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The Effect of Two Different Pedagogical Delivery Methods on Students' Retention of Knowledge Over Time

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Abstract

The purpose of the study was to determine the effect of two contrasting pedagogies (i.e., experiential learning and direct instruction) on students' retention of agricultural knowledge over time. A six-week deferred post-test was employed to assess long-term retention of the subject matter. The results indicated that initially, students who were taught both experientially and through direct instruction experienced a statistically significant increase in analytical scores, with the direct instruction treatment group outperforming the experiential learning treatment group. However, that increase was not statistically significant but was followed by a statistically significant decrease in analytical scores six weeks following instruction. Implications exist for preparing instructors to pace their lessons in a slower fashion to increase understanding and mastery of the content learned.

Keywords: Pedagogy; knowledge retention; experiential learning; direct instruction

Introduction

Students are being left behind due to an educational system that is broken and in need of overhaul (Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013). Although some students learn great details in their public school years, many forget much of what is taught to them over the course of their 13 years in public school systems (Conway, Cohen, & Stanhope, 1991). Therefore, a common goal of all educators is to increase the long-term knowledge retention of learners (Halpern & Hakel, 2002). However, the fact remains, "students ordinarily and regularly forget what they have learned in their classes" (Shulman, 1999, p. 13). In fact, the majority of the knowledge students seemingly have mastered, as evidenced by their performance on a final examination, is not retained or sustained over time (Bacon & Stewart, 2006). Numerous reasons exist for the vast amount of learning loss from students. Chief among them is students' use of cramming, which has shown "significant negative impact[s]" of retention over delayed periods of time involving long-term memory (McIntyre & Munson, 2008, p. 11). Although students admit that cramming does not lead to long-term retention, they continue the practice because the system has rewarded them for remembering and recalling information on demand (McIntyre & Munson, 2008).

It has been recommended that teachers discourage students from cramming by employing pedagogies that require a "deeper level of learning" (McIntyre & Munson, 2008, p. 11). The pedagogical approach that instructors choose to employ in the classroom has implications for

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increasing students' deep learning over time (Bacon & Stewart, 2006). Teachers need strategies and methods that will help students learn content long term (Dunlosky et al., 2013). Miller, McNear, and Metz (2013) suggested that one way to increase students' long-term retention of the subject matter is through the use of active and engaging pedagogies. Semb and Ellis (1994) echoed this claim by stating that instructors can impact the long-term retention of learning in their students positively if they will allow them numerous opportunities to apply their learning through higher order cognitive activities.

To accommodate deeper learning of students, McIntyre and Munson (2008) recommended that teachers slow down their pace of teaching and delivery of content so that students have adequate time to process new information. In addition, Weinstein and Mayer (1983) advocated for teachers to utilize elaboration, rehearsal, and organizational strategies for students, such as highlighting and underlining text, paraphrasing content, summarizing key points, and checking for understanding. McIntyre and Munson (2008) stated,

> For long-term retention, students need to engage with the study material and apply it to situations of relevance to them. The all-too-common use of PowerPoint slide lectures, even with in-class handouts of the slides, does not engage students to take notes in their own language and handwriting, which shunts their processing of the material, leaving all effective learning to the cramming period at the end of the term. (p. 12)

When teaching science concepts, teachers should consider active learning when constructing their units of instruction (Taraban, Box, Myers, Pollard, & Bowen, 2007). Because agriculture is considered a science (Ricketts, Duncan, & Peake, 2006), implications exist for the use of active learning pedagogies for increasing students' content understanding (Haynes, Robinson, Edwards, & Key, 2012).

Being able to learn and retain knowledge *in* and *about* agriculture has been a focus of agricultural education since the late 1980s (National Research Council, 1988) when the profession set its sights on improving individuals' agricultural literacy due to society being "ignorant about agriculture" (Blackburn, 1999, p. 1). Nearly 20 years later, the situation remains largely the same, however, as Dale, Robinson, and Edwards (2017) found that incoming freshmen students enrolled as agricultural majors had barely a passing knowledge of agriculture.

Understanding more about how various pedagogies affect students' ability to learn and remember agricultural content is imperative for sustaining the world's growing population. Mercier (2015) identified two imperative challenges facing agricultural education today: 1) a deficiency of people prepared to enter the food and agricultural industry; and 2) a majority of people who do not understand agriculture. Addressing these challenges could be met with better engagement strategies and methods of delivery of instructors who teach agricultural classes (Arum & Roska, 2011; Smith, Sheppard, Johnson, & Johnson, 2005). Therefore, it is vital that educators determine the best way to teach and distribute agricultural information to students for optimal long-term retention (Frick, Birkenholz, & Machtmes, 1995; Pense & Leising, 2004).

