Reconceptualizing Problem-Solving: Applications for the Delivery of Agricultural Education's Comprehensive, Three-Circle Model in the 21st Century

Authors

Whitney Figland
Dutchtown High School
whitney.figland@apsb.org

Richie Roberts, Ph.D.
Louisiana State University
roberts3@lsu.edu

J. Joey Blackburn, Ph.D.
Louisiana State University
jjblackburn@lsu.edu

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Abstract

Problem-solving has been an integral tenet of school-based, agricultural education (SBAE) since its inception. However, in many ways, the pedagogy has changed considerably. This shift appears to have caused problem-solving's pedagogical dimensions and underlying philosophical foundation to become conflated with other methods of instruction. Consequently, fundamental questions persist: "Should problem-solving be practiced as a distinct pedagogy?" And if so, "What implications exist for its use in SBAE?" In response, this philosophical study sought to examine perspectives on problem-solving and explain how it has been advanced in the discipline. A product of this investigation was the emergence of three principles that appear to be foundational to problem-solving: (1) identify problems, (2) analyze information, and (3) evaluate solutions. Distinguishing such principles helped describe how problem-solving has been operationalized historically. However, it also revealed a need to expand its current understanding and use. In response, we proposed the Integrated Problem-Solving Model for Agricultural Education to illuminate how it could be reconceptualized as a guiding philosophy for SBAE to better navigate increasingly complex issues and problems in the 21st Century.

Introduction

Over the past few decades, a variety of instructional methods have been advanced in education to encourage students to obtain the skills they need to thrive in the 21st Century (Koichu, 2019; Ulmer & Torres, 2007). However, more recently, it has become critical for educators to adopt methods of instruction that encourage students to develop higher-order thinking skills (Fuhrmann & Grasha, 1983; Jonassen, 2000; Ulmer & Torres, 2007). One explanation for this shift is that employers often view the ability to solve problems, a higher-order skill, as essential in the workplace (Gokhale, 1995; Robles, 2012; Zimmerman & Risemberg, 1997). Nevertheless, many students are not challenged to engage in real-world problems in their schooling (Jonassen, 2000). Instead, they learn through rote memorization and other forms of direct instruction in which the instructor passively transfers knowledge – an approach that does little to prepare students for a successful career (Jonassen, 2000). As a consequence, a need has emerged to embed more opportunities for students to authentically engage in problem-based experiences that accurately reflect the world in which they operate. Previous research has demonstrated that engaging students in learning activities that challenge their problem-solving abilities can foster metacognitive growth, i.e., the ability to reflect on learning and modify one's behavior accordingly (Sproull, 2001). For example, through the use of such an approach, students learn to grapple with problems, from simple to complex, by developing solutions that complement the knowledge and skills they developed through their coursework (Jonassen, 2000).

From a historical perspective, the problem-solving approach can be traced to classical philosophers such as Socrates and Plato, who believed that individuals came to truth by socially constructing meaning through participation in debates (Phillips, 2010). For example, *The Socratic Method* draws on cooperative dialogue in which individuals answer questions that stir new thoughts and ideas about the nature of knowledge and knowing (Phillips, 2010). This early approach to problem-solving appeared to serve as a basis for contemporary views on the method and helped further distinguish it as a pedagogy (Dewey, 1910; Phillips, 2010). Using this foundation, John Dewey (1910) further concretized the key dimensions of problem-solving. For instance, in Dewey's (1910) *How We Think,* he outlined five tenets called the *Complete Action of Thought or Reflective Thinking* that included: (1) a felt difficulty; (2) location and definition of a problem; (3) creation of possible solutions; (4) test solutions; and (5) further explorations and evaluation. These processes provided a basis for conceptualizing problem-solving as a process that could be used to mature students' intellectual development and critical thinking (Dewey, 1910). However, Dewey never used the term *problem-solving* in his academic work.

Despite this, Dewey, along with other educational philosophers, paved the way for problem-solving to be recognized and practiced as a pedagogy in the 20th Century (Moore & Moore, 1984). However, discourse on problem-solving has been muddled by the introduction of terms, such as problem-based learning (PBL) and inquiry-based instruction (IBI), that although are distinct in form and function also appear to exhibit striking "pedagogical congruence" (Parr & Edwards, 2004, p. 104). As a result, a definition for problem-solving does not appear to have reached consensus. Some disciplines have responded to this issue by crafting descriptions of the pedagogy that integrate the various perspectives of philosophers, researchers, and practitioners (Crunkilton & Krebs, 1967; Jonassen, 2000; Merwin, 1977). The definition of problem-solving, therefore, varies considerably among academic disciplines. For example, in technology education, Merwin (1977) defined problem-solving as "a sequence of procedures in the thinking process that a learner employs in dealing with a problem or task" (p. 123). Jonassen (2000) added that problem-solving could also allow students to "find [answers to] the unknown." (p. 65). In agricultural education, however, Crunkilton and Krebs (1967) defined problem-solving "as a method of teaching in which the teacher guides the class through a series of questions. . ." (p. 90). Because of such variant depictions, therefore, problem-solving's philosophical and operational tenets remain unclear.

