The Effect of Instructional Delivery Methods on the Critical Thinking Disposition of Distance Learners and Traditional On-campus Learners

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Abstract

The development of critical thinking skills in agricultural audiences has been identified as an important need. While several studies have examined the effect of teacher delivery methods that foster higher order thinking, levels of cognition, and critical thinking in agricultural education, few studies have addressed delivery methods fostering critical thinking in agricultural distance education courses. The purpose of this casual comparative study was to determine students' disposition to think critically in a graduate research methods course, offered by the same instructor in both traditional classroom and distance learning settings. The course was specifically designed to implement strategies for improving critical thinking. To conduct the study, a series of null hypotheses were set up to determine the differences between distance learners and traditional learners with respect to: (1) their perception of course effectiveness, (2) their perceptions of opportunities to think critically in the course, (3) their actual critical thinking disposition, and (4) their critical thinking disposition change as a result of the implementation of critical thinking teaching strategies. Results generally supported the contention that distance learners were not significantly different than traditional learners with respect to perceptions of course effectiveness, opportunities to think critically and critical thinking disposition; however, traditional learners were significantly different from distance learners in terms of change in some critical thinking disposition subscale factors, including truth-seeking and inquisitiveness. Based on the above, practitioners need to continue to explore ways to develop technology-based teaching strategies that build critical thinking dispositions and skills in both distance and traditional learners.

Introduction

The development of critical thinking skills in agricultural audiences has been identified as an important need, based on findings which suggest potential deficiencies in terms of students' ability to think critically (Rudd, Baker, & Hoover, 2000). Several studies (Newcomb & Trefz, 1987; Rudd, Baker, & Hoover, 2000; Torres & Cano, 1995) have examined the effect of teacher delivery methods which foster higher order thinking, levels of cognition, and critical thinking in agricultural education, but few studies have addressed delivery methods fostering critical thinking in agricultural distance education courses. As higher education courses are increasingly being offered through distance education delivery methods, it becomes increasingly more important to determine whether the quality of instructional delivery with respect to fostering critical thinking among our students can be maintained in the distance setting.

Studies have shown that distance education is comparable to the on-campus classroom in terms of cognition levels (Miller & Pilcher, 2001; Verduin & Clark, 1998). Using the Newcomb and Trefz (1987) model, Miller (2001) addressed instructional methods via distance education delivery that influenced higher order thinking in post-secondary agricultural education. Results indicated that not only did instructors teach at the same levels of cognition in distance and traditional settings, but also that there was a positive relationship between cognitive level of instruction and delivery method. Even though cognitive level of instruction may be comparable, research has not yet addressed whether the distance education environment is analogous to the traditional classroom in terms of its ability to foster, stimulate and provide opportunities for the implementation of critical thinking teaching instructional methods. Miller (2001, p. 22) may have asked the question best. "Can instructors capitalize on this unique opportunity in the distance education environment?" Based on the above, this study sought to determine the effect of instructional delivery methods, specifically designed to improve critical thinking, on the critical thinking disposition of distance and traditional students in agricultural education.

Theoretical Framework

Critical thinking has been called one of the most important attributes for success in the 21st century (Huitt, 1998). Meyers (1986) argued that for students to reach their fullest potential in today's society, they must learn to think and reason critically. Paul (2002) contended "in a world of accelerating change, intensifying complexity and increasing interdependence, critical thinking is now a requirement for economic and social survival".

Researchers and theorists have defined critical thinking as a "set of intellectual standards" that can be used by individuals while thinking (Paul, 2002). However, critical thinking is somewhat different than higher order thinking or levels of cognition. "Critical thinking is 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, Baker, and Hoover, 2000, p. 5).

The theoretical framework for this study is based on an extensive Delphi study conducted by Facione (1990), who used the information to identify seven constructs, called dispositions, of critical thinking. These dispositions include analyticity, self-confidence, inquisitiveness,

maturity, open-mindedness, systematicity, and truth seeking (Facione, 1998), which can be defined as follows:

