

The Interaction of Learning Style on Measures of Successful Intelligence in Secondary Agriculture Students Exposed to Experiential and Direct Instruction

Marshall A. Baker¹ and J. Shane Robinson²

Abstract

Understanding the teaching and learning paradigm is a relentless search for educators. Because individual students bring their own learning style preferences to the learning environment, teachers are asked to consider and even adjust their teaching to these preferences to improve student learning. In Kolb's (1984) experiential learning theory, learners have preferences for how they grasp and transform information. These considerations have implications for students' success, or lack thereof, in the classroom. This study determined the interactions that existed between learning style and successful intelligence of secondary agricultural education students. No statistically significant differences were found regarding teaching approaches and students' preferred method of grasping information. However, statistically significant interactions were identified related to students' preferences for transforming information and performance on an analytical assessment. Recommendations point to infusing variability in the classroom, especially in how students are asked to transform the information they have grasped previously. Further research should focus on the motivational outcomes resulting from experiential instruction delivered to students of varying learning styles.

Keywords: experiential learning; successful intelligence; learning styles; experimental; agricultural education; teaching methods

Introduction

Agricultural education has prescribed to an experiential philosophy of learning since the inception in the early 1900s (Baker, Robinson, & Kolb, 2012; Knobloch, 2003; Phipps, Osborne, Dyer, & Ball, 2008; Roberts, 2006). Research, has provided evidence that experiential learning improves academic performance, retention, satisfaction, complexity, and meta-cognitive process development in agricultural education (Anyadoh & Barrick, 1990; Baker & Robinson, 2014; Cheek, Arrington, Carter, & Randell, 1994; Cheek & McGee, 1985; Kotrilik, Parton, & Leile, 1986), as well as in other educational domains (Abdulwahed & Nagy, 2009; Eyler & Giles, 1999; Eyler & Halteman, 1981; Markus, Howard, & King, 1993; Specht & Sandlin, 1991; Steinke & Buresh, 2002).

Experiential learning, defined often by Kolb's (1984) ELT, presents learning as a cyclical process composed of the resolution of two dialectically opposed modes of thinking. ELT is a synthesis of work from key theorists (Dewey, 1934, 1938, 1958; Freire, 1974; James, 1890; Jung, 1960, 1977; Lewin, 1951; Rogers, 1961) that is built on the foundational definition of learning as the "process

¹Marshall A. Baker is an Assistant Professor of Agricultural Education in the Department of Agricultural and Human Sciences at North Carolina State University, 1 Lampe Drive, 210C Ricks Hall, Campus Box 7607, Raleigh, NC, 27696-7607, mabaker6@ncsu.edu

²J. Shane Robinson is a Professor of Agricultural Education in the Department of Agricultural Education, Communications and Leadership and the Associate Director of the Institute for Teaching and Learning Excellence at Oklahoma State University, PIO Building, Stillwater, OK, 74078, shane.robinson@okstate.edu

whereby knowledge is created through the transformation of experience” (Kolb, 1984, p. 38). ELT is based on six propositions: (a) learning is a process, not a set of outcomes, (b) learning is ultimately re-learning, (c) learning involves the resolution of conflicts, (d) learning is a holistic process, (e) learning occurs as the learner interacts with their environment, and (f) learning involves the process of creating knowledge (Kolb & Kolb, 2005).

The learning structure purported by ELT (Kolb, 1984) is grounded in four learning modes – concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE). Any one mode, or combination of modes, can govern learning at any given moment (Kolb, 1984). An educator plays an important role in facilitating movement through the four modes (Kolb, Kolb, Passarelli, & Sharma, 2014). Agricultural education has always been in a unique position to embrace this epistemological approach due to its experiential nature (Baker et al., 2012). ELT has been shown to increase student satisfaction in the course, improve retention of information as measured on examinations, develop a deeper, more complex understanding of concepts, improve practical use of information, and develop meta-cognitive skills useful in all domains (Abdulwahed & Nagy, 2009; Eyer & Giles, 1999; Eyer & Halteman, 1981; Markus et al., 1993; Specht & Sandlin, 1991; Steinke & Buresh, 2002). Though this research has been promising, Kirschner, Sweller, and Clark (2006) argued sufficient research, including controlled experiments, has not been conducted sufficiently to warrant such a strong faith in experiential learning. Moore (1999), a supporter of experiential learning, echoed this sentiment and suggested that supporters of experiential learning must be willing to admit that learning experientially does not always work.

One such area of concern is the effect of learning style on the effectiveness of experiential learning approaches. This complex experiential learning process is not identical for everyone. As an individual seeks to resolve the conflicts associated with various experiences, there are preferences in the tools or learning modes that are used. “The dilemma for the scientific study of individual differences is how to conceive of general laws or categories for describing human individuality that do justice to the full array of human uniqueness” (Kolb, 1984, p. 63). Kolb (1984) warned of the formist epistemology of learning types that are viewed as reality. In practice and research, there is a marked tendency to view these learning styles as fixed traits (Garner, 2000). An alternative epistemological approach, of which Kolb (1984) subscribes, is contextualism, where the person is examined in the context of the event by which both the person and the event are shaped.

