Comparing Inquiry-based Instruction and Direct Instruction on Students' Critical Thinking Ability in an Environmentally-focused Agriscience Curriculum

Dr. Blake C. Colclasure
Heartland Community College
ICB 2411
1500 W Raab Road
Normal, IL 61761
(309) 268-8564
blake.colclasure@heartland.edu

Dr. Andrew C. Thoron
University of Florida
307A Rolfs Hall
PO Box 110540
Gainesville, FL 32611
(352) 294-1992
athoron@ufl.edu

Dr. Ed W. Osborne
University of Florida
407 Rolfs Hall
PO Box 110540
Gainesville, FL 32611
(352) 273-2613
ewo@ufl.edu

Dr. T. Grady Roberts
University of Florida
117C Bryant Hall
PO Box 112060
Gainesville, FL 32611
(352) 273-2568
groberts@ufl.edu

Dr. Rose M. Pringle
University of Florida
G509A Norman Hall
PO Box 117048
Gainesville, FL 32611
(352) 273-4190
rpringle@coe.ufl.edu

Introduction

Environmental education has become an integral component of School-based Agricultural Education (SBAE) programs. In fact, the National Council for Agricultural Education (2015) included Environmental Service Systems and Natural Resource Systems as two of eight national career clusters. Furthermore, a first time Memorandum of Understanding was recently signed to enhance cooperation between the U.S. Environmental Protection Agency (EPA) and the National FFA Organization, with a goal to increase the impact of environmentally-focused programs in agricultural education (U.S. EPA, 2019). According to the American Association for Agricultural Education's National Research Agenda (Roberts, Harder, & Brashears, 2016), increasingly complex issues between environmental sustainability, societal systems, and agricultural production (World Economic Forum, 2010) has led to the need for future generations to be globally competent, possess 21st century skills, and to understand the multidisciplinary nature of agriculture. This study compared the use of two instructional approaches in an eight-week, environmentally focused CASE® curriculum on students' critical thinking ability.

Conceptual Framework

The conceptual framework that guided this study was the Presage-Process-Product (3P) model developed by Biggs (2003). The 3P model illustrates the relationship between presage, process, and product factors in teaching and learning. Presage factors include characteristics of the teacher and characteristics of the student. The presage factors investigated in this study were students' age, race, and gender. Process factors include the curriculum and teaching methods used in the learning environment. This study compared the 5E method of inquiry-based instruction (IBI) to direct instruction (DI) within a CASE® curriculum. Lastly, product factors include learner outcomes such as changes in students' knowledge, skills, and attitudes. This study investigated changes in student's critical thinking skills. The objectives for this study were to: (1) compare the critical thinking ability of high school agriscience students taught using the 5E method of IBI to a DI approach, and (2) examine the relationship between students' critical thinking ability and demographic characteristics.

Methods

This study was quasi-experimental and used a nonrandomized control group, pretest-posttest design (Campbell & Stanley, 1963). The population for the study was all secondary agriscience students in the United States. The accessible population included all students of agriscience teachers who completed the CASE® Institute for Natural Resource and Ecology (NRE) certification between 2013 and 2017. One hundred and sixty seven teachers were identified in the sampling frame. Convenience sampling was used to recruit teachers who were teaching the CASE® NRE course in a SBAE program during the spring of 2018, and who were willing to implement an eight-week modified curriculum for the following CASE® modules: (a) The Energy of Life, (b) Flourishing Fauna, (c) All Natural Flora, and (d) Agricultural Stewardship. A sample size of 13 teachers and 181 students agreed to participate in the study during the spring of 2018. Six teachers were randomly assigned to the control group and received 16 lesson plans that followed the direct instruction approach (Eggen & Kauchak, 2012). Seven teachers were randomly assigned to the experimental group and received 16 lesson plans that followed the 5E method of inquiry-based instruction (Bybee et al., 2006). All research instruments were given to students digitally through Qualtrics. Students self-reported demographic data (age, gender, ethnicity) at the start of the study. The Critical Thinking Test in Environmental Education

(CTTEE) (Cheak, 1999) was used to measure students' critical thinking abilities. The instrument was designed for students in grades eight through college. The CTTEE consisted of 27 multiple choice questions making up three sections (inferences, conclusions, bias). Previous reliability estimates of the instrument were reported to be .87, .70 (Cheak, 1999), and .72 (Robinson, 2001). For this study, the Kuder-Richardson 20 score was used to determine a reliability of .78. Students completed the CTTEE pretest before being exposed to the eight-week treatment. At the end of the study, students again took the CTTEE instrument. The order of sections was changed on the posttest, as suggested by Robinson (2005). Descriptive statistics in the form of means, frequencies, and standard deviations were used to describe the demographic characteristics of students. Objective 1 was analyzed through paired samples *t* tests and Objective 2 was analyzed through correlational statistics. An a priori alpha level of .05 was established for this study.

