Differences in Critical Thinking Ability According to College Entry Pathway

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Abstract

The purpose of this study was to determine if entry pathway—direct from high school versus transfer from community college—influenced the critical thinking abilities of agricultural education students. Seventy-five senior-level agriculture undergraduate students completed a critical thinking assessment test. Although students entering the four-year university directly from high school had statistically significant higher ACT scores and semester GPA's (which are known predictors of critical thinking ability), there were no statistically significant differences in critical thinking abilities between the two groups. When comparing students' performance to national norms, regardless of entry pathway, students scored statistically lower than national norm data in the skill areas of identifying additional information needed to evaluate a hypothesis and providing relevant interpretations for a specific set of results. Further, agricultural education transfer students were shown to have a greater ability to think creatively than students who entered the four-year university directly from high school. Recognizing the importance of creative thinking to student success and overall critical thinking skill, curriculum and instructional development within agricultural education should focus on intentionally integrating creative and critical thinking.

Introduction

Developing competencies, such as critical thinking, that enable individuals to participate fully as citizens remains the unifying purpose of public education (Kuhn, 1999). However, a universally accepted idea of what constitutes critical thinking does not exist (Tsui, 1998). Defining critical thinking involves both simplistic explanations focused primarily on analyzing and evaluating information (Duron et al., 2006), and complex explanations of critical thinking such as a *"reasoned, purposive, and introspective approach to solving problems or addressing questions with incomplete evidence and information and for which an incontrovertible solution is unlikely"* (Rudd et al., 2000, p. 5). Critical thinking is believed present when students perform in the higher-ordered thinking levels of Bloom's (1956) taxonomy, such as in the categories of analysis, synthesis, and evaluation (Bers, 2005; Duron et al., 2006).

Critical thinking is developed because of critical thinking disposition and a set of facilitating factors, which include age, gender, grade point average (GPA), training, and experience (Ricketts and Rudd, 2005). Critical thinking disposition is an individual's motivation to use critical thinking skills (Pascarella and Terenzini, 2005). In a study exploring the relationship between critical thinking disposition and problem-solving abilities of undergraduate agriculture students, Friedel et al. (2008) concluded that *"students with a preference to solve problems by generating many solutions and employing a strategy of thoroughness and attention to detail"* (p. 34) have a higher critical thinking disposition. While Brisdorf-Rhoades et al. (2005) found greatly varying critical thinking dispositions among undergraduate agriculture communication students, Rudd et al. (2000) found students enrolled in one college of agriculture did not have strong critical thinking dispositions.

The link between critical thinking disposition and two facilitating factors of overall critical thinking ability, age

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and gender, is not clear. Bers et al. (1996) and Rudd et al. (2000) found female students had greater critical thinking dispositions than male students. However, Brisdorf-Rhoades et al. (2005) and Burbach et al. (2012) were unable to find significant gender relationships. Similar discrepancies are evident between critical thinking disposition and age (Bers et al., 1996; Burbach et al., 2012; Jacobs, 1995). Research exploring the relationship between gender and overall critical thinking ability (as opposed to disposition) provides slightly more consistency, with gender showing limited to no significant influence on critical thinking ability (Brahmasrene and Whitten, 2011; Friedel et al., 2008).

Another facilitating factor of critical thinking is GPA. Most students with high critical thinking skills are likely to perform well in college courses (Williams and Stockdale, 2003). Collegiate GPA was found to be one of the most consistent predictors of critical thinking disposition among undergraduate agriculture students (Burbach et al., 2012; Friedel et al., 2008). Brahmasrene and Whitten (2011) were able to link incoming undergraduate business students' high school GPA to overall critical thinking ability. Similarly, Ricketts and Rudd (2005) found a positive correlation between GPA and overall critical thinking ability of National FFA delegates when leadership and innovativeness constructs were held constant.