The use of various pedagogies can affect the amount of knowledge students retain or forget (Sallee, Edgar, & Johnson, 2013; Thalheimer, 2010) as well as their positive perceptions for learning the content (Mueller, Knobloch, & Orvis, 2015). They also have been identified as having the greatest impact on students' attention, learning, and retention of knowledge over time (Marzano, Pickering, & Pollock, 2001; Sallee et al., 2013). Unfortunately, "effective teaching has continually been hampered by pedagogical constraints, such as time, materials, and ever changing technological advances" (Edgar, Retallick, & Jones, 2016, p. 38). Therefore, the need exists to determine which form of pedagogy could have the greatest effect on student learning in a short time frame.

Long-term retention of instruction is not a new topic for researchers of experiential learning. Recently, Kolb and Kolb (2017) discussed the idea of retention at length which is grounded in the work by Zull (2002) that connected the experiential learning cycle to specific areas of the brain and made a distinction between non-integrated instruction/recall learning and fully integrated learning. Procedural memory is the result of learned connections resulting from stimulus and response, semantic memory is most often associated with instruction and focuses on learning and abstraction, and episodic memory describes full cycle learning where one is sensing, reflecting, formulating abstraction, and taking action (Kolb & Kolb, 2017). Semb and Ellis (1994) looked at a number of recall studies exploring various instructional methods and concluded there was little difference and similar forgetting curves for all, but claimed a "qualitative difference" (p. 275) in the quality of learning resulting from active involvement of the student. Specht and Sandlin (1991) found that this fully integrated, experiential, learning process does not lead to immediate gains in retention, but led to significant gains of recall after six weeks. Experiential learning literature focuses on the shift from remembering to learning that occurs through actively involved, integrated, full-cycle learning (Herbert & Burt, 2004).

This study was underpinned using the experiential learning theory. Inherent to the theory is the notion that all learning is experiential (Joplin, 1981). Theoretically, experiential learning is a holistic approach to learning "that combines experience, perception, cognition, and behavior" (Kolb, 1984, p. 21) and is recognized as one of the most essential and natural forms of educational theory (Beard & Wilson, 2006). Regarding secondary agricultural education, the entire model of the program (i.e., classroom, SAE, and FFA) is a natural experiential playground (Baker, Robinson, & Kolb, 2012).

Kolb (1984) stated that experiential learning is that which is grasped and transformed by the learner (see Figure 1). Learners grasp and transform content, which results in either *divergent, assimilative*, *convergent, or accommodative* knowledge (Kolb, 1984).

