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Learning of Cover Crop Concepts Fostered by the *Cover Crop Science* 4-H Project Book

Taylor Irvin[*], Karyn Rader,[†] & Layla Jones[†]
Mentors: Rebekka Darner, PhD [*‡] & Matthew Hagaman, MS [‡]
[*]Presenter, Department of Agriculture [†]School of Biological Sciences [‡]Center for Mathematics, Science, & Technology

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Integrated Pennycress Research Enabling Farm & Energy Resilience

Introduction

The 4-H Cover Crop Science project book consists of 11 lessons that introduce concepts of general cover crop science and production agriculture to grades 3rd-8th (Cover Crop Science, n.d.). A project book provides 4-H students a set of projects that can be independently explored over a year to learn a specific area of agriculture; the year-long experience is presented at county and state fairs. The book was created by IPREFER educators to educate the youth on cover crop advantages and disadvantages and to introduce the potential of pennycress as a cash cover crop. As of the 2017 USDA census, 15.4 million acres of cover crops were planted with an established goal of 100 million acres by 2025 (Wallander et al., n.d.). The purpose of this study was to identify the extent to which the project book supports effective learning of the definition, advantages, and disadvantages of cover crops to foster a positive mindset of implementing cover crops in future farmers. In the Theory of Constructivism, learners are developing an understanding of the real world based on connections between prior and current experiences. Meaningful learning can occur when learners are exposed to project-based learning and collaboration in multiple forms (Mohammad et al., n.d.). The lessons relevant to this study combine the topics of cover crops in the traditional corn-soybean rotation and reducing soil erosion, which allows learners to develop their own understanding of cover crops that best relate to the scientific consensus of the definition.

Research Question

Do students develop a mental framework of cover crops through these activities that is more aligned to the scientific consensus?

Methodology

This study used an iterative design framework (Figure 1), in which lessons were evaluated and redesigned after each teaching iteration.

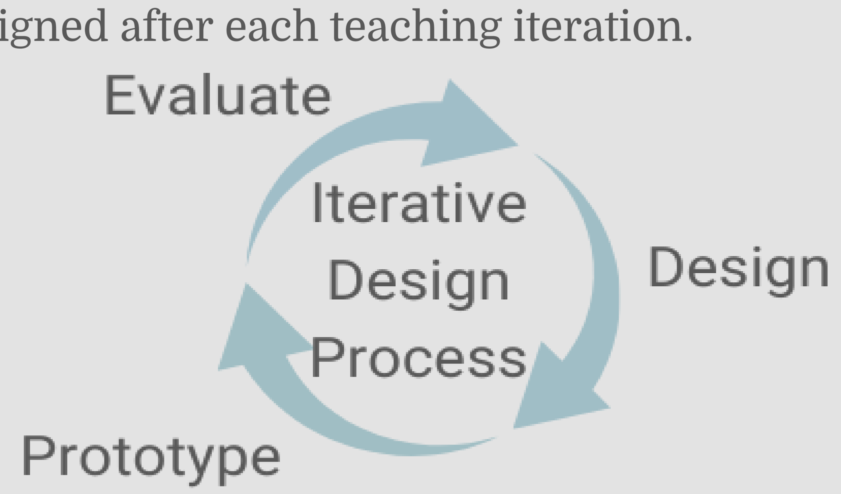

Figure 1. The iterative design framework allows for researchers to revise lessons after evaluating data after each teaching iteration (or repetition), enabling lessons to become more effective in fostering students' learning.

The authors integrated all the cover crop rotation and soil erosion lessons from the 4H project book to create a crop rotation matching activity, soil erosion box, and cover crop advertisement activity. Before being told the definition of a cover crop, students were given a test of prior knowledge (Figure 2), which was compared to their responses to the same questions at the end of the lesson.

Activity 1: The first activity allowed students to see how various cover crops fit into a crop rotation by matching images under months the crop is in the field. This activity correlates to question 1.

Activity 2: The second activity was a hands-on experience for students to see soil erosion in action by measuring displacement in a soil box. This activity correlates to question 2.

Activity 3: The last activity introduces the benefits and drawbacks of cover crops in a sales ad drawing. This activity correlates to question 3.