Drawing from Tyler’s (1978) possibility processing structures, Kolb (1984) shared,

The implication of the contextualist worldview for the study of human individuality is that psychological types or styles are not fixed traits but stable states. The stability and the endurance of these states in individuals come not solely from fixed genetic qualities or characteristics of human beings; nor, for that matter, does it come solely from the stable, fixed demands of environmental circumstances. Rather, stable and enduring patterns of human individuality arise from consistent patterns of a transaction between the individual and his or her environment. The way we process the possibilities of each new emerging event determines the range of choices and decisions we see. The choices and decisions we make, to some extent, determine the events we live through, and these events influence our future choices. (pp. 63-64)

Individual learners choose to process experiences in different ways. Some use apprehension and/or comprehension preferences, and others use intention and/or extension preferences. Those that prefer apprehension like the physical sensory mode of taking in information while those who prefer comprehension seek to take in new information abstractly. Learners that prefer intention, like to make sense of their surrounding by reflecting internally, while those preferring extension seek to make sense of the world by engaging with it directly (Kolb, 1984).

A person's preferred learning style can have a dramatic effect on his or her learning process, and as such, "experiential learning techniques per se are not preferred by everyone" (Kolb, 1984, p. 71). Sternberg and Grigorenko (2004) found that when students were taught in ways that align with how they prefer to learn, they outperformed students who are not afforded these same opportunities. However, other research has resulted in conflicting messages. Previous studies on the topic have concluded that a relationship exists between academic achievement and the converging learning style (Boyatzis & Mainemelis, 2000; Rutz, 2003). Other research, however, has suggested that students improve their academic performance when both converging and assimilating learning styles are evident (Kolb, 1984; Lynch, Woelfl, Steel, & Hanssen, 1998; Malcom, 2009; Newland & Woelfl, 1992). In agricultural education, research on learning styles and student outcomes have focused heavily on the use of the Group Embedded Figures Test (GEFT) assessment in post-secondary populations of interest. Unfortunately, the GEFT assessment has produced conflicting messages. In some studies (Brown, Terry, & Kelsey, 2013; Garton, Spain, Lamberson, & Spiers, 1999; Marrison & Frick, 1994), it was concluded that learning styles had no relationship to student achievement. Conversely, in other studies, statistically significant interactions were found between learning style and achievement, as defined by a multiple-choice examination (Dyer & Osborne, 1996), as well as between students' creative output and self-reported GPA (Friedel & Rudd, 2006).

Theoretical Framework

The theoretical framework underpinning this study was Kolb's (1984) Experiential Learning Theory (ELT). Kolb's ELT (1984) provided the congruence between the theoretical basis and the context of which the learning orientation inventory had value, as called for by Price (2004), to bring clarity to research on learning preferences. The concept of learning styles is embedded within the ELT framework whereby learners hold preferences in the four learning domains: (a) concrete experience, (b) reflective observation, (c) abstract conceptualization, and (d) active experimentation (Kolb, 1984).

These preferences for grasping and transforming experiences have been captured psychometrically since 1971 through the Kolb Learning Style Inventory (KLSI) (Kolb, 1985, 1986; 1999, 2007). A four-learning style model, as well as a nine-learning style model, has been used in previous studies. Research has demonstrated, through both exploratory and confirmatory factor analysis, that there is an underlying two-factor ipsative structure of how students transform educational experiences, congruent with Kolb's (1984) theory of experiential learning (Kayes, 2005). In this study, the emphasis was placed on the four-quadrant learning style approach of the KLSI 3.1 (Kolb, 1999) due to the psychometric stability of the instrument resulting from more widespread use and confirmation. The KLSI 3.1(1999) results in one of four learning styles: diverging, assimilating, converging, and accommodating.

An individual with the *diverging* style prefers to learn primarily through feeling (CE) and reflecting (RO). This style is known as the *creator* (see Figure 1). A person with this preference is best at viewing concrete situations from a myriad of perspectives. Divergent learners prefer to observe rather than to act, and enjoy situations that call for a wide range of feelings and ideas. Informal learning situations, a learner of this preference would prefer to work in groups and needs to receive personalized feedback and attention regarding their efforts and progress or lack thereof (Kolb & Kolb, 2009).

Learners with an *assimilative* style prefer to learn through observation (RO) and thinking (AC) and are referred to in Figure 1 as the *planner*. They like to make decisions based on logical reasoning and prefer to deal with technical tasks rather than social and interpersonal issues. These individuals prefer that a theory be elegant and logical rather than practical. Assimilators may prefer to work alone, and refrain from making quick decisions but rather spend adequate time thinking through a problem

before acting. In formal settings, these learners prefer lectures, readings, exploring analytical models, and having adequate time to think and plan (Kolb & Kolb, 2009).

