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Novel Use of Conceptual Change Framework Improves Video on Challenging Science Topic

Abstract

Educational campaigns are more complicated when members of our audiences hold scientific misconceptions related to new technologies. Our prairie strips research and education team produced a brief, focused video aimed to dispel a misconception related to the effect of prairie strip plants' roots on agricultural drain tiles in the Midwest. Our "Field Tile Investigation" video was based on the conceptual change framework from science education and featured a discrepant event. The goal was to move farmers, landowners, and their advisors to an understanding of prairie strips that was more compatible with the scientific standard.

Keywords: agricultural drainage, best management practices, conceptual change, roots, science education

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Introduction

An adult's scientific conceptions may be at odds with scientific standards (Strike & Posner, 1992), and misconceptions may stall adoption of new ideas or technologies in the Extension education setting. We encountered and addressed this phenomenon while educating farmers, landowners, and advisors about prairie strips, a conservation best management practice (BMP) used in the Midwest (Schulte et al., 2017). Specifically, we confronted a misconception related to the interaction of prairie roots with agricultural subsurface drainage tiles. Application of the conceptual change framework from science education assisted us in addressing the misconception in a new way. We recommend that Extension educators consider application of the framework when designing nonformal curriculum materials on challenging concepts.

Prairie Strips

Prairie strips are native plantings located along the contour and at the toe slope of a crop field. Application of this conservation treatment involves maintaining about 10% of a field as prairie strips (Grudens-Schuck, Helmers, Youngquist, & Johnson, 2017). The BMP helps control sediment, nitrogen, phosphorous, and other contaminant losses (Schulte et al., 2017). Also, the strips provide wildlife habitat, including for pollinators (Schulte, MacDonald, Niemi, & Helmers, 2016). Tile lines are installed below the soil surface to provide excess soil moisture an unimpeded path for exiting the field. Prairie roots grow to depths of 10 ft or more, where they may interact with subsurface tile lines.

Misconception

Through outreach events and social media interactions, we learned that individuals believed that prairie roots, by their very nature, would plug tile lines. Clogged tile lines are costly, so we appreciated the concern. However, there were no incidences of plugged tiles during the 10 years of our prairie strips field research or among the experiences of our farmer cooperators. Despite these circumstances, we recognized that the misconception could have a dampening effect on adoption (Reimer, Weinkauf, & Prokopy, 2012). The causal model for the misconception went something like this: The long, fibrous prairie roots seek out and grow into drainage pipes, clogging them.

Conceptual Change Framework

Science educators use the conceptual change framework to plan curriculum and instruction in the fields of physics and biology, and Extension educators have used the framework to a limited extent (Knoot, Grudens-Schuck, & Schulte, 2006). The framework focuses on conditions under which a learner "makes a transition from one conception to a successor conception" (Strike & Posner, 1992, p. 148). A learner's causal model (accurate or inaccurate) about a theory can be supported by aesthetic and cultural elements and may be strongly held. A misconception is more complex than simply "not knowing" something and may prevent an individual from changing his or her mind, even after correct information is provided. Direct contradiction, such as "No, prairie roots won't do that," typically is ineffective in changing a learner's mind. Instead, changing a prior misconception involves applying the following steps:

1. create dissatisfaction with the current concept;

2. consider describing or demonstrating an evidence-based discrepant event;

3. provide an alternative explanation that is simple and plausible; and

4. provide an alternative explanation that allows the learner to solve future problems (Strike & Posner, 1992).

A key to the process is drawing attention to a discrepant event. A discrepant event provides evidence that is difficult for the learner to refute (Clement, 2008, p. 421). The discrepant event typically causes the learner to feel less strongly about or to discard the misconception (Di Sessa, 2014). A reasonable near-term outcome would be for the learner to report less confidence in his or her misconception (Hemmerich, Van Voorhis, & Wiley, 2016). The "leap" from the misconception to the standard science conception does not always occur immediately.

Video Strategy

We produced a brief video titled "Field Tile Investigation" (6:03 min) to provide a challenge to the misconception we had identified (Youngquist, 2017). The video focuses on the interaction of prairie plant roots with agricultural subsurface drainage tile. A technician opens the video by acknowledging that prairie plants have deep roots but focuses right away on the key question "Are those deep roots penetrating into tile?" The video reveals a field-based demonstration that involved the placement of a second, separate video camera inside a drainage pipe that had been installed under prairie in 2008. An agricultural engineer narrates the travel of the video camera through the tile line. The viewer is able to see that there are very few roots (step 1). Yet something comes into view—but it is not a prairie plant root. The obstruction that becomes visible is a cluster of cottonwood roots (*Populus deltoids*). Cottonwood is a fast-growing tree species and is not considered to be prairie. In prairie, cottonwood is a weed, to be controlled or removed, because it competes for light, water, and nutrients. The internal video camera then moves to a drain tile under a field planted to continuous corn, a plant with less vigorous roots. The narrator explains that the amount of root matter in the pipe is the same or slightly higher than in the pipe of the 10-year prairie. The discrepant event (step 2) is the *absence* of significant root matter in the tiles from prairie (or crop). The alternative explanation (step 3), is that nonwoody crop and prairie roots are more likely to function the same with respect to drainage tile. The management reminder (step 4) directs farmers and landowners to control woody species in prairie strips to increase the vigor of prairie strips but also to protect the integrity of tile lines.

Discussion and Conclusion

The conceptual change framework for science education ties in with principles already valued by Extension educators, especially observability (Reimer et al., 2012). In our video, we paired the principle of observability with the tenet of the discrepant event to persuade the audience to move away from the idea that prairie roots routinely damage tile lines. The design of the video focused on a misconception and the steps required to unsettle prior knowledge. The video was brief, and it was focused.

We used the video with audiences enrolled in Become a Prairie Strips Consultant programs in 2017. Additionally, we can report that the video garnered 2,500 views between August 2017 and November 2018. Continued use of the video has included integration in online professional development courses and on-location workshops.

Most topical areas addressed by educators in Extension and partner agencies and organizations do not require an approach such as the one described here. It is likely, however, that misconceptions occur with some force regarding some of the subject matter we deliver. We urge educators to experiment with the conceptual change framework to improve communication with audiences regarding challenging scientific concepts.

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