Nevertheless, the pedagogy appears to have been considered an integral tenet of school-based, agricultural education (SBAE). For example, the use of the pedagogy emerged in SBAE in concert with the Smith-Hughes Act of 1917 (Moore & Moore, 1984). During this period, the U.S. experienced an industrial revolution, which shifted education and catalyzed reform efforts (Roberts, 1957; Roberts & Ball, 2009; Talbert et al., 2007). This shift also piqued national interest in the enhancement of skilled laborers (Roberts & Ball, 2009). Because of these changes in U.S. society, it is believed that problem-solving became diffused as a method of instruction in SBAE (Moore & Moore, 1984) and experienced more widespread adoption (Boone, 1990; Cano & Martinez, 1991; Crunkilton & Krebs, 1967; Dyer & Osborne, 1996; Flowers & Osborne, 1988; Hammonds, 1950; Krebs, 1967; Newcomb et al., 1993; Phipps & Osborne, 1988; Torres & Cano, 1995a; Torres & Cano, 1995b). However, problem-solving has been described, represented, and depicted in a variety of ways throughout its rich history in SBAE. Such variances were made explicitly clear in submissions that described problem-solving in *The Agricultural Education Magazine* (*The Magazine*).

For example, as evinced in *The Magazine*, problem-solving's use in SBAE emerged in the mid 20th Century (Hammonds, 1950; Krebs, 1967). However, in many ways, the pedagogy, and other methods of instruction, have evolved considerably in the early 21st Century as practitioners responded to key shifts in American society (Roberts & Edwards, 2015, 2018). In particular, in the early 2000s, the enactment of *No Child Left Behind* (NCLB) created a turning point in U.S. education policy that resulted in wide-sweeping reform efforts, which required states to adopt learning standards and assessments to monitor better and track students' progress, especially regarding mathematics, reading, and science (U.S. Department of Education, 2001). Such changes also largely influenced approaches to teaching and learning that were depicted in *The Magazine*. For instance, contributors published articles on learning approaches that featured: (a) PBL, (b) IBI, and (c) experiential learning that focused on applications of science, technology, engineering, and mathematics (STEM) (Retallick & Miller, 2005; Torres & Cano, 2005a).

Although such work was pivotal to positioning SBAE as relevant, during this period, problem-solving's pedagogical dimensions and underlying philosophical foundation also appeared to become blurred and conflated with other teaching and learning approaches. As a consequence, a dichotomy emerged in which some practitioners began to represent problem-solving as a distinct method of instruction, while others articulated it as an approach that was largely synonymous with other pedagogies (Parr & Edwards, 2004). Because of these discrepancies in the problem-solving literature, a lack of clarity exists in SBAE regarding how problem-solving should be delivered conceptually. To complicate this issue further, however, early literature in SBAE (Crunkilton & Krebs, 1967; Moore & Moore, 1984) on problem-solving argued it lacked a solid theoretical foundation and should be approached with caution when used as a method of instruction. As a consequence, two questions persist: *"Should problem-solving be practiced as a distinct pedagogical approach?* And if so, *"What implications exist for using problem-solving in the 21st Century and beyond?"* These questions motivated the current study.

Purpose

To address this issue**,** the purpose of this philosophical investigation was threefold: (1) describe existing perspectives and theories on problem-solving; (2) explain how problem-solving has been used as a method of instruction in SBAE; and (3) illuminate how the problem-solving could be reconceptualized to enrich the delivery of SBAE's comprehensive, three-circle model. This research aligns with the American Association for Agricultural Education's National Research Agenda Research Priority 7: *Addressing Complex Problems.* Specifically, this research addresses question one, "What methods, models, and programs are effective in preparing people to solve complex problems, interdisciplinary problems?" (Andenoro, Baker, Stedman, & Pennington, Weeks, 2016, p. 59).

Methods and Procedures

Philosophical research seeks to analyze existing axioms and beliefs in a given domain (Roberts & Edwards, 2020; Salevouris & Furay, 2015). This study, therefore, synthesized educational theories and perspectives from prominent problem-solving advocates, while also advancing new understandings for SBAE. From a philosophical perspective, problem-solving aligns with the worldview of pragmatism, which advances the belief that individuals construct meaning from their experiences as they interact with others and navigate issues and problems in a real-world context (Crotty, 1998). To meet the study's purpose, we synthesized theoretical and practitioner-oriented work as well as empirical evidence supporting problem-solving through the use of the following sources: (a) books, (b) peer-reviewed journal articles, and (c) *The Agricultural Education Magazine*.

