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Teaching and Learning of Electricity in Agricultural Education: A Literature Review

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Abstract

The persistent shortage of qualified agricultural education teachers, particularly in the specialized field of electricity, poses a significant challenge to the education system. This shortage limits students' access to essential skills and knowledge, hindering their career development in agriculture. To address this issue, it is imperative to prioritize recruiting and developing educators with expertise in agricultural mechanics, including providing comprehensive electrical training. By equipping teachers with the knowledge and skills required to effectively teach these subjects, we can ensure that students receive a high-quality education that prepares them for future careers in the agricultural industry. This literature review examines the current state of the agricultural mechanics discipline of electricity, highlighting the specific challenges teachers and students face. Through an analysis of existing research, we identify key themes such as the need for specialized training, the importance of hands-on experience, and the impact of teacher confidence on student learning. Based on our findings, we propose several recommendations for future research and practice, including developing targeted professional development programs, the integration of industry partnerships, and promoting innovative teaching methods.

Introduction

The shortage of qualified teachers continues to be a persistent issue in the education system, and agricultural education is not exempt from this challenge, leading to a shortage within the profession (Ingersoll, 2001; Smith et al., 2024). This shortage has affected School-Based Agricultural Education (SBAE) programs, particularly in agricultural mechanics courses, resulting in SBAE teachers reportedly being ill-equipped to teach these courses effectively (Trickett et al., 2023). However, to become qualified teachers with the necessary training to teach agricultural mechanics, teachers must first acquire the skills and knowledge necessary to provide students with the opportunity to gain experience in agricultural mechanics (Osborne & Dyer, 2000; Parr et al., 2006; Wells et al., 2013). SBAE teachers recognize the importance of incorporating agricultural mechanics into their curricula but often face challenges in effectively teaching these content areas (Shultz et al., 2014; Tummons et al., 2017). However, as the agricultural mechanics industry standards and practices evolve, curricula revisions and skill advancements are critical to ensure that SBAE teachers can adapt and address current and future challenges in the agriculture industry (Doerfort, 2011; Hurbert & Leising, 2000; Shultz et al., 2014).

In order to tackle this issue, it is crucial to prioritize the recruitment and development of SBAE teachers specializing in specific subject areas (Darling-Hammond et al., 2017; Gorter & Swan, 2018; Behrstock- Sherratt, 2016). Numerous studies have underscored the necessity for an increased focus on emerging agricultural mechanics courses within professional development and teacher preparation programs, especially in the field of electricity (Burris et al, 2005; Darling-Hammond et al., 2017; Harwell,

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2003; Shultz et al., 2014). Wells and Hainline (2021) and Rasty et al. (2017) found that after participating in an agricultural mechanics professional development workshop, the impact of teaching specific electrical skills saw a significant rise. However, the level of training and skills acquired at the post-secondary level was deemed inadequate (Wells & Hainline, 2021). Wells and Hainline (2021) discovered that all nine skills within the electrical skill set were deemed very important or important by respondents, yet the competencies to teach of these same skills received at the post-secondary level were assessed with low competency scores, specifically in the application of electrical wiring. Moreover, Rasty et al. (2017) arrived at similar conclusions, determining that the importance of six electrical skills identified by respondents was labeled as important or moderately important, while the amount of electrical training received at the secondary level was categorized as either some or none.

The role of SBAE teachers is crucial in equipping students for the workforce, especially when supported by comprehensive SBAE programs (Byrd et al., 2015; Roberts & Ball, 2009; Stringfield & Stone, 2017). To fulfill this vital role effectively, SBAE teachers must have the confidence and knowledge necessary to teach the agricultural mechanics curriculum (Burris et al., 2010; Granberry et al., 2023; Wells et al., 2021). This expertise fosters a safe learning environment and ensures that students receive up-to-date content, skills, and teaching methods essential for success in entry-level positions (Clark et al., 2021). Additionally, SBAE teachers actively engage students in various leadership activities, prepare them for careers in agricultural mechanics, and provide practical applications of the curriculum (Phipps et al., 2008; Stripling & Ricketts, 2016; Haynes et al., 2012; Parr et al., 2006; Young et al., 2009). However, when SBAE teachers lack preparedness in agricultural mechanics, they cannot deliver the best educational experience, which can lead to concerns about the safety of their classrooms and labs (Clark et al., 2021; Saucier et al., 2014). This inadequacy ultimately hampers their ability to prepare students for careers beyond the classroom (Byrd et al., 2015; McCubbins et al., 2017; Phipps et al., 2008; Rasty & Anderson, 2017; Saucier et al., 2014; Swafford & Hagler, 2018).

Consequently, the agricultural industry relies heavily on well-trained SBAE teachers to cultivate the future workforce and encourage preservice teachers to pursue agricultural mechanics courses at the post-secondary level (Doerfort, 2011; Roberts & Ball, 2009). Nevertheless, SBAE teachers who lack access to agricultural mechanics courses or need to refresh their skills require resources for support (Clark et al., 2021; McCubbins et al., 2017). This gap has prompted multiple studies advocating for agricultural industry leaders, stakeholders, and post-secondary institutions to offer professional development workshops to assist SBAE teachers in their pursuit of skill enhancement (Granberry et al., 2023; Rasty et al., 2017; Roberts & Ball, 2009; Wells & Hainline, 2021).

Theoretical Framework

This study was guided by the principles of systematic review methodology, specifically the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework, which provides a rigorous and transparent approach to synthesizing existing literature. Bastidas-Orrego et al. (2023) demonstrated in their review of agricultural policy that PRISMA facilitates the evaluation of diverse studies by ensuring methodological clarity and consistency. Similarly, Lopez-Sachez et al. (2023) employed PRIMSA to examine the adoption of information and communication technologies in higher education, highlighting how systematic review processes reveal convergent findings, practical recommendations, and gaps for further inquiry.