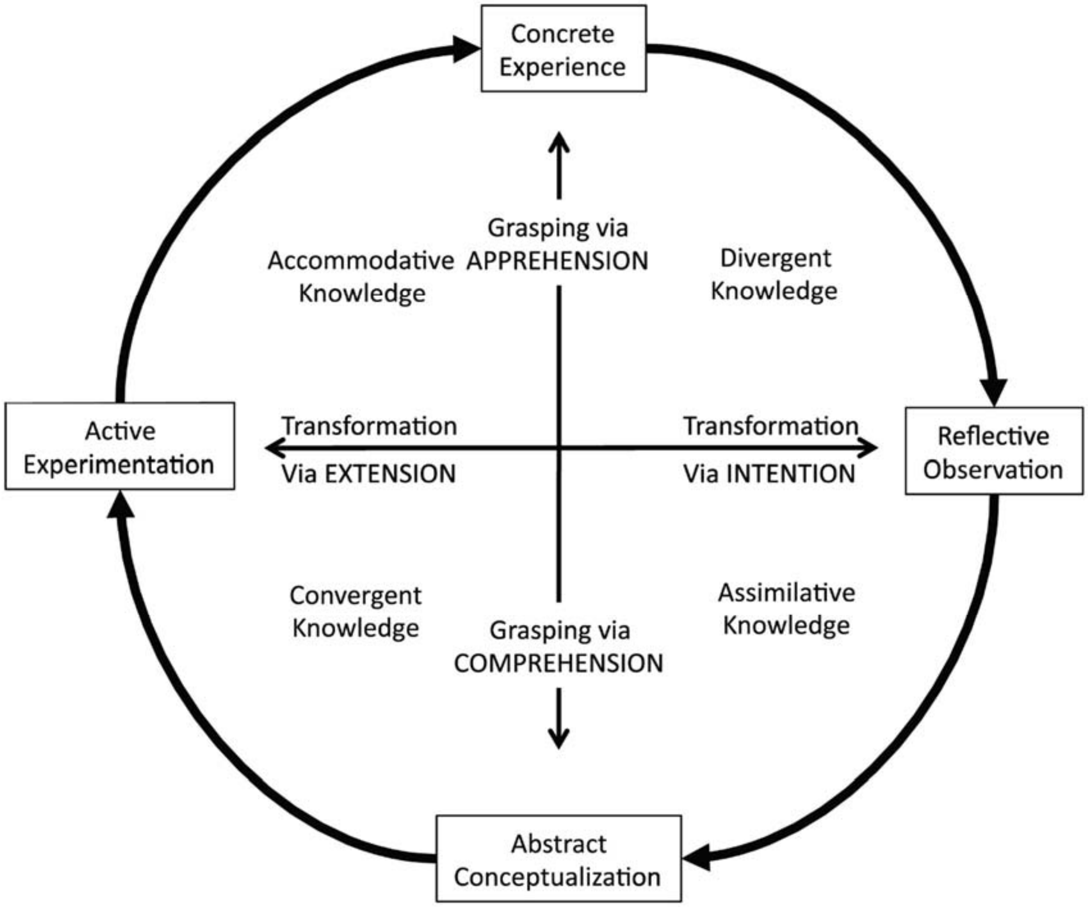

Figure 1. Kolb's (1984) Model of Experiential Learning Process. Reprinted from Experiential Learning: Experience as the Source of Learning and Development (p. 42),by David A. Kolb, 1984, Englewood Cliffs, NJ: Prentice-Hall, Inc. Copyright 1984 byPrentice-Hall, Inc. Reprinted with permission.

The knowledge grasped falls into one of four learning modes – behavioral, symbolic, affective, and perceptual complexity. Within these levels of complexity, are three developmental stages of the learner – acquisition, specialization, and integration. Acquisition, extends from birth to adolescence and includes the sensorimotor, iconic, and concrete operations (Kolb, 1984). It is in this stage that learners move from the focus on immediate experience to symbolic development and the transformation of that stimulus. Specialization, marks the time beyond adolescence where specialization and the refinement of meta-cognitive skills is the dominant learning practice. During this time, the personality dynamics and external social factors serve as the impetus for stability and life path decisions. In this stage, a learner establishes a sense of individuality through the acquisition of an identity both as a person and a learner (Kolb, 1984). Finally, the integration stage is where the learner's eyes are opened beyond the preferred and specialized modes of thinking and into a more integrated approach.

As people become more affluent and specialized in their knowledge, they are able to retrieve important concepts from their memory with little effort and integrate, or conditionalize, them to other settings (Bransford, Brown, & Cocking, 2000). Teachers can help students develop their expertise in the subject by using retrieval cues (Santrock, 2004) and testing them frequently on what they have learned (Carrier & Pashler, 1992; Roediger III & Karpicke, 2006).

Because all learning is experiential (Joplin, 1981), implications exist for how teachers choose to teach their content. Traditional methods of instruction (i.e., lecture and direct instruction) are used most frequently in education systems (Khalid & Azeem, 2012). They also tend to be the most common methods of choice for agricultural education teachers when integrating science, technology, engineering, and mathematics (STEM) principles into their lessons (Smith, Rayfield, &McKim, 2015). However, research has shown that active learning methods (i.e., experiential learning) are more likely to improve students' understanding of science (Mabie & Baker, 1996; Taraban et al., 2007). What is more, although traditional methods of instruction are effective with recognition tests, they tend to work poorly for long-term understanding (Halpern & Hakel, 2010). One pedagogy that provides authentic learning situations for students in classrooms and holds promise for long-term retention is experiential learning (Clark, Threeton, & Ewing, 2010). Historically, agricultural education has prided itself as a symbol of experiential learning (Baker, Robinson, & Kolb, 2012; Knobloch, 2003; Phipps, Osborne, Dyer, & Ball, 2008; Roberts, 2006). However, a dearth of information in the literature exists regarding the effects of experiential learning on students' long-term retention of the material in agricultural education.

Because teaching affects learning, instructors need to know which pedagogies yield the best results for long-term learning (Kiewra, 2002). Specifically, Clark et al. (2010) called for the evaluation of how experiential learning impacts students' knowledge of retention by stating, "further research into how experiential learning is aligned with other learning research will provide the profession a better understanding of why experiential learning offers a sound opportunity to improve student retention and provide students with richer experiences" (p. 58).

In comparison to experiential learning, direct instruction could be considered its polar opposite. Direct instruction has been the pedagogy used most widely in schools (Begeny & Martens, 2006). It allows for the quick and efficient transfer of information from the teacher to the student in a straightforward manner (Watkins & Slocum, 2003).

"Enhancing memory for what is taught in school should be a primary goal for any educator" (Semb & Ellis, 1994, p. 279). Since its inception, agricultural education has focused on providing students with deep, rich experiences to adjust to a constantly changing world (Fitzgerald, 1936). Because the retention of agricultural knowledge is crucial to the worlds' success, it is important to know which pedagogy impacts students' long-term retention most.

