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Impact of Experiential Learning on Cognitive Outcome in Technology and Engineering Teacher Preparation

Historically, practitioners have employed a variety of active techniques to promote the development of professionals in disciplines that necessitate direct skill-associated practice; education at the postsecondary level more habitually relies on conventional teaching methods that often do not permit adequate development of palpable skills (Healy, Taran, & Betts, 2011). The unfortunate result of these traditional abstract practices is the development of professionals with task knowledge but little associated task ability, serving as an indictment of instructional organization and implementation (Anderson, Reder, & Simon, 1996).

The implementation of realistic extension approaches in technology and engineering teacher preparation content courses that simultaneously promote conceptual knowledge and skill-based aptitude is challenging for university curriculum developers. Developing meaningful experiences while maintaining distinguishable curricular alignment requires significant deliberation provided that the intent is to convey authentically reflective and contemporary processes and approaches to future technology and engineering educators. Experiential learning is one method explored in efforts to address the demand for meaningful content experiences. Kemp (2010) characterizes experiential learning as active learning occurrences external to customary academic settings. In the framework of postsecondary education, experiential learning is a viewpoint and approach in which instructors target direct learner experience in efforts to advance individual knowledge and associated authentic skill (Holtzman, 2011).

"Experientially based learning strategies in general have a long history rooted in the early work of John Dewey (1938), and later evolved in work by Piaget (1950), Kurt Hahn (1957), Paulo Freire (1970), Vygotsky (1978), Kolb (1984), Jarvis (1987), and many others" (Marlow & McLain, 2011. p.2). Kolb's theory asserts that learning is a cognitive development linking persistent acclimatization to environmental engagement (Bergsteiner, Avery, & Neumann, 2010). Further, Fry, Ketteridge, and Marshall (2003) identify that concepts of situation-based education incite constructivist practices corresponding to aspects of Kolb's learning cycle. Concrete experience merged with cognitive practice and conceptual application is foundational to the constructivist experiential learning perspective (Jordi, 2011). These experiences span beyond mere environmental conditioning and enter into personal assembly of meaning. This is further supported in the context of technology and engineering education by

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Becker (2002), who asserts that a full behaviorism to constructivism shift is necessary in order to effusively prepare students for a technologically advanced global economy and workplace.

Huerta-Wong and Schoech (2010) note that learning is a process that includes more than an amalgamation of inputs and outputs but is largely dependent on the structure and significance of the environment in which learning takes place. Bangs (2011) adds that active student involvement and the application of existing personal knowledge and prior experiences into the new educational environment are significant features of the experiential learning process. Through this structure, students are asked to access current understanding and expand upon it in a direct and genuine fashion. It is well documented that experiential field-based learning has positive K–12 student engagement and retention impacts, but do preservice technology and engineering educators experience similar educational benefits? Additionally, do they perceive experiential learning to be valuable in their personal study, and do they plan to extend this structure of learning into the K–12 technology and engineering education classroom? A formulated investigation has been structured to explore these prospective educational benefits for preservice technology and engineering educators.

Research Questions

This research study was designed to investigate and identify the impacts, if any, that experiential learning activities have on the cognitive achievement of preservice technology educators. Two *research questions were posed to specifically guide this study:*

1. Is there an identifiable cognitive achievement difference in preservice technology educators who engage in experiential learning activities?
2. How do preservice technology educators perceive experiential learning activities?

This research examined experiential learning extension activity implementation through a quasi-experimental design, which consisted of experimental/treatment and control features to measure cognitive outcome but did not use random assignment. The primary intent is to gauge outcome effectiveness and perceptions of students concerning experiential learning in efforts to further inform course iteration.

Study Participants

Participants in this study were enrolled in a technology and engineering education teacher preparation program during the fall semesters of 2010 and 2011. Specifically, the participants were students in an Emerging Issues in Technology course. The Emerging Issues in Technology course explores contemporary agricultural, environmental, and biotechnological topics. Students completed associated learning activities, experimentation/data collection

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exercises, and modeling projects. However, two sections of the class were provided with experiential activities at a commercial aquaculture facility, an energy technology facility, and a wastewater treatment facility, while two sections of the course engaged in simulated lab-based activities.