Learners with a *converging* style emphasize thinking (AC) and acting (AE), and are referred to in Figure 1 as the *decision maker*. Those who prefer to learn in this way find practical uses for ideas and theories. Like assimilators, they prefer to solve problems and make decisions based on finding logical solutions. Interpersonal and/or ambiguous situations are not an area of strength since feelings and reflection are not a mode of learning indicative of this style. Informal learning settings, a converging learner prefers to experiment with ideas. This includes simulations, laboratory-based learning, and practical applications (Kolb & Kolb, 2009).

Finally, learners with an *accommodating* style learn primarily through acting (AE) and feeling (CE). They are referred to as the *doer* (see Figure 1). This learning preference seeks hands-on experiences and is comfortable in ambiguous learning situations. Setting goals and meeting challenges are indicative of this learning style. These learners tend to proceed in situations according to gut feelings over a logical analysis of issues. They can act before thinking and be disorganized because of their lack of preference for reflection. Informal learning settings, accommodators prefer to work in groups and find ways to accomplish group goals. Fieldwork is preferred over theoretical discussions (Kolb & Kolb, 2009).

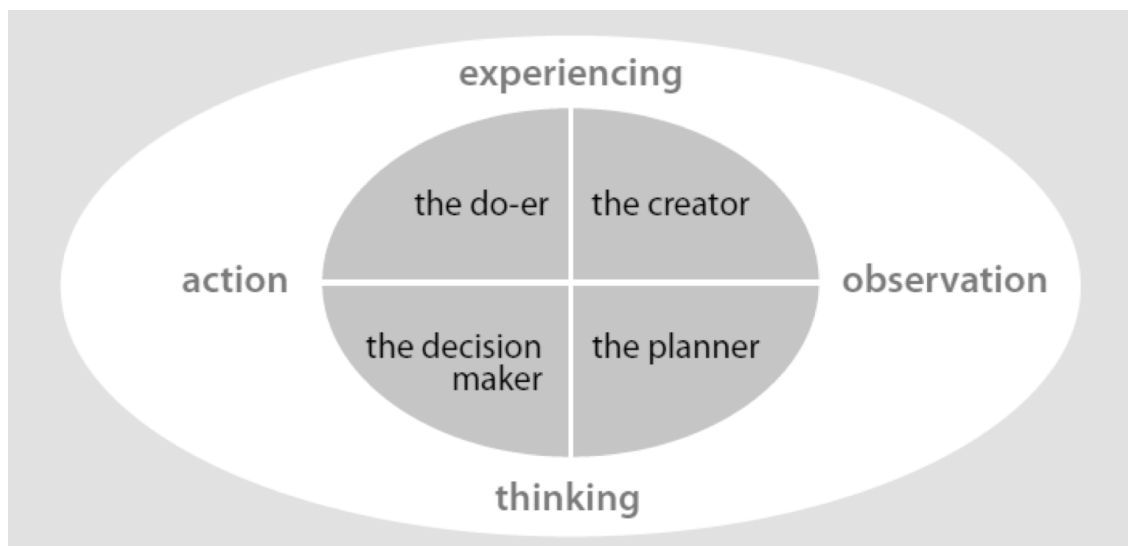


Figure 1. KLSI 3.1 Model of Experiential Learning Process. Reprinted from *The Kolb learning style inventory – Version 3.1: LSI workbook*. (p. 3), by David A. Kolb, 2007, Boston, MA: Hay Learning Transformations. Copyright 2007 by Haygroup. Reprinted with permission.

Sternberg's Theory of Successful Intelligence

Alireza, Mahyuddin, Elias, Shafee, and Shabani (2011) explained that it was imperative to utilize measures beyond standard examinations because the differences between learning style products are not detectable without broader assessments. Sternberg's (1999) Theory of Successful Intelligence defined achievement in this broader sense and framed the outcome variables. Sternberg (1999) listed three factors of learning that should be considered: a) analytical intelligence: skills used to analyze, evaluate, judge, or compare and contrast, b) practical intelligence: skills used to implement, apply, or put into practice ideas in real-world contexts, and c) creative intelligence: skills used to create, invent, discover, imagine, suppose, or hypothesize. Sternberg (1999) theorized that a construct of successful

intelligence “better captures the fundamental nature of human abilities” (p. 292). This concept of intelligence stands in contrast to the conventional general ability views of intelligence that Sternberg (1999) described as narrowly based and incomplete. At times, the method of experiential learning has been a difficult treatment to understand fully (Roberts, 2012), which led to the broader perspective of learning utilized in this study.