All references were subjected to internal and external criticisms to triangulate our findings (Salevouris & Furay, 2015). For instance, we evaluated each source for authenticity concerning its origin and content (Salevouris & Furay, 2015). Further, we analyzed how the investigation's (a) findings, (b) conclusions, (c) implications, and (d) recommendations might provide inferences for future work. To accomplish this, we used a conceptual mapping technique in which we scrutinized each source's existing similarities and discrepancies (Salevouris & Furay, 2015). For example, through mapping, we revealed each source's interconnectedness and congruence with the study's purpose (Salevouris & Furay, 2015). As a result, we developed key empirical assertions through the use of an analytic memoing technique (Saldaña, 2015). Then, we synthesized our findings by weaving our assertions into a narrative that described how problem-solving could be reimagined to deliver agricultural education's comprehensive, three-circle model in transformative new ways.

Perspectives and Theories on Problem-Solving

Through our analysis, six leading perspectives – John Dewey, Rufus Stimson, Werrett Charters, William Lancelot, John Bransford, and Scott Johnson – on problem-solving appeared to most prominently shape existing thought and use of the pedagogy in SBAE as well as in teaching and learning more broadly. Our description of each perspective is provided next.

John Dewey

John Dewey largely gained prominence as a thought leader as a result of his time at the University of Chicago after creating a progressive school, called the *Dewey Laboratory School,* that he used to foment his philosophy and theory on experience and education (Dewey, 1910, 1938). Dewey believed that students should be viewed as active pursuers of knowledge that lived, worked, and interacted in the world as a social being (Hyland, 1993). Dewey was also a strong advocate for students actively engaging in experiences that were based on real-world issues and problems (Dewey, 1938). In particular, Dewey maintained that teaching students to think and solve problems was integral to creating successful members of society (Dewey, 1910). Further, Dewey (1910) detailed in *How We Think* his five-step model for *reflective thinking.* Dewey's five axioms for reflective thinking included: (a) felt difficulty, (b) location and definition of the problem, (c) creation of solutions, (d) development of reasons for solutions, and (e) further exploration and evaluation (Dewey, 1910).

Rufus Stimson

Rufus Stimson has also been identified as a pivotal early leader to agricultural education in the U.S. (Moore, 1988, 2018). Perhaps, his most significant contribution to the discipline was the formalization of the project-based method, which is now recognized as the Supervised Agricultural Experience (SAE) component of agricultural education's comprehensive, three-circle model (Camp & Crunkilton, 1985; Foor & Connors, 2010; Moore, 1988). Although Stimson (1911, 1919) did not use the term *problem-solving*, many of the core features of the project-based method, align naturally with the pedagogy. For example, Stimson (1911) advanced three major projects relevant for farm work: (1) improvement, (2) experimental, and (3) productive. In his description of project types, Stimson (1919) explained that each would require students to identify relevant problems, collect evidence, and design a strategy to respond to each unique issue or problem. Such work also deeply influenced his protégé Werrett Charters.

Werrett W. Charters

Werrett Charters was a student of Dewey for three years at the University of Chicago. It is because of this experience that Charters is often recognized as a disciple of Dewey and a proponent of his philosophy and beliefs on teaching and learning. However, he also made pivotal advancements to problem-solving in his own right. For instance, in Charters' works *Methods of Teaching and Teaching* (1912) and *Teaching the Common Branches* (1924) he emphasized the importance of having students solve real-world problems that piqued their interest and motivated them to be actively engaged in the learning process (Charters, 1912, 1924). Similar to Dewey's (1910) reflective thinking model, Charters advanced both inductive and deductive reasoning (Charters, 1924). However, Charters also theorized that inductive thinking processes could help propel students' deductive thinking as they work through contextualized problems, form hypotheses, and arrive at concrete solutions (Charters, 1912). As a result, Charters (1924) advanced three stages of problem-solving: (a) definition of the problem, (b) creation of a hypothesis, and (c) testing and verifying the solution. Such advancements appear to have profoundly influenced how problem-solving was operationalized in its formative years in SBAE.