Purpose of the Study

The purpose of the study was to determine the effect of two contrasting pedagogies (i.e., experiential learning and direct instruction) on students' retention of agricultural knowledge over time. This goal is aligned with Research Priority 4: Meaningful, Engaged Learning in All Environments of the National Research Agenda of the American Association of Agricultural Education (Roberts, Harder, & Brashears, 2016). The research question that guided the study was, *Do the analytical effects achieved by experiential and direct instructional approaches persist over time?* The two null hypotheses created for this research question were as follows:

H_O 1: There is no statistically significant difference in the pre-test, post-test, and deferred post-test scores for students taught with the experiential approach.

H_O 2: There is no statistically significant difference in the pre-test, post-test, and deferred post-test scores for students taught with the direct instruction approach.

Methods

The population for this experimental design study included all students (N = 120) who were enrolled in a local, rural secondary agricultural education program in Oklahoma. This two-teacher program was chosen for the study because it is perceived as a *typical* and *holistic* program in Oklahoma. Further, its geographic proximity to Oklahoma University made it accessible to the teachers, students, and researchers. In all, 80 students agreed to participate in the study by completing the necessary IRB documents for consent and assent. To initiate the study, the two teachers bussed students to an off-site location in [City] where they were welcomed, checked in, and assigned to a treatment room (i.e., experiential learning or direct instruction). Thirty-eight students were assigned to the experiential learning treatment and 42 were assigned to the direct instruction treatment. The experiential learning treatment group consisted of 15 males (39%) and 23 females (61%). The direct instruction treatment group consisted of 23 males (55%) and 19 females (45%). Equal representation existed in both treatment groups regarding school grade, with the highest frequencies being freshmen (n = 35; 44%) and juniors (n = 20; 25%).

Because "no analysis, no matter how sophisticated, can compensate for poor data collection and measurement" (Stevens, 2009, p. 38), the researchers gave careful attention to the polarization of the treatments (Kirk, 1995). Specifically, two Oklahoma State University faculty members were assigned to deliver the curriculum to each respective treatment group. Although both had degrees in teacher education and worked at the university to prepare secondary teachers, they each received additional, explicit training regarding the study's content and pedagogy necessary to teach it effectively while staying true to the method being featured. Also, because both the direct instruction and experiential learning pedagogies require instructors to provide instant feedback, guidance, and support to students, four additional instructors were used per room to ensure fidelity and potency of the treatment. These instructors were pre-service agricultural education students at Oklahoma State University who were engaged in learning about specific pedagogies in their college curriculum. Each instructor received four hours of training in the treatment area he or she was assigned regarding the pedagogical delivery of the content taught.

Specifically, the content taught was a unit on wind turbines. The content was chosen because it fit into an existing career pathway in agricultural education, has implications for potential careers for secondary students, and is becoming a popular energy source in Oklahoma. Further, the content had not been taught previously by the two teachers, thus, making it novel and fresh for the students and assuring that the findings would be authentic and not contaminated by previous learning or exposure.

On arrival to the site, students were escorted to their assigned treatment room. There, they completed an analytical pre-test regarding their knowledge of the curriculum. Once every student had completed the pre-test, the daylong workshop began. The major goal of the study was for students to construct a wind turbine, complete with blade design, which would produce the most amount of energy output possible. Throughout the day, each treatment group participated in various activities relevant to their assigned pedagogy. For instance, the experiential learning instructional room was set up with six different stations that allowed students to interact regarding key concepts of blade design. Students were allowed to experiment with building different blade designs and then reflect on various aspects of the process by completing abstract facilitation sheets while using products such as cups, plates, and paper. Throughout the day, students in the experiential learning treatment room walked freely around the learning environment, interacted with the various stations, and designed and tested a number of different blade designs.

In contrast, the direct instruction treatment group received three distinct lessons targeting specific learning objectives related to wind energy. The instruction was scripted using a lesson plan template where the instructor shared a PowerPoint® presentation and specific information related to building wind turbines. True to the method, the instructor offered praise and rewards where appropriate. Specific KidWind® materials were used to demonstrate key principles. Students remained seated at their tables throughout the day and worked to master the objectives of the lesson.

Once students created their blade, they brought them to a measurement station to be assessed. These stations were standardized to ensure that each turbine in both conditions was measured consistently. This included the distance at which the turbines were placed from the fan, the speed of the fan, and the height of the wind turbine. Each blade design was connected to a Basic Wind Turbine KidWind® base that included a small generator connected to the hub. Using a voltage meter, the voltage reading of each blade design was recorded as a practical measurement.

The specificity of detail regarding the designing of blades was important because it offered experiences necessary for the instructional unit. In addition, it created episodic and procedural memories consistent with the information processing theory (Schunk, 2012). This attention to detail was necessary to determine the amount of learning sustained over time, in this case a six-week deferred post-test.

In the often cited Specht and Sandlin (1991) study, retention of knowledge was defined as six weeks following instruction. Therefore, this study employed a deferred analytical post-test to participants six weeks after the treatment ended. This assessment was administered in the secondary school setting by the agricultural education instructors.

