?
> >
> > **b.** How many schools implemented each of the SEA categories?

RQ 1 was a quantitative description of how participating schools interacted with the SEA offerings. Because the data from ROS concerning SEA scoring was lumped into seven categories, the researcher could not untangle with certainty which SEAs participating schools enacted (completely or partially). Therefore, RQ1a used a scale of completion per SEA category based on points scored out of the total available for each category (see Appendix B). Each SEA category was scored as completed (1) if $\frac{points\ achieved\ in\ category}{points\ available\ in\ category} \geq 0.7$, partially completed (0.5) if $0.7 > \frac{points\ achieved\ in\ category}{points\ available\ in\ category} \geq 0.3$, or not completed (0) if $0.3 > \frac{points\ achieved\ in\ category}{points\ available\ in\ category}$. Total score per school was determined by adding the score for each of the seven SEA categories. This allowed the researcher to describe the relative completion of each SEA category by each school. Note that because the *School Audit* and the *Final Presentation or Video* were both required and scored individually by ROS, that they are treated as separate categories in this study. RQ1b described the number of schools who completed, partially completed, or did not complete each SEA category, according to the coding established in RQ1a.

RQ 2. How did schools' participation in School Energy Action (SEA) categories relate to School Measured Savings (SMS)?

a. Did the number of SEA categories completed correlate with SMS?

b. Were schools' SMS correlated with participation in a particular SEA category (or categories)?

c. Did the SEA category that focuses on dashboard use (*Energy Savings*) correlate with SMS?

RQ 2 quantitatively described the potential relationships between SEA participation and SMS. The potential relationship was checked using Pearson's correlation coefficient in two iterations to compare both the total SEA category completion scale score (from RQ1a) and SEA total percent completion to the SMS.

RQ2b was investigated similarly by using Pearson's correlation coefficient to determine the strength of the relationship between a school's completion status of each SEA category (from RQ1a) and the school's SMS raw score. This analysis was run comparing the SEA completion scale score to the SMS and again with the SEA percent completion for each of the seven categories. RQ2c was technically included within RQ2b, but it was written separately to emphasize the exploration of the potential influence of a dashboard on SMS.

RQ 3. (How) do School Energy Actions (SEA) foster the components of the Theory of Planned Behavior (TPB) – attitude, subjective norm, and perceived behavioral control – regarding energy conservation behaviors?

a. (How) are the three components represented by the SEAs regarding energy conservation behaviors?

b. Was the typical school engaging in all three of the components of the TPB?

c. Was there a relationship between engaging the components of the TPB and SMS?

RQ 3 explored SEA offerings qualitatively and then tested whether relationships exist between SEA categories and SMS in regards to the TPB. RQ3a was investigated by manually coding SEAs for the components of the TPB (attitude, subjective norms, and perceived behavioral change). Coding was conducted by reading the description of each SEA (Appendix B) and comparing it to selected definitions of the components of the TPB (Appendix D). Coding was completed independently by the researcher, her primary advisor, and the program manager of ROS.

Of particular note is that, to an extent, all of the activities promote attitude and subjective norms. By participating in an energy contest, energy conservation behaviors are inherently portrayed as good. To be coded as meeting the attitude component, an activity had to explicitly highlight energy conservation as positive, such as how doing so reduces environmental impact. Similarly, all activities promote subjective norms to an extent through the participating teacher(s). To be coded as meeting the subjective norm component, energy conservation behaviors had to be endorsed by another person of importance, such as other students, administration, or parents. Once coded, components coded consistently were noted and all components within a SEA category were tallied.

Because the ROS data set did not include individual SEA scores, for RQ3b and RQ3c, the SEA's TPB coding results were grouped by their categories. RQ3a described the spread of components of the TPB within activities, and RQ3b detailed the average impact of the TPB on participating schools through the SEA categories where completion scale scores were greater than seventy percent (from RQ1a). RQ3c determined whether influencing behaviors via the components of the TPB through SEAs correlated with SMS achieved by the school using an independent samples t-test. Due to sample size, schools' activation of components of the TPB were rounded up (meeting three or two of the components) or rounded down (meeting one or zero of the components). These two groups were examined for significant differences between the means.

Summary

The previous chapter described how ROS scored its energy contest participants within the study period and how the data collected during this timeframe was analyzed by the researcher. The chapter also outlined the researcher's IRB interactions and the breakdown of statistics addressing each research question. The methods were selected to answer the research questions listed within the limits of secondary data and will be used to explore the implications of the results.

CHAPTER 4:

RESULTS

The following chapter will describe the results of this study according to the description of the research questions in Chapter 3. Results are subdivided as follows: pre-analysis, descriptive statistics, research question 1 (a and b), research question 2 (a, b, and c), research question 3 (a, b, and c), and additional findings. Figures and tables are found throughout to visually describe the data when applicable. Chapter 5 will describe the implications of these results and describe next steps for research and energy contest programmatic adjustments.

Pre-Analysis

Contest participation data from ROS was utilized from 40 K-12 schools who participated in either the spring or fall of 2019, nationally or based in Colorado. These four contest iterations were chosen because the scoring system used was consistent between them. Earlier contest sessions included fewer school energy action categories and/or included points for a home energy actions category which prohibited direct comparison.

Six schools were excluded from analysis because ROS explicitly described them as "dropouts" due to a lack of participation (i.e. no submission of products for SEA scoring). An additional nine schools were excluded by the researcher because they received an SEA score of zero. It was assumed that these schools did not participate for external reasons as well. Of the six official dropout schools, four were high schools, one was a middle school, and one was unknown (the school serves grades 6-12, but the grade level of targeted participants was not stated). The average SMS of these schools was 1.2% (2.0%, 1.4%, 1.4%, 0.0%, and two non-recorded SMS). Of the nine schools, pulled by the researcher, six of them had SMS scores of 0.0 percent. The remaining three had 5.4%, 5.8% and 7.6%, resulting in a non-zero average SMS score of 6.3%

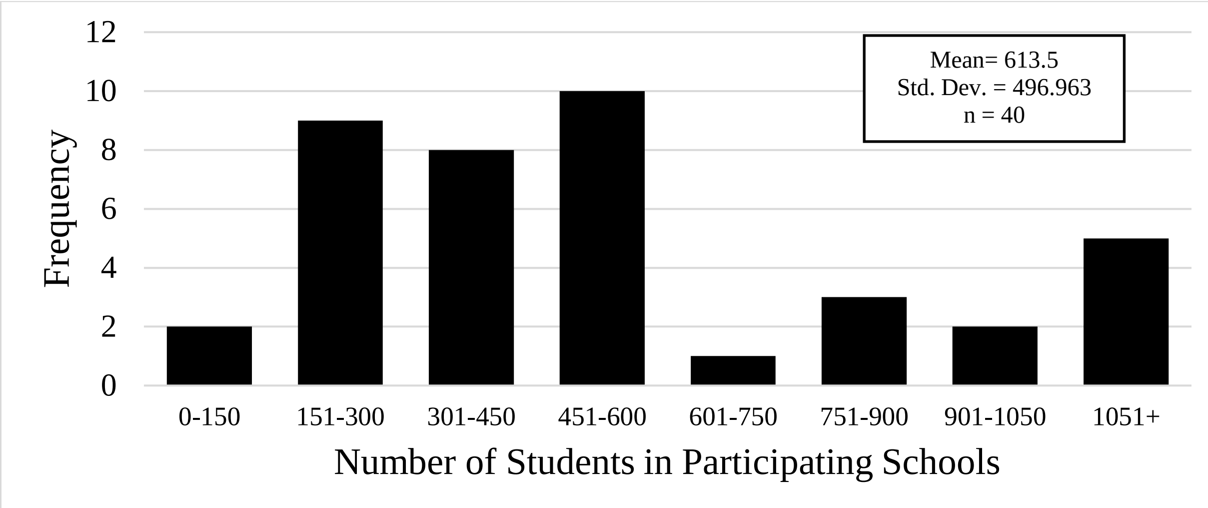
and a total average for the nine schools of 2.1 percent. For all excluded scores, the researcher assumes that savings were unintentional and due to non-behavioral factors such as HVAC upgrades or general electricity usage fluctuations.

The final pool of school data for analysis (n = 40) was then organized in Microsoft Excel to be imported into IBM SPSS Statistic 25. Variables for each school included its SMS raw score, coded SEA completion scale score for each of the seven SEA categories, and the combined SEA score. Coded descriptive data for each school was also organized: contest season (fall or spring), contest location (Colorado or nationwide), number of students, contest audience (elementary, middle, or high school), Title 1 status, and the presence/absence of external funding to participate in the contest. Once in SPSS, the categorical demographic variables described were coded as 0, 1, etc. as necessary.