Extending this perspective, Oh-Young et al. (2018) underscored the value of meta-analytic techniques in technical and vocational education, arguing that the structured synthesis enhances both the reliability of findings and their applicability for practitioners. When considered alongside the contributions of Bastidas-Orrego et al. (2023) and Lopez-Sanchez et al. (2023), their work demonstrates that systematic review and meta-analytic methodologies share a standard capacity to connect evidence across disciplines,

bridge research-practice divides, and inform future scholarly agendas. Collectively, these studies establish a methodological foundation for the literature review and collection of the existing electrical literature to develop common themes within results, practice recommendations, and future research recommendations.

Purpose and Objectives

This literature review aimed to analyze peer-reviewed research on professional development in electricity training with SBAE programs. We identified common themes across existing research to highlight trends, make recommendations for future electrical training, and suggest areas for future research. The three objectives of this review are:

1. Determine the number of research articles published between 1999-2024 that focus on electrical teaching and learning in SBAE.
2. Identify prevalent topics within existing research about electrical teaching and learning in SBAE.
3. Interpret key themes in existing research regarding electrical teaching and learning while providing recommendations for future research and practices.

Methods

This literature review reported and interpreted existing research focused on electricity training regarding electricity training for SBAE program. We used Heibel et al.'s (2023) methods to guide our study by utilizing the collection, triangulation, and data analysis guidelines within the study. To accomplish this, we utilized Kovar & Ball (2013) three strategies: 1) definitive search strategies, 2) inclusion criteria, and 3) source analysis and categorization.

Search Strategies

In order to gather information and articles, we conducted searches across various electronic databases, including Google Scholar, ResearchGate, Education Research Information Center, and several academic journals. The academic journals related to electricity training for SBAE programs include the *Journal of Agricultural Education*, the *Journal of Agricultural Systems, Technology, and Management*, the *Journal of Career and Technical Education Research*, *North American Colleges and Teachers of Agriculture (NACTA) Journal*, and the *Journal of Southern Agricultural Education Research*. We used a combination of keywords such as "electricity," "agricultural mechanics," "agriculture mechanics," "mechanics," and "electricity training" to identify potential articles. Our article search commenced in January 2024 and concluded in August 2024, then was run again in December 2024.

Inclusion Criteria

The inclusion criteria for our search encompassed specific populations, inservice teacher training coverage, and publishing dates (Table 1). The populations were SBAE teachers, educational and non-educational post-secondary degrees, and various skill levels of agricultural mechanics from the post-secondary degrees without an age limitation. Literature was peer-reviewed and published as manuscripts spanning over the course of 25 years (1999-2024); conference proceedings and thesis/dissertations were excluded.

Table 1

Inclusion and Exclusion Criteria for Literature Review

Inclusion criteria	Exclusion criteria
English language publication	Non-English language publication
Publication regarding electricity training/education	Publication not regarding electricity training/education
Publications with listed references/sources	Publication without references/sources
Publications and reports in peer-reviewed journals	Conference proceedings, thesis/dissertations

Analysis and Categorization

Article analysis and categorization involved an initial screening followed by a coding stage. The article title and abstracts were cross-referenced for screening with the established inclusion/exclusion criteria. If titles and abstracts did not contain adequate information for screening, the introduction, methods, discussion, and conclusion were investigated further. Articles that did not advance to the coding stage were set aside for possible use in other studies. In total, our data collection resulted in 31 articles related to the investigation of electrical teacher training sessions that enhanced SBAE teachers' electrical skills or investigated the SBAE teachers' change in perception of importance, competence, and ability to teach electrical skills. Articles with misrepresented data or significant grammatical errors were removed for further analysis. All articles collected for this study were cross-referenced using Opensource software to determine if the articles were published in predatory journals. Once the final article exclusions were made, 31 articles remained.

The coding stage involved full-text evaluations, during which three authors independently identified key findings, themes, research methods, recommendations of practice, and recommendations for research in the collected articles (N=31). As Heibel et al. (2023) and Kover and Ball (2013) recommended, we conducted peer debriefings to review our findings externally. We discussed our independent full-text evaluations and justified our reasoning. Following the discussion, two articles were omitted from the study due to the inclusion criteria not being met. According to Kovar & Ball (2013), utilizing this method of triangulation increases reliability in the findings and results. At the end of the coding stage, 29 articles remained, as two were identified as not meeting the inclusion requirement of focusing on electricity training/education. Following this collaboration, all common themes and findings were gathered into a Word document, and a breakdown was conducted of each author's themes, research, and practice recommendations. These were then organized into multiple common themes utilizing keywords and similar topics. Afterward, the key findings, research, and practice recommendation themes were refined into final themes.

Results

Research Topic Themes

Seven key research themes were identified after analyzing and coding the 29 articles collected. These themes were ranked according to the frequency with which articles aligned. The research theme ranking is displayed in Table 2 and includes *1. Electricity as a Critical Focus Area* (fifteen articles), *2. Lack of Preparation Training* (eleven articles), *3. Professional Development Needs* (seven articles), *4. Impact of Experience on Confidence and Competence* (seven articles), *5. Safety Concerns in Teaching Agricultural Mechanics* (six articles), *6. Curriculum Gaps and Content Relevance* (six articles), *7. Student Preparation and Competence* (six articles).