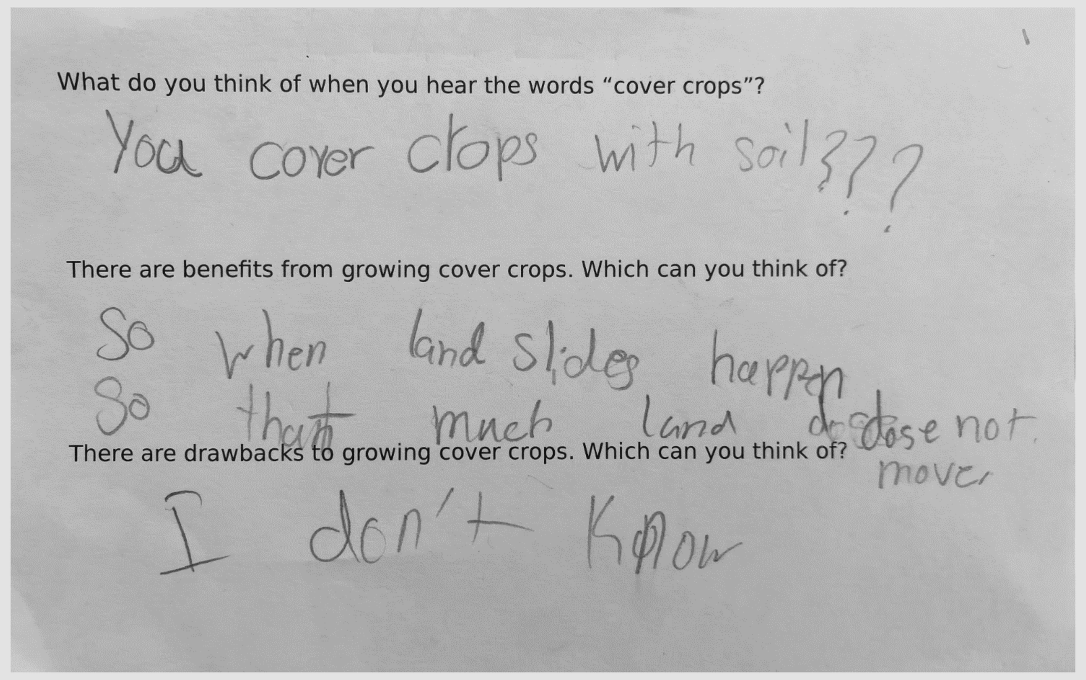

Figure 2. Pre- & post-test to evaluate students' learning about cover crops.

After activities, students were given the same test to identify post knowledge (Figure 2). Responses were scored based on their agreement with the scientific consensus, advantages, and disadvantages of cover crops. After each teaching iteration a Wilcoxon signed-rank test was run on pre/post scores on individual items to detect statistical significance. A paired t-test was performed on total pre/post scores.

Common themes found in post answers were tallied for each group along with the number of students answering "I don't know" on both sides and answering "I don't know" in the pre-test and attempting an answer in the post-test. These themes showed what concepts students were walking away from the lesson with and able to reiterate to someone new. Common themes were used to determine the strongest and weakest teaching points in order to evaluate and edit the activities to reinforce the objectives of the lesson.

Results

After the first teaching iteration (N = 27), total scores significantly improved between pre- and post-test ($t = -3.94$, $df = 26$, $p = 0.0055$; Figure 3). Item 1 showed significant pre/post improvement ($Z = -3.16$, $df = 26$, $p = 0.0016$). Significant improvement was not detected on item 2 or 3.

After the second teaching iteration (N = 23), total scores significantly improved between pre- and post-test ($t = -3.64$, $df = 22$, $p = 0.001445$; Figure 3). Significant improvement was not detected on individual items.

After the third teaching iteration (N = 8), total scores significantly improved between pre- and post-test ($t = -4.78$, $df = 7$, $p = 0.002012$; Figure 3). Significant improvement was not detected on individual items.