Descriptive Statistics

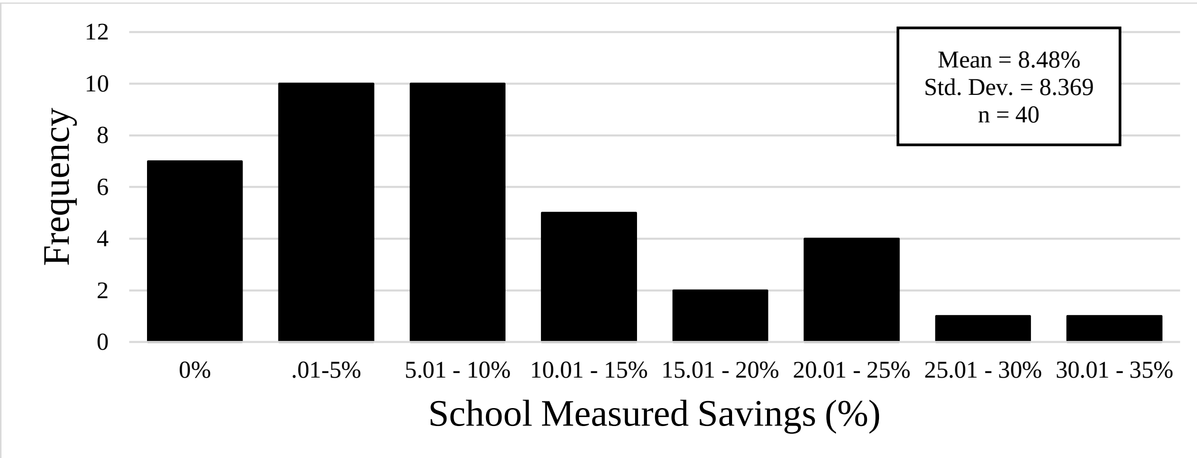
Of the 40 schools used in the study, 17 participated in Spring 2019 (42.5%) and 23 participated in Fall 2019 (57.5%). Seventeen schools participated in a Colorado-based contest (42.5%) while 23 (57.5%) were part of a nationwide contest. Fifteen (37.5%) of the participating schools targeted an elementary audience, 16 (40.0%) were based in middle schools, and nine (22.5%) in high schools. Mean student population was 614, ranging from 55 to 2471. School population distribution is further described in Figure 4. Fourteen (35.0%) schools were categorized as Title 1, while 26 (65.0%) were not. Overall, 28 (70.0%) schools were funded externally to participate in an energy-saving contest, while 12 (30.0%) received no assistance.

Figure 4
Distribution of Student Populations of Schools Participating in ROS Energy-Saving Contests



SMS values ranged from 0.0% (which could potentially be a negative score as ROS rounded all negative values to 0) to 31.9% compared to each school's own baseline. Seven schools had zero or negative change, resulting in an 82.5% success rate. The average SMS was 8.5% with a standard error of 1.3% and a standard deviation of 8.4 percent. Of the schools scoring a non-zero number, the average savings were 10.28% compared to the baseline. Frequency distribution of SMS is described in Figure 5. One school was determined to be an outlier (31.9% electricity savings as compared to its baseline). Because of this, questions regarding correlations with SMS were run with and without this data point.

Figure 5
Distribution of School Measured Savings (SMS) of Schools Participating in Renew Our Schools' Energy-Saving Contests

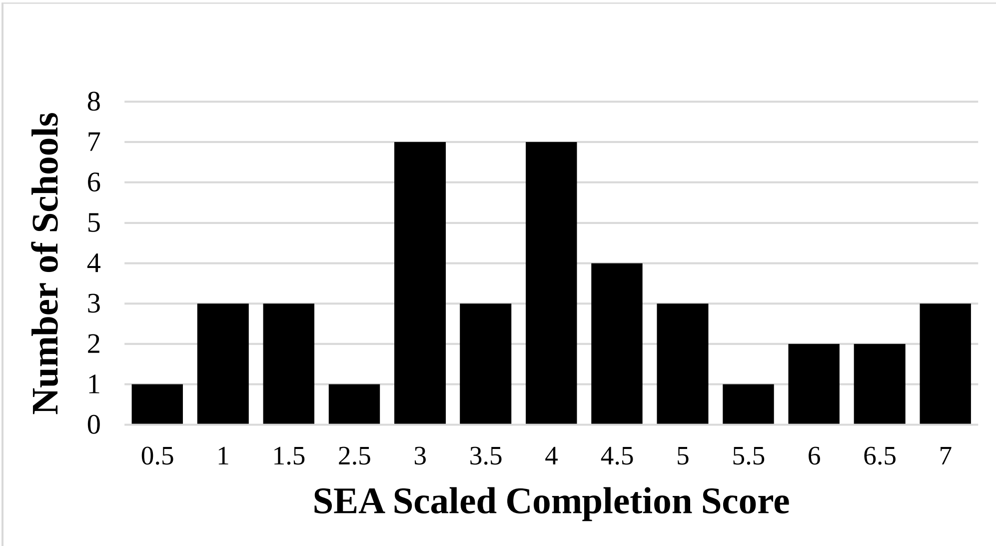


RQ1 Results: How were Renew Our Schools' School Energy Action (SEA) categories implemented by participating schools?

a. How many SEA categories did each school, on average, participate in?

School SEA completion scale scores ranged from 0.5 to 7. Seven was the highest score possible by achieving a "1" in every category, which three schools did. The average score was 3.9 with a standard deviation of 1.76. Distribution of total SEA scores is described in Figure 6. The average translates to a typical school completing slightly over half of the SEA categories. However, schools were not participating in each of the SEA categories equally.

Figure 6
Distribution of School Energy Action Scaled Completion Scores of Schools Participating in Renew Our Schools' Energy Savings Contests



b. How popular was the implementation of each of the SEA categories among participating schools?

The most popular SEA category completed by schools was the *School Audit* (39; 97.5%) followed by *Final Presentation or Video* (30; 75%). Presumably, this is because the *School Audit* and *Final Presentation or Video* are both listed as required for participating in the contest. The most popular non-required SEA category was *Creative Campaign* (17; 42.5%). Of note for RQ2c is that *Energy Savings* is the least popular SEA category completed, with few schools engaging it completely (5; 12.5%) or partially (5; 12.5%). The comprehensive breakdown of SEA scaled category completion is found in Table 2.

Table 2
SEA Scaled Category Completion of Schools Participating in Renew Our Schools' Energy- Saving Contests

	Completed x ≥70%	Partially Completed 70% > x ≥30%	Not Completed x < 30%
School Audit	39 (97.5%)	0 (0.0%)	1 (2.5%)
Final Presentation or Video	30 (75.0%)	2 (5.0%)	8 (20.0%)
Creative Campaign	17 (42.5%)	16 (40.0%)	7 (17.5%)
Students as Teachers	13 (32.5%)	14 (35.0%)	13 (32.5%)
Energy in the Classroom	11 (27.5%)	11 (27.5%)	18 (45.0%)
Local Experts	8 (20.0%)	15 (37.5%)	17 (42.5%)
Energy Savings	5 (12.5%)	5 (12.5%)	30 (75%)
Total	**123 (43.9%)**	**63 (22.5%)**	**94 (33.6%)**

RQ2 Results How did schools' participation in School Energy Action (SEA) categories relate to School Measured Savings (SMS)?

a. Did the number of SEA categories completed correlate with SMS?

Using Pearson's correlation coefficient, the variables of SMS and the SEA total completion score (determined from RQ1a) were found to have a small, positive correlation (r = .283). This would indicate that participating in more SEAs was related to higher electricity savings. However, this relationship was not significant (p = .077). This analysis was repeated with the percentage of total SEA completion ($\frac{x}{510}$) with a non-significant medium correlation (r = .300; p = .060).

The same tests were conducted excluding the high-achieving outlier (n = 39). The SMS and the SEA category scaled completion score (determined from RQ1a) had a non-significant small correlation (r = .178; p = .278). The percentage of SEA category completion also had a non-significant small correlation (r = .192; p = .242) with SMS.

b. Were schools' SMS correlated with participation in a particular SEA category (or categories)?

Pearson's correlation coefficient was conducted to compare completion status of each of the SEA categories as described in RQ1a to the SMS achieved by the corresponding school. Of the seven SEA categories, two were determined to have a significant relationship with SMS: *Energy in the Classroom* and *Energy Savings*. *Energy in the Classroom*, composed of traditional classroom lessons on energy topics, had a medium-strength, positive correlation (r = .489; p = .001). *Energy Savings*, the SEA category directly associated with dashboard engagement, had a medium-strength, positive correlation (r = .494; p = .001) with SMS. The SEA categories were rerun without the high achieving outlier with similar results (*Energy in the Classroom:* r = .445, p = 0005; Energy Savings: r = .392, p = .014). See Table 3 for a full profile of the relationships between SEA category completion and SMS.