- *Analyticity* targets the disposition of being alert to potentially problematic situations, anticipating possible results or consequences, and prizing the application of reason and the use of evidence, even if the problem at hand turns out to be challenging or difficult. The analytically inclined person is alert to potential difficulties, either conceptual or behavioral, and consistently looks to anticipatory intervention, reason giving, and fact-finding as effective ways to resolve matters.
- *Self-confidence* refers to the level of trust one places in one's own reasoning process. Critically thinking self-confident persons trust themselves to make good judgments and believe that others trust them as well, since they believe that others look to them to resolve problems, decide what to do, and bring reasonable closure to inquiry.
- The *inquisitive* person is one who values being well informed, wants to know how things work, and values learning even if the immediate payoff is not directly evident. This person seeks knowledge without provocation for the intrinsic benefit of knowing.
- *Maturity* addresses cognitive maturity and epistemic development. Mature thinkers are disposed to approach problems, inquiry, and decision making with a sense that some problems are ill-structured, and that some situations have more than one plausible option. Mature thinkers also realize that judgments based on standards, contexts, and evidence often must be made without having the benefit of knowing all information about the situation.
- *Open-mindedness* is a construct that targets the disposition of being tolerant of divergent views with sensitivity to the possibility of one's own bias. The open-minded person respects the rights of others to differing opinions.
- *Systematicity* targets the disposition to being organized, orderly, focused, and diligent in inquiry. No particular kind of organization (i.e. linear or nonlinear) is given priority. The systematic person strives to approach specific issues, questions or problems in an orderly, focused, and diligent way.
- *Truth-seeking* thinkers are those eager to seek the truth, who are courageous about asking questions, and honest and objective about pursuing inquiry even if the findings do not support one's interests or one's preconceived opinions. The truth-seeker would rather pursue the truth than win the argument.

These constructs can function both as dispositions, which individuals can possess to a greater or lesser degree, as well as skills, which can be refined and developed as a result of educational experience. In fact, Facione (1995) hypothesized a link between the *disposition* to think critically and critical thinking *skills*. Subsequent research has consistently shown a high correlational relationship between critical thinking disposition and critical thinking skill (Claytor, 1997; Facione & Facione, 1997; Facione, 1998; Giancarlo & Facione, 1994). Based on the above, it could be assumed that the specificity of Facione's work could be used to design instructional delivery methods for the teaching of critical thinking to both traditional and distance learners. However, only a limited number of studies have demonstrated how critical thinking can be taught by utilizing appropriate instructional delivery methods (Gadzella, 1996; Angeli, 1999). Gadzella (1996) found that providing students with opportunities to analyze issues critically throughout the course improved their critical thinking skills, especially in interpretation and evaluation of arguments. Reed and Kromrey (2001) examined the infusion of

critical thinking into curriculum and found that critical thinking skills increased, and Angeli (1999) discovered that in-class methods of infusing critical thinking were a more effective way of developing critical thinking in students than teaching about critical thinking to a class *a priori*.

More specifically, within the context of distance education, the literature is replete with information which suggests that interaction is the key to fostering critical thinking opportunities for students (Moore, 1989; Anderson & Garrison, 1995; Hilgenberg & Tolone, 1999; Smith & Castle, 1992). According to Moore (1989), learner-instructor, learner-content, and learner-learner interactions are necessary for a successful distance education experience. Anderson and Garrison (1995) surveyed 160 students in distance education courses deliver via audio teleconferencing. The findings indicated that opportunities for dialogue and interaction occurred in audio-teleconferencing, despite the absence of face-to-face interaction, and that learner-instructor interaction was instrumental in fostering a community of learners. Hilgenberg and Tolone (1995) assessed students' perceptions of critical thinking opportunities in distance education courses using a two-way audio and video delivery system and found that interaction fostered two-way communication with instructors and students. Smith and Castle (1992) researched distance learning as a context to foster critical thinking opportunities in South African education and examined the ability of distance technologies to affect students' disposition to think critically. Technology utilized for this research study included an experiential learning activity delivered via simulated radio-phone system. Based on the research findings, researchers concluded that the degree and quality of the interaction provided evidence of critical thinking incorporated as a result of the distance learning environment.

Purpose and Objectives

The purpose of this research study was to determine students' disposition to think critically in a graduate research methods course offered through traditional classroom and distance learning settings. Specifically, the study examined the differences between traditional on-campus learners' and distance learners' dispositions to think critically in a research methods course which utilized instructional delivery methods specifically designed to foster critical thinking. To fulfill the purpose of this study, the following research questions were addressed:

1. How do traditional on-campus and distance learners differ in their perceptions of course effectiveness?

2. How do traditional on-campus learners and distance learners differ in their perceptions of opportunities to think critically?

