

## The Electric Vehicle Experience

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Two words, experience and education, immediately bring one man to mind—John Dewey. Regarding experience and technology education, Hansen (2000) said that studies of technological teachers in Germany, England, and Canada indicate there is a preconception and tendency that these individuals bring to the profession with them. That is, these teachers reveal a “strong bias towards experience as a frame of reference for learning” (p. 23). This article emphasizes the role of experience as a foundation for a specific technology education program that is ongoing in a number of states. Additionally, from this foundation springs a natural flow of problem-solving activities, cognitive science strategies, and subject matter that addresses several ideals from the history of technology education. The present educational emphasis on problem solving, thinking, and social interaction arguably is also found in past Deweyan literature. Thus, his words seem appropriate as a starting point.

It is possible to find problems and projects that come within the scope and capabilities of the experience of the learner and which have a sufficiently long span so that they raise new questions, introduce new and related undertakings, and create a demand for fresh knowledge. (Dewey, 1964, p. 423)

There are a number of projects in technology education today that potentially adhere to this statement from Dewey. Examples in transportation technology are suggested by electric, fuel cell, and solar powered vehicles as well as human powered submarines. Based on my own experience, the construction of electric vehicles (EVs) in secondary and postsecondary schools is an exciting addition to the technology education curriculum. Even more exciting is the competition of these vehicles following construction.

EV guidelines are typically based on ELECTRATHON™ AMERICA

design rules and events that are held around the country. As an industrial technology educator in both Hawaii and Nebraska, I have seen these programs grow rapidly over the past few years. In both of these states, public power districts serve as sponsor or cosponsors for these activities. Participating schools develop their vehicles around electrical components and a one horsepower electric motor provided by the sponsor. Towards the end of the school year, endurance competitions are held so participants have the opportunity to display and enter their vehicles in hour-long races. Since endurance is the name of the game, vehicles must be designed for efficiency and aerodynamics rather than short bursts of speed. The objective of the competition is to drive an electrically powered vehicle as far as possible for one hour on a closed-loop course. Competitions are held annually, thus schools have the opportunity to rework last year’s vehicle or start fresh each year. The number of schools participating annually in a particular state points to the success of this program thus far. For example, the Hawaii Electric Company (HECO) cosponsors the electric vehicle competition with the state’s Department of Education. According to HECO’s Office of Education and Consumer Affairs, the number of schools participating has increased threefold to 33 for 2002 in comparison to 11 for the first year in 1996.

When one takes a closer look at the overall aspects of this program, I see an exemplary model of experiential learning for technology education. As a principal means of organizing a curriculum, these programs are project based and activity oriented. The progression from design through competition mirrors Dewey’s (1973) pattern of inquiry, where “inquiry is the directed or controlled transformation of an indeterminate situation into a determinately unified one” (pp. 237-

238). Moreover, this experiential curriculum provides numerous activities for developing problem-solving and cognitive science strategies. In the search for excellence in technology education, Zuga and Bjorkquist (1989) indicated that the way in which the course is organized and conducted demonstrates a type of educational activity that attempts to prepare students to be independent thinkers and problem solvers. The specific content of the course becomes a secondary issue; the activities provided for the student become the primary issue.

Electric vehicle activities generally unfold into two phases: one being construction and design, and the other is testing and competition.

### Construction and Design: A Progression in Inquiry and Reflection

Normally, the construction of EVs involves an amalgamation of different parts adapted primarily from bicycles or go-karts. It can be constructed from a variety of approaches such as designing and building from scratch, building from predesigned plans, and building the vehicle from a preconstructed subframe. Whatever method is chosen should be based on the experience or the lack of experience of the students and the teacher. For example, in a high school setting where students are new to tools and technology, a preconstructed frame would structure the activity to solve initial conceptualization problems. Additionally, this would provide a starting point for students to visualize the construction and placement of certain components such as the motor, driver’s seat, and a body. In this case, the instructor directs the project to a point where students take over and begin visualizing how different parts of the vehicle might be constructed. At this time, students can actively engage in an experimentation process—identifying relationships,