Pearson's correlation coefficient was also used to compare each SEA category's percentage completion and SMS. As with the SEA category completion, *Energy in the Classroom* and *Energy Savings* were the categories with a significant correlation. Using the whole population, both categories resulted in a medium-strength correlation with SMS (*Energy in the Classroom*: r = .469; p = .002; *Energy Savings*: r = .485; p = .002). Analysis without the high-achieving outlier was slightly weaker but still significant (*Energy in the Classroom*: r = .422; p = .007; *Energy Savings*: r = .385; p = .016). See Table 4 for a full profile of the relationships between SEA category completion percentage and SMS.

Table 3
Relationships Between School Energy Action (SEA) Category Participation by Scaled Completion Score and School Measured Savings (SMS)

Participating schools (n = 40)					
	r	*p*	*Completed*	*Partially Completed*	*Not Completed*
School Audit	*.194*	*.231*	39	0	1
Final Presentation or Video	*-.068*	*.675*	30	2	8
Energy in the Classroom	***.489***	***.001***	**11**	**11**	**18**
Energy Savings	***.494***	***.001***	**5**	**5**	**30**
Creative Campaign	*-.035*	*.828*	17	16	7
Students as Teachers	*.286*	*.073*	13	14	13
Local Experts	*.19*	*.24*	8	15	17
Total SEA score	*.283*	*.077*	123	63	94

Without outlier (n = 39)					
School Audit	*-.231*	*.158*	38	0	1
Final Presentation or Video	*.123*	*.456*	29	2	8
Energy in the Classroom	***.445***	***.005***	**10**	**11**	**18**
Energy Savings	***.392***	***.014***	**4**	**5**	**30**
Creative Campaign	*-.125*	*.448*	16	16	7
Students as Teachers	*.224*	*.17*	12	14	13
Local Experts	*.084*	*.611*	7	15	17
Total SEA score	*.178*	*.278*	116	63	94

Table 4
Relationships Between School Energy Action (SEA)Categories by Completion Percentage and School Measured Savings (SMS)

Participating schools (n = 40)	*r*	*p*	Mean completion percentage
School Audit	*-0.073*	*0.654*	*94.4%*
Final Presentation or Video	*-0.081*	*0.621*	*74.5%*
Energy in the Classroom	***0.469***	***0.002***	***43.8%***
Energy Savings	***0.485***	***0.002***	***23.8%***
Creative Campaign	*-0.002*	*0.989*	*63.0%*
Students as Teachers	*0.223*	*0.166*	*46.1%*
Local Experts	*0.182*	*0.261*	*40.1%*
Total SEA score	*0.300*	*0.060*	*49.2%*

Without outlier (n = 39)	*r*	*p*	Mean completion percentage
School Audit	*-0.109*	*0.510*	*94.2%*
Final Presentation or Video	*-0.143*	*0.384*	*73.8%*
Energy in the Classroom	***0.422***	***0.007***	***42.4%***
Energy Savings	***0.385***	***0.016***	***21.9%***
Creative Campaign	*-0.081*	*0.623*	*62.0%*
Students as Teachers	*0.145*	*0.378*	*44.7%*
Local Experts	*0.065*	*0.696*	*39.3%*
Total SEA score	*0.192*	*0.242*	*47.9%*

c. How did the SEA category that focuses on dashboard use (Energy Savings) correlate with SMS?

As noted above, *Energy Savings* was one of two SEA categories significantly correlated with SMS. SEA completion by category scaled score had a medium-strength positive correlation (r = .494; p = .001) with SMS. This relationship was maintained even after removing the outlier (r = .392, p = .014). A similar relationship was noted between the SEA category's percentage of completion and SMS (all schools: r = .485, p = 0.002; without outlier: r = .385, p = .016).

RQ3 Results (How) do School Energy Action (SEA) categories foster the components of the Theory of Planned Behavior (TPB) – attitudes, subjective norms, and perceived behavioral control – regarding energy conservation behaviors?

a. (How) are the three components of TPB represented by the SEAs regarding energy conservation behavior?

Coding was enacted independently by the researcher, her primary advisor, and the program manager of ROS. Each coder was provided with definitions for the components of the TPB (attitude, subjective norms, and perceived behavioral control) by Ajzen (1991) as compiled by LaMorte (2019) as described in Appendix D. These definitions were used to code the ROS activities by their descriptions. The program manager reported that she referenced LaMorte's webpage (2019) directly for clarification in addition to the definition chart provided by the researcher (Appendix D).

The three coding sheets were compared for consistency with mixed results. For all three coders, there was often hesitancy with coding noting that activities "could" or "had potential" to meet a particular component, but it was not explicitly stated in the description. These results were compiled but not included in this study's analysis due to the previously described lack of confidence. To determine coding certainty, activities were grouped by total agreement (all three coders listed a TPB component for an activity) or partial agreement (two of three coders listed a TPB component for an activity).

Through comparative coding there was one SEA out of 23 with complete agreement for attitude (4.3%), two for subjective norms (8.7%), and five for perceived behavior control (21.7%). For partial agreement, there were two activities representing attitude (8.7%), three representing subjective norms (13.0%), and five for perceived behavioral control (21.7%). When combining those with complete agreement and partial agreement, three activities represent attitude (13.0%), five represent subjective norms (21.7%), and ten represent perceived behavior control (43.4%). Because some SEAs were coded to multiple TPB components, there were a total of twelve SEAs that went above and beyond the general attitude representation of being in an energy contest and subjective norms of teacher involvement. Complete coding results are described in Appendix E.

The TPB coding of each SEA was then tallied within its respective category as compiled in Table 4. Creative Campaign had the highest representation of its activities and was the only category to be confidently represented by all three components of the TPB. The SEA categories *Students as Teachers* and *Energy Savings* were represented by four coding instances apiece. Interestingly, the required SEAs composed of the *School Audit* and *Final Presentation or Video* was not coded to any component. This was due to coding disagreement (*School Audit*) and hesitancy coding (*Final Presentation or Video*).

Table 5
Results of Coding of Renew Our Schools' School Energy Actions According to the Components of the Theory of Planned Behavior (TPB)

SEA Category Name	Number of instances TPB components were represented per SEA Category
Creative Campaign	Attitude- 2 Subjective Norms- 3 Perceived Behavioral Control- 2
Students as Teachers	Subjective Norms -1 Perceived Behavioral Control - 3
Energy Savings	Perceived Behavioral Control- 4
Energy in the Classroom	Subjective Norms- 1 Perceived Behavioral Control -1
Local Experts	Attitude - 1
School Audit	N/A
Final Presentation or Video	N/A

b. Was the typical school engaging in all three of the components of the TPB?

Once categories were coded, school participation in categories was used to give each school a TPB score. To count the parts of the TPB of a category, a school must have completed $x \geq 70\%$ of a category (out of total possible category points). According to this model, fourteen schools (35%) did not engage the TPB beyond the general attitude representation of being in an energy contest and subjective norms of teacher involvement. One school (2.5%) engaged one component (perceived behavioral control), and six (15%) schools engaged two (subjective norm and perceived behavioral control). The remaining 19 schools (47.5%) completed SEA categories that hit all three facets of the TPB.

c. Was there a relationship between engaging the components of the TPB and SMS?

Due to uneven sample size between the groups for each TPB coding score, scores were generalized by rounding up (two or three TPB components) or down (zero or one components). Fifteen schools were thus grouped into a “low impact” category and the remaining 25 were placed into a “high impact” category. An independent samples t-test was used to determine if a difference in SMS occurred between these two groups. There was not a significant difference in the scores between low impact (M = 7.14%, SD = 6.11%) and high impact (M = 9.29%, SD = 9.50%) schools; $t(38) = -0.768$, $p = .439$. Repeated without the high-achieving outlier (within the high impact group), there was not a significant difference in the scores between low impact (M = 7.14%, SD = 6.11%) and high impact (M = 8.35%, SD = 8.43%) schools; $t(37) = -0.481$, $p = .633$.

Additional Findings

Although not initially part of this study, because ROS included specific demographic information in its records, the researcher decided to briefly look for correlations between SMS and student population size and primary participant grade band. Pearson's correlation coefficient was used to test for a relationship between SMS and the number of students attending the participating school. A one-way ANOVA was used to test for a relationship between primary participant grade band (elementary, middle, or high school) and SMS. Neither of these variables had a significant relationship with SMS.

Summary:

This chapter served to describe the results of the eight sub-questions within the three main thesis questions as outlined from Chapter 3. The next chapter will describe the nuance of these results as well as recommendations for future research and energy contests moving forward.