3. Are there differences in the critical thinking dispositions of students choosing traditional on-campus instruction as opposed to those in distance instruction?

4. Are there differences in the change in critical thinking dispositions of traditional on-campus learners and distance learners as a result of teaching strategies aimed at developing critical thinking within each of the seven critical thinking constructs: analyticity, self-confidence, inquisitiveness, maturity, open-mindedness, systematicity, and truth-seeking?

For the purposes of statistical analysis, the research questions were posed as the following set of null hypotheses. Each hypothesis was tested at the .05 level of significance. Based on whether subjects were in the traditional or the distance classroom:

HO_1: There is no difference in the perceptions of traditional on-campus learners and distance learners concerning course effectiveness.

HO_2: There is no difference in the perceptions of traditional on-campus learners and distance learners concerning opportunities to think critically.

HO_3: There is no difference in critical thinking disposition score of traditional on-campus learners and distance learners.

HO_4: There is no change in critical thinking disposition score of traditional on-campus learners and distance learners.

Methods and Procedures

The population for this study consisted of all graduate students in the Department of Agricultural Education and Communication at the University of Florida who enrolled in a research methods course, which was offered by the same instructor in both distance (N = 20) and traditional classroom (N = 21) format. The distance class occurred in the Fall semester and the traditional class occurred in the Spring. The research design incorporated pretest-posttest comparisons and a casual comparative/*ex post facto* design, as outlined by Campbell and Stanley (1966).

Students in both classes were administered a pretest designed to measure their critical thinking disposition score prior to exposure to a specific set of instructional delivery methods. One class was delivered via distance education using a variety of delivery media, including teleconferencing, web, and digital video, as well as a set of distance education teaching strategies that were specifically designed to foster critical thinking. The second class was delivered in the traditional on-campus format, which also included teaching strategies for enhancing critical thinking. At the end of all instruction in the courses, the critical thinking dispositions inventory and an instrument analyzing students' perceptions of the course and perceived opportunities for critical thinking were administered to all of the participants.

The California Critical Thinking Disposition Inventory (CCTDI) was used in the pretest and the posttest to measure critical thinking disposition. The pretest consisted of the CCTDI, a 75-item Likert-type scale with seven sub scales. Alpha reliability for the CCTDI has been extensively tested and evaluated; for the seven sub scales, alpha reliability has been reported as ranging from r = .71 to r = .80. Alpha reliability for the overall instrument has been reported at r = .91. To calculate the CCTDI score, the seven subscales indexes are first summed, and then weighted and an overall score is calculated. Overall CCTDI test scores can range from zero to 420. Standardized item alpha for the CCTDI scale in the current study was r = .70 for the pretest and r = .86 for the posttest.

In addition to the CCTDI, the post-test survey included an adaptation of Biner's Teleconference Evaluation Questionnaire (TEQ), a 33-item questionnaire measuring instructor characteristics, course management skills, and technological skills in a distance education course. The TEQ, which was specifically developed for measuring student satisfaction in a classroom using interactive teleconference video, was tested by Biner (1993), and found to be very reliable. The traditional on-campus group received a version of the TEQ that did not include specific questions pertaining to distance education. Standardized item alpha for the scale used in the study was r = .96 for the distance version and r = .91 for the traditional version. In addition to the TEQ, the post-test survey also included a 22-item Likert scale designed to elicit students' perceptions of critical thinking opportunities in the distance education settings. Standardized item alpha for this scale was r = .74. Finally, the survey also included items measuring age, gender, and occupation, as well as two open-ended questions that allowed the students to reflect on the extent of critical thinking ability that was gained as a result of the course.

The last four digits of students' social security number was used as a means of coding, but the instruments were administered and scored in the absence of the instructor and the principle investigators so as to ensure privacy and validity in the study.

The instructional activities for the courses taken by the on-campus learners and the distance education students were specifically designed to foster critical thinking, and were based on the work of Facione (1990). Table 1 shows the specific instructional delivery methods that were used in each class.

