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Effects of the Order of Abstraction and Type of Reflection on Content Knowledge when Teaching Experientially in a High School Classroom

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Abstract

In classrooms today, teachers continue to strive to enhance student knowledge and application by designing learning environments which create experiences for students to interact collaboratively, solve problems, think critically, and learn by doing. Research has indicated that teacher knowledge of the experiential learning cycle has become increasingly important to assess what was learned. This exploratory study sought to determine the effect of reflection-in and reflection-on-action regarding content knowledge, the effect the order of abstraction had on content knowledge, and if any interaction existed between type of reflection and order of abstraction on content knowledge scores of secondary agriscience students. Utilizing a 2 x 2 randomized experimental design, research was conducted in a secondary agriscience classroom. How order of abstraction and type of reflection were implemented were found to be significant in the development of discussion skills. Agriscience teachers should be made aware of the benefits on student learning outcomes when effective concrete experiences are designed for their students to engage, reflect, conceptualize, and experiment.

Keywords: Experiential learning; reflection; order of abstraction; agriscience classrooms; learning environment; student learning outcomes

Introduction

Historically, the Hatch Act of 1887 provided momentum for the original agriscience programs. Liberty Hyde Bailey (1908) recognized the need for agricultural education teachers to have broad training in scientific concepts in order to teach a science-based curriculum (Hillison, 1996). In 1917, the Smith-Hughes Act shifted the emphasis from an academically, science-based curriculum to vocational training. Although the vocational components of the curricula were highlighted, the science in the field of agriculture remained (Hillison, 1996). Over time, emphasis in the field of agriculture has become progressively grounded in science and increasingly more technologically complex to meet the demands of the future (Hillison, 1996). Teaching science through agriculture where learning can be applied through concrete experiences has provided occasions to more effectively teach science (National Research Council, 1988). Nearly a century after the Smith-Hughes Act, teachers and schools are being continually pushed towards enhancing science, technology, engineering, and math (STEM) concepts in the learning environment. As the 21st century workplace continues to change, the need for students to be prepared to enter college or a career persists as an important discussion in all aspects of K-12 education, business, and industry (Carnevale, Smith, & Melton, 2011; Conley, 2014).

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In classrooms today, teachers continue to strive to enhance student knowledge and application by designing learning environments which create experiences for students to interact collaboratively, solve problems, think critically, and learn by doing. To increase the quantity and duration of experiences students engage in, many learning activities and teaching strategies have become focused on laboratory-based, scientific principles and methods (Abdulwahed & Nagy, 2009). These types of experiences can assist in preparing students to be academically and technically ready to pursue college and careers. Experiential learning has played a significant role in integrating STEM into the agricultural education program model (Baker, Brown, Blackburn, & Robinson, 2014).

School-based Agricultural Education (SBAE) programs are built with a strong foundation of curricular emphasis in relation to experiential learning (Baker, Robinson, & Kolb, 2012; Knobloch, 2003; Roberts, 2006; Zilbert & Leske, 1989). Despite the agreement that experiential learning has positive benefits, little has been reported in terms of how to successfully teach based on experiences (Baker et al., 2014). The three circle model which includes, classroom and laboratory instruction, a supervised agricultural experience, and participation in the National FFA organization in the SBAE program provides a foundational setting for formal experiential learning activities to take place on a daily basis.

Many agriscience teachers have been unaware of the experiential learning cycle and have needed instruction to develop curricular plans (Arnold, Warner, & Osborne, 2006; Shoulders & Myers, 2013) which would guide students through a series of four cyclical events that include a concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 1984; Roberts, 2006). Typically, formal experiential learning behaviors arise in classrooms and laboratories (Etling, 1993). Whereas the Supervised Agricultural Experience Program (SAEP) has been recognized as the experiential learning component of a SBAE program. Research conducted by Arnold et al. (2006) questioned to what extent experiential learning was used by high school agriscience teachers. Findings indicated although experiential learning was being implemented, it was not always cyclical (Arnold et al., 2006). Research conducted by Baker et al. (2012) concluded experiential learning theory should be incorporated into each of the three components of a SBAE program.