William Lancelot

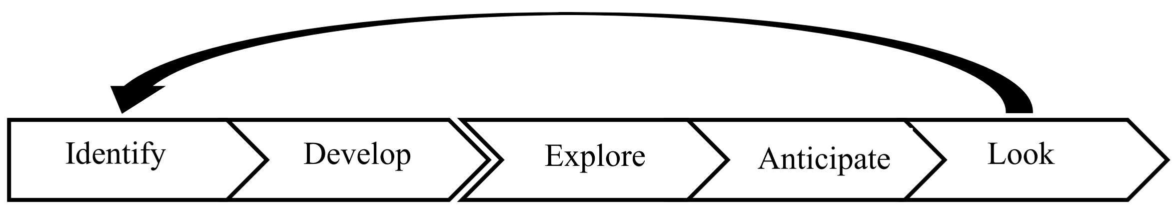
William Lancelot was another early proponent of problem-solving in SBAE. Lancelot received his bachelor's degree in agricultural education in 1919 and shortly after pursued his master's degree in education at Columbia University. During his graduate studies, Lancelot was introduced to the works of Dewey and Charters, which greatly influenced by his views on education and society (Lancelot, 1944). As a result, Lancelot advocated for transitioning education from a rote memorization model to one that closely mirrors problem-solving (Lancelot, 1944). In his book *Permanent Learning* (1944), he described different types of problems that students may encounter during their educational experiences, how to use such problems productively, ways to integrate problems across contexts, and the uses of the problem-solving in regard to teaching and learning. Further, Lancelot (1944) conceptualized 10 steps that educators could use to implement problem-solving as a pedagogy. Similar to Dewey and Charters, Lancelot also articulated the role of inductive and deductive reasoning. Because of his deep connection to SBAE, his work appeared to influence the discipline profoundly. However, in the proceeding decades, other prominent educational leaders influenced SBAE as well.

John D. Bransford

John Bransford was an educational psychologist at the University of Washington who authored several critical works regarding cognition, learning styles, and teaching. For example, in Bransford's and Stein's (1984) *The IDEAL Problem Solver,* he introduced an approach to problem-solving that encompassed the ideas and theories of several key theorists such as Kolb (1984), Newell and Simon (1972), and Sterberg (1981). The IDEAL problem-solving model also drew on concepts from the Socratic method, the scientific method, and John Dewey's reflective thinking model (Phipps, Osborne, Dyer, & Ball, 2008). In particular, the IDEAL problem-solving model largely reconceptualized Dewey's reflective thinking model using the following processes: (a) identify problems and opportunities, (b) develop goals, (c) explore possible strategies, (d) anticipate outcomes, and (e) look back. It is critical to note that in the IDEAL problem-solving model, each step is fluid and may not unfold successively (Bransford & Stein, 1984). Figure 1 depicts Bransford's and Stein's (1984) IDEAL problem-solving model.

Figure 1

Bransford's and Stein's (1984) IDEAL Problem-Solving Model



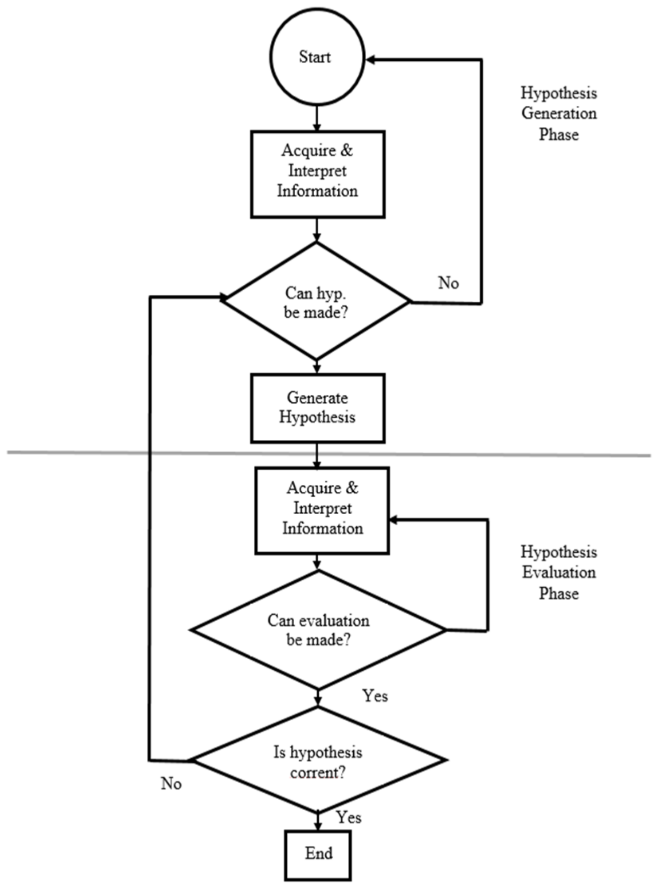
Note. Adapted from "The Influence of Cognitive Diversity on Group Problem-solving Strategy" by A. J. Lamm, C. W. Shoulders, G. T. Roberts, T. A. Irani, L. J. Snyder, and J. Brendemuhl, 2012, *Journal of Agricultural Education, 53*(1), p. 19. Copyright 2012 by *Journal of Agricultural Education*. Reprinted with permission.