The remaining two facilitating factors of critical thinking, experience and training, were the focal point of this study. While some studies (e.g., Bers et al., 1996, Burbach et al., 2012) found significant positive relationships between education level (freshman, sophomore, junior, or senior classification) and critical thinking disposition, contradicting evidence has also been presented (Brisdorf-Rhoades et al., 2005). Recognizing that some gains could be attributed to natural development that would have occurred in the absence of college, Saavedra and Saavedra (2011) found students in their final year of college had statistically significant higher critical thinking abilities than first-year students. Although these studies found increases in student critical thinking disposition and ability over the span of a four-year degree, definitively attributing casual relationships to these increases is more difficult.

Gellin (2003) provided a possible explanation for these increases with the discovery that students continually involved in co-curricular activities achieved higher gains in critical thinking than those who were not involved. Delving deeper into the effects of experience and training on critical thinking development, Jacobs (1995) compared the critical thinking dispositions of traditional-aged community college students to those of entering freshmen at a private university (Facione et al., 1995). The community college group had weaker critical thinking dispositions than the incoming freshmen.

Although critical thinking disposition is related to critical thinking ability (Friedel et al., 2008; Ricketts and Rudd, 2005), an individual's disposition to think critically is a factor that should be examined with caution since it leaves a lot of unaccounted variance (Kuhn, 1999). Disposition is often interpreted in the sense of habit, but individuals do not employ critical thinking from habit. Rather they think critically because they see the value in doing so (Kuhn, 1999). Therefore, this study explored critical thinking ability rather than disposition. Specifically, a need exists to explore critical thinking ability in regard to the facilitating factors of experience and training. Research has shown weaker critical thinking dispositions among community college students as compared to entering freshmen at a private university (Jacobs, 1995). However, limited research exists on the critical thinking abilities of similar groups. Do students who enter a four-year university directly from high school have different critical thinking abilities than students who transfer from a community college?

Purpose and Objectives

As part of a larger investigation, the purpose of this study was to determine if entry pathway—direct from high school versus transfer from community college—influenced the critical thinking abilities of agricultural education and studies students. The following research objectives guided this study:

1. Compare selected demographic and academic characteristics of agricultural education students, categorized by entry pathway.
2. Compare the critical thinking abilities of students who entered the four-year university directly from high school to those of students transferred from a community college.
3. Compare the critical thinking abilities of students who entered the four-year university directly from high school to national critical thinking norms.
4. Compare the critical thinking abilities of students who entered the four-year university via community college transfer to national critical thinking norms.

Methods and Procedures

The Iowa State University (ISU) Institutional Review Board approved the study protocol and all participants provided written informed consent prior to participation in the study. The target population of this study was all senior-level undergraduates (90+ semester credit hours; N=181) within the Department of Agricultural Education and Studies at ISU during the spring 2013 semester. Entry pathway was determined according to the ISU Registrar's official classification. As recommended by Dillman et al. (2009), the ISU 10-day enrollment list was used to select a random representative sample of 124 students at a 95% confidence level. In comparing demographic and academic information of the sample to population data, a Pearson's χ^2 analysis yielded no significant difference for gender, and multiple two-sample t tests yielded no significance differences for age, semester credit hours, semester GPA, cumulative credit hours, cumulative GPA, transfer credit hours, transfer GPA, total GPA, and ACT score.

We chose to assess critical thinking abilities with the Critical Thinking Assessment Test (CAT) because it uses open-ended responses and has national reference norms. The CAT is a National Science Foundation supported instrument created to assess and improve critical thinking and real-world problem-solving skills (Center for Assessment and Improvement of Learning [CAIL], 2012). The CAT includes 15 short-answer questions based on real-world situations developed by university faculty across the nation to accurately assess important components of critical thinking (CAIL, 2010). The questions (skill areas) are grouped into four overlapping broad categories according to question topic: (a) creative thinking, (b) problem solving, (c) evaluate and interpret information, and (d) effective communication.