As education has been reformed, the role of the teacher has changed from delivering information in a passive teacher-centered environment to facilitating learning in an active student-centered environment (Padron & Waxman, 1999). Research has indicated that teacher knowledge of the experiential learning cycle and how people learn has become increasingly important to assess what was learned (Arnold et al., 2006; Baker et al., 2014; Knobloch, 2003; Shoulders & Myers, 2013).

Baker, Robinson, and Kolb (2012) suggested the need to compare students who are engaged in a series of agricultural education experiences to those who experience similar concepts delivered in a lecture-based approach. Similarly, Baker et al. (2014) posited the need to train in-service and preservice teachers to be cognizant of reflection-in-action techniques. Shoulders and Myers (2013) cautioned that researchers also need to assess potential perceived barriers for teachers' incorporation of reflective or experimental activities. Arnold et al. (2006) indicated class enrollment, time, supervision, and management of student activities as potential challenges faced by teachers when utilizing the experiential learning model. This research sought to build from the recommendations of Baker et al. (2014) by determining if statistical significance exists in order of reflection and order of abstraction when providing opportunities for high school agriscience students to engage in the experiential learning cycle. This research also sought to continue to explore how to best implement and deliver instruction in secondary agriscience classrooms/laboratories based on the perceived barriers that may exist.

Although the teacher is challenged to manage student learning in a way that facilitates learning rather than simply introducing information, changed methods of instruction have provided opportunities for greater student achievement and academic success. Students have benefited through the development of higher order thinking skills, active engagement (Arnold et al., 2006), listening skills, problem-solving, creative thinking, self-esteem, and self- motivation (Leske & Zilbert, 1989) when they are exposed to experiential learning. These are all skills needed for students to be prepared for both college and career in the 21st century (Casner-Lotto, & Barrington 2006; Conley, 2005; Crawford, Lang, Fink, Dalton, & Fielitz, 2011; Stone & Lewis, 2012).

Theoretical and Conceptual Framework

To enhance learning, instructional methods should be focused on student engagement (Baker et al., 2012). When effectively designed, a concrete learning experience should be paramount for student engagement in the learning process. It is posited by some that engagement in a concrete experience should occur at the beginning of the learning process for optimal learning to occur (Phipps, Osborne, Dyer, & Ball, 2008). An examination of past perspectives has indicated that education through experience (Dewey, 1938) and learning by doing are key components to enhancing student learning outcomes.

Kolb's (1984) experiential learning theory (ELT) postulated the theoretical and conceptual framework for this study. Figure 1 provides the conceptual Model of the Experiential Learning Process (Kolb, 1984). Based on the major tenets of ELT, reflective observation along with abstract