Scott Johnson

Another vein of literature that has greatly influenced problem-solving theory and practice is troubleshooting. And, perhaps, the individual that has most profoundly advanced thought on troubleshooting is Scott Johnson. For example, Johnson's (1989) technical troubleshooting model provided conceptual guidance for practitioners to support students as they navigate complex curricular problems. In the first phase of the model, students collect and interpret information through two primary sources: (1) procedural knowledge, and (2) external sources (Johnson, 1991). Procedural knowledge refers to an individual's understandings that result from processes such as reading diagrams, using mathematical formulas, and understanding manuals (Johnson, 1989). Meanwhile, external sources of information typically originate from the knowledge that individuals glean from jobs, technical support, and evaluations (Johnson, 1989). Of note, both sources of knowledge help troubleshooters form a more concrete understanding of the problem (Johnson, 1991). Based on Johnson's (1989) model, after individuals acquire information from the aforementioned sources, they enter an interpretation phase (Johnson, 1991). This step is critical because troubleshooters must identify which concepts are relevant based on their prior learning and experiences (Johnson, 1989). If enough information has been gathered, then the troubleshooter can then move into the hypothesis generation phase. During this step, individuals generate one or more hypotheses about the problem (Elstein et al., 1978; Frederiksen, 1984; Johnson, 1989). After the hypothesis generation phase, troubleshooters evaluate their results, which allows the troubleshooter to test their hypotheses and determine whether it should be accepted or rejected (Johnson, 1991). If the troubleshooter did not solve the problem, they restart the process, as depicted in Figure 2 (Johnson, 1991).

Figure 2

Troubleshooting Model



Note. Adapted from "A description of expert and novice performance differences on technical troubleshooting tasks" by S.D. Johnson, 1989, *Journal of Industrial Teacher Education*, *26*(3), p. 20. Copyright 1989 by *Journal of Industrial Teacher Education*. Reprinted with permission.

Problem-Solving's Use in SBAE

In addition to being articulated by leading educational theorist, problem-solving has also been advanced in SBAE since its early inception as a way to facilitate authentic learning for students (Moore & Moore, 1984; Parr & Edwards, 2004; Retallick & Miller, 2005; Torres & Cano, 2005b). As an illustration, Phipps and Cook (1956) advanced Dewey's (1910) stages of problem-solving by contextualizing the pedagogy using examples in agriculture. Later, Crunkilton and Krebs (1967) introduced five key phases to consider when using the problem-solving in SBAE. Those phases included: (a) interest approach; (b) create objectives; (c) anticipate problems; (d) solve the problem; (e) evaluate and apply (Crunkilton & Krebs, 1967).

Further, Phipps and Osborne (1988) described their views on problem-solving in *The Handbook on Agricultural Education in Public Schools*. Phipps and Osborne's (1988) approach included similar elements outlined in previous works on problem-solving. For instance, their six-step method included: (a) experience a situation, (b) locate and define the problem, (c) attempt a trial solution, (d) explore reference and information, (e) arrive at a group solution, and (f) evaluate. Finally, Newcomb et al. (1993) addressed problem-solving in *Methods of Teaching Agriculture*, which appears to be one of the most recent attempts to outline the pedagogy for SBAE. In this work, the problem-solving method to teaching and learning is outlined in six steps, which were grounded in the previously reported literature. Those six steps to teaching the problem-solving approach in agricultural education included: (a) interest approach, (b) objectives to be achieved, (c) problems to be solved or answered, (d) problem solution, (e) test solutions through application, and (f) evaluate solutions (Newcomb et al., 1993). Therefore, through our analysis, it appeared that leading perspectives on problem-solving and prominent literature in SBAE demonstrated significant "pedagogical congruence" (Parr & Edwards, 2004, p. 104). As a consequence, a synthesis of these concepts was warranted to advance thought on problem-solving for SBAE.

Synthesis: Advancing the Shared Principles of Problem-Solving

To advance new understandings, we distilled shared principles from the leading perspectives on problem-solving and the SBAE literature. To accomplish this, we grounded our approach in a concept known as *consilience*, first introduced by William Whewell (1840). Consilience represents the merging of stands of knowledge from various disciplines, perspectives, and domains to offer new understandings of a phenomenon (Whewell, 1840). Using this approach, we engaged in a mapping technique to visualize each perspective's similarities and discrepancies while also acknowledging that some authors might not have specifically used the term problem-solving but in essence were describing a similar concept. A product of this procedure was the emergence of three shared principles that appear to be foundational to existing descriptions and representations of problem-solving as a pedagogy. To promote understanding, we chose to represent the shared principles using practical language in hopes that practitioners, researchers, and theorists alike might find them useful. Given such caveats, we offer the three principles of problem-solving that emerged from our analysis: (1) identify problems, (2) analyze information, and (3) evaluate solutions.