formulating ideas, testing hypotheses, and proposing solutions to vehicle construction problems and anomalies. This progression in inquiry provides grounding for development of cognitive and problem-solving strategies such as reflection and reflective thought. The laboratory setting allows ample time for teachers and students to thoroughly think through problems. As a result, alternative means of vehicle design and construction can be considered for their consequences. According to Dewey (1933), “reflective thought allows for systematic preparation, the invention of better solutions and meaningful enrichment of life, problems and experiences. Reflective thought gives increased control and expanded valuing sensitivities” (p. 21). In short, the value of these reflections are that students begin to see connections between the actions they take and the results that occur and they realize that these connections give them more control over the project and their environment.

As a cognitive process, reflective thought is further described as having a “chaining” feature, meaning “not simply a sequence of ideas, but a consequence—a consecutive ordering in such a way that each determines the next as its proper outcome, while each outcome in turn leans back on, or refers to, its predecessors” (Dewey, 1933, p. 4). In a laboratory setting, this chaining feature resembles the assembly/problem-solving phase of EV construction. As parts and components are initially installed, a psychomotor process of hands-on and minds-on interaction can be observed. This trial-and-error process includes the manipulation of components and parts, assembly and disassembly of components from the vehicle, and tool and vehicle manipulation to approach various tasks from different angles or perspectives. Through these physical problem-solving activities, students are learning which ideas and components will work and those that will not. They also learn that this problem-solving process is grounded in a minds-on physical manipulation followed by reflection. As progress is made, links or

the chain is slowly completed in the design, construction, and assembly of the vehicle. From my observations, these are technological problem-solving processes that are thoughtful and can be described on a continuum as somewhere between tinkering and invention. Moreover, I suspect this chaining-like feature in technology is a learned behavior that students imitate from watching teachers or other skilled technologists.

As students grow in their problem-solving skills, reflection following manipulative experiential activities becomes automatic. Reflection as a cognitive science strategy is described as “those intellectual and affective activities in which individuals engage to explore their experiences in order to lead to new understanding and appreciations” (Boud, Keough, & Walker, 1985, p. 18). As a specific mode of thinking, Dewey’s reflective thought process needs to be part of this cognitive strategy, particularly if problems remain from vehicle construction or assembly. Problems create a mental dilemma or a “forked-road situation” causing perplexity, confusion, and ambiguity. “Demand for the solution of a perplexity is the steadying and guiding factor in the entire process of reflection” (Dewey, 1933, p. 14). Thus reflective thought, “the kind of thinking that consists in turning a subject over in the mind and giving it serious consecutive consideration” (Dewey, 1933, p. 3), provides a pathway or a solution out of the confusion or dilemma. Frequently, we need to step away from the hands-on activity just to reflect. This allows the mind to consider alternatives and potential courses of action. Once a solution is mentally defined, it needs to be tested during future laboratory sessions when the students return to manipulative activities. The result is purposeful planning, meaning these experiences of thoughtful manipulation, reflection, and reflective thought develop self-direction in the student.

Students and teachers new to EV design and construction will find that initially this is a daunting task. As mentioned earlier, predesigned plans

and subframes will facilitate assembly and construction. However, the complete assembly of vehicle parts, components, and subsystems implies that no one can do it all. Ideally, student groups will take on different construction tasks such as brake assembly, motor mounting, electrical wiring, etc. This approach capitalizes on models of socially distributed expertise. Each group and each student within the group becomes a resident expert on a certain system. Accordingly, “students are responsible for doing collaborative research and sharing their expertise with their peers within and between classroom groups” (DeMiranda & Folkestad, 2000, p. 7). Later these pools of expertise will be valuable during EV testing and competition.