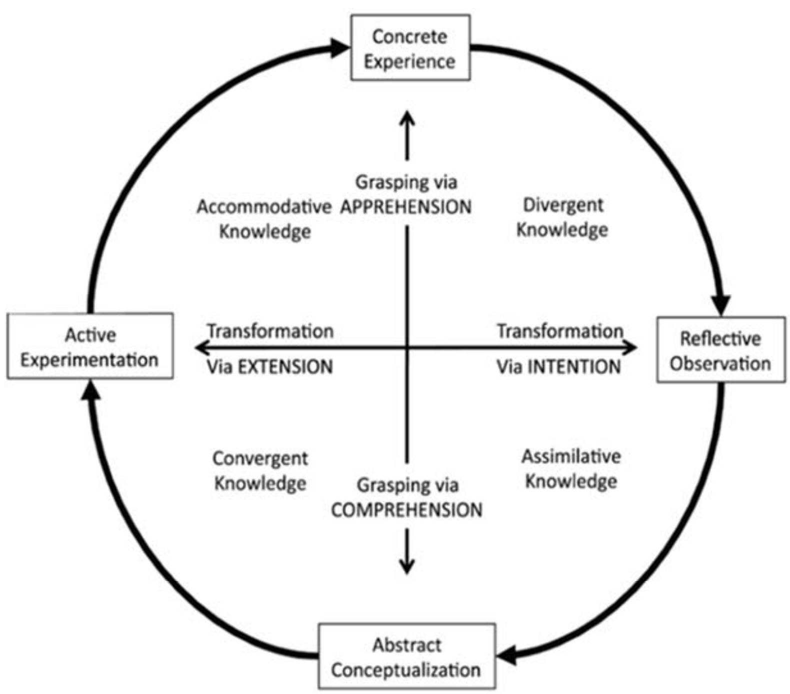

Figure 1. Model of Experiential Learning Process. Reprinted from *Experiential Learning: Experience as the Source of Learning and Development* (p. 42), by David A. Kolb, 1984, Englewood Cliffs, NJ: Prentice-Hall, Inc. Copyright 1984 by Prentice-Hall, Inc. Reprinted with permission.

conceptualization were the major focus for this research. Reflection in-action is synchronous and occurs throughout the teaching process. This type of reflection aids the learner by providing opportunities for them to think about their decisions during the learning process (McAlpine &Weston, 2000). Asynchronous reflection or reflection on-action occurs after the learning activities have occurred. Overall, "reflection is a mechanism for the construction of knowledge from experience" and has resulted in assisting effective learning opportunities (McAlpine & Weston, 2000, p. 371).

Collaborative, student-centered, learning environments that seek to explore real-world problems and provide opportunities for social experience tend to enhance reflective practices (Jonassen, Davidson, Collins, Campbell, & Haag, 1995). Meaningful and rigorously designed occasions for reflection encourage development of higher order thinking skills and can positively impact overall student achievement scores (Arnold, et al., 2006; Moon, 1999; Sobral, 2000).

During the abstract conceptualization stage, content is organized and comprehended by the learner (Roberts, 2006). The processing of interactions with the environment should occur in a way which support cognitive development, where students can make meaning from the experience (Kolb, 1984). Dale's Cone of Experience (1946) provided a model that distinguished between various levels of abstract to concrete experiences which can occur throughout the learning cycle. With respect to Dale's Cone of Experience (1946) in relation to abstract conceptualization, this research focused on whether or not the order of abstraction significantly impacted learning outcomes. The pre-abstraction treatment consisted of an abstract experience (a lecture with discussion) followed by a concrete experience (a laboratory experiment) and the post-abstraction consisted of a concrete experience (a laboratory experiment) followed by an abstract experience (a lecture with discussion).

According to Roberts (2006) experiential learning is a cyclical process, defined by the context in which it occurs, and involves an initial focus, an interaction with the phenomenon being studied, reflection on the experience, development of generalizations, and finally opportunities to test those generalizations. There are four dimensions required in order for experiential learning to occur contextually. The four required dimensions are: the level, the duration, the intended outcome, and the setting (Roberts, 2006).

Purpose and Objectives

Based on the recommendations of an exploratory study conducted by Baker et al. (2014), this study sought to determine the effect of reflection-in and reflection-on-action regarding content knowledge, the effect that the order of abstraction had on content knowledge, and if any significant interaction existed between type of reflection and order of abstraction on content knowledge scores of secondary agriscience students. The following objectives guided this study:

1. Describe the effect an interaction between order of abstraction and type of reflection has on content knowledge scores, calculation scores, and discussion scores;
2. Describe the variance in content knowledge, calculation, and discussion scores attributed to the order of abstraction;
3. Describe the variance in content knowledge, calculation, and discussion scores attributed to the type of reflection employed.

Methodology

Overall the design of this study was modeled after the Baker et al. (2014) study. The current investigation utilized a 2 x 2 randomized experimental design (Ary, Jacobs, & Sorensen, 2010). The population of interest was secondary agriscience students, defined as ninth through twelve grade pupils enrolled in a high school agritechnology course. A suburban/rural interface area high school of approximately 1200 students was selected and agreed to participate in the study during the fall of 2015. The School-based Agricultural Education program included enrollment of 40 students in two sections of the agritechnology course.