Table 2

Research Themes for Teaching and Learning of Electricity Literature Analysis, Theme Descriptions, Number of Articles, and Article Reference List (N=29) (1999-2024)

Theme	Description	Articles (*n*)	Article Reference List
1. Electricity as a Critical Focus Area	Research highlights electricity as a crucial component of agricultural mechanics education.	14	Albritton & Robert, 2020; Anderson et al., 2023; Anderson & Paulsen, 2023; Byrd et al., 2015; Duncan et al., 2006; Hurbert & Leising, 2000; Figland-Cook et al., 2022; McKim & Saucier, 2012; Mills et al., 2019; Peake et al., 2007; Trickett et al., 2023; Wells & Hainline, 2021; Wells et al. 2013; Wells et al., 2021
2. Lack of Preparation Training	Research identifying concerns of insufficient preparation and training for both preservice and inservice teachers in electricity	9	Anderson et al., 2023; Burris et al., 2005; Ford et al., 2008 ; Clark et al., 2021 ; Hubert & Leising, 2000 ; Peake et al., 2008 ; Sanders et al., 2023 ; Shultz et al., 2014; Trickett et al., 2023
3. Professional Development Needs	Research investigated the current professional development needs of preservice and inservice teachers in electricity.	7	Albritton & Roberts, 2020; Byrd et al., 2015; Duncan et al., 2006; Peake et al., 2007; Shultz et al., 2014; Wells & Hainline, 2021; Wells et al., 2021
4. Impact of Experiences on Confidence and Competence	Research investigates how experiences impact agricultural mechanics skills, confidence, and competence.	7	Burris et al., 2005; Burris et al., 2010; Figland-Cook et al., 2022; Gorter & Swan, 2018; Shultz et al., 2014; Wells et al., 2013 ; Wells et al., 2021
5. Safety Concerns in Teaching Agricultural Mechanics	Research identifies the importance of preservice and inservice teachers' safety views, yet safety training needs to be improved.	6	Anderson et al., 2023; Clark et al., 2021; Dyer & Andreasen, 1999; Ford et al., 2008 McKim & Saucier, 2012 ; Shultz et al., 2014
6. Curriculum Gaps and Content Relevance	Research identifying curriculum gaps and content relevance within the electricity discipline.	6	Burris et al., 2005; Burris et al., 2010; Clark et al., 2021; Figland-Cook et al., 2022; Ford et al., 2008; Hainline & Wells, 2019
7. Student Preparation and Competence	Research investigating the significant gaps in student preparation for electricity at the secondary level.	6	Burris et al., 2005; Figland-Cook et al., 2022; Ford et al., 2008; Mills et al., 2019; Ramsey et al., 2012; Rasty et al., 2017

Note: Several articles were coded under more than one theme; therefore, the frequency reported is greater than (*f*=29, 100%).

The first theme identified in fourteen out of twenty-nine articles was *Electricity as a Critical Focus Area*, which highlighted that agricultural mechanics education pointed to a significant gap in teacher preparedness and training, particularly in electricity. Several studies showed that SBAE teachers were increasingly seeking alternative methods to build competence in electrical instruction, with many teachers perceiving a lack of sufficient agricultural mechanics instruction and training, especially in electricity (Albritton & Robert, 2020; Anderson et al., 2023; Anderson & Paulsen, 2023; Byrd et al., 2015; Figland-Cook et al., 2022; Mills et al., 2019; Peake et al., 2007; Wells & Hainline, 2021). The increasing importance of electricity content in agricultural mechanics courses was underscored by Trickett et al. (2023) and Wells et al. (2021), both of whom stressed the growing need for electrical knowledge in the curriculum. Teachers also reported a lack of laboratory management competencies in electricity, which affected their ability to effectively teach students (McKim & Saucier, 2012). These gaps in teacher training contributed to heightened anxiety and a lack of confidence, especially among new teachers, and underscored the urgent need for improved training and professional development in electricity and the integration of new technologies (Duncan et al., 2006; Hurbert & Leising, 2000; Wells et al., 2013). Overall, these studies collectively pointed to a pressing need for targeted, comprehensive training programs that addressed the technical challenges teachers faced in teaching electricity.

The second theme identified across nine articles was *Lack of Preparation and Training*. These articles indicated that many preservice and inservice teachers in SBAE felt underprepared to teach electricity (Burris et al., 2005; Hubert & Leising, 2000). This lack of preparation often resulted in insufficient safety training, which contributed to heightened anxiety and avoidance among teachers. Consequently, research highlighted the need for additional pedagogical training (Anderson et al., 2023; Burris et al., 2005; Hubert & Leising, 2000; Sanders et al., 2023). Studies also emphasized the inadequate preparation of preservice teachers in agricultural mechanics, with many reporting limited experience in laboratory-based courses (Burris et al., 2005; Sanders et al., 2023; Trickett et al., 2023). Teachers specifically expressed a need for further training in electricity due to a reported low capability in teaching electrical systems (Peake et al., 2008; Shultz et al., 2014). This inadequate training also extended to inservice SBAE teachers, with numerous respondents admitting they had not received sufficient instruction in electricity during their preparation (Clark et al., 2021; Ford et al., 2008).

The third theme, *Professional Development Needs*, was identified in seven articles and highlighted a significant demand for increased professional development in agricultural education, particularly in areas such as welding, electricity, and technical skills (Albritton & Roberts, 2020; Duncan et al., 2006; Peake et al., 2007; Shultz et al., 2014; Wells & Hainline, 2021). Many SBAE teachers in these studies reported low levels of confidence in their electricity abilities and a strong desire for more professional development in electricity and other technical areas (i.e., welding and small engines) (Wells et al., 2021). This underscores the importance of ongoing professional development and alternative training methods to enhance SBAE teachers' competencies (Albritton & Roberts, 2020; Byrd et al., 2015; Wells & Hainline, 2021). Specific areas such as welding and electricity are often highlighted as particularly high-priority topics (Duncan et al., 2006; Shultz et al., 2014; Peake et al., 2007). The need for continuous professional development is further emphasized by research showing that beginning SBAE teachers frequently lack the technical skills to effectively teach electricity (Albritton & Roberts, 2020). These findings collectively reinforce the urgent need for specialized professional development programs that focus on filling these skill gaps and supporting inservice secondary SBAE teachers in improving their proficiency in electricity (Albritton & Roberts, 2020; Byrd et al., 2015; Duncan et al., 2006; Peake et al., 2007; Shultz et al., 2014; Wells & Hainline, 2021; Wells et al., 2021).