A criterion-referenced test (CRT) based on the selected educational objectives of the wind turbine blade design instructional unit served as the main analytical assessment for the study. The CRT was created as a collaborative effort by the researcher, KidWind® staff and consultants, experts in the field of wind energy engineering, and pedagogical experts in agricultural education. The purpose of the CRT was to capture students' ability to analyze, critique, judge, compare and contrast, evaluate, and assess concepts related to the objectives of the lesson. The CRT included 40 total questions, of which 30 were multiple-choice and ten were matching. The CRT was utilized for two purposes: (1) to determine that no statistically significant differences in analytical knowledge of blade design content existed prior to the experiment, and (2) as the first of three repeated measures in the SPF-2•3 ANOVA.

Creswell (2008) explained that, "content validity is the extent to which the questions on the instrument and the scores from these questions are representative of all the possible questions that a researcher could ask about the content or skills" (p. 172). Further, Creswell (2008) suggested that researchers should establish both face and content validity on instruments through the review of the assessment by a panel of experts. Therefore, experts from KidWind® assessed the CRT for content validity, suggested changes, and approved the final set of 40 questions. Suggestions included the deletion of two ambiguous questions, insertion of four discriminating items, three content-related mistakes, and a few typological errors. Pedagogical experts assessed the CRT for face validity and found it appropriate for secondary agricultural education students.

In addition to issues of validity, reliability refers to the extent that the scores made by an individual remain nearly the same in repeated measurements (Ary, Jacobs, & Razavieh, 2002).

Wiersma and Jurs (1990) suggested eight specific methods to increase the reliability of criterion-referenced examinations, including homogenous items, discriminating items, enough items, high quality copying and format, clear directions for the students, a controlled setting, motivating introduction, and clear directions for the scorer. Each of these suggestions were considered carefully and addressed fully in the development of the CRT used for this study.

The role of reliability indices in criterion-reference examinations has been described adequately in the literature (Kane, 1986; Lang, 1982; Popham & Husek, 1969; Wiersma & Jurs, 1990). Although traditional reliability indices based on internal consistency are not relevant, it is an important indication of reliability in criterion-referenced examinations (Kane, 1986). Kane (1986) purported that a reliability coefficient less than .50 would not provide reliable results. The Kuder-Richardson 20 (*KR20*) formula (Cronbach, 1970), a test for internal consistency used commonly with criterion-referenced examinations, was used to determine the test's reliability.

The CRT included the same questions and answers over the three periods of time (pre-test, post-test, deferred post-test). However, the order of questions and answers were altered to prevent students from memorizing the answers or becoming conditioned to the questions and responses. Reliability coefficients (*KR20*) for each of the three tests were as follows: (a) .82 for the pre-test, (b) .90 for the post-test, and (c) .88 for the deferred post-test. Therefore, it was determined that the CRT used in this study was a reliable measure of students' analytical knowledge.

A SPF-2•3 repeated measure MANOVA design was employed to analyze the data. Stevens (2009) shared that repeated measures "are the natural design to use when the concern is with performance trends over time" (p. 413). Assumptions of normality and independence of observations were met. Mauchly's test of sphericity produced a p value of .30, making the assumption tenable. Since no simple main effects were found, the main effects using univariate analysis of variance was assessed. Levene's test produced p values of .13, .07, and .96 for the pre-, post-, and deferred post-tests, respectively.

Findings

The study's research question sought to examine if analytical effects achieved by experiential and direct instructional approaches persisted over time. Prior to the conduction of the study, the pre-test was administered as both one of three repeated measures and a pre-test assessment of pre-existing differences in analytical content knowledge related to blade design. Table 1 presents the findings of a one-way ANOVA that found no statistically significant differences in the analytical knowledge of blade design prior to the treatment, $F(1, 78) = 1.28$, $p = .26$. Thus, it was assumed that the groups were similar in their analytical knowledge entering the experiment (see Table 1).

Table 1

Comparison of Pre-Test Analytical Scores: An ANOVA Summary Table

Source of Variance	*SS*	*df*	*MS*	*F*	*p*
Group	62.11	1	62.11	1.28	.26
Error	3795.10	78	48.66		
Total	3857.2	79			

All analytical scores, including each of the repeated measures, utilized the criterion-referenced examination built around the blade design learning objectives. The test included forty multiple choice and matching questions that added to a total possible score of 40. The scores ranged from 4 to 32 points coordinating with a typical school grade of 10% and 80%, respectively. The experiential learning treatment group means were 15.35 (*SD* = 5.59) for a learning preference of grasping via apprehension, 15.75 (*SD* = 6.94) for a learning preference of grasping via comprehension, 15.67 (*SD* = 5.15) for a learning preference of transforming via extension, and 15.14 (*SD* = 7.35) for a learning preference of transforming via intention (see Table 2). The direct instruction group means were 16.55 (*SD* = 7.32) for a learning preference of grasping via apprehension, 19.18 (*SD* = 9.04) for a learning preference of grasping via comprehension, 17.45 (*SD* = 7.94) for a learning preference of transforming via extension, and 16.77 (*SD* = 7.72) for a learning preference of transforming via intention (see Table 2).