CHAPTER 5:

CONCLUSION

This chapter will discuss the implications and limitations of the research questions, as well as propose suggestions for future research and recommendations for energy-saving contests. It is the culmination of the rationale for the study (Chapter 1), review of relevant literature (Chapter 2), planned methods used to explore the research questions (Chapter 3), and results of the study (Chapter 4). By addressing the research questions, the study was designed to engage broader objectives for energy education as follows:

- Explore various successes and shortcomings of the energy-saving contest model developed by ROS.
- Provide insight to ROS about the study's findings regarding relationships discovered between SEAs and SMS.
- Discuss the results of this study to provide recommendations for organizations who host energy savings contests particularly in schools including ROS.

Together, the results of the research and the energy education objectives provide a lens into best practices for energy contests and energy programming in general.

Pre-Analysis

Fifteen schools were excluded from analysis because of a lack of SEA engagement. Outside the scope of this study but worth exploring is why these schools dropped out (either formally or through inaction). The cost to purchase and install eGauge monitoring hardware is nearly two thousand dollars. From a programmatic standpoint, an energy contest provider like ROS wants to invest in schools that will give in return through student engagement and/or. electricity conservation. Perhaps there is one or more underlying barriers that these schools are experiencing that prevent them from meeting these goals.

It would be interesting to study demographics regarding the teachers and/or administrators who encouraged their schools to participate. This line of research would echo an interview done by Vine and Jones (2016) where an energy contest organizer described their experience as follows: “The key to success is not motivating participants but motivating local program managers” (p. 169). In the case of ROS contest iterations, this would be the championing teacher or administrator. There may be some underlying reason these individuals are successful at inspiring change in others, such as a pre-existing interest in energy conservation or flexibility in schedule.

Most (12) of the schools excluded from this study did not achieve SMS, however three did. Their electricity savings (5.4%, 5.8% and 7.6%) were lower than the average of the schools analyzed in this study (8.5%), but they should not be ignored. Were these schools enacting energy conservation behaviors but not reporting them? If so, they were mildly successful, and their processes should be examined. Perhaps other barriers exist related to doing or reporting on SEAs that underrepresent their efforts in energy education. If these schools were not practicing conservation behaviors, were these savings a coincidence or a result of efficiency upgrades, management modifications, or other changes?

Because the study consisted only of schools that did SEAs, the researcher could not statistically compare the SMS between schools participating in any SEA with those who did not do any of them. It is an underlying hypothesis of this study that participation in SEAs increased electricity conservation efforts. Although SMS was found to correlate with two SEA categories, non-participatory schools could be examined simultaneously to further understand the relationship between energy education and energy conservation in a contest model.

Descriptive Statistics

The forty schools of the study were composed of diverse demographics. ROS is open to elementary, middle, and high schools with a wide range of school size represented. Contests were open to both schools with and without Title 1 status, and most schools received external funding to participate both in Colorado and nationwide. Schools are also not restricted from eligibility based on building size and/or participating student grade band; instead, they are placed in sub-groups with similar characteristics. This demonstrates the flexibility of the ROS contest model while maintaining a fair playing field for participants. From the brief analysis of the demographics of grade band and student population size, no particular subgroup was found to save significantly more electricity. This reinforces the notion that energy contests may be successful across multiple contexts as was evident by the success of various programs described by Vine & Jones (2016). There may be factors outside of the collected demographics, such as racial demographics, parental involvement, or the school's surrounding population density that influence success.

School measured savings (SMS) represented a large range of success. Although the average SMS was 8.4%, seven schools had a 0% SMS score. However, ROS does not distinguish between zero and negative electricity savings. It might be beneficial to interview those participating in energy-saving contests that were unsuccessful in a numerical sense. These schools were using more electricity, despite any efforts made. To what extent were they dedicated to making change, particularly compared to schools with successful SMS? Which SEAs were they completing? Which conservation behaviors were they attempting? Although the energy-saving contest model is not restrictive, it has not been universally successful and there are likely other factors to consider.

RQ1 Discussion

a. How many SEA categories did each school, on average, participate in?

Schools' SEA category completion scale scores ranged the entire possible spectrum of 0.5 to 7. This range supports the hypothesis of high variability of participation in SEAs. The average score was 3.9 with a standard deviation of 1.76, meaning a typical school completed slightly over half of the SEA categories. This demonstrates that classrooms are often, but not universally, capable of participating in several SEAs and it is promising to know that schools have the potential to tap into these assets. This is important because participating may increase learning about electricity as dashboards did in the classroom study by Clark et al. (2017). However, doing so requires time and dedication, and these resources are limited. Organizations that arrange programming should be cognizant and respectful of this fact.

Because schools try to win the energy contest by accumulating points, they may target those that will earn more points. Alternatively, those activities with a higher point value may be too cumbersome or complicated to complete. Since all categories are not being enacted by all schools, ROS should be strategic about the point value of the SEAs. Perhaps those categories demonstrated in this study to correlate with SMS should be given a relatively high point value to encourage their implementation.

Additionally, ROS currently requires participation in two activities: *School Audit* and *Final Presentation or Video*. If schools are engaging in four SEA categories on average, this means that approximately half of an average school's engagement is with the required categories. Perhaps, based on the results of RQ2 and/or RQ3, different or additional SEAs should be required for participation in the ROS energy contest. In the present model, schools were not participating in each of the SEA categories equally.

b. How popular was the implementation of each of the SEA categories among participating schools?

Because the *School Audit* and *Final Presentation or Video* are required, they were the most popular ones (completed by 39 and 30 schools respectfully). This supports the hypothesis that required SEA categories would be the most popular. However, being required did not ensure participation in the activity. All other activities were completed by less than 50% of participating schools. It raises the question: Would fewer options with tighter objectives encourage schools to participate in more SEAs or is variety better for customization to classrooms' needs and interests?

Creative Campaign was the most popular non-required SEA category, with 42.5% completion and 40% partial completion with *Students as Teachers* as a close runner-up with 32.5% completion and 35% partial completion. Engagement in the other SEA categories was increasingly divisive with *Energy Savings* at the bottom, being completely passed over by 75% of classrooms. It would be interesting to collect qualitative data surrounding why teachers selected the SEAs they did. Were they the easiest to complete? Were they worth the most points, similar to lessons the teacher had experienced, or simply seemed the most interesting? Learning underlying motivation will provide insight into the needs of classrooms and adapt SEAs accordingly.

Not explored in this study but of related interest would be to identify which specific activities were enacted by schools. ROS only recorded the cumulative point values of each category for each school for the data set used in this study. There may be particular activities that are significantly more or less popular than others which are currently hidden by the metrics. As mentioned above, classrooms have limited opportunities to complete the SEAs, and therefore ROS should ensure their activities are optimized.

RQ2 Discussion

a. Did the number of SEA categories completed correlate with SMS?

Completing more SEAs (to the specificity of categories) was not significantly correlated with energy savings. This does not support the hypothesized correlation between the two variables. This could have occurred because individual activities within a category may be more or less impactful for SMS. This could mean that total SEA engagement is less important than engagement in particular SEAs as was explored in RQ2b. Relatedly, it is possible that the completion of an SEA was not descriptive enough to discern its relationship with SMS. Current SEA descriptions are found in Appendix B. Without a detailed description for each SEA, there may be large differences between its enactment between schools, skewing results and masking the potential impacts of different engagement techniques. Alternately, there may be no relationship between the two variables.

b. Were schools' SMS correlated with participation in a particular SEA category (or categories)?

SMS was positively correlated with two SEA categories: *Energy in the Classroom* and *Energy Savings*. This begs the follow-up question of what makes these categories unique? The *Energy in the Classroom* category contains SEAs that engage students through a traditional model of classroom lessons. These SEAs could be done outside of the energy contest model. A follow-up study could explore whether teaching lessons alone is as effective on impacting SMS as doing them in an energy contest. It is possible that place-based inquiry lessons are sufficient to inspire change for some audiences as these descriptors have been demonstrated to make lessons relatable (Endreny, 2009).

The *Energy Savings* SEA category features dashboard engagement to track saving efforts. This category's correlation with SMS may be a self-fulfilling prophecy because the actions directly pose challenges to save electricity (in terms of reducing the percentage used) and track it on the dashboard. This would be especially true if saving the electricity was necessary to score full points for the SEA. Also of note is that this SEA category was the least completed among participating schools (12.5% completed; 12.5% partially completed; 75% not completed). However, this study suggests dashboard engagement encourages participation in energy conservation behaviors in line with Buchanan et al. (2014); Oltra et al. (2013); and Willis et al. (2010).

Another possibility is that the schools doing the *Energy Savings* category are the high achievers who are self-motivated to win rather than obtaining motivation from the content of a particular SEA or SEA category. Because 25% of points are scored by completing SEAs, classrooms may be driven to do as many SEAs as possible in addition to cutting their electricity usage. If so, it may not be the content of the SEA driving reduction as much as the contest model itself. Relatedly, several schools used the *Create-Your-Own* SEA category to score hundreds of additional points, bolstering their score well beyond the basic point grid. Perhaps it would be useful for ROS to install a requirement of completing a particular percentage (i.e. 80%) of SEAs before they can bank extra points in one or two categories. This would encourage participation in various experiences and, through them, classrooms could acquire numerous perspectives on why and how to save electricity.

