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Demonstrations and lectures about solar energy in Arkansas: The importance of experiential learning

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ABSTRACT

Renewable energy has experienced sluggish adoption rates among businesses and homeowners in both Arkansas and the United States. This study sought to determine the effect of adult experiential learning related to solar energy using an experimental design. Forty-one participants were randomly assigned to one of two treatment groups: (1) a group that experienced a lecture which was followed by a demonstration and (2) a group that experienced a demonstration first which was followed by a lecture. Participants' knowledge of solar energy was assessed after the first learning experience and then again after the second learning experience. Results suggest that while lecture and demonstrations yielded similar scores on adult knowledge, learners that engaged in a lecture after a demonstration scored significantly higher than those that engaged in a demonstration after a lecture. Further, lecture after demonstration yielded a significant increase in learners' mean score from before the lecture, while demonstration after lecture did not yield in a significant increase in learners' mean score from before the demonstration. These results indicate that educators can enhance knowledge acquisition and learning by placing demonstrations and lectures in a proper order.

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1. Introduction

While the common consumer typically considers food and clothing as the two main products of agriculture, communities are also faced every day with less commonly associated aspects of the agricultural industry, such as energy [1,2]. Currently one of the five priority areas for the National Institute of Food and Agriculture, the creation of a secure, affordable, and abundant energy supply is not only at the core of issues regarding the production of biofuels [3] but also a key factor in the livelihood of agricultural producers, whose energy costs can greatly impact their abilities to continue production [4]. Renewable energy, while considered one of the possible solutions to the nation's current energy crisis, has experienced sluggish adoption rates among businesses and homeowners in both rural and urban communities due to current policy [5], the availability of affordable and dependable electricity, and general lack of knowledge regarding the issues surrounding renewable energy adoption [6,7]. Public opposition to the development of renewable energy installations have also contributed to its thwarted adoption [8], suggesting that education, if delivered effectively, could have the potential to impact public acceptance of renewable energy [9]. Efforts to increase adoption have focused on each of these areas, and agricultural educators have customarily served a role in educating consumers about novel agricultural technologies. Specifically, Doerfert [1] recognized that agricultural leaders, policy makers, and consumers are all key contributors to technological adoption, and the process of researching methods of increasing adoption rates of agricultural technologies, including those related to energy, is within the responsibilities of the agricultural education profession.

Education focused on agricultural technology adoption has typically been held in nonformal settings [10]. As in formal education settings, the formats in which these nonformal educational sessions occur vary by subject, location, and event. The characteristics of nonformal educational sessions "employed by effective teachers have the potential to greatly impact learning and produce a subsequent behavior change" [11, p. 143]. However, there is currently a lack of research regarding best practices related to effective teaching in nonformal settings [11].

Researchers exploring education's role in the adoption of renewable energy have focused on several variables posited to alter the effectiveness of an educational event, including sources of information [12,13], the motivation of various messages (such as an economically driven message versus an environmentally

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driven message) [14], the topic(s) on which educational events focus [14], and the impact of information interventions [15]. Schelly [12] found that homeowners in Wisconsin who were considered early adopters of solar energy installations took action to adopt after engaging in specific communities of information that were considered trustworthy by the participants. Theodori et al. [13] explored the information sources most impactful on the hydraulic fracturing perceptions of community members in a community impacted by hydraulic fracturing and found that newspapers, the natural gas industry, and conservation/environmental groups contributed most to respondents' knowledge of hydraulic fracturing. The study did not attempt to collect information regarding the formats through which information was disseminated, leaving the reader to assume that each source distributed written information. However, as was seen in Schelly's [12] study, specific communities of information may elect to disseminate information through events that invite more active engagement of learners in nonformal settings. Walker et al. [8,15] discussed the information interventions that have been impactful in changing consumers' energy use behavior, and noted that the educational components of numerous interventions, including social marketing approaches, commitment strategies, eliciting adoption intentions, and providing information about the behavior of others can each be effective in altering consumers' behavior. Again, the methods through which these educational components were delivered to consumers were considered to be static and were not considered a variable to be evaluated when examining educational events. In their study, Walker et al. [8,15] found that a provided information intervention in the form of either a written informational pamphlet or verbal explanation of that pamphlet was only impactful on some participants' behaviors, but not others. The authors recognized that information interventions are useful, but that they can be delivered in many ways, suggesting that investigation into the effectiveness of varying educational methods impacting renewable energy adoption is warranted.