Sections of this course were selected as a result of the anticipated academic level of the students enrolled. Students in the Emerging Issues in Technology course are in the secondary level of their major and typically student teach the following semester or spring semester of the following year. Students enrolled in these courses have existing knowledge bases and experiences associated with materials and processes, energy and power infrastructures, electronics, robotics, engineering graphics, architectural graphics, and other engineering design principles and processes. Participants in the selected course of the postsecondary technology teacher education program may have been previously enrolled, although not gauged in information and data collection for this study, in technology and engineering education at the secondary or middle grades level. Table 1 and Table 2 provide general demographical breakdowns of student participants in the Emerging Issues in Technology course.

The majority of the Emerging Issues in Technology student participants were male, from 21–23 years of age, and Technology and Engineering Education majors. The two student groups in this study consisted of 73 participants. Of the 73 participants, 62 were male, 62 were from 21–23 years of age, and 65 were majoring in Technology and Engineering Education. In the teacher preparation program, many students also minor in Graphic Communications. Major classification for the two groups identified in the study is representative of primary major categorization.

Table 1
Non-Experiential Group Demographics

Gender *n* - (%)		**Age Range *n* - (%)**		**Major *n* - (%)**	
Male	30 - (91%)	18–20	3 - (9%)	Tech. & Eng. Education	30 - (91%)
Female	3 - (9%)	21–23	27 - (82%)	Tech./Graphics	3 - (9%)
		24–26	1 - (3 %)		
		27+	2 - (6 %)		

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Table 2
Experiential Group Demographics

Gender *n* - (%)		Age Range *n* - (%)		Major *n* - (%)	
Male	32 - (80%)	18– 20	2 - (5%)	Tech. & Eng. Education	35 - (87.5%)
Female	8 - (20%)	21–23	35 - (87.5%)	Tech./Graphics	5 - (12.5%)
		24–26	1 - (2.5 %)		
		27+	2 - (5 %)		

Methodology

Instructor permission was granted for two sections of Emerging Issues in Technology in the 2010 fall academic semester and two sections of Emerging Issues in Technology in the 2011 fall academic semester. Institutional Review Board approval was attained for the use of human subjects in research. The 2010 academic semester consisted of planned course instruction with follow-up experiential learning activities. The course topics of study were Agriculture Technologies, Biotechnologies, Medical Technologies, and Nanotechnologies. The course topics were placed in the context of teaching newly emerging technology topics to K–12 technology and engineering education students.

Experiential follow-up activities consisted of visiting a commercial aquaculture facility, an energy technology facility, and a wastewater treatment facility. The aquaculture facility activity consisted of artificial ecosystem infrastructure development and operative observation. Additionally, students were given interactive tasks associated with commercial applications of tank repositioning, feeding, and water oxidation to promote the development of facility-raised tilapia. The energy technology facility activities consisted of a site orientation followed by interaction with stations that access real-time data feeds from wind, solar, geothermal, and other renewable energy sources. The wastewater treatment facility experience provided a sequenced orientation to sewage and industrial wastewater for reclamation, treatment, and reuse. Students observed suspended solids gravity separation, bacteria waste digestion, filter bed purification, and natural water discharge. During observation, they were periodically invited by the plant supervisor to conduct operations such as systems checks, area shutdown, and process initiation. These three separate experiences served as field-based reinforcement observation and application opportunities for students to authentically situate concepts and processes discussed in a formal classroom setting.

Students attended class meetings and participated in experiential learning exercises for a full academic semester. The course email rosters were acquired from the instructor, and in the 14th week of the semester, an email and survey link was sent to the class requesting their participation in a follow-up survey. No

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identifying information was requested nor gathered during the survey procedures. Several scales were evaluated for inclusion in this study. Specifically, the Mindfulness Attention Awareness Scale and the Langer Mindfulness Scale were reviewed, but neither prompted the nature of experiential learning targeted within this study, as they both lend themselves primarily to the construct of mindfulness made up of engagement, novelty production, novelty seeking, and attention/awareness factors (Yeganeh, 2006). Therefore, four brief prompts were generated by the investigator, and the instrument was titled the Experiential Learning Perception Survey.