Need and Purpose of the Study

Over the last ten years, the discussion of learning styles has been dominated by the conclusion that individual differences in learning preference do not impact performance (Brown & Kelsey, 2013; Cano, Garton, & Raven, 1992; Garton, Spain, Lamberson, & Spiers 1999; Thornton, Haskell, & Libby, 2006; Whittington & Raven, 1995). Alireza et al. (2011) has challenged that conclusion and suggested that perhaps the measures being examined are not broad enough to detect any effects. The conflicting conclusions surrounding learning styles are troubling for educators as they design and deliver instruction. Educators could be either incorrectly dismissing learning style, systematically advantaging certain learners, or focusing too much on diversified learning methods when all students can excel regardless of learning preference. This concern is elevated in an educational program like agricultural education where the curriculum is purposefully built to be experiential and inherently concrete.

The purpose of this study is to examine performance, more broadly defined by Sternberg (1999), to determine if the differences found in the study by Blind Authors (2014) could be attributed to learning style. Two research questions framed this study:

1. What are the preferred learning style indicators of secondary agricultural education students in the selected agricultural education program, as measured by the KLSI 3.1?
2. What interaction exists between learning style, measures of successful intelligence, and the instructional approach?

Methods and Procedures

The population of interest in this complete random factorial (CRF – 22) experimental study (Kirk, 1995) was all students enrolled in the participating secondary agricultural education program ($N = 120$). The agricultural education program is in a rural community with a population of approximately 46,000 people (www.city-data.com/city/Stillwater,Oklahoma.html). The entire program was chosen to attempt to acquire a representative sample of a *typical*, holistic, agricultural education program in Oklahoma. This somewhat isolated population, though limiting in generalizability, provided additional control of nuisance variables associated with varying social contexts of communities and schools. It is recognized that experimental approaches, by nature, yield high control and internal validity, but external validity can be limited (Kirk, 1995). As such, it is advised that conclusions and recommendations be interpreted with the research context in mind. From this population, a sample of 80 participants completed IRB consent and assent forms and participated in the full study. Of the 80 participants, 38 were assigned randomly to the treatment group and 42 to the comparison group. Descriptive statistics were used to answer research question one. Research question two was answered through the CRF – 22 design employing two omnibus MANOVA analyses – one focusing on the grasping dimension, and one focusing on the transforming dimension. Additionally, simple main effects were analyzed to determine if interactions existed between learning style and other dependent measures of successful intelligence (Stevens, 2009).

Wind turbine blade design served as the content of interest for the experiment. This content was chosen purposefully as it was congruent with course objectives for agricultural education, was a relevant and worthy topic considering the growth of wind turbines in Oklahoma, and included adequate

science, technology, engineering, and mathematics (STEM) concepts. The goal was to provide a full unit of instruction, which typically would be taught over the course of one week in an instructional setting, during a four-hour period to maintain the experimental control. Instruction was delivered in two different treatments – direct instruction and experiential learning designs. To reduce teacher effect, eight instructors were assigned randomly to the two experimental conditions so that each condition included a lead instructor and three assistant instructors (Weiss, 2010).

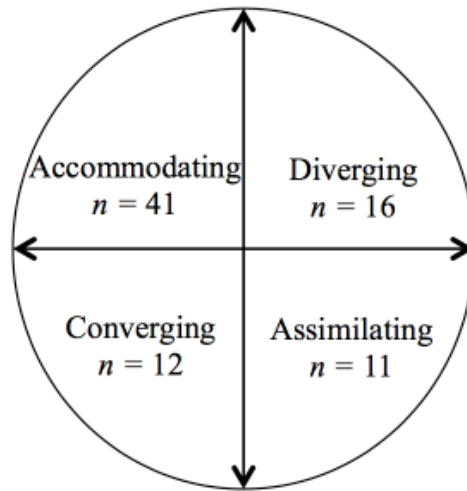
Kolb's Learning Style Inventory 3.1

Kolb's (1999) KLSI 3.1 is one of the most influential and widely distributed instruments used to measure individual learning preferences (Kayes, 2005). The KLSI is based on Kolb's (1984) ELT, where learning consists of four constructs – CE, RO, AC, and AE. This instrument includes twelve sentence stems followed by four possible sentence endings. Subjects rank each of the four endings based on their preference for using the four modes. This procedure results in a 48-response instrument that is self-reported. We tabulated a total score for each student's learning mode. In addition, combined scores for each of the dialectically opposing modes of grasping and transforming (Kolb, 1984) were calculated. Research has generally supported the internal reliability of the LSI-2, the previous version of the instrument, with Cronbach's alpha estimates ranging from .80 to .87 (Geiger, Boyle, & Pinto, 1993; Loo, 1999a; Willcoxson & Prosser, 1996). Kayes (2005) analyzed the current version, KLSI 3.1, for internal reliability and found Cronbach's alpha estimates ranging from .77 to .82 for each of the four-dimensional constructs and .77 to .84 for the grasping and transforming constructs, respectively. In addition, research has confirmed the internal construct validity of a two-factor structure (Kayes, 2005; Loo, 1999a, 1999b; Yahya, 1998) proposed originally by Kolb (1984). Thus, it was determined that the KLSI 3.1 was a valid and reliable measure of learning style in this study.