Principle #1: Identify Problems

A fundamental characteristic of problem-solving is ensuring that students have the knowledge and skills they need to identify relevant problems (Bransford & Stein, 1984; Crunkilton & Krebs, 1967; Dewey, 1910, 1938; Charters, 1912, 1924; Lancelot, 1944; Newcomb et al., 1993; Phipps & Osborne, 1988). This notion applies to whether problems are presented in the context of a classroom or in a more authentic learning environment (Dewey, 1910, 1938). To equip students with such skills, however, requires introducing them to foundational agricultural knowledge so that they can begin to understand connections, notice disturbances, and appropriately detect when an issue or problem exists (Lancelot, 1944). Therefore, developmental appropriateness is of central importance to ensure that students are prepared as they gain exposure to problems (Charters, 1924), especially in the context of SBAE. As a consequence, SBAE teachers should frame problems in ways that challenge students, but that do not trigger forms of dissonance that may be interpreted as *uneducative* (Dewey, 1910). Through a synthesis of the literature, it became apparent that to ensure students are able to identify problems successfully, SBAE instructors must scaffold them in ways that allow students to mature before they confront issues and problems of a greater cognitive complexity (Bransford & Stein, 1984; Charters, 1912, 1924; Crunkilton & Krebs, 1967; Dewey, 1910; Goossen et al., 2017; Lancelot, 1944).

Principle #2: Analyze Information

As inevitable and ubiquitous as problems are in everyday life, human beings often resist analyzing trends and other relevant data to arrive at possible solutions (Dewey, 1910; Phipps & Osborne, 1988). An essential principle of problem-solving, therefore, is to analyze information. Through our synthesis, we noted that authors of seminal works on problem-solving described a plethora of ways to collect and analyze relevant evidence. For example, articulated strategies included conducting observations (Dewey, 1910, 1938), analyzing test and control specimen (Charters, 1924), as well as generating a hypothesis based on individuals' procedural or external sources of knowledge and then assembling relevant corroborating or disconfirming evidence (Johnson, 1989). Despite the diversity in strategies available, however, SBAE teachers should ensure that students systematically collect information and evaluate it using rigorous procedures (Bransford & Stein, 1984; Charters, 1924; Dewey, 1910, 1938; Johnson, 1989, 1991).

Principle #3: Evaluate Solutions

Because problem-solving is a process, the solution emerges over time, through trial and error (Bransford & Stein, 1984; Charters, 1912; Crunkilton & Krebs, 1967; Dewey, 1910, 1938; Lancelot, 1944; Newcomb et al., 1993; Phipps & Osborne, 1988). Due to the dynamic nature of such, the evaluation of a solution is in a constant state of flux by which new discoveries can alter the beginning, middle, or late phases of the problem-solving process (Dewey, 1938; Johnson, 1989, 1991). This developmental view of the final principle, therefore, recognizes that as students learn and acquire information, an iterative progression transpires in which they co-influence past, present, and future solutions to numerous issues and problems (Dewey, 1938; Charters 1924). It is through this non-linear process; therefore, that SBAE students can critically reflect and begin to authentically evaluate whether their solution to a given problem is viable.

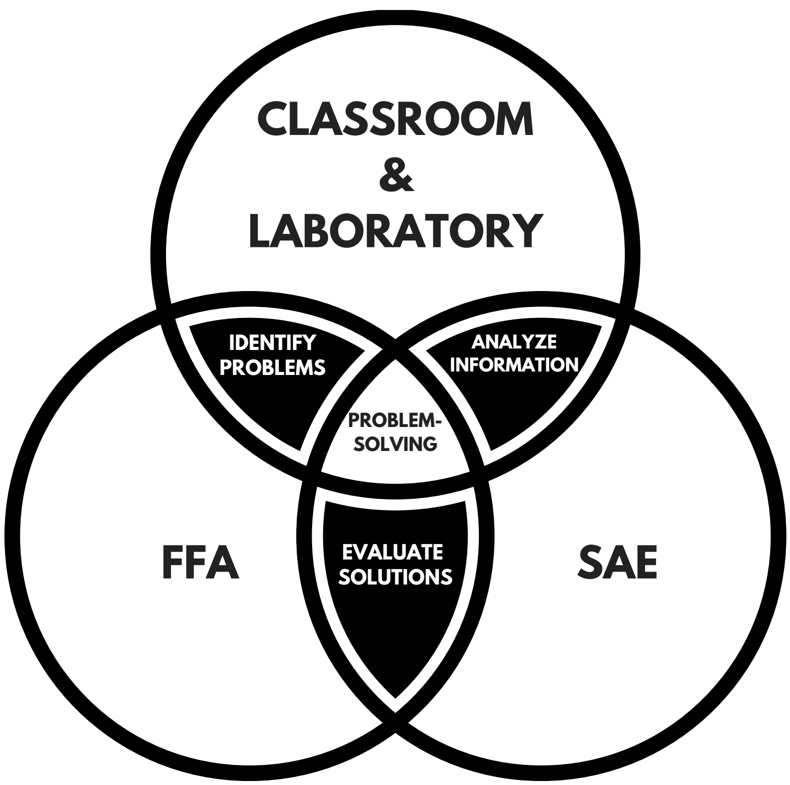
Reconceptualizing Problem-Solving for SBAE