Students in the agricultural education program at the selected high school were randomly assigned to a treatment group from the two class rosters provided by the agriscience teacher (See Figure 2). Further, all study materials were reviewed and approved by the university Institutional Review Board and parental consent was received from all student participants since the participants were minors. Proper research protocol was followed to obtain permission to conduct research in the high school and permission was granted by the school board.

	Reflection In-Action	Reflection On-Action
Pre-Abstraction	Treatment Group A	Treatment Group B
Post-Abstraction	Treatment Group C	Treatment Group D

Figure 2. 2 x 2 Randomized experimental design

Upon review of the teaching materials (lesson plans and assessments) used by Baker et al. (2014), it was determined that those materials were not appropriate for the high school population of the current study. Some modifications were made to address the high school audience of this study as compared to the collegiate students in the Baker et al. (2014) study. This study did use the same Lab-Aids® biofuels investigation laboratory activity focused on comparing energy stored in two fuels, kerosene and ethanol. Lesson plans, a PowerPoint presentation, and pre/post assessments were developed by the researchers.

Two essential questions were designed for the biofuels lesson: 1) what are biofuels? and 2) what are advantages or disadvantages of using biofuels? The 20 question multiple choice pre-assessment focused on gaining students' background knowledge for comparing biofuels and fossil fuels with regard to chemical makeup, energy values, food and fuel sources, and government actions that may be related to biofuel research. In addition to the same 20 multiple choice pretest questions, the post-assessment included data tables requiring participants to calculate average temperature and mass, energy absorbed, average mass of fuel consumed, and average energy content of fuel. Four discussion questions related to the data collected and calculated were also included in the post-assessment.

All of the data calculations and discussion questions were similar to the calculations and discussion reviewed in the laboratory settings of both the reflection in-action and reflection on-action treatment groups. All of the instructional materials that were developed for this research were reviewed for face and content validity by content and curriculum design experts and were verified to contain appropriate content and teaching methods for the secondary agriscience classroom/laboratory. The lab report was modified from the Lab Aids® version to include reflections stops for the reflection in-action treatment group.

The treatment groups varied based on type of reflection (in-action vs. on-action) and time of abstraction (pre-laboratory activity vs. post-laboratory activity). The students in the pre-abstraction groups participated in a biofuels lecture/discussion that provided abstract concepts of biofuels, and then participated in an agriscience laboratory experience focusing on biofuels; comparing the energy stored in kerosene and ethanol. The students in the post-abstraction groups engaged in the biofuels agriscience laboratory experience first, followed by the biofuels lecture/discussion abstraction. The students in the reflection in-action groups were asked probing questions during the experimentation process in the laboratory portion to engage in reflection during the instruction. Reflection in-action time ranged from three to five minutes and occurred five times during the laboratory session. The students in the reflection on-action group were asked probing questions after completing the laboratory experience to engage in reflection following instruction. Approximately 15 minutes was provided at the end of the laboratory session for the reflection on-action treatment group to respond to the questions.

The school's agriscience teacher delivered the lecture with discussion based on the lesson plans developed by the researchers while graduate students from the University of Florida Agricultural Education and Communication Department, who had high school teaching experience delivered the laboratory experience. All agricultural education professionals that were selected to deliver the instruction did receive training on the content to be delivered. One of the researchers observed the lecture with discussion and laboratory delivery to ensure the designed lesson plans were delivered as intended. All teaching sessions were found to adhere to the developed plan, thus fidelity of treatment was ensured. Each teaching session began with daily announcements and attendance procedures conducted by the school's agriscience instructor. These activities accounted for approximately five to seven minutes of the 50-minute class period.