The investigator-generated Experiential Learning Perception Survey had four prompts pertaining to experiential appreciation, perceived experiential value to course, knowledge formation stemming from experiential learning, and anticipated experiential learning in personal teaching practice. Students also completed a 60 item cumulative cognitive assessment composed of 16 true or false items, 32 multiple-choice items, and 12 matching items used each semester in the Emerging Issues in Technology course. At the conclusion of the academic semester, both perception and cognitive data were compiled and entered.

The 2011 academic semester course sections were offered identical course information in a formal classroom setting as the 2010 course sections. However, the 2011 academic semester course sections implemented simulated laboratory-based reinforcement experiences in place of field-based experiential opportunities. A laboratory aquaponics tank was used to explore aquaculture set-up, structure, and function; a series of green technology multimedia aides were used to reinforce discussion of energy technologies; and a groundwater simulation unit and a live bacteria-based water treatment purifier were used to explore wastewater treatment. At the conclusion of the semester, the same 60 item cumulative cognitive assessment was administered. The cognitive data was compiled, entered, and paired with the 2010 course sections for analysis of Research Question #1: Is there an identifiable cognitive achievement difference in preservice technology educators who engage in experiential learning activities?

Data and Analysis of Findings

The first evaluated hypothesis was: There is no difference in cognitive achievement of preservice technology educators who engage in experiential learning activity and preservice technology educators who do not engage in experiential learning activity. This hypothesis was evaluated in Table 3 using the nonparametric Mann-Whitney U test. As indicated by Sheskin (2007), the Mann-Whitney U test was selected for this study based upon its assumptions, sampling, and non-parametric basis (non-Gaussian population). The test statistic for the Mann-Whitney U test was compared to the designated critical value table based on the sample size of each student participant sample. The critical alpha

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value was set at 0.05 for this investigation. The *p*-value for the test (< 0.0001) was determined to be smaller than 0.05, therefore, the null hypothesis was rejected. The analysis of data suggests that there was a statistically significant cognitive achievement difference between the sample of preservice technology educators who engaged in experiential learning activity and the sample of preservice technology educators who were not engaged in experiential learning activity.

Table 3
Mann-Whitney U Hypothesis Test Results

Difference	*n*1	*n*2	Diff. Est.	Test Stat.	*P*-value
Experiential – Non-experiential	40	33	1.682	1829.5	< 0.0001

As earlier indicated, the experiential group was provided four prompts pertaining to experiential appreciation, perceived experiential value to course, knowledge formation stemming from experiential learning, and anticipated experiential learning in personal teaching practice. Participants were also provided with two open text fields: (a) major advantages of experiential learning format and (b) major disadvantages of experiential learning format. The Experiential Learning Perception Survey was used in this study to investigate Research Question #2: How do preservice technology educators perceive experiential learning activity? Proportional level of agreement for the 30 respondents to the Experiential Learning Perception Survey is identified in Table 4. Ten of the experiential group student participants elected not to complete the survey. Ninety-one percent of respondents identified agreement that they found the experiential activities to be enjoyable, 94 percent identified agreement that experiential activity enhanced course content, 94 percent had a level of agreement that experiential learning heightened their knowledge concerning real-world application of content, and 91 percent either agreed or strongly agreed that they intend to personally implement experiential learning in their teaching.

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Table 4
Experiential Learning Perception Survey Results

Statement	Strongly Disagree n – (%)	Disagree n – (%)	Undecided n – (%)	Agree n – (%)	Strongly Agree n – (%)
I found the experiential learning opportunities to be enjoyable.	2 – (6%)	0 – (0%)	1 – (3%)	13 – (44%)	14 – (47%)
The content covered in this course was enhanced by the experiential opportunities	1 – (3%)	0 – (0%)	1 – (3%)	15 – (50%)	13 – (44%)
The experiential learning opportunities have heightened my knowledge concerning real-world application of course content.	1 – (3%)	0 – (0%)	1 – (3%)	13 – (44%)	15 – (50%)
I intend to employ experiential learning in my teaching practice.	1 – (3%)	0 – (0%)	2 – (6%)	14 – (47%)	13 – (44%)