Embedded in the three principles of problem-solving are features that stand as prominent attributes of the pedagogy. Therefore, our synthesis of ideas, theories, and models was a necessary step to illuminate how problem-solving has been advanced and used as a method of instruction. However, this process also revealed the need to expand our current view and understanding of problem-solving in SBAE. We maintain that such a reconceptualization could crystalize new possibilities for future research, theory, and practice.

For example, although problem-solving has largely been represented as a method of instruction, and rightfully so, we maintain that problem-solving's current limits and parameters in SBAE could be expanded so that it may also be viewed as a *guiding philosophy* for the discipline. To that end, we offer (see Figure 3) the Integrated Problem-Solving Model for Agricultural Education to demonstrate how this idea could be operationalized in SBAE. In the model's development, our goal was to enrich agricultural education's comprehensive, three-circle model by embedding the core principles of problem-solving – identify problems, analyze information, and evaluate solutions – in a way that would aptly depict the synergistic and complementary power of this merger.

Figure 3

Integrated Problem-Solving Model for Agricultural Education



Note. The principles of problem-solving are shaded to demonstrate their permeability through and between each dimension of SBAE.

Foundationally, therefore, the model advances the notion that problem-solving is entrenched through and between each dimension of agricultural education. Consequently, the principles of problem-solving are interwoven with the three components of agricultural education: (a) classroom and laboratory, (b) Supervised Agricultural Experience (SAE), and (c) The National FFA Organization (FFA). It is important to note that the principles of problem-solving are not exclusive to a single dimension of agricultural education. Instead, they should be considered permeable as the problem-solving process unfolds for students through trial-and-error.

To contextualize the model, we developed the following example to demonstrate how the model might be used in SBAE. To begin, consider a student enrolled in an *Introduction to Horticulture* course (Classroom and Laboratory) who noticed that the Poinsettias she planted in class a few weeks prior appeared to be stunted in growth (Principle #1: Identify Problems). To capitalize on the learning embedded in this problem, her SBAE teacher encouraged her to reflect on the learning concepts introduced earlier in the semester. After a few minutes, she answered, "Maybe it is because the plants are under the shade cloth, so they are not getting enough sunlight." Her SBAE teacher responded, "That is a great start, perhaps, you should design a project (SAE) that will allow you to collect data to determine whether or not your hypothesis is correct." Over the next few weeks, she collected data using control and experimental trials, and as a result, began to observe trends through an analysis of relevant information (Principle #2: Analyze Information). After this procedure, she drew the conclusion that because Poinsettias are a tropical flower, they were not getting enough direct sunlight when placed under a shade cloth in the greenhouse. She also developed a solution to this problem for individuals who may be experiencing similar issues. Because her SBAE teacher perceived she had done quality work, he encouraged her to carry out additional trails so this knowledge could be used to impact the community through a service project (FFA). As a result, she decided to work with the local FFA Officer Team to organize a professional development opportunity for senior citizens based on the knowledge she had acquired through her classroom and Supervised Agricultural Experiences (SAEs). During this session, she also asked the senior citizens to provide feedback on their experience so that she could more carefully evaluate the solutions she provided regarding growing Poinsettias (Principle #3: Evaluate Solutions). As illustrated above, the SBAE teacher wove the three principles of problem-solving throughout each programmatic dimension of agricultural education – classroom and laboratory, SAE, and FFA – for his student. Such use of problem-solving may be easy to dismiss as *common sense*. However, we counter this position on several grounds. First, what may appear to be common sense for some, may not be viewed as such by those who are new to the discipline, have little experience, or have only considered limited perspectives on problem-solving. And finally, existing descriptions of problem-solving in SBAE do not appear to have represented it in ways that capture the intricacies of the reconceptualization advanced in our philosophical discussion.