Anderson and Garrison (1995) believed that instructional programs designed for interaction developed a "community of inquiry and critical thinking" (p. 19). In order to facilitate critical thinking, the distance course was therefore designed to include a combination of two-way videoconferencing and interactive asynchronous Web/CD-ROM delivery modalities that included digital video, audio-narrated PowerPoint and an online discussion forum. Each of these delivery media was utilized to stimulate critical reflection and interaction among students, instructor and graduate teaching assistant. For example, the digital video and discussion forums were used in tandem to provide a discussion mechanism for students, instructor and the course teaching assistant. In addition, the teaching assistant was specifically assigned to respond to students with questioning methodology designed to stimulate critical thinking and evaluate of their comments. The students were also encouraged to interact with each other, and electronic mail communication was encouraged as a way to support and sustain a sense of community and interaction. Students in the traditional setting were assumed to have that sense of community (Lave & Wenger, 1991, p. 59-84). Strategies for teaching critical thinking were also used in the traditional setting. Instead of technological interaction, the instructor used discussion, modeling, questioning, and debate to cultivate the dialogue that is so important to critical thinking (Anderson, Howe, Soden, Halliday, & Low, 2001). Finally, since there were two groups in the study and the mean differences between them were evaluated, the hypotheses were tested using independent samples t-tests and analysis of variance (ANOVA) procedures, which were calculated using the Statistical Package for the Social Sciences (SPSS) 10.0. Alpha was set at .05 for data analysis.

Table 1
Proposed Critical Thinking Cognitive Skills, Sub-Skills, and Instructional Delivery Methods for the Distance and Traditional Research Methods Course

Skill	Sub-skill	Instructional Component Distance Class	Instructional Component Traditional Class
Interpretation	Categorization	Digital video	Lecture
	Decoding Significance	Audio-narrated PowerPoint lecture	
	Clarifying Meaning	Online discussion forum	In-class discussion
Analysis	Examining Ideas	Research Proposal	Modeling
	Identifying Arguments	Grant Proposal	Research Proposal
	Analyzing Arguments	Case studies	Case studies
Evaluation	Assessing Claims	Article critiques	Article critiques
	Assessing Arguments	Email interaction with instructor	Socratic questioning
Inference	Querying Evidence	Guest speakers via Web-based digital video	Guest speakers
	Conjecturing Alternatives	Action learning	Action learning
	Drawing Conclusions	Research papers	Research Papers
Explanation	Stating Results	Two-way video conferencing interaction	Presentations
	Justifying Procedures		Debates
	Presenting Arguments		
Self-Regulation	Self-Examination	Final exam	Final exam
	Self Regulation		

Findings

A total of 40 subjects participated in the study; of these, 20 subjects were part of the research methods course taught by distance and 20 subjects were part of the course using the traditional classroom instruction. The same instructor using the same curriculum taught both courses. Results of the distance education research methods course showed that respondents' ages ranged from 23 to 56 years old. Thirty percent (n = 6) of the distance group was male and seventy percent (n = 14) were female. The traditional group included respondents with ages that ranged from 22 to 53. Twenty percent of the traditional subjects were male (n = 4), and 80 percent (n = 16) were female.

Hypothesis One

The first null hypothesis, which states there is no difference in the perceptions of traditional on-campus learners and distance learners concerning course effectiveness, was tested using independent samples t-tests for both the summed scale and the individual scale items. As in Biner's original instrumentation, the modified TEQ consisted of three subscales, which were (1) instructor characteristics (alpha =.88), (2) course management skills (alpha =.71), and (3)

technological skills (alpha =.90), needed in the distance course. The course management construct, which consisted of items pertaining to library access, computer access, conscientiousness of the site/class coordinator, accessibility of departmental personnel, and class enrollment and registration procedures was the only scale with significant differences between the distance and traditional learners. With alpha at .05, the summed TEQ scale scores indicated no difference t(34) = -.04, p = .97 (two-tailed) between the two groups. The t-tests yielded no differences for overall effectiveness of the instructor *t*(32) = .41, p = .15 (two-tailed) or course management *t*(28) = -1.48, p = .15 (two-tailed), however three individual variables under the course management construct yielded statistically significant differences between the two groups. Table 2 contains the summary of the independent samples t-tests for the items in the course management construct.