ISU faculty scored the CAT assessments for this study under direct supervision of CAIL-trained individuals and used detailed scoring rubrics provided by CAIL to enhance consistency and reliability in evaluations. Inter-rater reliability examinations on the CAT indicated consistency at the level of α=0.82 (CAIL, 2010). Inter-rater reliability was further established by having a minimum of two faculty scorers for each question. Internal consistency was deemed reasonably good by CAIL (2010) at a level of α=0.70. CAIL (2010) explained that the lower internal consistency was due in part to the numerous components of critical thinking evaluated by the instrument.

A modified version of Dillman et al.'s (2009) tailored design method was followed when requesting student participation. Five points of contact with students yielded 75 completed tests, which accounted for 60.48% of the randomly selected senior-level students. Nonresponse error was addressed by comparing respondents' and non-respondents' personal and demographic data to population data (Miller and Smith, 1983). A Pearson's χ^2 analysis yielded no significant difference for gender and a two-sample t test yielded no significance differences for age, cumulative GPA, and ACT score between respondents and non-respondents. However, caution should be used when extrapolating results beyond the population since respondents were representative of a homogenous sample in regard to educational degree pursuit.

Measures of central tendency were used to describe demographic and academic characteristics. A two-sample t test was used to compare academic characteristics according to entry pathway (Gall et al., 1996). University-specific terminology was used to describe academic characteristics. Semester credit hours included the number of credit hours in which the participant was enrolled during the semester of the study. Semester GPA reflected the previous semester's GPA. Cumulative credit hours included the number of credit hours taken at the current university, and cumulative GPA reflected the GPA of these credit hours. Total credit hours completed was defined as the sum of both credit hours taken at the current university and any credit hours that may have been transferred from another institution.

A two-sample t test was used to compare the CAT scores of students who entered the four-year university directly from high school to those of students who transferred from a community college (Gall et al., 1996). A one-sample t test was used to compare participants' scores to CAT national norm data collected from junior and senior-level higher education students across the nation (Gall et al., 1996). Effect sizes quantifying group differences were interpreted using Cohen's (1992) criteria; 0.02 was considered small, 0.15 was medium, and 0.35 was large.

Results and Discussion

Objective one sought to compare selected demographic (Table 1) and academic characteristics (Table 2). Respectively, students who entered the four-year university directly from high school and those who transferred were both primarily white (100%; 100%) males (65.9%; 67.6%) between the ages of 21 and 25 (92.7%; 97.1%). A Pearson's χ^2 analysis yielded no significant difference for gender, and a two-sample t test yielded no significant difference for mean age between the two groups. Students who entered the four-year university directly from high school averaged 17.30 (SD=16.50) transfer semester credit hours, with a transfer GPA of 2.74 (SD=1.37) and a cumulative GPA of 2.90 (SD=0.54). The transfer semester credit hours and GPA of this group were calculated from dual-credit courses transferred to the university from students' high school work. Students who entered the four-year university from community college averaged 63.72 (SD=14.33) transfer semester credit hours, with a transfer GPA of 2.87 (SD=0.61) and a cumulative GPA of 2.66 (SD=0.56). A series of two-sample t tests were conducted to explore potential differences among groups. Resulting in a large effect size, students who entered the four-year university directly from high school had statistically significant higher ACT scores ($p<0.01$; d=0.76) and semester GPA ($p<0.05$; d=0.51) than transfer students.

Objective two sought to compare the critical thinking abilities of students who entered the four-year university directly from high school to those of transfer students. Table 3 shows results from this comparison ranked by difference in mean. Table 3 also displays the specific skill areas assessed by the CAT categorized by four broad domains: evaluate and interpret information, problem solving, creative thinking, and effective communications.