The agriscience teacher administered a content knowledge pre-assessment to the participants in January of 2015, four days prior to treatment. The treatments were delivered during four consecutive days of instruction, Monday through Thursday of the following week. The content knowledge post-assessment was administered by the agriscience instructor to the participants five days following the instruction and two weeks after the pre-assessment. The post-assessment included mathematical calculations and discussion questions similar to those introduced in the laboratory experience. All assessments were scored and a percentage was recorded in a spreadsheet by the university researchers. The assessment scores were used to determine if student knowledge of biofuels was significantly different after participating in the class and laboratory instruction based on each treatment determined by the 2 x 2 randomized experimental design. The assessments were divided into three categories: content knowledge, calculations, and discussion. Each section was scored and the data was compiled for analysis.

Data analysis was conducted using SPSS Version 22. Descriptive statistics were used to summarize the population. Dependent samples t-tests were used to report means and standard deviations of the pre/post assessment scores for content knowledge, calculations, and discussion. Analysis of variance was used to determine interaction effects. Levene's test of equality of error variance was used to ensure the assumption of equal variances was not violated.

Population

Replication of this study at the secondary level, introduced several limitations. Baker et al. (2014) indicated the need for a sample size of 76 participants to ensure a power base of .80 for a full-scale replication of this study. However, due to the constraints of conducting research within a high school classroom, of the 40 agriscience students enrolled in two agritechnology courses, the total sample size was 26 for a 65% response rate. Students ($n = 14$) were removed from the study because they were absent from any one of the class sessions when data was being collected, beginning with the pretest and ending with the posttest. The various treatment groups sample sizes ranged from five to nine. A complete report of the population and treatment groups is found in Table 1. Though the total group of participants was relatively balanced between male and female participants, some of the treatment groups had more variation. A majority of participants self-reported they had some prior experience with biofuels. After the study, students self-reported they had a slightly positive rating of their overall learning experience during the biofuels lesson.

Table 1

Description of Population and Treatment Groups

	Total	Treatment Group A	Treatment Group B	Treatment Group C	Treatment Group D
N	26	6	9	5	6
Gender					
Male	54%	17%	89%	40%	67%
Female	46%	83%	11%	60%	33%
Age					
	M = 15.23 (SD = 1.03)	*M* = 15.33 (SD = 1.21)	*M* = 15.33 (SD = 1.12)	*M* = 15.00 (SD = 1.00)	*M* = 15.17 (SD = .98)
Prior Experience					
None	23%	33%	0%	40%	33%
Some	69%	67%	89%	20%	77%
A great deal	8%	0%	11%	40%	0%
Rating of Experience[a]					
	M = 6.23 (SD = 2.21)	*M* = 6.50 (SD = 1.76)	*M* = 7.11 (SD = 2.21)	*M* = 5.60 (SD = 2.79)	*M* = 5.17 (SD = 2.04)

Note. [a] Means and standard deviations for the 10 point-rating scale of experience: 1 being totally disliked, 5 being neutral, 10 being totally liked

Findings

The findings have been organized into sections based on the three different components of the assessment: Knowledge test scores, calculation scores and discussion scores. Null hypotheses were created for the purposes of statistical analysis and are included in each of the following sections.

Knowledge Test Scores

H_o 1: There is no variance in knowledge scores due to the interaction of order of abstraction and method of reflection.

H_o 2: There is no significant difference in the overall mean knowledge scores between the reflection in-action and the reflection-on-action.

H_o 3: There is no significant difference in overall mean knowledge scores between the pre-abstraction and post-abstraction groups.

The means for the knowledge test scores related to reflection-in and reflection-on action were 51.33 (SD = 14.69), and 47.73 (SD = 14.38) respectively. Pre-abstraction group had a mean of 46.35 (SD = 12.45), and post abstraction had a mean of 52.86 (SD = 15.65). A complete report of descriptive statistics for the Knowledge Test Scores is found in Table 2. Levene's test of equality of error variance was used to ensure the assumption of equal variances was not violated, and yielded $F(3, 22) = 1.67$, $p = .20$. The ANOVA for the discussion assessment scores is summarized in Table 3. The interaction effect of reflection and abstraction yielded an $F(1, 22) = .720$, $p = .40$, and the first null hypothesis failed to be rejected. Since no simple main effects were detected an analysis of main effects was necessary (Kirk, 1995). There was no significant main effect of the type of reflection, $F(1, 22) = 1.64$, $p = .21$, or order of abstraction on the knowledge test scores $F(1, 22) = .50$, $p = .49$, resulting in a failure to reject the second and third null hypotheses.