While lecture has been identified as the most common method of information transmittal [16,17], Grandstaff [18] and Etling [10] noted that nonformal education is more learner-centered, and is frequently associated with educational events within an activity context, such as the Wisconsin energy fair discussed by Schelly [12]. Numerous researchers and theorists have posited that individuals must both engage in an experience as well as transform that experience in order to effectively learn [19–25]. The cost and time limitations frequently pressuring nonformal education programs and the potential impact their educational events can have on agricultural technology adoption and decision making suggest that recommendations regarding the order in which learners are exposed to information may be needed in order to maximize the effectiveness of nonformal education programs. The call for increased examination of how nonformal education programs are delivered to learners has been made specifically for those trying to increase renewable energy usage [26]. Sovocool [26] recognized that responses to presented information are not only impacted by the information itself, but also by how it is presented and how people interact with the medium through which the information is delivered. Therefore, included in his list of research questions for social scientists in renewable energy is one that seeks to discover the types of information that are most effective at influencing energy users.

This study addressed Sovocool's question by assessing how specific methods of delivering educational material impact adult learners' knowledge of renewable energy. Based on a randomized counterbalanced experimental design wherein a convenience sample of Arkansas city leaders ($n = 41$) was randomly assigned to one of two 2-h educational interventions, the researchers assessed the impact of the order of experiential learning stages on the city leaders' knowledge of solar energy. While the inclusion of one specific state's city leaders leads the researchers to caution against generalizing findings to populations outside of Arkansas, the methods and results can aid in the development of studies examining experiential learning in renewable energy across the globe. The development of evidence-based knowledge to improve educational practice includes five phases: (1) identification of research problems; (2) execution of empirical studies; (3) replication of those studies with different subjects, circumstances, and settings; (4) review and synthesis of the conducted research; and (5) adoption and continued evaluation [27]. Sovocool's [26] offering of a research problem focusing on evaluation of information types gives researchers an opportunity to take action in the second phase by conducting empirical studies such as the one presented here. While the findings are not widely generalizable beyond Arkansas city leaders, they do serve to add to the body of empirical knowledge so that future researchers can engage in "research replication (Phase 3) with different subjects and in a variety of settings and circumstances" [27, p. 4]. It is only with the execution of empirical studies that researchers can continue on toward research in Phases 3, eventually leading to adoption of sound educational practices based in research.

2. Theoretical/conceptual framework

Experiential learning refers to "a series of pragmatic activities sequenced in such a way that it is thought to enhance the educational experience for the student learner" [19, para. 2]. Kolb's experiential learning theory (Fig. 1) displays the four stages that must be "sequenced" in a learning experience.

While Zull [25] stated that the first stage entered and the direction in which learners continue on the cycle can vary, Roberts [23] noted that experiential learning begins with initial focus on the learner and incorporates an opportunity for the learner to engage in a direct experience within the context of the learning. Kolb [22] theorized that learning can only occur when learners first grasp information, either through a concrete experience or through abstract conceptualization, and then transform that information, either through active experimentation or reflective observation. Educators can either guide students in grasping knowledge through providing them with a direct, hands-on experience, or with a concept taught in a more abstract method, such as lecture. Educators can then direct students in knowledge transformation by providing them with an opportunity to experiment or to reflect.

One of the aspects influencing the instructor's decision with regard to the selection of appropriate experiential learning stages is the development of the learner. Knowles [28] stated that learners' needs fall on a continuum of assumptions, with the concepts of pedagogy and andragogy being at the poles of that continuum. The learners' location on that continuum varies by the situation, and it is the responsibility of the instructor to determine which set of assumptions to which to adhere when selecting learning experiences. When following the assumptions of pedagogy, the learners do not bring influential previous experiences to the learning situation, and rely on the instructor for the primary learning experience. Pedagogical experiences typically focus on information transmittal, and consist of lecture, assigned reading, and passive presentations [28]. When following the assumptions of andragogy, the instructor assumes that the learner is bringing personal experiences to the learning setting that will influence his or her future learning experience. Therefore, learning experiences include more active, personal experiences, such as "laboratory experiments, discussion, problem-solving cases, simulation exercises, [and] field experience" [28, p. 44]. Inappropriate selection of learning experiences

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