The fourth theme identified was *the Impact of Experience on Confidence and Competence* in seven articles. A strong link was found between experience and teacher confidence in electricity. Teachers with more experience reported higher confidence levels in their ability to teach, with prior experience in mechanics significantly boosting confidence in teaching technical areas like electricity (Burris et al., 2010;

Figland-Cook et al., 2022; Shultz et al., 2014; Wells et al., 2013). Conversely, many teachers reported low confidence and needed additional instruction in electrical education, with studies reporting that positive hands-on experiences and teaching had been shown to significantly enhance teachers' understanding and confidence in teaching electricity (Burris et al., 2005; Figland-Cook et al., 2022; Wells et al., 2021). Furthermore, an increase in self-efficacy regarding agricultural mechanics skills was associated with a greater likelihood of teachers continuing their careers in the field (Gorter & Swan, 2018). These findings underscored the importance of hands-on experience and additional training in building teacher confidence and enhancing long-term career commitment in electrical education (Burris et al., 2010; Figland-Cook et al., 2022; Gorter & Swan, 2018; Shultz et al., 2014; Wells et al., 2021).

The fifth theme was *Safety Concerns in Teaching Agricultural Mechanics*, identified in six articles. Research revealed significant gaps in the instruction and training at the secondary level, particularly in laboratory management and safety areas (Anderson et al., 2023; Clark et al., 2021; Dyer & Andreasen, 1999; Ford et al., 2008; McKim & Saucier, 2012). Many teachers reported inadequate instruction during their preparation, particularly in laboratory management and competencies in areas like electricity (Ford et al., 2008; McKim & Saucier, 2012). Dyer and Andreasen (1999) found that many SBAE teachers failed to fully implement safety guidelines, which raised concerns about safety knowledge and practices in the classroom. Furthermore, there was a notable gap in continuing electrical instruction for experienced teachers, with many expressing a need for further training (Dyer & Andreasen, 1999). Electrical safety emerged as one of the highest areas of need for additional training, as a lack of safety training and unprepared SBAE teachers was linked to increased anxiety and avoidance of specific electrical topics (Anderson et al., 2023; Clark et al., 2021; Shultz et al., 2014). These findings collectively underscored the need for more comprehensive and ongoing training to address these deficiencies and improve both safety and instructional quality in electrical education (Anderson et al., 2023; Clark et al., 2021; Dyer & Andreasen, 1999; Ford et al., 2008; McKim & Saucier, 2012; Shultz et al., 2014).

The sixth theme, *Curriculum Gaps and Content Relevance*, was identified in six articles. These articles revealed several critical gaps and discrepancies in both student and SBAE teacher preparation and instructional quality within electrical skills (Burris et al., 2005; Burris et al., 2010; Clark et al., 2021; Figland-Cook et al., 2022; Ford et al., 2008; Hainline & Wells, 2019). Research findings highlighted a noticeable lack of knowledge and skills in electrical students, compounded by limited instructional offerings at the postsecondary level (Clark et al., 2021; Figland-Cook et al., 2022). Additionally, research studies found a significant discrepancy between the perceived importance of effective teaching experiences in addressing this gap, specifically through self-efficacy and positive experiences (Burris et al., 2005; Burris et al., 2010). This aligned with the findings of Hainline and Wells (2019), who pointed out that curriculum gaps were a major factor contributing to the lack of quality instruction and quantity dedicated to electricity. However, despite these challenges, electrical courses remained a core component of the high school curriculum to ensure students were adequately prepared for careers in the field (Ford et al., 2008). Overall, these studies highlighted a gap in knowledge and skill in electricity among students, which was attributed to the limited instruction available at the postsecondary level.

The final theme, *Student Preparation and Competency*, was identified in six articles. Research in electricity revealed several challenges related to student participation, teacher training, and the preparation of future educators (Burris et al., 2005; Figland-Cook et al., 2022; Ford et al., 2008; Mills et al., 2019; Ramsey et al., 2012; Rasty et al., 2017). Ford et al. (2008) pointed out that many teachers felt underprepared to teach electricity, acknowledging that their undergraduate programs did not provide enough instruction in these areas to adequately support their students. In regard to student engagement, a significant barrier identified was that students enrolled in SBAE programs often lacked prior experience in electricity during secondary education, further hindering their preparedness for these courses (Figland-Cook et al., 2022). To combat this barrier, hands-on experience was particularly critical, as it significantly enhanced teachers' understanding and confidence in delivering electricity content (Burris et al., 2005). Mills et al. (2019)

concluded that experiences in secondary agricultural mechanics training had positively impacted teaching competency, noting that such experience contributed to greater teaching effectiveness. This aligned with Rasty et al. (2017), who found a relationship between agricultural education teachers' perceived importance of electricity skills and the amount of training they received during secondary education. Additionally, Ramsey et al. (2012) emphasized the value of Supervised Agricultural Experience (SAE), noting that it held the most potential for students to develop entry-level technical skills critical for career pathways in agriculture. Collectively, these findings highlighted the need for more robust, hands-on electrical training for students and future educators to better equip them for teaching and learning in this essential field.

Research Study Recommendation Themes

Research recommendations derived from the reviewed articles (*N*=29) are summarized in Table 3, with six recommendations for future research themes identified. These themes were ranked according to the frequency with which articles aligned. The research themes identified are *1. Skill Development Workshops* (nine articles), *2. Teacher Preparation and Training Effectiveness* (seven articles), *3. Curriculum and Content Relevance* (six articles), *4. Industry Connections* (five articles), and *5. Impact of Experience and Confidence* (four articles).