Table 2

Mean Knowledge Test Scores for Treatment Conditions of Type of Reflection and Order of Abstraction

Type of Reflection	Order of Abstraction	M	SD	n
Reflection In	Pre-Abstraction	53.33	11.25	6
	Post-Abstraction	50.00	17.14	9
	Total	51.33	14.69	15
Reflection On	Pre-Abstraction	41.00	9.61	5
	Post-Abstraction	53.33	16.02	6
	Total	47.73	14.38	11
Total	Pre-Abstraction	46.25	12.45	12
	Post-Abstraction	52.86	15.65	14
	Total	49.81	14.39	26

Table 3

Analysis of Variance Summary Table for Knowledge Test Scores

Source	SS	df	MS	F	P
Reflection	346.76	1	346.76	1.64	.21
Abstraction	105.11	1	105.11	.50	.49
Reflection*Abstraction	152.39	1	152.39	.720	.40
Error	4653.33	22	211.51		
Total	5174.04	25			

Note. $p < .05$

Calculation Scores

H_o 4: There is no variance in calculation scores due to the interaction of order of abstraction and method of reflection.

H_o 5: There is no significant difference in the overall mean calculation scores between the reflection in-action and the reflection-on-action.

H_o 6: There is no significant difference in overall mean calculation scores between the pre-abstraction and post-abstraction groups.

The means for the calculation scores related to reflection-in and reflection-on action were 43.80 (SD = 30.00), and 45.73 (SD = 31.96) respectively. Pre-abstraction group had a mean of 39.75 (SD = 31.38), and post abstraction had a mean of 48.79 (SD = 29.74). A complete report of descriptive statistics for the Calculation Scores is found in Table 4. Levene's test of equality of error variance was used to ensure the assumption of equal variances was not violated, and yielded $F\,(3, 22) = .104$, $p = .96$. The ANOVA for the discussion assessment scores is summarized in Table 5. The interaction effect of reflection and abstraction yielded an $F\,(1, 22) = 1.35$, $p = 2.58$, and the fourth null hypothesis failed to be rejected. Since no simple main effects were detected an analysis of main effects was necessary (Kirk, 1995). There was no significant main effect of the type of reflection, $F\,(1, 22) = .003$, $p = .96$, or order of abstraction on the calculation scores $F\,(1, 22) = .83$, $p = .37$, resulting in a failure to reject the fifth and sixth null hypotheses.

Table 4

Mean Calculation Scores for Treatment Conditions of Type of Reflection and Order of Abstraction

Type of Reflection	Order of Abstraction	M	SD	n
Reflection In	Pre-Abstraction	53.00	29.86	6
	Post-Abstraction	37.67	30.24	9
	Total	43.80	30.00	15
Reflection On	Pre-Abstraction	31.80	29.26	5
	Post-Abstraction	57.33	31.66	6
	Total	45.73	31.96	11
Total	Pre-Abstraction	39.75	31.38	12
	Post-Abstraction	48.79	29.74	14
	Total	44.62	30.24	26

Table 5

Analysis of Variance Summary Table for Calculation Scores

Source	SS	df	MS	F	P
Reflection	2.79	1	2.79	.003	.957
Abstraction	796.41	1	796.41	.833	.371
Reflection*Abstraction	1287.91	1	1287.91	1.348	.258
Error	21025.72	22	955.72		
Total	22862	25			

Note. $p < .05$

Discussion Scores

H_o 7: There is no variance in discussion scores due to the interaction of order of abstraction and method of reflection.