Table 2

Analytical Pre-Test Means and Standard Deviation

	Experiential Learning		Direct Instruction	
	n	*M (SD)*	*n*	*M (SD)*
Grasping via				
Apprehension	26	15.35 (5.59)	31	16.55 (7.32)
Comprehension	12	15.75 (6.94)	11	19.18 (9.04)
Transforming via				
Extension	24	15.67 (5.15)	29	17.45 (7.94)
Intention	14	15.14 (7.35)	13	16.77 (7.72)
Treatment Total	38	15.47 (5.96)	42	17.24 (7.78)

Analytical post-test scores were assessed using the same criterion-referenced examination as the pre-test with slight question and response order changes. The test included forty multiple choice and matching questions that added to a total possible score of 40. The scores ranged from 7 to 37 points, coordinating with a typical school grade of 18% and 93%, respectively. The experiential learning treatment group means were 24.15 (*SD* = 7.80) for a learning preference of grasping via apprehension, 25.42 (*SD* = 9.89) for a learning preference of grasping via comprehension, 26.75 (*SD* = 8.35) for a learning preference of transforming via extension, and 20.79 (*SD* = 7.29) for a learning preference of transforming via intention (see Table 3). The direct instruction comparison group means were 29.07 (*SD* = 6.30) for a learning preference of grasping via apprehension, 29.18 (*SD* = 8.32) for a learning preference of grasping via comprehension, 28.69 (*SD* = 7.47) for a learning preference of transforming via extension, and 30.00 (*SD* = 7.87) for a learning preference of transforming via intention (see Table 3).

Table 3

Analytical Post-Test Score Means and Standard Deviations

	Experiential Learning		Direct Instruction	
	n	*M (SD)*	*n*	*M (SD)*
Grasping via				
Apprehension	26	24.15 (7.80)	31	29.07 (6.30)
Comprehension	12	25.42 (9.89)	11	29.18 (8.32)
Transforming via				
Extension	24	26.75 (8.35)	29	28.69 (7.47)
Intention	14	20.79 (7.29)	13	30.00 (7.87)
Treatment Total	38	24.55 (8.40)	42	29.10 (6.76)

Analytical deferred post-test scores ranged from 6 to 34 points, coordinating with a typical school grade of 15% and 85%, respectively. The experiential learning treatment group means were 17.12 (*SD* = 8.82) for a learning preference of grasping via apprehension, 20.00 (*SD* = 7.07) for a learning preference of grasping via comprehension, 18.00 (*SD* = 8.19) for a learning preference of transforming via extension, and 18.11 (*SD* = 8.89) for a learning preference of transforming via intention (see Table 4). The direct instruction comparison group means were 17.57 (*SD* = 8.53) for a learning preference of grasping via apprehension, 22.20 (*SD* = 7.66) for a learning preference of grasping via comprehension, 18.85 (*SD* = 10.58) for a learning preference of transforming via extension, and 18.64 (*SD* = 7.15) for a learning preference of transforming via intention (see Table 4).

Table 4

Analytical Deferred Post-Test Score Means and Standard Deviations

	Experiential Learning		Direct Instruction	
	n	*M (SD)*	*n*	*M (SD)*
Grasping via				
Apprehension	17	17.12 (8.82)	28	17.57 (8.53)
Comprehension	8	20.00 (7.07)	10	22.20 (7.66)
Transforming via				
Extension	16	18.00 (8.19)	27	18.85 (10.58)
Intention	9	18.11 (8.89)	11	18.64 (7.15)
Treatment Total	25	18.04 (8.26)	38	18.79 (8.46)

The MANOVA (see Table 5) for the repeated measure design indicated that there were no statistically significant simple main effects, Λ = .98, $F(2,60) = .56$, $p = .58$. Attention then turned to main effects of which statistically significant differences were found, Λ = .25, $F(3,76) = 88.13$, $p = .00$ (see Table 5).

Table 5

Summary of MANOVA Analyses Testing for Both Simple Main and Main Effects of the Deferred Analytical Repeated Measures ($df = 60$)

Source of Variance	Λ	*F*	*p*	Power
Time x Group	.98	.56	.58	.02
Time	.25	88.13	.00	.75

Contrasts revealed that there were statistically significant differences between the three repeated analytical measures, $F(2,122) = 86.01$, $p = .00$, $\eta_p^2 = .59$, with a large practical effect (see Table 6). Table 7 clarified further those disparities in identifying statistically significant differences between the pre- and post-test, $F(1,61) = 172.84$, $p = .00$, $\eta_p^2 = .74$, as well as a statistically significant difference between the post- and deferred post-tests, $F(1,61) = 87.36$, $p = .00$, $\eta_p^2 = .59$ (see Table 7).