However, this suggestion assumes that classrooms benefit from participating in all SEAs, which is not fully understood one way or the other. This study hints that this may not be the case, as only particular SEA categories correlated with SMS. Yet, this assumes that the priority of schools is saving electricity which may not be true for all participants. While monetary savings – and thus reduced electricity consumption – was ranked as a significant motivator by a pool of

ROS contest participants, so were “increased knowledge of energy issues by staff” and “student participation” (Group 14 Engineering, 2016, p. 7). SEAs themselves may be beneficial in ways not reflected in the SMS and therefore this study.

Additionally, as mentioned above, it may not be the activities themselves that matter as much as the buy-in of the schools. Creating and/or fostering a school culture that supports sustainability through projects like an energy contest can influence children’s opinions about such endeavors (Tucker & Izanpanahi, 2017; Cole, 2014). This facet of the contest may be more valuable than short-term SEA engagement. Engagement may also be highly influenced by the level of motivation of the participants. If only one classroom or grade is invested in the project the overall impact would generally be less than if the whole school participated. If the fundamental difference(s) in the classrooms’ level of motivation and number of participating students matter more than any influence of external activities, contest organizers may want to untangle where this underlying motivation comes from. Should contests target those most likely to succeed or work on educating various audiences regardless of their success level? How can the championing teacher and students get more of their peers on-board and how can ROS facilitate this process?

c. How did the SEA category that focuses on dashboard use (Energy Savings) correlate with SMS?

The *Energy Savings* SEA category was one of two to have a significant correlation with SMS as discussed in RQ3b. This supports the hypothesis of *Energy Savings* correlating with savings due to its dashboard engagement and ideal feedback structure (Hysong, Best, & Pugh, 2006). However, as previously mentioned, the question remains of whether it was using the dashboard that made a difference or whether this SEA category was undertaken by the most enthusiastic participants. The study found the category to be significant, but because it was undertaken by few classrooms, the generalizability of this relationship is limited.

RQ3 Discussion

a. (How) are the three components of TPB represented by the SEA categories regarding energy conservation behaviors?

Of the seven SEA categories, *Creative Campaign* had the highest representation of the TPB in its activities and was the only category to be confidently represented by all three components of the TPB. It was the most popular SEA category after the two required ones. Interestingly, the *School Audit* and *Final Presentation or Video* were not coded to any component. This was due to coding disagreement (*School Audit*) and hesitancy (*Final Presentation or Video*) in coding.

Coding was not as straightforward as anticipated. There were two instances of total agreement but with hesitancy, eight instances of partial agreement with hesitancy, and four activities (12 instances) with no coding agreement. This translates to 26 (37.7%) coding cases without confidence. This general inconsistency likely resulted from the brevity of the SEAs' descriptions (Appendix B). These descriptions allow for flexibility of interpretation, which can be useful for adapting to different age groups and subject areas. However, their vague nature also means classrooms may miss the major objective(s) of an activity, such as emphasizing student efficacy.

However, some SEA categories leant themselves to coding agreement of the components of the TPB more than others as can be seen from the results in Table 5 and Appendix E. This could provide additional insight into the strength of particular SEAs over others. Those without coding consistency, like *Local Experts* may be the best candidates for revamping their description and/or content.

Although it is the SEA descriptions that are predicted to be the cause of the coding inconsistencies, they might not be the only source. The definitions of the TPB components used (Appendix D) were chosen because they were concise, but there may have been an assumed level of familiarity with the theory necessary for these definitions to be used effectively for coding. Additional information provided to the coders concerning the TPB (such as examples of each component in programming) may have lessened the potential for ambiguity regarding applying each component to the SEAs. Whatever the root cause(s), coding disagreement led to the limited implications of RQ3.

b. Was the average school engaging in all three of the components of the TPB?

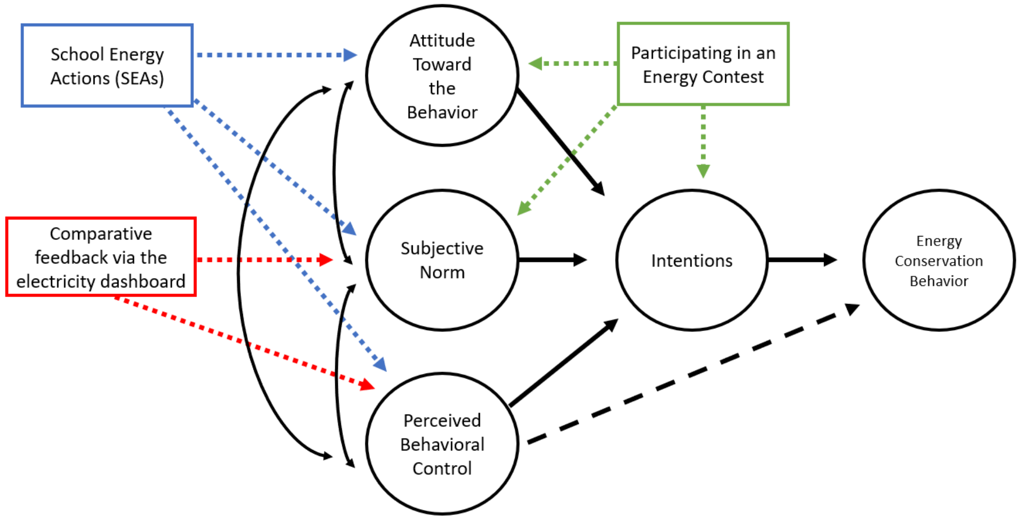
The average school was engaging 1.75 components of the TPB. Approximately half of participating schools were doing SEAs that matched all components, creating a mode engagement of three. On the other side of the spectrum, approximately 33% of schools were not engaging the components based on the coding for SEAs. This is underwhelming compared to the predicted engagement in the hypothesis, and thus the hypothesis was not supported in this coding session. However, these schools may still be promoting the components of the TPB simply by participating in an energy contest.

By nature of its programmatic model, an energy contest emphasizes the positive nature of energy conservation. This was noted and excluded in the coding and perhaps made it harder to code a SEA to the attitude component. To a certain extent, subjective norms received similar treatment to address constant endorsement of energy conservation behavior by teachers in enacting the SEAs. Due to these restrictions, it may have been easier to code an activity to perceived behavioral control than the other two. This explanation is reflected in the results of coding (perceived behavioral control- 10 instances, subjective norms- 5 instances, attitude- 3 instances). Perhaps most importantly, through its primary goal of reducing electricity consumption, the energy contest theoretically impacts participant intentions. By directly engaging intentions, the energy contest may be impacting energy behaviors more than is described in this study's coding.

From this qualitative exploration, all participants are potentially influencing their attitude, subjective norms, and intentions surrounding energy conservation behaviors by actively engaging in the energy contest. These facets may also be strengthened by the SEAs. The only facet not described in this way is perceived behavioral control. However, as this component was coded most frequently in SEAs, it is likely that participants engaged with it as well. According to this study, energy contests appear to be a way to encourage students to engage in energy conservation behaviors because they meet multiple components of the TPB as shown in Figure 5. To demonstrate whether this hypothesis is true, future research could survey participating classrooms about changes in their perceptions regarding energy conservation behavior to look for changes along the components of the TPB. To further test the value of an energy contest, such surveys could be compared across contest participant groups who completed different SEAs, groups who complete SEAs outside of an energy contest setting, and a neutral group of students who receive no energy education engagement.

Figure 5

Proposed Effects of the Energy Contest Model on Energy Conservation Behavior



Note. Adapted from "The theory of planned behavior" by Ajzen, I. 1991. *Organizational behavior and human decision processes, 50*(2), p. 182.

c. Was there a relationship between engaging the components of the TPB and SMS?

No significant relationship was uncovered between engaging facets of the TPB and SMS. This does not support the hypothesized relationship between the variables. The correlational test conducted for this question assumes that the components of the TPB are additive and meeting more of them strengthens intent and likelihood of performance of the behavior. While this may be true, it may also be that the components of the TPB are not equal in individual strength. Perceived behavioral control is harder to demonstrate with electricity, which could make its activation more valuable. According to the TPB this component also engages both intentions and behavior, making it potentially more influential. Future research could be done exploring the strength of each component in achieving energy conservation.

As mentioned in the discussion of RQ3b, coding done in this study may not have accounted for primary activation of the components of the TPB through active contest participation. Coding might also have not been representative of how participating classrooms actually engage in the SEAs due to the brevity of SEA descriptions. Because of the inherently flexible nature of coding and the inconsistencies that arose from this study's coding experience, further research is required to determine if and how the TPB fits in an energy contest model. The inconsistencies also suggest that the SEA descriptions need refinement.