Table 1. Demographic Information of Direct from High School and Transfer Students (n = 75)

	Direct HS (n = 41)		Transfer (n = 34)	
Demographics	f	%	f	%
Gender				
Male	27	65.9	23	67.6
Female	14	34.1	11	32.4
Age				
Under 20 years of age	2	4.9	0	0.0
21–25 years of age	38	92.7	33	97.1
Over 26 years of age	1	2.4	1	2.9
Race				
White	41	100.0	34	100.0

Each of these four domains is comprised of a portion of the 15 questions of the CAT. Evaluate and interpret information included eight questions, problem solving had eight questions, creative thinking included six questions, and effective communication had nine questions. There were no statistically significant differences in critical thinking abilities between students who entered directly from high school and transfer students.

Objective three sought to compare the critical thinking abilities of students who entered the four-year university directly from high school with national critical thinking norms (Table 4). Resulting in a moderate effect size, these students scored statistically lower (p<0.05) than CAT national norm data in the skill areas of explaining how changes in a problem situation might affect the solution (d=0.39) and identifying additional information needed to evaluate a hypothesis (d=0.39). Resulting in a large effect size, these students scored statistically lower (p<0.01) than national norm data in the skill areas of providing relative alternative interpretations for a specific set of results (d=0.68) and identifying additional information needed (d=0.87). These students' overall critical thinking scores were also statistically lower (p<0.01; d=0.47) than national norm data. The direct-from-high-school students scored sta-

Table 2. Comparison of Academic Information of Direct from High School vs. Transfer Students (n = 75)

Item	Direct HS (n = 41)		Transfer (n = 34)						
	M	SD	M	SD	Diff.^{z}	*t*	*Df*	p^y	Effect size^x
Cm. H.	94.99	17.98	49.25	16.98	45.74	11.24	73	<0.01**	2.62
ACT	22.41	3.08	19.96	3.40	2.45	3.02	64	<0.01**	0.76
Tr. H.	114.70	17.31	113.32	9.71	0.85	0.25	73	0.80	0.06
Sm. GPA	3.07	0.72	2.72	0.63	0.35	2.19	73	0.03*	0.51
Cm. GPA	2.90	0.54	2.66	0.56	0.24	1.91	73	0.06	0.44
Tr. GPA	2.74	1.37	2.87	0.61	-0.13	0.52	73	0.60	0.13
Sm. H.	14.34	2.60	14.51	2.15	-0.17	0.31	73	0.76	0.07
Tr. H.	17.30	16.50	63.72	14.33	-46.42	12.86	73	<0.01**	3.01

Note: Cm. = cumulative; Sm. = semester; Tr. = transfer; H = hours

^{z}Direct from HS minus transfer. ^{y}Probability of difference. ^{x}Mean difference divided by pooled group SD (0.1–0.3 = small, 0.3–0.5 = moderate, > 0.5 = large).

* p < 0.05. ** p <0.01

Table 3. T-Test Comparisons of Direct from High School vs. Transfer Students for Each Skill Area of the CAT (n = 75)