H_o 8: There is no significant difference in the overall mean discussion scores between the reflection in-action and the reflection-on-action.

H_o 9: There is no significant difference in overall mean discussion scores between the pre-abstraction and post-abstraction groups.

The means for the discussion scores related to reflection-in and reflection-on action were 48.20 (SD = 23.92), and 50.45 (SD = 22.25) respectively. Pre-abstraction group had a mean of 52.92 (SD = 22.81), and post abstraction had a mean of 45.93 (SD = 23.20). A complete report of descriptive statistics for the discussion scores is found in Table 6. Levene's test of equality of error variance was used to ensure the assumption of equal variances was not violated, and yielded F (3, 22) = .221, p = .88. The ANOVA for the discussion assessment scores is summarized in Table 7. The interaction effect of reflection and abstraction yielded an F (1, 22) = 12.17, p = .002, and was determined to be significant. Accordingly, the seventh null hypothesis was rejected. There was also a significant main effect between the types of reflection, F (1, 22) = .14, p = .002, resulting in the rejection of the eighth hypothesis. There was no significant main effect of order of abstraction on the knowledge test scores F (1, 22) = .50, p = .49, resulting in a failure to reject the ninth and final null hypothesis.

Table 6

Mean Knowledge Discussion Scores for Treatment Conditions of Type of Reflection and Order of Abstraction

Type of Reflection	Order of Abstraction	M	SD	n
Reflection In	Pre-Abstraction	70.50	9.62	6
	Post-Abstraction	33.33	18.10	9
	Total	48.20	23.92	15
Reflection On	Pre-Abstraction	37.40	18.87	5
	Post-Abstraction	61.33	19.81	6
	Total	50.45	22.25	11
Total	Pre-Abstraction	52.92	22.81	12
	Post-Abstraction	45.93	23.20	14
	Total	49.15	22.84	26

Table 7

Analysis of Variance Summary Table for Discussion Scores

Source	SS	df	MS	F	P
Model	4870.976	3	1623.000	4.372	.015
Reflection	51.050	1	51.050	.137	.002
Abstraction	.202	1	.202	.001	.982
Reflection*Abstraction	4520.705	1	4520.705	12.173	.002
Error	75860.000	22			
Total	13041.385	25			

Note. $p < .05$

Conclusions

The lack of simple main effects on the first sections of the assessment indicate that type of reflection and order of abstraction are independent of each other when analyzing knowledge acquisition and calculation skills. However, the significance of the interaction on the discussion assessment indicates that how the order of abstraction and type of reflection are implemented are significant in the development of discussion skills. This conclusion is consistent with previous research indicating meaningful and rigorous reflection can result in developing higher order thinking skills and achievement gains (Arnold, et al, 2006; Jonassen et al., 1995; Moon, 1999; Sobral, 2000).

In terms of students' discussion assessment scores, participants who were asked to reflect-in-action demonstrated significant statistical gains (p=.002). These results from the students in this study indicate that the mode of reflecting is important if discussion abilities are the primary learning objective. This finding helps to confirm the notion that teachers must be present and engaged throughout a learning experience (Baker & Robinson, 2011; Baker et al., 2014). Though it should be noted that previous research (Baker et al., 2014) found that the type of reflection can impact significant gains in knowledge scores, which differs from the findings of this study.

As suggested by Phipps et al. (2008) when a concrete experience occurs at the beginning of the learning process, student learning outcomes are optimized. Although the findings of this research cannot be generalized beyond the students in this study, and some of the findings of this research were not statistically significant, as a follow-up, exploratory study it is encouraging to observe an opportunity to conduct a completely randomized factorial 2 x 2 design in a secondary agriscience classroom. During a time when preparing students to be college and career ready is a major focus in education, increased incorporation of experiential learning throughout the agricultural education curricula to encourage better discussion can serve as an important method for providing opportunities for students to connect what they are learning in the classroom to experiences and real world application. Development of higher order thinking skills will assist in preparing students to think critically and solve problems.