Table 6

Comparative Analysis of Student Analytical Knowledge by Treatment Group: A Split-Plot Factorial 2.3 Repeated Measures ANOVA Summary Table ($n = 63$)

Source of Variance	*SS*		*MS F*	*F*	*p*	η_p^2
Repeated Measure Effects						
Time	4086.63 2	2	2043.32	86.01	.00	.59
Error	2898.47	122	23.76			
Between Subjects Effects						
Group	31.33	1	31.33	.68	.41	.01
Error	2826.22	61	46.33			

Table 7

Repeated Measure Analytical Repeated Design Within-Subjects Contrasts

Source of Variance	*SS*	*df*	*MS*	*F*	*p*	η_p^2
Time						
Level 1 vs. Level 2	7108.30	1	7108.30	172.84	.00	.74
Level 2 vs. Level 3	4958.56	1	4958.56	87.36	.00	.59
Error						
Level 1 vs. Level 2	2508.68	61	41.13			
Level 2 vs. Level 3	3462.334	61	56.76			

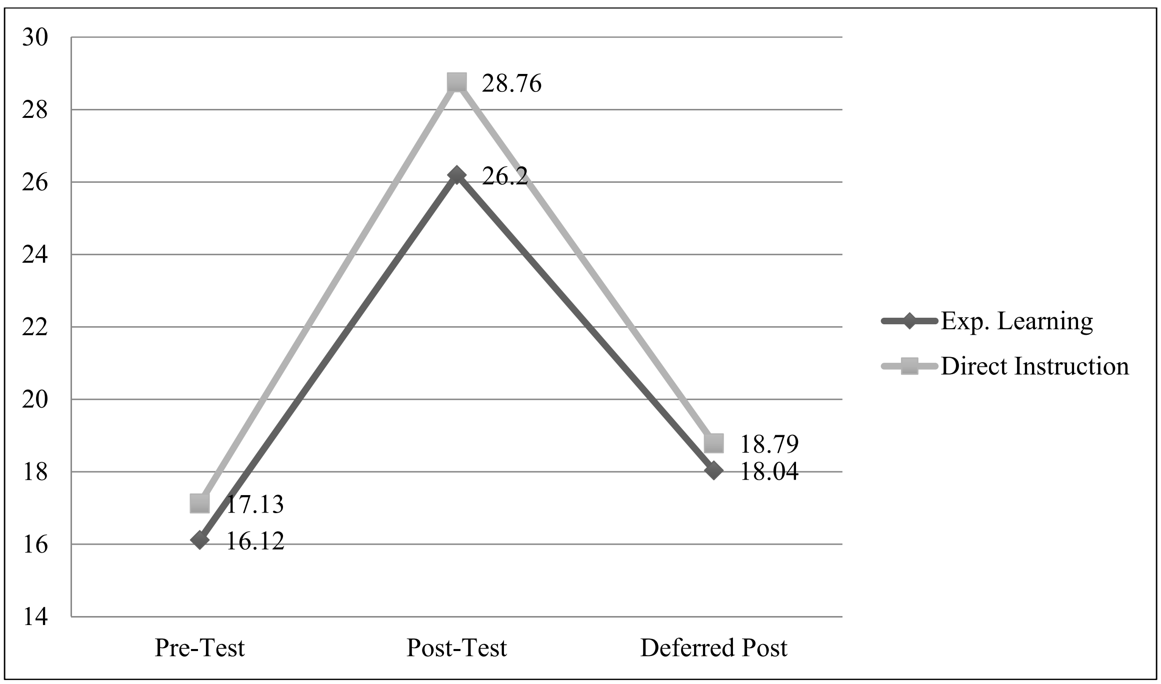

Figure 3. Graph of Repeated Measure Analytical Scores

Both of these contrasts also produced strong practical effects, as indicated by measure of effect. The graph (see Figure 3) of repeated measures also depicts that no statistically significant differences existed between analytical scores for the two treatments over time, $F(1,61) = .68$, $p = .41$. As such, both null hypotheses were rejected, which indicated there were differences between the three repeated measures of both experiential learning and direct instruction approaches (see Figure 3).

Conclusions

Initially, students who were taught using both experiential learning and direct instruction pedagogies experienced a statistically significant increase in analytical scores. However, that increase was followed by a statistically significant decrease six weeks following instruction. Students in the direct instruction treatment group appeared to outperform their experiential learning counterparts at all three stages of testing. Differences were not statistically significant at any stage. In addition, neither group (i.e., experiential learning and direct instruction) of students retained a passing knowledge of the content six weeks later.