Table 4

Recommendations for Future Research Themes for Teaching and Learning of Electricity Literature Analysis, Theme, Descriptions, Number of Articles, and Article Reference List (N=29) (1999-2024)

Theme	Description	Articles (*n*)	Article References List
1. Skill Development Workshops	Determine how specific demographic factors influence professional development needs in terms of confidence and skills in electricity.	8	Anderson et al., 2023; Burris et al., 2010; Burris et al. (2005); Ford et al., 2008; Granberry et al., 2023; Peake et al., 2007; Wells and Hainline, 2021; Wells et al., 2021
2. Teacher Preparation and Training Effectiveness	Investigate the effectiveness of teacher preparation programs and professional development in electricity.	7	Albritton and Roberts, 2020; Anderson et al., 2023; Burris et al., 2005; Figland-Cook et al., 2022; Granberry et al., 2023; Hurbert and Leising (2000); Peake et al., 2007
3. Curriculum and Content Relevance	Investigate changes in agricultural mechanics courses at postsecondary institutions.	6	Byrd et al., 2015; Clark et al., 2021; Hubert & Leising, 2000; McKim & Saucier, 2012; Trickett et al., 2023; Wells et al., 2013
4. Industry Connections	Research that aims to improve agricultural education by aligning it with industry needs and future workforce demands.	5	Anderson et al., 2023; Ramsey et al., 2012; Rasty et al., 2017; Shultz et al., 2014; Wells et al., 2021

Theme	Description	Articles (*n*)	Article References List
5. *Impact of Experiences on Confidence and Competence*	Investigate the relationship between teaching experiences and teachers' confidence and skill in agricultural mechanics.	4	Anderson et al., 2023; Burris et al., 2010; Gorter & Swan, 2018; Wells and Hainline, 2021

Note: Several articles were coded under more than one theme, therefore the frequency reported is greater than (*f*=29, 100%).

The first research recommendation theme, *Skill Development Workshops*, was highlighted in seven articles and primarily focused on how specific factors influence alternative learning opportunities for SBAE teachers. Burris et al. (2010) and Ford et al. (2008) called for research into alternative strategies to identify key areas of specialization for SBAE teacher training aimed at building confidence in teaching electricity for both novice and experienced educators. Wells and Hainline (2021) suggested examining how demographic factors influence the professional development needs of SBAE teachers. Investigating these alternative learning opportunities could also lead to exploring specific factors that shape training effectiveness. For example, Burris et al. (2005), Granberry et al. (2023), and Peake et al. (2007) recommended assessing whether SBAE teachers with different levels of experience require distinct types of alternative training. Additionally, future research should explore the impact of teacher-led professional development on improving electrical skills and examine the most effective ways for teachers to acquire industry-relevant content knowledge, ensuring their teaching aligns with current industry standards (Wells et al., 2021). Anderson et al. (2023) emphasized the need for research into the impact of inservice training on long-term competence in teaching electricity, which could guide the development of more effective professional development programs.

A prominent theme identified across six articles is the need for future research is *Teacher Preparation and Training Effectiveness* at the teacher preparation program level, specifically in electricity. Anderson et al. (2023) and Peake et al. (2007) emphasized the importance of identifying both the necessary skills and the most challenging areas for SBAE teachers, particularly in electricity. Peake et al. (2007) and Granberry et al. (2023) called for further research to better understand the effectiveness of teacher preparation programs, specifically in relation to technical areas within agricultural mechanics. Additional recommendations focused on investigating the training opportunities available to teachers both within and outside of formal preparation programs. Burris et al. (2005) raised concerns about how teachers acquire essential competencies outside of their teacher preparation programs, suggesting that future studies explore the role of ongoing professional development in enhancing teachers' technical expertise. In alignment with this, Albritton and Roberts (2020) and Figland-Cook et al. (2022) advocated for improved hands-on training in electrical education in teacher preparation programs that would help strengthen their foundational knowledge in this key. Furthermore, Hurbert and Leising (2000) recommended research into the alignment between the competencies agricultural education teachers are expected to teach in secondary programs and the content covered in preservice education.

The third research recommendation theme, *Curriculum and Content Relevance,* emerged from six articles and focused on the alignment and effectiveness of agricultural mechanics coursework. Several studies highlighted the need for postsecondary institutions to reassess and update their agricultural mechanics curricula to better address current industry demands (Clark et al., 2021; Wells et al., 2013). Additionally, curriculum recommendations emphasized the importance of equipping preservice teachers with the necessary knowledge, competencies, and skills to effectively teach agricultural mechanics (Hubert & Leising, 2000; McKim & Saucier, 2012). In line with this, Wells et al. (2013) suggested developing an up-to-date catalog of required agricultural mechanics coursework to ensure consistency and relevance across programs. For institutions that rely on outside departments to teach agricultural mechanics, Byrd et

al. (2015) recommended examining the impact of such courses on student learning outcomes, which could provide valuable insights into their quality and effectiveness. Furthermore, Trickett et al. (2023) proposed investigating the reasons behind the reduction of agricultural mechanics courses and evaluating the long-term effects of this decline on teaching readiness.

The fourth research recommendation theme*, Industry Connections,* identified five articles that suggest studies that explored the alignment between agricultural mechanics education and workforce needs, as well as the perceptions of industry professionals and educators regarding the skills required for success in secondary and post-secondary settings (Anderson et al., 2023; Ramsey et al., 2012; Rasty et al., 2017; Shultz et al., 2014; Wells et al., 2021). Anderson et al. (2023) recommended that SBAE teachers conduct community needs assessments to identify the skills needed by the local workforce, ensuring that agricultural mechanics curricula are aligned with industry demands. Additionally, research should determine which specific skills are necessary for success at the postsecondary level and in the workforce (Anderson et al., 2023). Rasty et al. (2017) suggested studying the perceptions of industry leaders and post-secondary professionals regarding the depth of agricultural mechanics skills that should be taught and the level of importance they foresee for these skills in the next decade. To further inform curriculum development, Shultz et al. (2014) proposed comparing the perceptions of teachers regarding content importance with those of industry experts to better understand how the two groups prioritize skills. Furthermore, Ramsey et al. (2012) recommended investigating teachers' perceptions of the adoption of career pathways as a framework for planning and delivering SBAE programs. Lastly, Wells et al. (2021) called for research into the extent of existing partnerships between agricultural teacher education programs and industry, which could provide valuable insights into opportunities for collaboration and curriculum development.