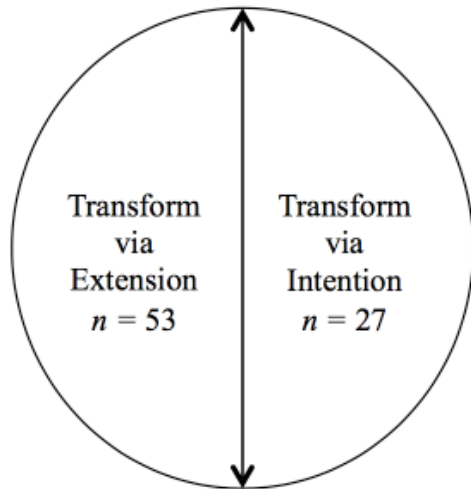
Approach to Analyzing the Effect of Learning Styles

One week prior to the experiment, Kolb's (1999) Learning Style Inventory, Version 3.1 (Kolb, 2007), was administered to each of the students who agreed to participate in the study. This instrument scored, and a data source of subjects with the specified learning style was identified. It was found that certain learning styles had inadequate sample sizes to achieve necessary statistical power (see Figure 2). Research has demonstrated, through both exploratory and confirmatory factor analysis, that there is an underlying two-factor ipsative structure of how students transform educational experiences congruent with Kolb's (1984) theory of experiential learning (Kayes, 2005). A procedure was employed to assess learning style in a two-dimensional view rather than the standard four-dimensional manner outlined by Kolb (2007). This procedure required that participants be classified based on their preferences for either grasping or transforming information. Each participant was assigned two learning preferences. The statistical analyses were conducted and reported using this grasping and transforming distinction. This analysis not only provided procedural checks (Stevens, 2009), but also allowed the examination of the role of learning style with adequate sample size and power.

Conventional Four Learning Style Framework (Kolb, 2007)



Viewing Learning Style by Transformation



Viewing Learning Style by Grasping

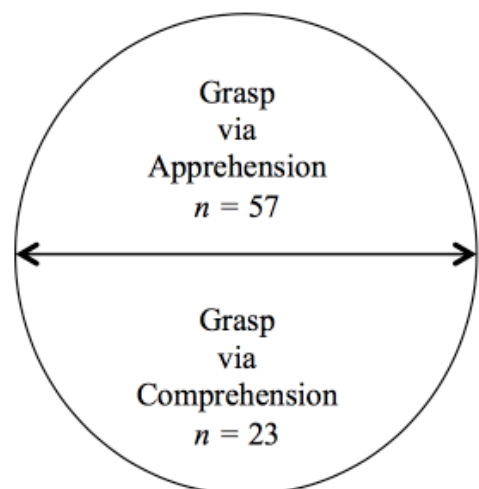


Figure 2. Visual Representation of Learning Style Interpretation.

Successful Intelligence Assessments

Successful intelligence measures, as defined by Sternberg (1998), were used to include a broader array of metrics to detect interactions connected to learning styles as suggested by Alireza et al. (2011). Three metrics were employed to measure analytical, practical, and creative use of the information presented in the treatment. The Analytical Wind Energy Assessment (AWEA), a criterion-referenced test based on the selected educational objectives of the blade design instructional unit, served as the main analytical assessment for the study. The assessment was created as a collaborative effort between the researchers and the KidWind® staff and consultants, experts in the field of wind energy engineering, and pedagogical experts in agricultural education. The AWEA conformed to the eight criteria necessary for improving the reliability of criterion-referenced examinations (Wiersma & Jurs,

1990) and produced Kuder-Richardson 20 (Cronbach, 1970) reliability coefficients, which were as follows: (a) .82 for the pre-test, and (b) .90 for the post-test. Based on these coefficients, it was determined that the AWEA was a reliable measure of students' analytical knowledge for this study.

Sternberg (1998) explained that practical knowledge requires students to apply, use, put into practice, implement, employ, and render practical what they know. The practical application used in this study was an authentic assessment that represented the most logical extension of the lesson – to design, build, and test a wind blade using materials provided by the instructors. Each student was provided a universal blade hub and asked to create a wind turbine design intended to produce the most voltage possible in one hour using a common bank of materials. Each blade design was attached to a model tower containing a small generator, which was placed in front of a box fan set at a constant speed. The voltage output was measured using a voltage meter. All variables, aside from the design of the blade, were held constant, and each voltage output was recorded.

Creativity was operationalized in this study as the ability to produce something that is both novel and useful (Sternberg, 1998). The measurement of creativity was based on the idea that creativity can be measured (Guildford, 1950) and the basic strategies employed by the Torrance Tests of Creative Thinking (TTCT; Torrance, 1974). The TTCT (Torrance, 1974) operationalized creativity as statistical infrequency, which can be calculated and scored objectively. As such, two pictures were captured of each blade design created by the participants, and they were assessed on six chosen divergent elements: (a) number of blades, (b) blade length, (c) blade pitch, (d) blade shape, (e) blade material, and (f) blade elaboration. A statistical scoring process was used to determine the divergence of each design to quantify the creative intelligence in the context of wind turbine blade design.