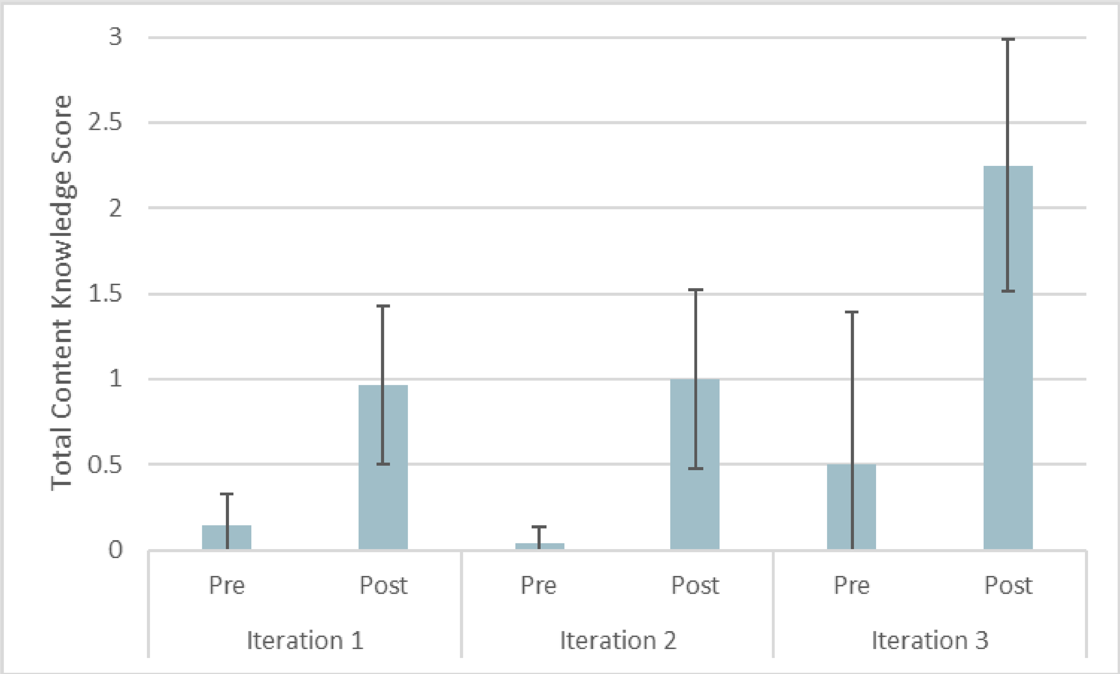

Figure 3. Average scores on the pre- and post-test for each teaching iteration.

Conclusion

All three iterations include the matching activity and soil erosion experience. The lesson adjustments between Group 1 and Group 2 add the sales ad drawing to Group 2. Group 1 also experienced a conversation about cover crops with the definition written on a whiteboard, whereas Group 2 did not. Group 3 experienced all three activities with the cover crop definition being written on the board.

Differences in total content knowledge score are a result of these changes. Total significance in learning for each teaching iteration shows the importance of using different teaching methods to reach lesson objectives. Individual item significance is not found; however, this shows that meaningful learning occurred in the different cover crop activities together rather than separate as each activity reinforced ideas that were fostered in the previous activity.

Future Work

Multiple methods of teaching were used to illustrate cover crop concepts to initiate generational change in the understanding of cover crops. Changes that were made in regards to this study will be adopted into the 4-H Cover Crop Science project book as it is being prepared for National 4-H adoption. Pieces of two lessons were adjusted and combined. Activities that will be added are the cover crop rotation matching game and cover crop sales ad drawing. A resource was created to give background knowledge on various cover crops for the sales ad activity and will be available for use.

This study shows that students are able to align their view of cover crops with the scientific consensus when presented lessons in multiple forms. With the low number of cover crop lessons available, 4-H chapters, agriculture and science teachers, and homeschool programs are able to adapt the 4-H Cover Crop Science project book into their yearly science curriculum.

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Acknowledgements

IPREFER is supported by Agriculture and Food Research Initiative Competitive Grant No. 2019-69012-29851 from the USDA National Institute of Food and Agriculture. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

We also thank our students for their engagement in the cover crop activities, allowing us to evaluate and iteratively develop the lessons.