Additional findings

Because the relationships between SMS and the demographics of student population size and participating grade band were not significant, the effects of these demographic differences are presumed to be negligible on success in this study. However, there may be other differences between schools, such as hometown population densities, funding source, or the degree of a culture of sustainability within the school that predict or partially cause SMS. Additional demographic data could be collected to explore potential correlations with SMS variability. Furthermore, qualitative data of the participating classrooms' experiences could add valuable insight about their view of the SEAs and the contest model overall.

Recommendations for Future Research

Based on the results discussed in Chapter 4 and reflected upon in the previous section of Chapter 5, the researcher has identified multiple directions for future research. The largest and most obvious suggestion is to run a quasi-experiment within a K-12 setting. Before the presence of COVID-19, the researcher devised a proposal to test the effectiveness of various energy conservation programming models by comparing energy usage pre- and post-programming. The researcher would compare which lesson style – building audit, dashboard engagement, or a combination of the two – was most likely to inspire energy conservation behavior as noted in a change of electricity usage through monitoring hardware. This research design, although not seen to fruition, could be adapted to compare various potential programming structures within the contest model. Running a true experiment would be extremely limited within a school setting because students cannot be randomly assigned to schools and participation is voluntary. In these scenarios, quasi-experiments can identify relationships and make more educated speculations on the cause-effect relationships of programming options.

However, doing a quasi-experiment would require an intensive investment of time and other resources. Therefore, continued analyses of school data including student demographics collected as a step of running contest iterations may also be helpful to guide SEA offerings and other organizational decisions. Below, the researcher briefly describes additional questions that could be explored by ROS or other organizations that host energy contests and/or other energy conservation programming:

Are there alternative measures that correlate with SMS?

This study primarily focused on SEA participation as a potential correlational factor for achieving high SMS. There may be additional aspects such as student race/ethnicity, funding source, or classroom size that impact SMS within the ROS contest model. Moving forward, additional participant variables can be collected by ROS and analyzed in a similar manner to this study. The variables currently collected should continue to be catalogued to provide a larger sample for future analysis. With additional data points, a more complete picture of relationships may become apparent.

Why do some schools drop out (formally or through non-participation)?

Time and money are spent to prepare schools to participate in a contest. These resources may be wasted if a participating school does not use the technology or take part in programming. Unidentified barriers may exist which prevent or inhibit classrooms from taking action. If a pattern exists, ROS may benefit by offering schools at risk for these barriers additional support or shifting them to alternative programming opportunities.

To address this issue, it could be insightful to interview administrators, building managers, teachers and/or students about their energy contest experience. Qualitative descriptors can provide an additional dimension that would be missed with categorical data alone. By describing the successes and shortcomings of their efforts to save energy, participants can help ROS improve their SEAs in an attempt to optimize energy literacy and conservation within the contest model.

Which SEAs are correlated with SMS?

The data set provided for this study did not include individual scoring of the SEAs. There may be specific SEAs that are valuable hidden within an otherwise stagnant category. By repeating the analysis at the level of granularity of individual SEAs, such relationships could be uncovered. If they do exist, such SEAs could potentially be required for participation. On the other hand, if no relationships exist, ROS's SEAs may require a revamping of content in accordance with a behavior change theory such as the TPB.

Implications and Recommendation for Energy Contests

Based on the results of this study, the researcher has developed a few core suggestions for ROS and other energy contest providers:

1. Consider alternate required SEAs

Because of limited time available for classrooms to spend on SEAs, it becomes imperative to carefully consider which ones are required by ROS. Required activities should not take an overwhelming amount of effort. However, they are the ones most likely to be done by participating schools, so it may be useful to reevaluate which ones best match behavior change theories such as the TPB.

Energy in the Classroom was correlated with SMS in this study. This may be because the SEAs included in the category focus on inquiry-based tasks to determine energy usage within the building. This is an example of place-based learning which can create connections with place which in turn may encourage responsible consumption (Kudryavtsev et al., 2012). By exploring electricity usage using their building, energy contests cultivate sustainability within the school's culture which may help build a norm of energy conservation within students (Cole, 2014). Due to these connections, it could be useful to tie the *School Audit* to a lesson from the category *Energy in the Classroom* and make both required.

Dashboard engagement, whether via an SEA within the *Energy Savings* category or integrated into an *Energy in the Classroom* SEA is also recommended to be made a requirement. Doing so may meet the component of perceived behavioral control in a novel way compared to more traditional energy conservation programming. Everyone uses electricity, both directly and indirectly, yet discussing energy consumption values is much less common. The dashboard makes the topic of energy usage timely, individualized, non-punitive, and customizable (Hysong et al., 2006) and through this study has been correlated with SMS. This makes it worth emphasizing in programming when possible.

2. Consider changing the point values of activities

Similar to suggestion one, schools may be more likely to participate in SEAs that have a higher point value in order to increase their chance of winning. Point values have currently been determined by a combination of incentive to participate in certain SEAs and relative amount of effort necessary to complete them. While the latter rationale is fair, it does not address the variability in effectiveness of activities to foster energy conservation behavior. By focusing on which activities are most valuable through participant interviews and analyses of SMS relationships to individual SEAs, point value can also be subtly used to steer schools toward selected SEAs while still offering a wide array. After all, what works for one school may be less effective for others. Changes should be subtle and tracked to observe variation (or lack thereof) in success of SMS.

3. Refine SEA descriptions and resources

The current open-endedness of the SEA descriptions is a double-edged sword. It allows for customization for various audiences and enables classrooms to tap into their interests. However, it may also require teachers to put in more time and effort than they may have available for the contest. This in turn may be one cause of participants becoming dropouts. From the researcher's perspective of working for the Wisconsin K-12 Energy Education Program (KEEP), many teachers are not confident teaching about energy conservation topics. They participate in KEEP professional development to bolster their personal knowledge and self-efficacy of these topics. If teachers are self-selecting to participate in ROS energy contests, they likely have more comfort with teaching about energy. Depending on the goals of ROS, this may be a sufficient audience. However, if ROS currently includes or plans to include schools with less pre-established knowledge of energy conservation, it may be beneficial to offer training and/or additional resources before the contest period. ROS may create these pieces in-house or collaborate with energy education providers like KEEP.

Technology-minded teachers, especially in response to COVID-19, appreciate and take advantage of pre-made online resources. From tutorial videos and Google Slide Decks to lesson scripts and example discussion questions, ROS can make teaching and exploring energy concepts more accessible. Weaving these resources into a more robust description of the objectives and outline of each SEA allows for a more universally understood – and marketable – collection of activities. For those more independent and/or highly motivated teachers, customizing or ignoring the SEA resources may be acceptable, but by offering the resources to all, a level playing field of support is created.

Providing more detailed descriptions also allows the SEAs to more explicitly encourage activation of components of the TPB. Classrooms are more likely to engage the SEA in a way that meets a component if the instructions include discussion questions or explorations that highlight it. By more strongly emphasizing TPB components through SEAs, classrooms may bolster their intentions and/or behavioral change efforts. In this way, the SEAs could be even more valuable for fostering behavior change both short and long-term.

4. Provide follow-up support

Through this study, the researcher was able to become familiar with ROS's model of engagement with its participants. One aspect that is not addressed in ROS programming is follow-up support and analysis. This issue is not unique to ROS, as most energy contests' objectives do not extend far beyond the contest period (Vine & Jones, 2016). No matter how successful a contest is in terms of monetary or kilowatt savings, impact is limited if it is confined to the time-period of the contest. Echoing the suggestion of Vine and Jones (2016), energy contests should provide tiered support to reinforce energy-saving behavior beyond the contest period.

In the opinion of the researcher, the participant pool of schools within ROS energy contests is small enough to provide a follow-up lesson for alumni. Because schools retain eGauge technology after the contest period, it could ideally be used for further student engagement. Perhaps this could include ways to incorporate eGauge into an energy conservation lesson or unit to be taught annually. ROS might also be able to devise an instructional guide for schools to compete against themselves by tracking and analyzing their own electricity data. A teacher survey conducted by ROS noted that the prize money was not the major inspiration. Instead, teachers regularly cited “student participation and engagement around a worthy cause” as the primary value of participation (Group 14 Engineering, 2016, p 3). This kind of reward is renewable in the sense that a contest could be run yearly within a school without additional cash flow or technology installation. Demonstrating that participants can retain energy conservation strategies to bolster the development of long-term habits helps sell the programming to both participants and funders, as well as increases the traceable impact of the work of ROS.