Findings

Research question one sought to determine the learning styles of secondary agricultural education students participating in this experiment. Under the conventional four learning style framework depicted in Figure 2 (Kolb, 2007), it was determined that 41 (51.25%) students were classified as accommodating, 16 (20.00%) diverging, 12 (15.00%) converging, and 11 (13.75%) assimilating. It was thus deduced that 53 (66.25%) students transform via extension and 27 (33.75%) students transform via intention. Also, 57 (71.25%) students grasp via apprehension while 23 (28.75%) students grasp via comprehension.

Research question two sought to determine what interactions existed between students' learning style, their successful intelligence, and the instructional approach chosen. The means and standard deviations for each of the three measures, creativity (see Table 1), practical use (see Table 2), and analytical ability (see Table 3), provide context to treatment differences and differences between learning style categories.

Table 1

Creative Score Means and Standard Deviations

		Experiential Learning		Direct Instruction	
		<i>N</i>	<i>M (SD)</i>	<i>n</i>	<i>M (SD)</i>
Grasping via	Apprehension	26	6.04 (3.01)	31	3.68 (2.02)
	Comprehension	12	6.67 (3.92)	11	3.91 (2.81)
Transforming via	Extension	24	6.33 (3.09)	29	3.69 (2.27)
	Intention	14	6.07 (3.71)	13	3.85 (2.19)
Treatment	Total	38	6.24 (3.28)	42	3.74 (2.20)

Table 2

Practical Score Means and Standard Deviations

		Experiential Learning		Direct Instruction	
		<i>N</i>	<i>M (SD)</i>	<i>n</i>	<i>M (SD)</i>
Grasping via	Apprehension	26	.85 (.43)	31	.41 (.30)
	Comprehension	12	.67 (.42)	11	.39 (.30)
Transforming via	Extension	24	.83 (.37)	29	.36 (.27)
	Intention	14	.72 (.54)	13	.51 (.33)
Treatment	Total	38	.79 (.44)	42	.41 (.29)

Table 3

Analytical Pre-Test Post-Test Mean Differences and Standard Deviations

		Experiential Learning		Direct Instruction	
		<i>N</i>	<i>M (SD)</i>	<i>n</i>	<i>M (SD)</i>
Grasping via	Apprehension	26	8.81 (6.43)	31	12.52 (5.49)
	Comprehension	12	9.67 (8.25)	11	10.00 (7.07)
Transforming via	Extension	24	11.08 (7.41)	29	11.24 (6.13)
	Intention	14	5.64 (4.48)	13	13.23 (5.54)
Treatment	Total	38	9.08 (6.95)	42	11.86 (5.96)

Two omnibus multivariate analyses of variance were utilized (see Table 4) to identify any interactions between learning styles and performance in the three types of successful intelligence.

Table 4

Summary of Two MANOVA Analyses Testing for Simple Main Effects of the Treatment Conditions by Learning Style (*df* = 73)

Source of Variance	Λ	<i>F</i>	<i>p</i>	Power
Group x Transforming	.85	3.16	.02	.80
Group x Grasping	.95	.84	.50	.26

Using Wilk’s statistics, there were statistically significant simple main effects between the treatment group and the transforming learning style, $\Lambda = .85, F(3, 76) = 3.16, p = .02$. Viewing the simple main effects from the grasping learning style distinction, non-statistically significant interactions were found $\Lambda = .95, F(3, 76) = .84, p = .50$. As described by Stevenson (2009), once the statistically significant simple main effect was identified in the group by transformation analysis, focus turned solely to the nature of that interaction.

Each interaction is depicted visually in Figure 3. Further analysis of the simple main effects found a non-significant interaction between both the practical intelligence voltage measure, $F(1, 79) = 2.86, p = .10, \eta_p^2 = .04$ and the creative intelligence measure, $F(1, 79) = .05, p = .82, \eta_p^2 = .00$. Analysis of the interaction between treatment group and analytical intelligence, named test gain in the graphs,

yielded a statistically significant interaction, $F(1, 79) = 11.41, p = .00, \eta_p^2 = .14$, with a large practical effect (Cohen, 1977).