Implications and Discussion

Agriscience teachers are continually asked to do more with less. Standards-based education, Federal and State mandated accountability systems for teachers and students, STEM integration, curricular updates, differentiated instruction, interdisciplinary education, and college and career readiness are consistently occurring in current educational discussions in the media, and in faculty meetings. ELT is just one example of research-based instructional methodology that agriscience teachers and their students would benefit from understanding and implementing in their classrooms.

If we know the vital role an educator plays during each stage of the learning process (Baker, et al., 2014; Roberts, 2006), and the principle reason ELT is not effectively implemented is due to the missing connection between the teacher and the experience (Baker et al., 2012), then how can we, as a profession of teacher educators, work to better support the needs of agriscience teachers? How can we better prepare them during preservice instruction, decrease their work load, provide necessary resources, and assure they utilize research-based practices to enhance student learning outcomes in their classrooms? In the undergraduate agricultural teacher education program, is there a need to evaluate the current curricular components to assure preservice teachers are provided with the theory and practice to possess the self-efficacy required to confidently implement effective instructional methods that are based on the tenets of ELT?

Supervised Agricultural Experience Programs (SAEP) are consistently labeled as the experiential learning components in SBAE programs (Newcomb, McCracken, Warmbrod, & Whittington, 2004). Perhaps, agriscience teachers are unaware of the daily opportunities to incorporate experiential learning into the classroom and laboratory and in agreement with Baker, et al. (2012) should be encouraged to utilize ELT in all components of the three-circle model.

Recommendations for Practice

Agriscience teachers should be made aware of the benefits on student learning outcomes when effective concrete experiences are designed for their students to engage, reflect, conceptualize, and experiment. Teachers should design lessons that consider each of the four factors in ELT to provide students with opportunities that will enhance learning while increasing student engagement. High quality professional development models should be designed to assist preservice and in-service agriscience teachers to develop curricular activities that effectively utilize and reinforce the tenets of ELT. This recommendation is also supported by previous research (Arnold et al., 2006; Baker, et al., 2014; Dewey, 1938; Knobloch, 2003; Shoulders & Myers, 2013). Simple changes can be made to encourage agriscience teachers to reflect on their own teaching practices, integrate more opportunities for students to actively engage in the lesson through discussion with purposeful questioning, and include occasions for students to reflect on the experience. Instead of asking, “What did you learn today?” teachers should ask their students “how can you use or apply what you learned today” to a certain situation. This type of question will drive students to think deeper and intentionally transfer their new knowledge to improve the learning experience.

Recommendations for Research

Baker et al. (2014) indicated the need for a sample size of 76 participants to ensure a power base of .80 with a full-scale replication of this study. As indicated by this research, a limitation to the generalizability in the replication of this exploratory study, at the secondary level, was the sample size. Therefore, it is recommended this study be replicated in secondary agriscience classrooms where student enrollment is higher than 20 per class. Multiple classes should also be available for data collection. In the typical secondary classroom, students are removed for various school functions and appointments, and are frequently absent from individual classes for the entire school day. Obtaining parental and student consent forms in a timely manner can also become problematic. Larger class sizes may assist in gaining the power required for generalizability of future findings.

Given the need for additional time for the reflection in-action experience treatment group, it is recommended that this study be replicated in secondary agriscience classrooms with block scheduling. The 50-minute class period utilized in this study limited the number of experimental trials during the laboratory experience and the amount of time allocated for student discussion and therefore, the overall reflection time for the participants in the reflection in-action experience groups was also limited. Maximizing opportunities for meaningful reflection (Sobral, 2000), thus the amount of discussion time, may positively impact gains in knowledge and discussion scores.

Considerations and adaptations should be made for the delivery of the lecture portion of the lesson when block schedules are used. The content of the lecture should be adapted to better align with the post assessment. Incorporation of mathematical calculations in the lecture may assist in increasing post assessment calculation scores.

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