E/I	PS	CT	EC	Skill area assessed	Direct HS M	Direct HS SD	Transfer M	Transfer SD	Diff.^{z}	*t*	*df*	p^y	Effect size^x
	X	X	X	Identify additional information.	0.98	1.00	1.25	1.05	0.27	1.12	69	0.27	0.30
	X	X	X	Explain how changes might affect a solution.	0.76	0.97	1.02	1.11	0.26	1.09	66	0.28	0.28
		X	X	Provide alternatives for results.	1.24	0.94	1.38	0.74	0.14	0.71	73	0.48	0.14
X	X			Separate relevant from irrelevant information.	3.03	1.12	3.12	0.91	0.09	0.39	72	0.70	0.12
X				Evaluate whether information supports a hypothesis.	0.60	0.50	0.68	0.47	0.08	0.68	71	0.50	0.14
	X			Use basic mathematical skills to solve a problem.	0.76	0.43	0.79	0.41	0.04	0.39	72	0.70	0.07
X				Determine whether an inference is supported by information.	0.56	0.50	0.56	0.50	0.00	0.02	70	0.99	0.03
X				Summarize pattern of results.	0.79	0.41	0.79	0.41	0.00	0.01	70	0.99	0.02
	X	X	X	Identify additional information.	0.32	0.47	0.29	0.46	-0.02	0.21	71	0.83	0.03
		X	X	Provide relevant alternative interpretations.	0.46	0.64	0.35	0.49	-0.11	0.85	73	0.40	0.18
X			X	Evaluate strength of correlational-type data.	1.23	1.19	1.03	1.06	-0.20	0.75	72	0.46	0.17
X	X			Identify solutions for a problem.	1.15	0.86	0.97	0.83	-0.18	0.92	70	0.36	0.21
X	X		X	Identify the best solution.	2.09	1.88	1.84	1.71	-0.25	0.60	70	0.55	0.18
X	X		X	Use/apply relevant information.	1.12	0.75	0.82	0.76	-0.30	1.71	70	0.09	0.40
		X	X	Provide alternatives for spurious associations.	1.73	0.63	1.41	0.82	-0.32	1.86	61	0.07	0.46
				CAT total score	16.55	4.60	16.26	3.59	-0.30	0.32	73	0.75	0.07

Note: E/I = evaluate and interpret information; PS = problem solving; CT = creative thinking; EC = effective communication

^{z}Transfer minus direct. ^{y}Probability of difference at p < 0.05. ^{x}Mean difference divided by pooled group SD (0.1–0.3 = small, 0.3–0.5 = moderate, > 0.5 = large).

* p < 0.05. ** p <0.01

Table 4. T-Test Comparisons of Direct from High School Students vs. National Means for Each Skill Area of the CAT (n = 41)

E/I	PS	CT	EC	Skill area assessed	Direct HS M	Direct HS SD	National M	National SD	Diff.^{z}	*t*	*df*	p^y	Effect size^x
		X	X	Provide alternatives for spurious associations.	1.73	0.63	1.56	0.86	0.17	1.73	40	0.09	0.23
X				Summarize pattern of results.	0.79	0.41	0.67	0.46	0.12	1.90	38	0.06	0.29
X			X	Evaluate strength of correlational-type data.	1.23	1.19	1.21	1.13	0.02	0.08	39	0.94	0.01
X	X		X	Use/apply relevant information.	1.12	0.75	1.11	0.64	0.01	0.10	40	0.92	0.02
X	X			Identify solutions for a problem.	1.15	0.86	1.18	1.03	-0.03	0.22	39	0.83	0.03
	X			Use basic mathematical skills to solve a problem.	0.76	0.43	0.82	0.41	-0.06	0.94	40	0.35	0.15
		X	X	Provide alternatives for results.	1.24	0.94	1.35	1.04	-0.11	0.72	40	0.48	0.11
X	X			Separate relevant from irrelevant information.	3.03	1.12	3.14	0.92	-0.11	0.65	39	0.52	0.11
X				Determine whether an inference is supported by information.	0.56	0.50	0.68	0.41	-0.12	1.52	40	0.14	0.26
X				Evaluate whether information supports a hypothesis.	0.60	0.50	0.73	0.44	-0.13	1.66	39	0.11	0.28
X	X		X	Identify the best solution.	2.09	1.88	2.29	1.81	-0.2	0.67	39	0.51	0.11
	X	X	X	Explain how changes might affect a solution.	0.76	0.97	1.15	1.06	-0.39	2.60	40	0.01*	0.39
	X	X	X	Identify additional information.	0.98	1.00	1.41	1.25	-0.43	2.74	39	0.01*	0.39
		X	X	Provide relevant alternative interpretations.	0.46	0.64	0.93	0.74	-0.47	4.70	40	<0.01**	0.68
	X	X	X	Identify additional information.	0.32	0.47	0.82	0.68	-0.5	6.84	40	<0.01**	0.87
				CAT total score	16.55	4.60	19.04	6.04	-2.49	3.46	40	<0.01**	0.47

Note: E/I = evaluate and interpret information; PS = problem solving; CT = creative thinking; EC = effective communication

^{z}Transfer minus direct. ^{y}Probability of difference at p < 0.05. ^{x}Mean difference divided by pooled group SD (0.1–0.3 = small, 0.3–0.5 = moderate, > 0.5 = large).