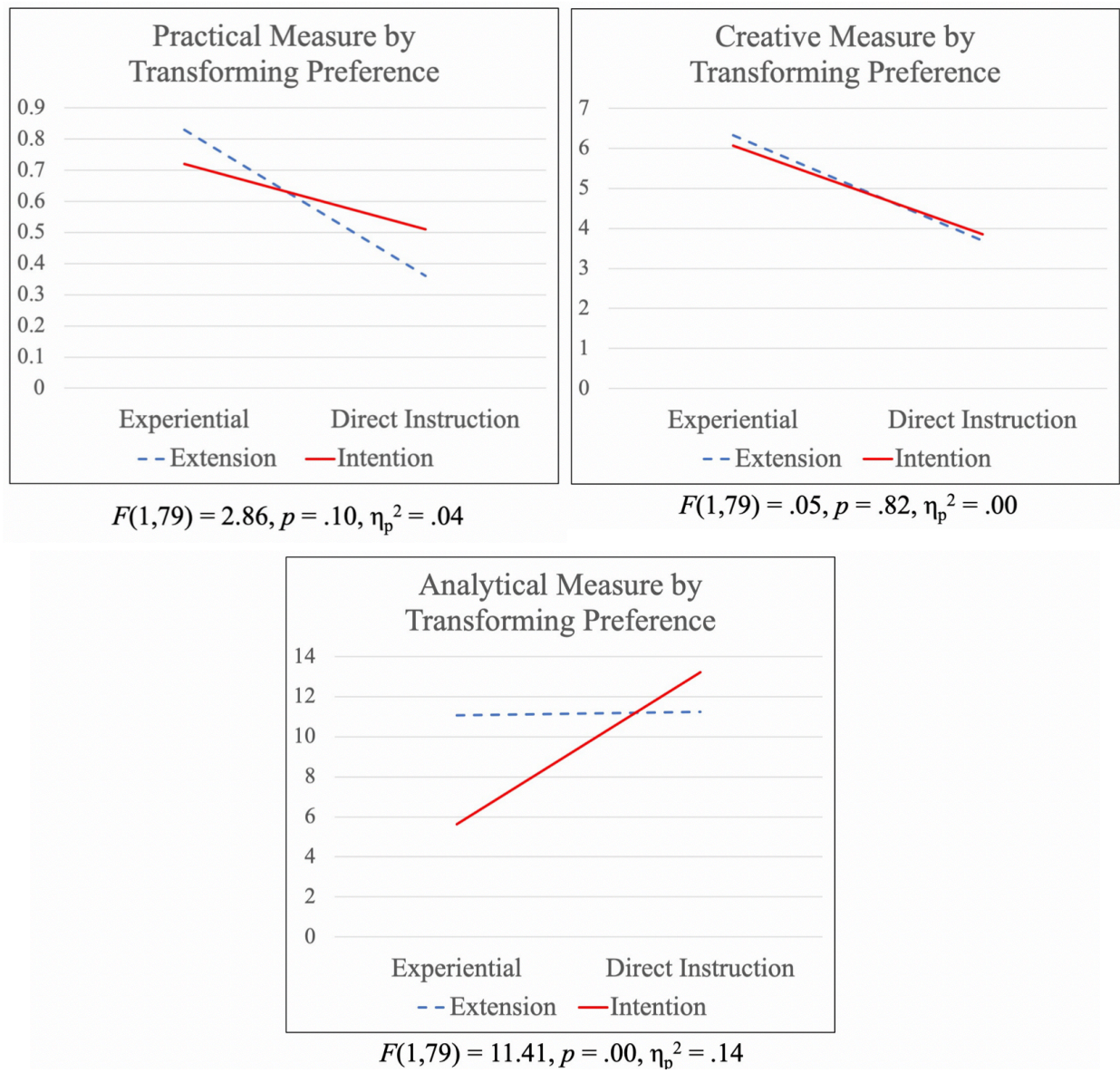


Figure 3. Graphs of Simple Main Effects for Each of the Measures of Successful Intelligence within the Transformation Analysis

Conclusions, Discussions, and Implications

Conclusion 1: Agricultural education students in this study were predominantly accommodators. As such, students generally preferred to transform information via extension and grasp information via apprehension.

The trend of homogeneity in learning styles within selected settings has emerged in a number of studies (Kolb & Kolb, 2005). A similar study of learning styles found the majority of students in the

same college program and major, pursuing similar passions, and involved in a common activity were quite similar in learning style, as defined by the KLSI (Kolb, 1999). In agricultural education, Brown et al. (2013) found this same trend, as 60% of students attending a leadership camp were extroverted in their learning style – another perceived match of a learner and environment.

Kolb (2007), in the KLSI workbook, described an accommodator as a “doer” (p. 4). This description, juxtaposed with the FFA Motto of *Learning to Do, Doing to Learn, Earning to Live, and Living to Serve* (National FFA Organization, 2008), calls to question whether agricultural education, as operationalized by the secondary agricultural education program of interest in this study, strongly favors this preference for apprehension and extension. If agricultural education is naturally experiential (Baker et al., 2012), how does the program in Oklahoma recruit and retain students with a preference toward grasping through comprehension and transforming through intention?

Conclusion 2: Students’ ability to perform analytically is dependent on their preferred method of transforming an experience.