Using a 5-point Likert scale to determine course effectiveness with 1 = to very poor and 5 = very good, the traditional group's (*M* = 4.88, *SD* = .33) perception of their ability to access the library, as could be expected, was significantly higher than the distance group (*M* = 4.00, *SD* = 1.00), t(28) = -3.146, *p* = .002. The distance group (*M* = 5.0, *SD* = .00) felt more strongly about the general conscientiousness of the site/class coordinator, e.g., in delivering materials, unlocking room doors, tuning in broadcasts than the traditional group (M = 4.54, *SD* = .52), t(23) = 3.08, p = .005. The distance group (*M* = 5.0, *SD* = .00) also had a better perception about the accessibility of site and/or class coordinator than the traditional group (*M* = 4.67, *SD* = .49), t(21) = 2.24, p = .036. The null hypothesis was rejected and the research hypothesis was retained.

Table 2
Summary of t-tests for Course Management construct of TEQ

Variable	Mean Distance	Mean Traditional	df	*t*	Sig.
Library access	4.00	4.88	28	-3.15	.002
Computer access	4.62	4.76	28	-.75	.458
Conscientiousness of site/class coordinator	5.00	4.54	23	3.08	.005
Accessibility of site/class coordinator	5.00	4.67	21	2.24	.036
Accessibility of departmental personnel	4.23	4.67	26	-1.72	.097
Class enrollment and registration procedures	4.31	4.51	27	-.618	.542

Hypothesis Two

Both groups either agreed or strongly agreed that the instructional procedures employed in the class provided them with opportunities to think critically, but there were some differences between the groups. The second null hypothesis, which states there is no difference in the perceptions of traditional on-campus learners and distance learners concerning opportunities to think critically was tested using independent samples t-tests. Table 3 contains a summary of the analysis for the significantly different variables as well as the summed scale.

Although the summed scale indicated no difference between distance learners (*M* = 3.90, *SD* = .39) and traditional learners (*M* = 3.81, *SD* = .22), t(31) = .78, p = .44 (two-tailed), the traditional format students (*M* = 4.50, *SD* = .51) agreed more strongly than the distance students (*M* = 3.85, *SD* = .99), t(31) = -2.15, p = .018 (two-tailed) that class discussion was generated

through various instructional techniques. According to the data, the distance students (M = 4.46, SD = .52) reported that critically thinking about specialized knowledge happened more often in their course than in the traditional course (M = 3.73, SD = .59), t(26) = 3.46, p = .002 (two-tailed). The data also shows that the distance learners (M = 4.62, SD = .51) thought the meaningful explanations were more helpful to creating opportunities for critical thinking than the traditional students (M = 4.20, SD = .41), t(26) = 4.20, p = .024 (two-tailed). The null hypothesis was rejected and the research hypothesis was retained.

Table 3
T-tests and means for statistically different items and the summated scale for perceptions of opportunities for critical thinking

Variable	Mean Distance	Mean Traditional	*df*	*t*	Sig.
Class discussions	3.85	4.50	31	-2.15	.018
Development of specialized knowledge	4.46	3.73	26	3.46	.002
Meaningful explanations	4.62	4.20	26	2.39	.024
Summated scale	3.90	3.81	31	.784	.440

Hypothesis Three

To evaluate whether or not there were differences in critical thinking disposition among students who chose either the distance format or the traditional format, the hypothesis, which stated there is no difference in critical thinking disposition score of traditional on-campus learners and distance learners was tested using analysis of variance (ANOVA) procedures. The CCTDI pretest and posttest total scores indicated that there was no significant difference in critical thinking disposition between the individuals who chose either the traditional or distance education form of instruction (see Table 4). Although the sample size was rather small and the variability was rather large, the third null hypothesis was accepted and the research hypothesis was rejected.

Table 4
Total pretest-posttest CCTDI scores

	Pretest			Posttest		
	M	*SD*	*n*	*M*	*SD*	*n*
Distance learners	307.65	16.97	20	309.54	29.46	13
Traditional learners	309.95	32.01	20	306.20	33.01	20
Total	308.83	25.51	40	307.52	31.23	33

Hypothesis Four

Pretest and posttest scores on the CCTDI were analyzed to determine the effect the critical thinking teaching procedures had on each of the groups. The fourth hypothesis, which states that there is no difference in the *change* of critical thinking disposition score of traditional on-campus learners and distance learners also utilized ANOVA procedures. Significant differences were found among the subscale scores. Table 5 summarizes the ANOVA procedures and outlines the statistical change from the pretest to the posttest.