The final research recommendation theme, *Impact of Experience on Confidence and Competence*, was identified in four articles. This theme focused on how experiences shaped confidence and competence in agricultural mechanics. Burris et al. (2010) recommended investigating strategies to boost confidence in teaching electricity, particularly for both new and experienced teachers. More specifically. Burris et al. (2010) suggested examining the efficacy of first- and fifth-year teachers throughout the school year, rather than only at the end, to gain a more comprehensive understanding of their development. This same study also suggested examining the role of teaching efficacy in teachers' decisions to leave the profession, as this could have provided insights into teacher retention (Burris et al., 2010). Future research should have focused on collecting additional data on past Agricultural Mechanics Power and Design (AMP'D) experiences, which aimed to enhance high school students' skills in agricultural mechanics and introduce them to teaching the subject at the secondary level to better understand the long-term impact of such programs (Gorter & Swan, 2018). Looking into the long-term impact of programs, Anderson et al. (2023) and Wells and Hainline (2021) both recommended investigating the impact of inservice training and professional development on teacher competence, particularly in technical subjects like electricity. Lastly, Burris et al. (2010) proposed studying how teacher attitudes affected safety instruction and identifying ways to improve motivation for safety practices in the classroom.

Practice-Based Recommendation Themes

Four key practice themes were identified after analyzing and coding the 29 articles collected and are summarized in Table 4. These themes were ranked according to the frequency with which articles aligned. The research theme ranking is *1. Curriculum Development and Coursework* (fourteen articles), *2. Collaboration with Industry* (seven articles), *3. Professional Development Opportunities* (five articles), and *4. Mentoring and Support Programs* (four articles).

Table 6

Recommendations for Practice Themes for Teaching and Learning of Electricity Literature Analysis, Theme, Descriptions, Number of Articles, and Article Reference List (N=29) (1999-2024)

Theme	Description	Articles (*n*)	Article References List
1. *Curriculum Development and Coursework*	Enhance the agricultural mechanics curriculum and courses to assess current offerings to determine the need for expanded or integrated courses.	12	Albritton & Roberts, 2020; Burris et al., 2010; Clark et al., 2021; Duncan et al., 2006 ; Dyer & Andreasen, 1999; Figland-Cook et al., 2022; Granberry et al., 2023; Hubert & Leising, 2000 ; McCubbin et al., 2017; McKim & Saucier, 2012; Sanders et al., 2023; Wells et al., 2021
2. *Collaboration with Industry*	Aligning and collaborating with the industry can allow for the identification of community needs and the integration of relevant skills into the curriculum.	7	Anderson et al., 2023; DiBenedetto et al., 2018; Hubert and Leising, 2000; Rasty et al., 2017; Sanders et al., 2023; Trickett et al., 2023; Wells and Hainline, 2021
3. *Professional Development Opportunities*	Provide more professional development opportunities for teachers to stay up-to-date and develop their agricultural mechanics skills.	5	Albritton and Roberts, 2020; Clark et al., 2021; Duncan et al., 2006; Shultz et al., 2014; Wells and Hainline, 2021
4. *Mentoring and Support Programs*	Emphasizes the importance of mentorship for new agricultural mechanics teachers to pair beginning teachers with experienced teachers.	4	Anderson et al., 2023; Burris et al., 2010; Clark et al., 2021; Ford et al., 2008

Note: Several articles were coded under more than one theme; therefore, the frequency reported is greater than (f = 29, 100%).

The first recommendation for practice, *Curriculum Development and Coursework,* was identified in twelve articles. Granberry et al. (2023) and Sanders et al. (2023) emphasized the need to improve secondary teacher education programs by increasing the number of courses and credit hours, focusing on electrical systems for preservice SBAE teachers. To better prepare teachers, there is also a push to increase training in preservice programs, with a focus on improving hands-on electrical training to boost teacher confidence (Albritton & Roberts, 2020; Hubert & Leising, 2000). Curriculum development recommendations include integrating agricultural mechanics content into existing agricultural education courses in the teacher preparation programs and ensuring that courses align with current industry needs and technological advancements (Duncan et al., 2006; Granberry et al., 2023; McCubbin et al., 2017). Additionally, providing inservice training, especially in technical areas like electricity, is essential for ensuring teachers remain competent and confident in delivering the curriculum (Burris et al., 2010; Clark et al., 2021). Additionally, Figland-Cook et al. (2022), suggested developing a series of one-credit-hour

agricultural mechanics courses that can be offered as prerequisites or supplemental training for teachers. Several of the studies reviewed emphasized the need for improved teacher preparation programs, with a focus on developing targeted curricula that reflect the changing demands of the industry (Figland-Cook et al., 2022; McCubbins et al., 2017; Wells et al., 2021). This includes exploring articulation agreements with community colleges to streamline transitions into agricultural mechanics coursework (Figland-Cook et al., 2022). Moreover, Wells et al. (2021) recommended continually refining teacher education programs and courses to incorporate the latest advances in agricultural mechanics and ensure alignment with industry needs. Finally, safety education should be integrated into teacher preparation programs, including mandatory first aid certification and specific training in electrical safety (Dyer & Andreasen, 1999; McKim & Saucier, 2012).