* p < 0.05. ** p < 0.01

Table 5. T-Test Comparisons of Transfer Students vs. National Means for Each Skill Area of the CAT (n = 34)

E/I	PS	CT	EC		Transfer		National						
				Skill area assessed	M	SD	M	SD	Diff.[z]	*t*	*df*	p[y]	Effect size[x]
X				Summarize pattern of results.	0.79	0.41	0.67	0.46	0.12	1.76	33	0.09	0.29
		X	X	Provide alternatives for results.	1.38	0.74	1.35	1.04	0.03	0.26	33	0.80	0.04
X	X			Separate relevant from irrelevant information.	3.12	0.91	3.14	0.92	-0.02	0.14	33	0.89	0.02
	X			Use basic mathematical skills to solve a problem.	0.79	0.41	0.82	0.41	-0.03	0.37	33	0.72	0.06
X				Evaluate whether information supports a hypothesis.	0.68	0.47	0.73	0.44	-0.05	0.66	33	0.52	0.12
X				Determine whether an inference is supported by information.	0.56	0.50	0.68	0.41	-0.12	1.40	33	0.17	0.27
	X	X	X	Explain how changes might affect a solution.	1.02	1.11	1.15	1.06	-0.13	0.69	33	0.50	0.12
		X	X	Provide alternatives for spurious associations.	1.41	0.82	1.56	0.86	-0.15	1.05	33	0.30	0.18
	X	X	X	Identify additional information.	1.25	1.05	1.41	1.25	-0.16	0.91	33	0.37	0.14
X			X	Evaluate strength of correlational-type data.	1.03	1.06	1.21	1.13	-0.18	0.99	33	0.33	0.17
X	X			Identify solutions for a problem.	0.97	0.83	1.18	1.03	-0.21	1.46	33	0.15	0.22
X	X		X	Use/apply relevant information.	0.82	0.76	1.11	0.64	-0.29	2.20	33	0.03*	0.41
X	X		X	Identify the best solution.	1.84	1.71	2.29	1.81	-0.45	1.52	32	0.14	0.26
	X	X	X	Identify additional information.	0.29	0.46	0.82	0.68	-0.53	6.63	33	<0.01**	0.92
		X	X	Provide relevant alternative interpretations.	0.35	0.49	0.93	0.74	-0.58	6.94	33	<0.01**	0.94
				CAT total score	16.26	3.59	19.04	6.04	-2.78	4.53	33	<0.01**	0.58

Note: E/I = evaluate and interpret information; PS = problem solving; CT = creative thinking; EC = effective communication

[z]Transfer minus direct. [y]Probability of difference at p <0.05. [x]Mean difference divided by pooled group SD (0.1–0.3 = small, 0.3–0.5 = moderate, > 0.5 = large).

* p < 0.05. ** p < 0.01

tistically lower (p<0.05) on three of the eight skill areas within the problem-solving domain, on four of the six skill areas within the creative thinking domain, and on four of the nine skill areas within the effective communication domain (Table 4).

Objective four was to compare the critical thinking abilities of students who entered the four-year university via transfer from a community college with national critical thinking norms (Table 5). Of note, transfer students performed statistically lower than national norm data in the skill areas of identifying additional information needed (p<0.01; d=0.92), providing relevant interpretations for a specific set of results (p<0.01; d=0.94), and using and applying relevant information (p<0.05; d=0.41). Further, transfer students scored statistically lower (p<0.05) than the national norm on two of the eight skill areas within the problem-solving domain, on two of the six skill areas within the creative thinking domain, on three of the nine skill areas within the effective communication domain, and on the overall critical thinking score.