The experiential learning respondents indicated both strengths and weaknesses in the free response portion of the Experiential Learning Perception Survey. Several prevalent trended themes emerged upon review of the major advantages of experiential learning: (a) the hands-on nature of the experiences, (b) the real-world property of the experiences, and (c) the reinforcing of course content through the experiential activities. Similarly, several themes arose upon review of the major disadvantages of the experiential learning free response: (a)

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the organization of off-campus transportation, (b) concerns with the distance of off-campus experiential locations, and (c) the concern that the transfer and relationship of content to experiential applications was sometimes underlying and not directly apparent. The advantages primarily focused on the attributes of the direct experience, while the disadvantages were largely logistical concerns that without a large amount of prior planning on the instructors' end could present themselves as issues, specifically in a K–12 environment.

Limitations and Contamination Concerns

The nature of this quasi-experiential study design directly targets a specific preservice technology teacher education program. The findings from this study could be informative to other academic institutions with preservice technology teacher education offerings. Attribution of findings to similar but separate groups is problematic where non-Gaussian populations are studied. Additionally, implementation fidelity is an ever-present concern for studies that utilize treatment groups. In this study, one section of the non-experiential group reported participation in tours of course content related non-operational facilities. Although the facilities were identified not to be in operation and did not extend interactive hands-on aspects, this experience deviated from the second section of the non-experiential group. Research Question #1 was re-evaluated excluding the one section of the non-experiential group with reported contamination concerns. Again, Research Hypothesis #1 is: There is no difference in cognitive achievement of preservice technology educators who engage in experiential learning activity and preservice technology educators who do not engage in experiential learning activity. The Mann-Whitney U hypothesis test results can be found in Table 5. The *p*-value for the test (< 0.0001) was determined to be smaller than 0.05, therefore, the null hypothesis was again rejected. The re-analysis of data excluding one of the Non-experiential sections suggests that there was a statistically significant cognitive achievement difference between the sample of preservice technology educators who engaged in experiential learning activity and the single section sample of preservice technology educators who were not engaged in experiential learning activity.

Table 5
Mann-Whitney U Hypothesis Test Results

Difference	*n*1	*n*2	Diff. Est.	Test Stat.	*P*-value
Experiential – Non-experiential	40	15	3.53	1416.5	< 0.0001

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Conclusions

In this article, the author has framed an intervention approach based on the personal assembly of meaning in an attempt to reinforce conceptual learning that is designed to culminate in authentically reflective practice while building associated professional skillsets. Through analysis of the study sample outcome data, it was determined that preservice technology and engineering educators who engaged in the organized experiential learning activities benefitted in the form of cognitive outcome from the learning extension approach and structure. However, Gleason et al. (2011) identifies that no independent active or experiential approach is singularly superior, and in fact the approach could be significantly enhanced by instructional styles and learner receptiveness to teacher personality. It is acknowledged that there are influential variables outside of the designed treatment employed in this study. Overall, it is evident that involvement in experiential learner extension opportunities contributes to associated cognitive competency development.

Additionally, experiential learning opportunity was found by the treatment group to be enjoyable, enhance the course offering, have direct real-world extension, and possess course features that will be implemented in the future. It is again acknowledged that experiential learning perception results may have been partially attributable to Gleason's et al. (2011) identification of receptiveness to personality and instructional style. Subsequent variable control and/or variable isolation investigations would enable a clearer determination of impact and influence. However, there is marked receptiveness and identified value by treatment group participants concerning experiential learning activity and application as evidenced by the agreement level pertaining to statements on the Experiential Learning Perception Survey as well as free response items, specifically, major advantages of the experiential learning format.

Jenkins et al. (2007) notes that qualified educational practices through exploratory research have continued to enrich and advance university programs (as cited by Harris & Tweed, 2010). Explorations of instructional interventions not only inform curriculum development, teaching strategies/practices, and course structure but also inform teacher education programs' learner qualities and attributes of their programs' students. A student profile that includes receptiveness, impact, engagement, and the circumstances under which each occurs is informative in developing iterations to courses as well as the expansion of overall programmatic scope.

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