Summary

This chapter proposed potential explanations and context of the results of this study as well as suggestions for future research and recommendations for ROS’s energy-saving contest model. The findings of this study provided insight concerning the effectiveness of the ROS contest model. Although the contest experience is not universal among participants, factors correlated with success in energy savings can provide recommendations for best practices. Additional research concerning energy contests within K-12 schools is recommended as ROS has demonstrated them to be successful, but the experience is variable. Through local explorations of electricity data in an energy contest, students can increase their energy literacy to become responsible consumers. By making the energy contest experience more universal, accessible, and long-term, programming may become an even more powerful platform.

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APPENDICES

Appendix A: Definitions

The following definitions are described to aid in clarity and reference for this study:

- **Attitude:** For this study, attitude refers to the component of the Theory of Planned Behavior. According to Ajzen (1991) as complied by LaMorte (2019), attitude is “the degree to which a person has a favorable or unfavorable evaluation of the behavior of interest.”
- **Behavior change**: For this study, behavior change is measured by a school’s changes in electricity usage via SMS which reflects implementation of intentional energy conservation behavior(s).
- **Contest (also called energy-saving contest, energy savings contest, or energy contest)**: An initiative where groups compete to save the most of one or more house resources (such as water or electricity) within a given timeframe. The contest is typically supplemented with energy literacy initiatives in the form of lessons, demonstrations, pamphlets, etc. In this study, energy contests were conducted within K-12 schools to see who could save the most electricity.
- **eGauge**: The brand of electricity monitoring hardware used in energy contests by ROS. By attaching monitoring hardware to the wiring of a building, it can detect and record the current electricity usage of the system. eGauge also provides an electricity dashboard that can be used to view real-time electricity usage.
- **Electricity dashboard**: The visual display of real-time electricity usage data captured by electricity monitoring hardware that can be accessed on an online platform. Data is

typically displayed in line graphs which can be manipulated to discern trends over time (see Figure 3).

- **Energy conservation**: The process of using energy necessary to complete tasks in a less wasteful manner. In this study, energy conservation refers to the reduction of unnecessary electricity usage in a school setting such as from lighting in unoccupied classrooms or the plug-loads of computers overnight. Energy conservation in this study is due to intentional changes in classroom behavior surrounding electricity consumption.
- **Energy education**: Educational programming focusing on how energy is used in society including energy sources and conservation strategies. This study distinguishes between this subject area and energy topics taught in the realm of physics such as conservation of matter and the laws of motion. The latter are more directly tied to science standards and typically explored more deeply by classrooms.
- **Energy usage**: In this study, energy usage, energy usage refers to the amount of electricity being consumed by all technologies, appliances, and fixtures within the classroom and school building as a whole. These items must be plugged in or otherwise connected to the building's infrastructure to be counted and thus devices like cell phones and non-charging laptops are excluded from total consumption figures by this limitation.
- **Intentions (also called intentionality)**: For this study, intentionality refers to the component of the Theory of Planned Behavior. It describes an individual's level of desire and/or willingness to perform a particular behavior.

- **Perceived behavioral control**: For this study, perceived behavior control refers to the component of the Theory of Planned Behavior. According to Ajzen (1991) as complied by LaMorte (2019), perceived behavioral control "refers to a person's perception of the ease or difficulty of performing the behavior of interest."
- **Real-time**: On an electricity dashboard, "real-time" refers to the display of current electricity usage of the system being monitored. Typically, data is updated every fifteen minutes, but some dashboards allow the viewer to adjust the timeframe to even shorter intervals.
- **Renew Our Schools (ROS)**: Organization that hosts K-12 energy-saving contests. Their energy contest model is the subject of this study.
- **School Energy Actions (SEA)**: A term used by ROS to describe energy education activities associated with their K-12 contests. Participating schools score points based on their completion of SEAs. At the time of the study, there were twenty-three SEA options divided into seven categories (see Appendix B).
- **School Measured Savings (SMS)**: A term used by ROS to describe the electricity savings of a school participating in their K-12 contests. The SMS of a participating school is calculated as shown below as a metric of calculating energy conservation success:

$$\left[\frac{(Total\ kWh\ of\ 20\ best\ contest\ eligible\ days - (baseline\ kWh\ \ x\ \ 20\,)}{(baseline\ kWh\ \ x\ \ 20)}\right]$$

- **Subjective norms:** For this study, subjective norms refer to the component of the Theory of Planned Behavior. According to Ajzen (1991) as complied by LaMorte (2019), subjective norms are "the belief about whether most people approve or disapprove of the behavior. It relates to a person's beliefs about whether peers and people of importance to the person think he or she should engage in the behavior."

- **Theory of Planned Behavior (TPB)**: A behavior change theory by Ajzen (1991) in which the likelihood of a behavior being enacted is dependent on the individual's intention to do it. Intentions, in turn, are influenced by attitudes, subjective norms, and perceived behavioral control. See Figure 1 for a visual representation.

Appendix B: Renew Our Schools' School Energy Actions (SEAs) Overview

SEA Category	SEA	Description	What gets submitted	Points
REQUIRED	School Audit	Conduct an audit of at least 20 rooms in your school and five areas that need improvement. Please use your discretion as to which classrooms look like they use the most energy. Look for rooms that are over-lit, too warm or too cold, or have many electronic devices left on. Use your tools provided in your tool kit to determine the light levels, temperature, and electricity usage of the devices in the room. Describe five specific areas of your school that need improvement.	Competition audit form (on website)	40
	Final Presentation or Video	Submit a student-created presentation or video that demonstrates your school's efforts, hard work, and findings. It needs to include the following: the area(s) of your school that were found to use the most energy, the area(s) of your school where the greatest energy use improvement was achieved, your struggles and successes, what you learned, your methods of involving the entire school, and how you got the word out!	Final presentation	50
Energy Savings	eGauge Demonstration	Gather all students in the school to observe the eGauge and shut down all lights in the building. Watch the load change.	Picture of all students viewing the eGauge screen. Quantify the kW reduced.	20
	Energy Savings Hour	Determine your school's average daily energy use and see if you can reduce your load by 15% for one hour.	Entry confirming time window of energy savings hour.	20

	Energy Savings Persistence	Incorporate the energy savings hour into daily practices for one whole week.	Show the reduction on the eGauge for every day for one five-day school week.	30
	Energy Savings Weekend	Determine your school's average daily energy use when the building is unoccupied and see if you can reduce your unoccupied building load by 10%	Entry confirming time window of energy savings weekend	15
Energy in the Classroom	Lesson Plan: General	Implement one energy-themed (renewables, conservation, sustainability) lesson into a classroom in the school	Lesson plan and two examples of student work	10
	Lesson Plan: Your Community's Energy Source	Create and teach a lesson plan that traces your community's energy source from start to finish. Map out where your community's energy comes from. Who provides your electricity and gas? What types of renewable energy are used in your area?	Lesson plan and two examples of student work	10
	Lesson Plan: Energy Facts about your community	Create and teach a lesson plan in which students research energy facts about your community.	Lesson plan and two examples of student work	10
	Phantom Loads	Explore phantom loads and list five appliances in your school that have a phantom load.	Lesson plan and two examples of student work	10
	Lesson Plan: Kill-o-watts	Use your kill-o-watt meters to calculate how much the electricity is used by five appliances found in your school during a week. *(Remember, units of energy are kWh)	Lesson plan and two examples of student work	10
	Using a Light Meter	Take lighting level measurements in five classrooms and report on what was found compared to the standard lighting levels. Measurements to be taken at desk level at three locations in each room – at a desk, in a corner, and in front of the white board.	Lesson plan and two examples of student work	10
	School Energy Policy	Present an energy conservation idea to your administration as a way to incorporate a change in your building. Some examples are smart plugs, smart	A copy of the new energy policy signed by an administrator	20

		power strips, lighting change, etc. Create a policy that your administrator signs.		
Creative Campaign	Signage/Posters/Lightswitch covers	Your signage can be in the form of banners, murals, posters, billboards, or small signs to be hung around school creating awareness and reminding your school community to conserve energy. Try to think of something 'catchy' that will be noticed! You may include information specific to your school (mascot, school name, etc.) or it can be a 'universal message' that can be used in any school or location.	Submit two of the best student creations	20
	Homeroom competition	Conduct an energy-themed competition among homerooms, grade levels, etc. in your school.	Submit pictures of the competition.	15
	Environmental Club	Take a picture, create a mission statement, and develop three measurable long-term goals of your school's environmental club.	Submit picture, mission statement, and long-term goals of your school's environmental club.	20
Local Experts	Local Energy Expert: Club	Invite a local energy expert or organization to speak to your club (if you invite more than one, they must be from different organizations)	Submit pictures of the expert speaking with the group. Submit a description of the expert and their role in the energy/sustainability field.	20
	Local Energy Expert: School	Invite a local energy expert or organization to speak to your school. Maximum of two. (One can be the same person as your mentor)	Submit pictures of the expert speaking with the group. Submit a description of the expert and their role in the energy/sustainability field.	30