Results

A total of 181 students participated in the study and were exposed to either IBI or DI for a duration of eight weeks. Students were given the option to self-report demographics. Of the 181 students, 46.4% ($n = 84$) identified as male and 33.7% ($n = 61$) identified as female. Thirty-six percent did not indicate gender. Student ages varied from 14 to 19 with most students being 16 years of age (34.3%, $n = 62$) or 15 years of age (24.3%, $n = 44$). Most students in the study were White, non-Hispanic (58%, n = 105), followed by Hispanic or Latino (11%, n = 20), and Black (3.3%, n = 6). Twenty-one percent did not indicate ethnicity. Student demographics were similar between both treatment groups. Of the 181 students that participated in the study, 156 students (86.2%) completed the CTTEE pretest and 112 students (61.9%) completed the CTTEE posttest. The paired sample completion rate was 54.7% (n = 99). Students exposed to IBI achieved a mean CTTEE pretest score of 14.21 (SD = 5.06) and a mean posttest score of 13.15 (SD = 5.30). Students exposed to DI achieved a mean CTTEE pretest score of 14.61 (SD = 4.59) and a mean posttest score of 14.07 (SD = 5.52). A paired samples *t* test was conducted for each group and no statistical differences between pretest and posttest scores were found, therefore follow-up ANCOVA statistics were not conducted. Furthermore, significant correlations were not found between age or gender and the CTTEE. Moderate correlations were found in the DI group between ethnicity and the CTTEE pretest (r = .31) and between ethnicity and the CTTEE posttest (r = .34). Lastly, a significant correlation was found between the CTTEE pretest and posttest (r = .67) for students in the IBI group.

Conclusions & Implications

Findings from this study indicate the neither IBI nor DI improved students' critical thinking abilities in an eight-week, environmentally focused CASE® curriculum. Previous literature supports the use of IBI over traditional instruction to improve students' critical thinking ability (Thoron & Myers, 2012). This study was part of a larger study which yielded some limitations. Students completed a total of twelve instruments during an eight-week duration. The CTTEE posttest was measured at the very end of the study and teachers expressed that students were experiencing test fatigue. A follow-up analysis compared the amount of time students took to complete the CTTEE pretest and posttest and found that students spent less time on the posttest. Lastly, results of this study contradict previous findings that suggest student gender influences critical thinking abilities in environmental education (Arslan, 2012). Recommendations for future research include implementing a longer treatment duration with fewer instruments.

References

Arslan, S. (2012). The influence of environmental education on critical thinking and environmental attitude. *Social and Behavioral Sciences, 55*, 902-909.

Biggs, J. (2003). *Teaching for quality learning at university* (2nd ed.). Buckingham, UK: Open University Press.

Bybee, R. W., Taylor, J. A., Gardiner, A., Van Scotter, P., Powell, J. C., Westbrook, A., & Landes, N. (2006). *The BSCS 5E instructional model: Origins and effectiveness.* Colorado Springs, CO: BSCS.

Campbell, D. T., & Stanley, J. C. (1963). Experimental and quasi-experimental designs for research on teaching. In N. L. Gage (Ed.), Handbook for research on teaching (pp. 171-246). Chicago, IL: Rand McNally.

Cheak, M. (1999). *The development and field-testing of an instrument designed to measure critical thinking in environmental education.* Unpublished doctoral dissertation, Southern Illinois University, Carbondale, IL.

Eggen, P., & Kauchak, D. (2012). *Strategies and models for teachers: Teaching content and thinking skills* (6th ed.). Boston, MA: Pearson Education.

National Council for Agricultural Education (NCAE). (2015). Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content Standards, 1-142.

Roberts, T. G., Harder, A., & Brashears, M. T. (eds.) (2016). *American Association for Agricultural Education national research agenda: 2016-2020*. Gainesville, FL: Department of Agricultural Education and Communication.

Robinson, T. Y. (2001). *Field-testing of the critical thinking test in environmental education for use with sixth grade students.* Unpublished master's thesis, Southern Illinois University, Carbondale, IL.

Robinson, T. Y. (2005). *A study of the effectiveness of environmental education curricula in promoting middle school students' critical thinking skills* (Doctoral dissertation). Southern Illinois University, Carbondale, IL.

Thoron, A. C., & Myers, B. E. (2012). Effects of inquiry-based agriscience instruction on student scientific reasoning. *Journal of Agricultural Education, 53*(4), 156-170.

United States Environmental Protection Agency (EPA). (2019). Memorandum of Understand on Collaboration of Effort between the U.S. Environmental Protection Agency and the National FFA Organization, 1-3.

World Economic Forum. (2010). Realizing a new vision for agriculture. A roadmap for stakeholders. Retrieved from https://www.weforum.org