This study led to three primary conclusions. First, college entry pathway does not influence critical thinking ability. Although students who entered the four-year university directly from high school had higher ACT scores and semester GPA's, which are known predictors of critical thinking, their critical thinking abilities were not statistically different than those of students who transferred from a community college. Because research claims that GPA (Burbach et al., 2012; Friedel et al., 2008; Ricketts and Rudd, 2005) and standardized college entrance exams (Brahmasrene and Whitten, 2011; Jacobs, 1995) are accurate predictors of critical thinking, we anticipated that direct-from-high-school students' critical thinking abilities would be higher than those of transfer students. However, there were no statistically significant differences between the two groups on any of the 15 specific skill areas assessed by the CAT.

Next, agricultural education students' abilities to identify relevant information and offer alternative interpretations were below expectations. Regardless of entry pathway, students scored statistically lower than CAT national norm data in the skill areas of identifying additional information needed to evaluate a hypothesis and providing relevant interpretations for a specific set of results. This conclusion is of particular importance because an integral aspect of critical thinking is *"addressing questions with incomplete evidence and information for which an incontrovertible solution is unlikely"* (Rudd et al., 2000, p. 5). Numerous critical thinking definitions recognize the importance of identifying relevant information and providing alternative interpretations (Duron et al., 2006; Jacobs, 1995).

Finally, agricultural education transfer students have a greater ability to think creatively than students who entered the four-year university directly from high school. The direct-from-high-school students scored statistically lower than national norms on four of the six skill areas within the creative thinking domain, while transfer students scored statistically lower on only two of the six skill areas within the creative thinking domain. Creative thinking abilities are crucial since students need curiosity and imagination to be successful in higher education (Wagner, 2008). Also, "students with a preference to solve problems by generating many solutions" (Friedel et al., 2008, p. 34) have higher critical thinking dispositions.

Summary and Implications

Conclusions drawn from this study have implications for curriculum development, learning assessment, and future research. Although not generalizable beyond students enrolled in the academic department examined, the implication for curriculum development is worthy of discussion. Since critical thinking ability did not differ according to entry pathway, curricular and instructional approaches for senior-level agriculture education and studies students do not need to differ according to entry pathway. Instead, a directed focus on developing all students' abilities to gather additional information required to support a claim and to offer alternative interpretations for results should be integrated into the curriculum. Further, recognizing the importance of creative thinking to student success (Wagner, 2008) and overall critical thinking skill (CAIL, 2012), curriculum and instructional development within agricultural education should focus on intentionally integrating creative and critical thinking. By allowing students to develop unique ideas founded in well-reasoned, logical claims, integration of these two thinking techniques can be accomplished (Bonk and Smith, 1998).

The implication for learning assessment stems from the various assessment instruments available in higher education. This study used an assessment instrument that focuses on evaluating and interpreting information, problem solving, creative thinking, and effective communication. Since critical thinking is a dynamic construct, future assessments should use instruments that explore other components of critical thinking to compare students according to entry pathway. We also recommend continued use of critical thinking assessments that use open-ended responses since multiple-choice exams may not accurately assess critical thinking ability (Bers, 2005). However, researchers should use care when selecting such assessment tools since students' ability to communicate effectively could influence how their critical thinking ability is assessed and scored.

Implications for continued research emerge from the identified differences in creative thinking ability according to entry pathway. Future research should be directed toward thoroughly exploring differences in agricultural education students' critical thinking abilities according to the specific constructs of critical thinking identified by the CAT. Future research conducted at the collegiate level should examine agricultural education curricular differences between the first two years of community college and the first two years at a four-year university. Longitudinal studies conducted at the departmental and/or collegiate level should track agricultural education students' critical thinking development over the span of a four-year degree.

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