At the .05 alpha level, the overall difference (M = .070) between the two groups was not significant, but traditional learners (M = 2.45) showed significant (p = .031) difference from the distance learners (M = -1.46) regarding positive change of the truth-seeking critical thinking disposition. Traditional learners (M = 1.15, p = .022) were also more apt to improve on the inquisitiveness scale than the distance learners (M = -3.46). The fourth null hypothesis was rejected and the research hypothesis was retained.

Table 5
Mean change in critical thinking dispositions

CCTDI Construct	Distance Mean Change	Traditional Mean Change	*df*	F	Sig.
Truth-seeking	-1.46	2.45	1,31	5.090	.031
Open-mindedness	.38	.01	1,31	.039	.846
Analyticity	-1.23	1.20	1,31	2.960	.095
Systematicity	-1.46	2.10	1,31	3.897	.057
Self-confidence	-1.08	-.80	1,31	.021	.885
Inquisitiveness	-3.46	1.15	1,31	5.786	.022
Maturity	-1.62	1.15	1,31	3.411	.074
Total	-7.15	5.20	1,31	3.520	.070

Conclusions

It appears from the results of this study that distance education instruction can be comparable to traditional instruction in terms of perceived course effectiveness and perceptions of opportunities to think critically on the parts of students. The finding that distance students didn't feel like the library was accessible is not a surprise, and provides evidence to support the need to investigate opportunities to bring university student support services, like the library, to distance students more effectively. Interestingly, the distance learners also felt the instructor was more attentive and conscientious as to their needs. This could have influenced distance students in terms of their perceptions as to the opportunities for critical thinking. On the other hand, the only variable those traditional students perceived as more beneficial than distance students for the creation of critical thinking opportunities was discussion. This indirectly supports the literature (Moore, 1989; Anderson & Garrison, 1995; Hilgenberg & Tolone, 1999; Smith & Castle, 1992), which addresses the importance of, as well as the challenges, in creating interaction opportunities in distance education.

In terms of fostering critical thinking, however, it appears that most of the critical thinking disposition constructs decreased for distance students, although the overall disposition score was not significantly different. It may be the case that distance students, due to background, experience, demographics, etc. exhibit critical thinking dispositions differently than traditional students, and are thus less likely to respond differently to instruction designed to foster these specific critical thinking dispositional constructs. It could also be that traditional students still have an advantage in being able to enjoy the benefits of the on-campus graduate student environment, which is designed for and which presumably provides opportunities to more easily engage in many forms of intellectual growth and development.

Potential limitations of the study include the fact that the sample size was relatively small. A larger sample would have been more powerful in terms of effect size, but the small class sizes determined the number of subjects in the study. The study was also conducted at one institution with one type of course. For these reasons the results of this study can only be generalized to students taking that course at that institution. However, the research design and attempt to control for extraneous variation by using the same instructor and curriculum make it a very replicable study and generalizations to similar students should yield similar results.

Interestingly, the overall CCTDI scores did not change for either group of students. One reason for this may be due to the lack of content or discipline specific critical thinking evaluation. Although the CCTDI remains the standard instrument used by researchers to evaluate critical thinking disposition, researchers such as Ennis (1989) believed that critical thinking should be discipline-specific. Based on the above, directions for further research would include looking at both discipline specific dispositions as well as skills. To that end, the researchers are currently engaged in developing reliable and valid discipline specific critical thinking skills measures to provide a clearer picture of the influence of certain teaching methods on the critical thinking of our students.

Recommendations

Educators in distance and traditional settings should use strategies that promote and improve critical thinking in their students. However, teachers and educational researchers working with distance students need to increase strategies that improve the specific critical thinking dispositions of *truth seeking* and *inquisitiveness*. Additionally, the inability of distance students to engage in discussion and dialogue compared to traditional students should be addressed by researchers. Research with the newest videoconferencing technology (i.e. Polycom) and critical thinking development in distance students should be conducted to improve to the dialogical relationship that promotes critical thinking.

It is clear that more research is needed to determine why distance and traditional learners seemed to be affected differently by the same types of critical thinking teaching strategies. Practitioners need to continue to explore ways to develop technology-based teaching strategies that build critical thinking dispositions and skills. Further replicable research should build on this study by using more classes and institutions that control for factors such as GPA, time, and subject specificity. Lastly, it is recommended that agricultural educators continue to design distance education curriculum with critical thinking in mind.

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