Fighting and embracing technology in Precision Agriculture curriculum adoption

Introduction/Need for Research

Precision Agriculture (PA) is the science of improving crop yields through assisted management and decisions (Singh et al., 2020). PA provides benefits such as increasing output, reducing inputs, and improving economic and environmental sustainability (Shannon, 2018; Singh, 2020). School Based Agricultural Educators (SBAE) indicate teaching PA curriculum is important but is often not taught due to lack of funding, curriculum, and certifications (Reynolds et al., 2023). Other curriculum implementation barriers include lack of specialized equipment, experience, and professional development (Heidenreich et al., 2018). Teachers lack the knowledge and self-efficacy needed to effectively teach PA (Reynolds et al., 2023). Female teachers perceive themselves to be less competent to teach Agricultural Mechanics courses than their male counterparts, and report concerns about safety, credibility, instruction, and competence (Byrd et al., 2023; Tummons et al., 2017). SBAE curriculum should be updated to reflect current PA industry needs. As the teaching population becomes increasingly younger and more female, new concerns arise on maintaining Agricultural Mechanics (and PA) instruction. Researchers intentionally conducted this qualitative inquiry without a predetermined theoretical framework with concerns locking into a framework might limit critical issues from surfacing.

Methodology

The purpose of this instrumental case study (Stake, 2005) was to describe barriers faced and strategies used to overcome PA curriculum implementation for SBAE. The bounded system was early-career female SBAE teachers in Missouri teaching courses in Agricultural Mechanics and who had an interest in PA. Nine female SBAE were purposefully selected from within this bounded system to participate in the study. Data sources included two 45-minute focus group interviews, observations from mentorship meetings, and written participant reflections.

Findings

This instrumental case study describes the experiences of nine early-career female SBAE who participated in a PA curriculum and mentoring program, then attempted to implement a newly developed PA curriculum. Through implementation, teachers experienced barriers relating to school-specific technology policies and a lack of confidence in their own content knowledge. Teachers relied on community partners and peers to help overcome these barriers.

Theme 1: Receiving conflicting messages about technology usage: Teachers described tensions between administrative expectations to integrate modern technologies in curriculum and school policies which limited student access to devices. Mrs. Smith noted PA curriculum aligned to administration expectations, “it fits to a T. The curriculum includes everything that they want to see taught,” yet technology restrictions created barriers to implementation. Mrs. Smith later went on to say, “I broke the technology rule and allowed my students to use the cell phones to collect weather data.” To navigate these technology constraints, teachers adapted instruction and

relied on external supports. Participants discussed specific ways they partnered with local community members and businesses to teach PA concepts. Experiences included field trips to local agricultural businesses, seed dealers, feed stores, custom fertilizer applicators, and equipment repair shops, where students saw PA technologies in practice. Teachers also invited industry specialists as guest lecturers to show students to how their specific businesses used PA, who somehow didn't face technological constraints. These adaptations allowed participants to maintain student engagement while still aligning instruction with industry expectations.

Theme 2: Lacking content knowledge to confidently teach PA: Many participants expressed discomfort teaching PA content; this discomfort arose from perceptions that their own lack of knowledge would restrict their ability to teach well. Participants emphasized a desire to perform at a high level, which further heightened anxiety when teaching unfamiliar material. Ms. Howell shared, "Whenever I do anything, I want to do a really good job at it." Mrs. Allie explained that teaching PA felt overwhelming because she was afraid she would "do a mediocre job." Even after completing the multiday training, teachers described lingering fears and nervousness about translating new knowledge into classroom instruction, particularly when teaching complex or technical concepts to students. Teachers mentioned participation in the community of practice allowed them to normalize uncertainty and share instructional experiences openly. Mrs. Smith reflected, "I really appreciated the trainings. They made teaching PA not quite as scary." Ms. Jones noted, "I feel like I actually know more about PA than I realize." Teachers relied on peer discussion, mentorship meetings, and shared resources to validate their understanding and build confidence over time. Additionally, participants began integrated PA concepts into existing curriculum areas to go deeper despite not having full mastery of every topic.

Conclusions, Recommendations and Implications

PA teachers in case study are unique, and study findings should be inferred with caution. Feelings of uncertainty in teaching PA were amplified by logistical barriers such as technology restrictions and the teacher's desire to perform at a high level. Teachers faced a paradox where technology policies inhibit them from teaching industry-validated technical skills. Agricultural Mechanics teachers are less likely to implement content they do not feel confident teaching (Reynolds et al., 2023, Tummons et al., 2017). In response to challenges, teachers relied on peer support through the community of practice to share experiences and build confidence (Heidenreich et al., 2018). In states/schools who heavily restrict classroom technology use, we recommend including current industry technologies, but provide accommodations for restrictive technology policies and rationale for policy exceptions for industry-validated technology. Those designing PA curriculum should consider if offering a "menu" of ways to teach the same concept with a variety of tools and technologies would be useful. Researchers should conduct a needs assessment with school administrators to better understand priorities and gauge technology policies in local schools may be beneficial. It does no good to design curriculum that cannot be utilized due to technology barriers. Future research should be conducted to understand how male and female teachers utilize local experts in implementing PA curriculum.

References

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