The results of this study support the claims of differences (Dyer & Osborne, 1996; Kolb, 1984; Lynch, Woelfl, Steel, & Hanssen, 1998; Malcom, 2009; Newland & Woelfl, 1992; Rutz, 2003; Sternberg & Grigorenko, 2004) in student outcomes based on learning preferences, and further clarified where exactly these differences occur. Though differences were found between all three categories of successful intelligence, learning style played a role only in the analytical measure – which would align most closely to secondary schools’ traditional view of achievement on an examination. This finding appears to refute literature on a battery of learning style assessments that found they rarely play a significant role in formal learning processes (Brown et al., 2013; Cano et al., 1992; Garton et al., 1999; Thornton et al., 2006; Whittington & Raven, 1995).

Analyses of the graphed interactions (see Figure 3) highlight an obvious and consistent treatment effect where experiential learning yielded higher gains in both practical and creative intelligence measures – congruent with findings reported by Blind Authors (2014). However, Blind Authors (2014) reported also that direct instruction yielded higher analytical intelligence scores. The interaction in this study elucidated the more complicated relationship between analytical performances, type of instruction, and preference for transforming information. Students who prefer to transform via intention perform better analytically if taught in a more abstract way as prescribed in the methods of direct instruction. Students preferring to transform via extension performed better analytically when exposed to curriculum allowing active experimentation – an element of experiential learning. Kolb (1984) explained that, “the learning process is not identical for all human beings. Rather, it appears that the physiological structures that govern learning allow for the emergence of unique individual adaptive processes that tend to emphasize some adaptive orientations over others” (p. 62). Educators should consider both types of transformation that aid in the development of all students ensuring their unique cognitive processes are occurring, especially when an analytical task such as an examination is of particular interest.

The statistically non-significant interactions resulting from the study also are of interest. Though a large percentage of students preferred to grasp information through concrete experiences, this preference did not have a statistically significant effect on any of the three measures of successful intelligence. Agricultural education often boasts the benefits of a *hands-on* approach. However, this study seems to support the premise that all students can grasp information through either apprehension or comprehension – sensory or cognitive. The focus of instruction, therefore, should be on how students are guided to transform those grasped experiences. Whether students learn in the classroom or in the field, there should be opportunities for both intentional reflection and extension through experimentation.

Recommendations for Practice

Agricultural educators should be reminded that an experiential approach to teaching and learning implies a balanced delivery of both methods of grasping and transforming information. Failure to maintain balance in the four modes could systematically place students with certain learning preferences at a disadvantage. As often explained, variability remains a powerful element of quality instruction (Rosenshine & Furst, 1973). Special attention should be afforded to methods of transformation when an analytical measure, such as an examination, is of specific interest. In the high stakes test climate of public education, of which agricultural educators play an important role, this could be of specific importance. Agricultural educators should be comforted by the fact that students of all learning styles can grasp information from both concrete experiences and abstract conceptualization in a formal, *traditional* classroom setting.

Specifically, teachers should be most concerned with learning preferences when asking students to perform analytically, defined by Sternberg (1999) as skills used to analyze, evaluate, judge, or compare and contrast. Educators can deliver selected content in any manner they choose, but the opportunity for transformation by the student should be individualized based on learning style. Students who prefer to grasp information concretely, need an opportunity to transform the information through extension or experimentation. In contrast, those who prefer abstract delivery of content, need an opportunity to transform the information through intention and reflection. Student choice following instruction could provide this differentiation.

Teacher educators should purposefully model both the intention and extension dimensions of learning to pre-service teachers by demonstrating and providing methods of transformation. Perhaps it would be beneficial to utilize Kolb's (2015) experiential learning cycle in teacher education to make clear the learning process which includes the grasping of new information and the transforming of that into current schemas. The KLSI would be very helpful in the teacher training process to at least spark conversations around learning preferences. Based on the conclusions of this study, transformation appears to be the area that warrants attention related to individual learning differences. Often, transformation is described as reflection and/or application. A focus on the role that both reflection and application play in the learning process is important, and perhaps students have different needs for those two methods based on their style. Teacher educators should utilize the Educator Role Profile (ERP; Kolb et al., 2014) to help teachers identify their preferred teaching role in relation to the experiential learning cycle. An awareness of teacher preferences is important in purposefully designing instruction that completes the experiential learning cycle. Teachers that constantly design instruction around their personal preference of transformation could be systematically disadvantaging students with a different preference.

Recommendations for Research

Four extensions of this study are recommended. First, studies exploring the cause of the homogeneity of learning style in agricultural education could expose potential strategies for recruitment of a more learning diverse student body. Is there a trend related to learning styles of students who choose against participating in agricultural education? Second, research related to learning styles should employ a broader array of assessments to capture the effects that learning preferences have on various student outcomes. Third, further research should explore the relationship between learning styles, methods of instruction, and motivation for the subject taught. Sternberg (1999) included motivation as an important construct to be measured in addition to measures of successful intelligence. Finally, the clinical nature of this experiment required a non-traditional setting, which introduced the potential for bias to occur due to a novelty effect (i.e., students in the study were displaced from their usual classroom

to a dissimilar learning environment in a different part of town). Research should be replicated in a less controlled, more typical secondary school setting.

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