The second recommendation for practice was *Collaboration with Industry,* which was identified in seven articles that emphasized the importance of collaboration between agricultural education programs, industry representatives, and other stakeholders to ensure that agricultural mechanics education aligns with community and industry needs. Anderson et al. (2023) recommend partnering with local businesses to identify specific community workforce needs, helping to shape curricula and professional development opportunities for teachers. Similarly, Sanders et al. (2023) advocate for greater collaboration between teacher educators and faculty from non-teacher preparation programs to enhance the quality of agricultural mechanics education. Wells and Hainline (2021) recommend partnering with industry representatives to provide professional development opportunities for teachers, ensuring that they stay current with industry trends and best practices. Trickett et al. (2023) and Sanders et al. (2023) also emphasized the need for industry partnerships to better prepare students for careers in agricultural mechanics, ensuring that educational programs are aligned with workforce expectations. This includes evaluating and aligning university-level agricultural mechanics courses with identified industry needs, creating a more seamless transition for students into the workforce. Effective communication and collaboration between teacher preparation programs, active teachers, and industry leaders are essential for prioritizing the skills critical in agricultural mechanics (Rasty et al., 2017). Hubert and Leising (2000) argued that agricultural educators, producers, government leaders, and industry experts must develop a shared vision for agricultural mechanics and technology education. Furthermore, DiBenedetto et al. (2018) stressed the importance of open communication among teacher education programs, school administration, and inservice teachers to design and provide curricula and inservice training relevant to the needs of students and the industry.

The third practice theme*, Professional Development Opportunities,* consists of five articles that aimed to enhance the skills and professional development of SBAE teachers, with a focus on practical training and technical areas such as electricity. Clark et al. (2021) suggest offering short training sessions to refresh SBAE teachers' skills, providing ongoing opportunities for educators to stay updated with current practices and technologies. Albritton and Roberts (2020) emphasized the need to increase practical electricity training within preservice teacher programs, ensuring that new teachers gain hands-on experience in key electrical skills before entering the classroom. To support teachers already in the field, Duncan et al. (2006) recommends providing inservice training specifically focused on electricity, while Wells and Hainline (2021) suggest broadening the scope of professional development to include critical areas such as electricity and laboratory safety. Shultz et al. (2014) also advocates professional development programs that address electrical safety and introduce new technologies, ensuring that teachers remain prepared to teach safe, effective, and current practices in agricultural mechanics.

The final recommendation for practice was *Mentoring and Support Programs*, consisting of five articles emphasizing the importance of mentorship and support systems within the agricultural mechanics discipline. Anderson et al. (2023) recommended creating mentoring programs for beginning teachers, pairing them with experienced mentors to support their transition into teaching and enhance their instructional skills. Similarly, state and national teacher associations could play a key role by developing agricultural mechanics mentoring programs specifically for new teachers (Anderson et al., 2023).

Additionally, Burris et al. (2010) highlighted the importance of providing early-career teachers with mentoring and additional training in electricity to build their confidence and improve their effectiveness in this area. Ford et al. (2008) emphasized the need for systematic mentoring to nurture young teachers' professional development over time, ensuring they continue to grow throughout their careers. Lastly, Clark et al. (2021) recommended offering short training sessions to introduce or refresh SBAE teachers' skills, helping them stay current with the latest teaching methods and technical knowledge.

Conclusions and Recommendations

Overview

Through this literature review, we collected and examined research investigating knowledge, benefits, and outcomes of providing SBAE teachers with electricity-focused training sessions. The objectives for this review were to 1) Determine the number of research articles published between 1999-2023 that focus on teaching and learning of electricity in SBAE, 2) Identify prevalent topics within existing research about electrical teaching and learning in SBAE, and 3) Interpret key themes in existing research regarding electrical teaching and learning while providing recommendations for future research and practices. The literature collected and analyzed included peer-reviewed articles published between 1999 and 2023. Articles were analyzed to determine the research topic themes, research study recommendations, and practice recommendations. Guided by the PRISMA framework, this study applies a systematic and transparent approach to synthesizing research. Prior studies demonstrate that such methods enhance methodological consistency, reveal key themes and research gaps, and strengthen the applicability of findings across disciplines (Bastidas-Orrego et al., 2023; Lopez-Sanchez et al., 2023; Oh-Young et al., 2018). This framework thus provides the foundation for analyzing and organizing themes within the existing electrical literature.

Research topic themes on agricultural mechanics education revealed key challenges for both teachers and students, particularly a lack of preparation and training in technical areas of electricity and laboratory management (Burris et al., 2005; Clark et al., 2021). Many teachers reported feeling unprepared to teach these topics, leading to anxiety and avoidance, while students often enter programs without sufficient prior knowledge or hands-on experience (Anderson et al., 2023; Figland-Cook et al., 2022). Teachers express a strong need for ongoing professional development, particularly in electricity to boost their competence and confidence (Albritton & Roberts, 2020; Wells et al., 2021). Safety concerns, especially regarding electrical safety, persist despite efforts to improve training (Dyer & Andreasen, 1999; Shultz et al., 2014). Experience significantly enhances teacher confidence, with more experienced instructors reporting greater proficiency in technical areas (Burris et al., 2010; Figland-Cook et al., 2022). The growing emphasis on electricity in the curriculum highlights the need for targeted training programs (Peake et al., 2007; Trickett et al., 2023). Additionally, student preparation is hindered by a lack of prior experience in electricity, underscoring the importance of hands-on learning and supervised agricultural experiences (SAEs) (Mills et al., 2019; Ramsey et al., 2012). These themes emphasize the need for improved training, curriculum design, and professional development to bridge gaps in electricity. Within the lens of the PRISMA framework, this systematic review provided a structured and transparent approach to synthesizing these findings, ensuring methodological consistency and revealing convergent themes across studies (Bastidas-Orrego et al., 2023; Lopez-Sanchez et al., 2023; Oh-Young et al., 2018). The PRISMA process ultimately strengthened the interpretation of results, highlighting the interconnected needs for improved training, curriculum design, and professional development in electricity education.