Specht and Sandlin (1991) noted that, "the key difference in the two learning methods may be in the area of students' retention of the concepts rather than in their initial perceptions of those concepts" (p. 207). Though the methodology of this study mimicked the six-week deferred post-test, it failed to confirm Specht's and Sandlin's (1991) assertion. Not only did students who were in the experiential learning group perform lower on the analytical assessment directly after instruction than those who were taught using direct instruction, but they also retained the information at a lower rate six weeks later in comparison to those who received the information through direct instruction. It is important to note, however, that the analytical scores of students in both direct instruction and experiential learning experienced a steep decline to near pre-test levels six weeks after instruction. Thus, simply, analytical knowledge was not retained. Bransford et al. (2000) would identify this problem as an inability to *conditionalize* the knowledge; the learners did not see the relevance of the learning and failed to access what they knew when confronted with an opportunity for transfer. Kolb and Kolb (2017) would conclude that semantic memory development, rather than full episodic memory, was the result of both types of instruction.

This finding highlights a critical question for educational leaders to consider in educational reform. As states adopt the common core standards nationwide, and thus implement new high-stakes exams, a greater pressure to conditionalize information will be required. Mere recall will no longer be sufficient. American education, of which agricultural education is subsumed, must carefully establish what the true aims of education should be. As policy directs, so schools should deliver. It is alarming to consider that the American public education system is spending a vast majority of the effort and resources on the *banking* of analytical knowledge, which this study indicated, is an investment with a rather short half-life.

Recommendations for Practice

This study employed a one-day treatment for 80 students. Teachers should increase the duration of the treatment to ensure proper *soak time* for their students and ensure that students are personally invested in the subject of interest. Educators should recognize that simply being experiential, also described as active, does not lead to long-term retention. Retention of knowledge is dependent on multi-cycle learning (Kolb & Kolb, 2017). Therefore, instructors are encouraged to slow down and take their time when teaching new concepts to students for better mastery (McIntyre & Munson, 2008). Further, to increase retention of knowledge long term, instructors should consider testing students more frequently over an extended time frame (Carrier & Pashler, 1992; Roediger III & Karpicke, 2006). To offset decay and remind students of what they have learned, teachers should use retrieval cues (Santrock, 2004), especially in instances like the one that occurred in this study where students completed the deferred post-test in a different location than which they learned the content originally.

In addition, teachers should focus more effort on *conditionalizing* the content by making it meaningful and relevant to the learners (Bransford et al., 2000). Tyler (1949) stated that teachers should make each lesson important for learners by stressing its purpose, *writ large*. Therefore, focusing on meaning, relevance, and importance of the learning can increase students' intrinsic desire to learn the content, which may have lasting impacts on their ability to attend to, encode, store, and recall the information years later (Carrier & Pashler, 1992; Schunk, 2012).

Recommendations for Future Research

The treatment for the current study was completed inside one full day with one program in one state. It is recommended that the study be replicated with additional teachers and students across the state and country to determine the long-term effects associated with the type of pedagogy teachers choose to use in their classrooms. In addition, the treatment should be lengthened in terms of days taught to accommodate a more *natural* duration for delivering a full curricular unit of study at the secondary level. Then, the long-term retention of student knowledge should be reassessed as a result of the longer treatment duration.

Research should investigate the roll of student interest and personal connection to the content. This study did not account for students' interest or felt need for instruction on wind energy blade design. Qualitative analyses regarding both teachers and students should be conducted to determine the strengths, weaknesses, opportunities, and threats associated with employing polar opposite pedagogies in the classroom and their effect on student retention.

Discussion

High stakes testing continues to drive decisions made at the secondary level. Teachers feel the pressure to *cover* information as a means to expose students to what they will likely see on the standardized test at the end of instruction. Unfortunately, *teaching* (and specifically, *covering*) does not equate to student *learning*. This study provided evidence that, although students can succeed at varying levels regarding a particular test regardless of pedagogy, their long-term retention of that same knowledge six weeks later is abysmal. Perhaps the results of this study were most impacted by authentic student interest? Rogers (1964) posited that learning must have: (a) a quality of personal involvement, (b) be self-initiated, and (c) be evaluated by the learner. Perhaps it is more about the state of the learner than the chosen methods? Good teaching is not as simple as selecting a particular method to get specific results. This study showed that simply choosing a method of instruction will not guarantee that learning will sustain over time. Teaching is much more intricate than selecting a particular method of instruction. Students need time to process information, especially if and when the information is new. Teachers must spend time inspiring students and helping them understand the importance of the lesson if long-term recall of the information is to occur. Teaching students for long-term, sustained learning is an imperative task and will become increasingly important for improving the overall academic standing of American students when compared to other countries.

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