	Local Energy Expert: Mentor	Invite a local expert to mentor your students in the competition. This person could assist with the audit and lead a 'walkthrough' of the building looking for energy-saving tactics. Certain experts could include: energy engineer, employee of a local utility, green architect, energy consultant.	Submit pictures of the expert working with the group. (For the school district competition, this can be your assigned mentor.) Submit a description of the expert and their role in the energy/sustainability field.	30
	Energy Source Tour	Take your students on a tour of an energy source in your community-wind farm, coal plant, solar farm	Pictures of students on the tour and a description of the energy source.	40
Students as Teachers	Admin Presentation	Present an energy conservation idea to your administration as a way to incorporate a change in your building (smart plugs, smart power strips, lighting change, etc.) Raise money to make that change. Ten bonus points if you make the change! (this excludes the School Energy Policy from above) May be done more than once.	Pictures of students presenting idea to administration and a description of your idea.	30
	Fundraiser	Hold a fundraiser/raise money to make your school more energy efficient. For example, host a bake sale to make money to replace light bulbs in a few classrooms, buy smart strips, etc.	Pictures of students at the fundraiser, a description of the activity and what was purchased with the money, and a before and after picture of the change.	20
	Students As Teachers!	Students teach other students a lesson about energy conservation (regardless of age of teaching and learning students)	Pictures of students teaching students and a written description of the lesson.	30

Create Your Own		Design your own energy themed idea. Please submit the idea to Program Manager for approval BEFORE you begin.	TBD	

Appendix C: Overview of Variables and Variable Manipulation per Research Question

Research Question	Variable(s)	Variable Manipulation
RQ1a	*SEA raw scores (per category)	1. Conversion of SEA categories score (%) to completion scale score per category: *Completed (1): $x \geq 70$ *Partially completed 0.5: $70\% > x \geq 30\%$ *Not completed (0): $x < 30\%$ 2. Tally of completion scores per school
RQ1b	*RQ1a manipulated data	Tally of completion scale score per SEA category
RQ2a	*RQ1a2 manipulated data *SEA category percentage completion *SMS (raw % score)	Pearson's correlation coefficient
RQ2b	*RQ1b manipulated data *SEA category percentage completion *SMS (raw % score)	Pearson's correlation coefficient
RQ2c	*RQ1b manipulated data *SEA category percentage completion *SMS (raw % score)	Pearson's correlation coefficient
RQ3a	*definitions of the TPB components (Appendix D) *SEA descriptions	Coding of SEA descriptions to components of the TPB using pre-determined definitions (Appendix D)
RQ3b	*RQ3a manipulated data	Tally of coding of the TPB components per school
RQ3c	*RQ3b manipulated data *SMS (raw % score)	Manipulation of TPB component coding into two Independent samples t-test
Additional findings	*SMS (raw % score) *participating grade band by school	One-way ANOVA
Additional findings	*SMS (raw % score) *student population	Pearson's correlation coefficient

Appendix D: RQ3A Coding Definitions of the Components of the Theory of Planned Behavior for Renew Our Schools' School Energy Actions

TPB Component	Full Definition (Ajzen, 1991) as Compiled by LaMorte (2019)	Abbreviated Coding Definition Used (with researcher's notes to coders noted by asterisks)
Attitude	This refers to the degree to which a person has a favorable or unfavorable evaluation of the behavior of interest. It entails a consideration of the outcomes of performing the behavior.	Portrays favorable evaluation of behavior *assume all SEAs influenced by attitude of conservation as good due to contest participation
Subjective Norm	This refers to the belief about whether most people approve or disapprove of the behavior. It relates to a person's beliefs about whether peers and people of importance to the person think he or she should engage in the behavior.	Portrays peers and/or people of importance to individual demonstrate the individual should engage in the behavior *assume all SEAs influenced by subjective norm of teacher
Perceived Behavioral Control	This refers to a person's perception of the ease or difficulty of performing the behavior of interest. Perceived behavioral control varies across situations and actions, which results in a person having varying perceptions of behavioral control depending on the situation.	Portrays ease/feasibility of performing the behavior

Appendix E: RQ3A Coding of Renew Our Schools' School Energy Actions to the Theory of Planned Behavior by Coding Agreement

Total Agreement[1]		
Attitude	**Subjective Norms**	**Perceived Behavioral Control**
-Signage/Posters/Lightswitch Covers	*-School Energy Policy* *-Signage/Posters/Lightswitch Covers*	*-Energy Savings Hour* *-Energy Savings Persistence* *-Energy Savings Weekend* *-Signage/Posters/Lightswitch Covers* *-Admin Presentation*
Partial Agreement[2]		
-Homeroom Competition *-Local Energy Expert: Mentor*	*-Homeroom Competition* *-Environmental Club* *-Students As Teachers!*	*-eGauge Demonstration* *-School Energy Policy* *-Environmental Club* *-Fundraiser* *-Students As Teachers!*
Total Agreement (with hesitancy)[3]		
-eGauge Demonstration *-Phantom Loads* *-Lesson Plan: Kill-o-watts* *-Students As Teachers!*	*-Students As Teachers!*	N/A
Partial agreement (with hesitancy)[4]		
-Using a Light Meter *-Energy Savings Hour* *-Energy Savings Persistence* *-Energy Savings Weekend*	*-Energy Source Tour*	*-Final Presentation or Video*

Total agreement on no representation[5]:

-Local Energy Expert: Club
-Local Energy Expert: School

Activities with no coding agreement:

-School Audit
-Lesson Plan: General
-Your Community's Energy Source
-Energy Facts About Your Community

1. All three coders confidently applied the component to the SEA; used for analysis
2. Two coders confidently applied the component to the SEA; used for analysis
3. All three coders applied the component to the activity with hesitancy due to ambiguous nature of SEA's description
4. Two coders applied the component to the activity with hesitancy due to ambiguous nature of SEA's description
5. All three coders confidently agreed that no components applied to the SEA
6. No component was listed twice between coders for the SEA but at least one component was listed by one coder

Appendix F: SEA Category Completion by Participating Schools' Demographics

	School Audit			Final Presentation or Video			Energy In The Classroom			Energy Savings			Creative Campaign			Students As Teachers			Local Experts		
	C[1]	**PC[2]**	**NC[3]**	**C**	**PC**	**NC**	**C**	**PC**	**NC**	**C**	**PC**	**NC**	**C**	**PC**	**NC**	**C**	**PC**	**NC**	**C**	**PC**	**NC**
Elementary (15)	15	0	0	13	1	1	5	5	5	1	3	11	7	7	1	7	4	4	3	6	6
Middle (16)	15	0	1	10	0	6	3	4	9	2	2	12	5	7	4	4	5	7	3	5	8
High (9)	9	0	0	7	1	1	3	2	4	2	0	7	5	2	2	2	5	2	2	4	3
Spring 2019 (17)	17	0	0	13	1	3	1	6	10	0	2	15	8	5	4	2	7	8	1	10	6
Fall 2019 (23)	22	0	1	17	1	5	10	5	8	5	3	15	9	11	3	11	7	5	7	5	11
Colorado (17)	17	0	0	15	1	1	9	5	3	4	12	1	8	7	2	9	6	2	7	6	4
Nationwide (23)	22	0	1	15	7	1	2	6	15	1	18	4	9	9	5	4	8	11	1	9	13
Title 1 (26)	26	0	0	22	1	3	9	9	8	5	2	19	13	10	3	10	11	5	7	11	8
No Title 1 (14)	13	0	1	8	1	5	2	2	10	0	3	11	4	6	4	3	3	8	1	4	9
Externally Funded (28)	28	0	0	25	1	2	9	10	9	5	3	20	14	11	3	10	11	7	7	12	9
Not Ext. Funded (12)	11	0	1	5	1	6	2	1	9	0	2	10	3	5	4	3	3	6	1	3	8
Student Population																					
0-150 (2)	2	0	0	1	0	1	2	0	0	1	0	1	1	1	0	2	0	0	1	1	0
151-300 (9)	9	0	0	7	1	1	3	4	2	3	6	0	1	5	3	4	2	3	2	4	3
301-450 (8)	8	0	0	6	1	1	1	2	5	0	7	1	3	4	1	1	4	3	2	2	4
451-600 (10)	10	0	0	9	0	1	4	3	3	0	7	3	8	2	0	5	3	2	2	4	4
601-750 (1)	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0
751-900 (3)	2	1	0	2	0	1	0	1	2	0	3	0	0	3	0	0	2	1	0	1	2
901-1050 (2)	2	0	0	0	0	2	0	0	2	0	2	0	0	0	2	0	0	2	0	0	2
1051+ (5)	5	0	0	4	0	1	0	1	4	0	5	0	3	1	1	0	3	2	0	3	2

1. Completed ($x \geq 70\%$)
2. Partially Completed ($70\% > x \geq 30\%$)
3. Not Completed ($x < 30\%$)