### **Testing and Competition: Having an Experience**

Everything depends on the quality of the experience which is had. The quality of an experience has two aspects. There is an immediate aspect of agreeable or disagreeableness, and there is its influence upon later experiences. (Dewey, 1938, p. 27)

Like other technology education projects and experiences, EV design and construction begins in a school setting—the shop or laboratory. From here testing and competition are authenticated during real-world events, outside the classroom. These aspects, particularly testing and competition, are key to the EV process. They round out the experience and make it “whole” by taking the project to completion in a cultural context. An EV competition is a public performance. For the student, learning has made a dramatic shift from the classroom or laboratory to the community where performance will be observed by a variety of spectators. Inevitably these spectators value the knowledge and understanding demonstrated by the performers. Here, Dewey’s concern for the quality of an experience and how it influences later experiences is right in line with situated cognition. It is believed that situating learners in social contexts where understanding is valued and socially

acquired enhances the probability of transfer and application of that knowledge to contexts in the realm of practice outside the classroom (Schell & Black, 1997; Stern, 1998). As the instructor, the competition becomes a matter of balance and coaching. In other words, when problems arise, how much do I stand back and how much do I actively participate in student problem solving? Coaching requires teachers to monitor and regulate student attempts at problem solving so they don't go too far into the wrong solution yet allowing students to have opportunity to experience the complex process and emotions of real problem solving (Bransford & Vye, 1989; Sternberg, 1998). My own approach is to stay out of the problem-solving process as much as possible and only get involved when push comes to shove, particularly with college-age students. During the annual EV competition in Hawaii, this aspect of teacher involvement is regulated by local guidelines. Teachers are not allowed in the pits during active competition, period. Thus, forcing these high school students to rely on themselves and each other.

EV competitions are ongoing yearly events. In Hawaii, this is the seventh consecutive year for the EV Electron Marathon. In Nebraska, prior to a final competition there are several regional EV competitions. This repetition of events provides continuity allowing schools to compete over a series of competitions. The nature of Hawaii's island state lends itself to only one annual competition, understandably so due to the expense and logistics of transporting vehicles between islands for the competition. For land-locked Nebraskans, regional events are held prior to a final, giving participants the opportunity to debug their vehicles during earlier competitions. In either case, these events provide an experience continuum. For Dewey (1938), this experience-continuum was seen as a means for evaluating the educational significance of varying experiences. He said that "continuity and interaction in their active union with each other

provide the measure of the educative significance and value of an experience" (pp. 44-45). Additionally, the two principles of continuity and interaction "intercept and unite"; they are "the longitudinal and lateral aspects of experience" (Dewey, 1938, p. 44). What students and teachers learn during one EV competition will be carried on to other competitions as well as other similar experiences in life, a longitudinal aspect. This might be a lesson in hands-on technological awareness such as the importance of checking all electrical connections for tightness prior to the event. When these same students learn from these experiences and then apply them to different situations, that is a lateral aspect. An example here might be lessons in proper planning, group cooperation, and problem solving. Beyond these contemporary EV activities, this program makes several connections with historic ideals formulated for technology education.

### History and Concluding Thoughts

The simile of new wines in old bottles is trite. Yet no other is so apt. We use leathern bottles in an age of steel and glass. The bottles leak and sag. The new wine spills and sours. No prohibitory holds against the attempt to make a new wine of culture and to provide new containers. Only new aims can inspire educational effort for clarity and unity. (Dewey, 1964, p. 426)

Dewey's simile for new wines and old bottles has been used by a number of scholars to criticize educational practices that turn out to be the same old stuff with just a new name. In 1942, Bode coined a similar phrase as a metaphor for industrial arts curriculum saying that it was "time to stop putting old wine into new bottles" (pp. 8-9). He was referring to industrial arts not having realized certain ideals of progressive educators of the 1920s and 1930s, more specifically the ideal of a reconstructionist mission. A close examination of the EV experience indicates this activity falls short of having a reconstructionist curriculum. Zuga (1992) illustrated what a social reconstructionist curriculum orientation

is not. She indicated that "it is not having the teacher choose course content or the social problem" (p. 8). In this case, the social problem (designing and creating less polluting power systems for vehicles) has been driven from the top down, so to speak, and students do not have a choice. In Hawaii, HECO in collaboration with the Department of Education initiated the EV program. The choice by individual schools, teachers, and students is whether to participate in EV activities.