Conclusions

Problem-solving has evolved considerably since its early origins. For example, initially, it was depicted as a distinct method of instruction (Charters, 1912). However, since that time, it appears to have become conflated with other pedagogical approaches (Parr & Edwards, 2004). As a consequence, the tenets of problem-solving became ambiguous over time (Crunkilton & Krebs, 1967; Moore & Moore, 1984). In this investigation, therefore, we sought to examine existing perspectives on problem-solving and explain how problem-solving has been used as a method of instruction. Through our analysis, we conclude that six leading perspectives – Dewey, Stimson, Charters, Lancelot, Bransford, and Johnson – appeared to most profoundly influence the ways in which the pedagogy has been operationalized. From these leading perspectives, we also conclude that three shared principles of problem-solving could be distilled: (1) identify problems, (2) analyze information, and (3) evaluate solutions. The first principle, identify problems, reflected that need for educators to scaffold problems in ways that are challenging but also developmentally appropriate so that students can gain confidence before attempting to solve problems of a greater complexity (Bransford & Stein, 1984; Crunkilton & Krebs, 1967; Dewey, 1910, 1938; Charters, 1912; 1924; Lancelot, 1944). Meanwhile, the second principle, analyze information, represented the need for students to collect and analyze quality data using rigorous procedures before drawing conclusions about a problem (Bransford & Stein, 1984; Charters, 1924; Dewey, 1910; Johnson, 1989, 1991).

The last principle, evaluate solutions, suggested that because problem-solving is a process, students should evaluate their solutions to problems over time through trial and error (Bransford & Stein, 1984; Crunkilton & Krebs, 1967; Dewey, 1910, 1938; Charters, 1912, 1924; Lancelot, 1944; Newcomb et al., 1993; Phipps & Osborne, 1988). Although our distillation of the shared principles helped describe how the pedagogy has been operationalized as a method of instruction, it also called attention to the need to expand our current use of problem-solving. Therefore, we introduced the Integrated Problem-Solving Model for Agricultural Education, which advanced the principles of problem-solving embedded through and between each component of agricultural education's comprehensive, three-circle model: (a) classroom and laboratory, (b) SAE, and (c) FFA. We argue, therefore, that problem-solving can not only be operationalized as a pedagogy but also a guiding philosophy for SBAE moving forward.

Implications, Recommendations, and Discussion

In recent decades, a growing number of voices from business, government, and higher education have called for more curricular focus to be placed on enhancing agriculture graduates' ability to communicate, think critically, and innovate (Blickenstaff et al., 2015; Fields et al., 2003). By fostering these process-oriented skills, it is reasoned that future agriculturalist who enter the workforce will be better prepared to traverse a world fraught with complexities that require them to adapt and solve problems on issues such as climate change, disease, global hunger, and water scarcity (National Research Council, 2014; Roberts et al., 2020; Warren English et al., 2018). In response, this philosophical investigation illustrated the ways in which SBAE could draw on its problem-solving foundations to reposition itself, as the headwinds of change threaten to intensify in the 21st Century and beyond (Brown, 2016). However, such a reorientation will be complex for the discipline to adopt, with even basic discussions about this change, presenting numerous conceptual and practical hurdles.

As a consequence, we offer the following possibilities for future research and practice. First, more dialogue is needed about problem-solving, when conceptualized as both a method of instruction as well as a guiding philosophy for SBAE. To achieve this, perhaps professional development sessions could be offered by the *American Association for Agricultural Education* (AAAE) and the *National Association of Agricultural Education* (NAAE). A concerted effort should also be dedicated to diffusing the Integrated Problem-Solving Model for Agricultural Education. As such, we recommend the model be shared, along with illustrative case study examples, in *The Magazine* as well as the *FFA New Horizons*. Teacher educators should also introduce the model to preservice teachers by having them consider innovative ways to integrate such into their future SBAE programs. We also suggest that podcasts, popular press articles, and other communication mediums promote SBAE students, advisors, and programs that use the model in exemplary ways. Finally, we recommend the use of social network analysis to analyze the model's diffusion challenges better by identifying opinion leaders who influence others in SBAE at the node, dyad, and network levels (Borgatti et al., 2018).

Although problem-solving has a deeply entrenched philosophical foundation in SBAE (Moore & Moore, 1984), more work is needed to explore its dimensions. Therefore, we recommend that research be conducted to examine the programmatic outcomes associated with use of problem-solving as a guiding philosophy. For example, does such an approach improve students' career readiness, creativity, critical thinking, engagement, learning, and motivation (Roberts & Robinson, 2018)? Further, what motivates a SBAE instructor to adopt such a philosophy in an individual program? Additional research is also needed to examine the outcomes of problem-solving's use as a method of instruction in SBAE. As an illustration, how do the ways SBAE teachers conceptualize, use, and talk about problem-solving affect student outcomes? And do students who solve problems through team-based learning approaches learn better than those assigned individual problem-solving projects (Figland et al., 2020)? These corollary questions warrant further examination.

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