Research recommendations in agricultural mechanics education emphasize the need for improved teacher preparation and training, particularly in the area of electricity. Studies call for further research into the effectiveness of teacher preparation programs and the role of ongoing professional development (Anderson et al., 2023; Peake et al., 2007). Skill development workshops are recommended to offer tailored

training for teachers based on experience levels and demographics (Ford et al., 2008; Burris et al., 2010). The impact of experience on teacher confidence and competence highlights the importance of teaching experience, especially in technical subjects like electricity, in boosting teacher retention (Burris et al., 2010; Wells et al., 2021). Recommendations also stress the need to update curriculum relevance to better align with industry demands and equip preservice teachers with the necessary skills (Clark et al., 2021; Wells et al., 2013). Additionally, industry connections should be strengthened to ensure agricultural mechanics education meets workforce needs (Anderson et al., 2023; Shultz et al., 2014). These themes collectively stress the need for more robust teacher training, updated curricula, and stronger industry partnerships to address gaps in agricultural mechanics education. By utilizing the PRISMA framework, this systematic review allowed for transparent synthesis of these recommendations, identifying five interconnected themes that highlight critical areas for growth in agricultural mechanics education. The PRIMSA guidelines brought coherence to a wide range of research findings, offering a unified perspective on how teacher preparation, curriculum design, and professional learning can evolve to meet the demands of modern agricultural education and industry.

Research practice recommendations in agricultural mechanics education highlight key areas for improvement, particularly in mentoring, curriculum development, industry collaboration, and professional development. Mentoring programs are seen as crucial for supporting new teachers, especially in technical areas like electricity, by pairing them with experienced mentors and offering preparatory courses to build foundational skills (Anderson et al., 2023; Burris et al., 2010; Figland-Cook et al., 2022). Curriculum recommendations emphasize expanding agricultural mechanics coursework, particularly in high-demand areas such as electricity, while aligning courses with industry needs to better prepare both teachers and students (Granberry et al., 2023; Albritton & Roberts, 2020; Wells et al., 2021). Collaboration with industry is also a priority, with a focus on creating partnerships to ensure educational programs meet workforce demands and provide relevant professional development opportunities for teachers (Anderson et al., 2023; Sanders et al., 2023; Rasty et al., 2017). Finally, the importance of continuous professional development is stressed, particularly in electricity and laboratory safety, to help teachers stay current with emerging technologies and best practices (Clark et al., 2021; Shultz et al., 2014). These recommendations underscore the need for stronger mentoring, updated curricula, closer ties with industry, and ongoing teacher training to address gaps in agricultural mechanics education. The PRISMA framework, through the lens of structured synthesis, ensured consistency across studies and revealed recurring priorities for improving electricity instruction and teacher preparedness (Bastidas-Orrego et al., 2023; Lopez-Sanchez et al., 2023; Oh-Young et al., 2018). By applying the PRISMA framework, these collective insights move beyond isolated findings to provide a clearer, evidence-based direction for enhancing the quality and relevance of agricultural mechanics education.

Gaps in Literature

The literature reveals several significant gaps in existing research, particularly regarding electrical skills development for SBAE teachers, which can guide future research directions. One key gap is the insufficient preparation and professional development for both preservice and inservice teachers, highlighting the need for more effective training programs (Albritton & Roberts, 2020; Burris et al., 2010; Clark et al., 2021; Ford et al., 2008; McCubbin et al., 2017). Studies suggest that SBAE teachers should seek alternative methods to enhance or advance their electrical skills. Additionally, research calls for further examination of teacher preparation programs, particularly in the areas of electricity and safety training, as well as ensuring that curricula align with current industry standards and practices (DiBenedetto et al., 2018; Duncan et al., 2006; Wells & Hainline, 2021). Future research should address the gaps between teacher preparation and safety training while also investigating the skills disparity between teachers at the end of their preparation programs and their readiness when they begin teaching in the field. Regarding the PRISMA framework, this review systematically synthesized these findings, revealing consistent patterns across studies that highlight the need for structured, evidence-based approaches to improve teacher

preparation in electricity. PRISMA's apparent and comparative methodology provides a foundation for future research aimed at bridging the divide between teacher education, technical competence, and classroom readiness.

The second identified gap concerns the quality of curriculum and content in teacher preparation programs. Several studies highlight the need to address curriculum gaps to ensure that the skills taught by SBAE teachers align with current industry demands (DiBenedetto et al., 2018; Granberry et al., 2023; Ramsey et al., 2012; Shultz et al., 2014; Wells & Hainline, 2021). Researchers also recommend bridging this gap through mentorship programs for new SBAE teachers, offering crucial support, skill development, and guidance to improve instructional quality (Anderson et al., 2023; Figland-Cook et al., 2022; Ford et al., 2008). Future research should investigate the alignment between industry-required skills and those taught in agricultural mechanics programs at both the secondary and post-secondary levels. In line with the PRISMA framework, this review identified curriculum and mentorship needs through a structured synthesis of existing studies, enabling clearer connections between research findings and practical implications. The PRISMA approach enhanced the transparency and organization of evidence, revealing that curriculum alignment and mentorship are key strategies for addressing gaps in teacher preparation and improving instructional confidence and effectiveness.

The final gap identified is the lack of research on how teachers' and students' past experiences in agricultural mechanics impact their confidence and competence. Several studies suggest that investigating the factors influencing confidence in agricultural mechanics is crucial for enhancing both teaching effectiveness and student learning outcomes (Burris et al., 2005; Figland-Cook et al., 2022; Wells et al., 2021). Understanding how prior experiences shape teachers' confidence and motivation could inform strategies for adjusting teacher preparation programs, helping to better equip instructors with the necessary skills and self-assurance. Additionally, future research could focus on the experiences of current and past preservice teachers, examining their motivations to either persist in or withdraw from teacher preparation programs. Such research would provide valuable insights into the factors influencing teacher retention and professional development, ultimately guiding program design and support structure improvements. Using the PRISMA framework, this synthesis highlighted how prior experiences and confidence are interconnected themes across the literature, underscoring the need for continued research into how these elements shape teacher development and the long-term success of SBAE programs.

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