In a recent historical analysis, Petrina and Volk (1995) examined ideals formulated for industrial arts by progressive educators including a reconstructionist mission, philosophical basis of experience, and unitary organization of curriculum. They argued that these formative ideals "provided meaning and mobilized support for the industrial arts movement" (p. 24), but in reality these principles were accepted only rhetorically, eventually being discarded and lost. Additionally, they indicated that "within these areas are keys to resolve contemporary problems and shape a vision for the future" (p. 24). The EV experience described herein may not completely fulfil these historical ideals. But it does have a social significance, a basis in experience and potential for an integrative or unitary organization of curriculum. This educational activity is, in my view, a new aim from technology education. It is not the same old practices disguised with a new cover. It develops an experiential foundation that is personally relevant to the students and at the same time draws them into a deep thinking process. How many 15 or 16-year-olds do you know who are not interested in driving, let alone competing with a motorized vehicle? Moreover, this is a new approach because it allows for flexible curriculum designs with more than just the single goal of technical competency. As I have illustrated in this article, the project base becomes a task in team problem solving leading to reflective thought and the use of cognitive science strategies. However, it still includes a

traditional hands-on, skills-based orientation. This is necessary because you just cannot “make” an EV without certain skills, knowledge, and tools from the “old” areas such as metalworking,

electricity, plastics, and automotive. So to be trite I will conclude by saying the EV experience is “new wines from old bottles,” and so far this wine has served its customers well.

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## References

- Bode, B. (1942). *Industrial arts and the American tradition*. Founders Day address, Epsilon Pi Tau, Columbus, OH.
- Boud, D., Keogh, R., & Walker, D. (1985). Promoting reflection in learning: A model. In D. Boud, R. Keogh, & D. Walker (Eds.), *Reflection: Turning experience into learning* (pp. 18–40). New York: Nichols.
- Bransford, J., & Vye, N. J. (1989). A perspective for cognitive research and its implication for instruction. In *Yearbook of the Association for Supervision and Curriculum Development* (pp. 173–205). Alexandria, VA: Association for Supervision and Curriculum Development.
- DeMiranda, M. A., & Folkestad, J. E. (2000). Linking cognitive science theory and technology education practice: A powerful connection not fully realized. *Journal of Industrial Teacher Education*. Retrieved from <http://scholar.lib.vt.edu/ejournals/JTE/v37n4/demiranda.html>
- Dewey, J. (1933). *How we think* (Rev. ed.). New York: Heath.
- Dewey, J. (1938). *Experience and education*. New York: Heath.
- Dewey, J. (1964). John Dewey on education (R. D. Archambault, Ed.). Chicago: The University of Chicago Press.
- Dewey, J. (1973). *The philosophy of John Dewey* (J. J. McDermott, Ed.). Chicago: The University of Chicago Press.
- Hansen, R. E. (2000). The role of experience in learning: Giving meaning and authenticity to the learning process in schools. *Journal of Technology Education*, 11(2), 23–32.
- Petrina, S., & Volk, K. (1995). Industrial arts movement’s history, vision, and ideal: Relevant, contemporary, used but unrecognized—Part I. *Journal of Technology Studies*, 21(1), 24–32.
- Schell, J. W., & Black, R. S. (1997). Situated learning: An inductive case study of a collaborative learning experience. *Journal of Industrial Teacher Education*, 34(4), 5–28.
- Stern, D. (1998). Situated learning in adult education. Retrieved from [http://www.ed.gog/databases/ERIC\\_Digests/ed418250.html](http://www.ed.gog/databases/ERIC_Digests/ed418250.html) (ERIC Digest No. 195, ED 418250)
- Sternberg, R. J. (1998). Principles of teaching for successful intelligence. *Educational Psychologist*, 33(2–3), 65–72.
- Zuga, K. F. (1992). Social reconstruction curriculum and technology education. *Journal of Technology Education*, 3(2). Retrieved from <http://scholar.lib.vt.edu/ejournals/JTE/v3n2/html/zuga.html>
- Zuga, K. F., & Bjorkquist, D. C. (1989). The search for excellence in technology education. *Journal of Technology Education*, 1(1). Retrieved from <http://scholar.lib.vt.edu/ejournals/JTE/v1n1/zugabjor.jte-v1n1.html>

