Teaching and Assessing Critical Thinking Skills in Michigan Secondary Agriculture, Food, and Natural Resources Programs

by

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Schweitzer, Renee L. ***Teaching and Assessing Critical Thinking Skills in Michigan Secondary Agriculture, Food, and Natural Resources Programs***

Abstract

As the agriculture, food, and natural resources (AFNR) industry feeds, clothes, and fuels the ever-growing population while facing significant challenges to production and distribution, the need for critical thinkers in the industry grows. While significant literature on critical thinking instruction exists, extensive research done to determine how critical thinking is taught in AFNR programs does not. This exploratory, mixed methods study aimed to investigate how Michigan secondary AFNR educators incorporate critical thinking instruction and assessment practices into their programs. The study, based on the critical thinking framework by Swartz and McGuinness (2014), included two phases. Phase one included a cross-sectional, web-based survey that incorporated selected-response and open-ended questions to collect participants' attitudes toward critical thinking instructional strategies and to gather their current practices. Phase two included semi-structured interviews that intended to further explore AFNR teachers' practices. After analysis, the results found Michigan AFNR instructors have favorable attitudes toward using strategies to develop students' thinking skills, metacognition, and thinking dispositions. Some variation was identified between teachers based on their years of AFNR teaching experience, years of AFNR industry experience, route to teaching, and type of school where currently teaching. Furthermore, three themes emerged from the qualitative results that provided additional insight into the critical thinking instructional practices, challenges, and principles of AFNR instructors. Finally, this study suggests opportunities for AFNR education to improve critical thinking instruction and assessment.

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Table of Contents

List of Tables

List of Figures

Chapter I: Introduction

Whether called soft skills, student success skills, or twenty-first century skills, both employers and post-secondary institutions agree that high school graduates need cognitive and social skills such as communication, critical thinking, listening, decision making, and problem solving in addition to the industry-specific technical skills necessary to succeed in the workforce today (Al Kandari & Al Qattan, 2020; D'Antoni, 2019; Evans, 2020). While these cognitive and social skills are all identified as important by many industries and employers, critical thinking and its subskills (e.g., analysis, synthesis, problem solving, *etc*.) are consistently identified as an area that needs significant improvement in new hires (Carnevale et al., 2020; Hart Research Associates, 2015; National Association of Colleges and Employers, 2022).

This need for critical thinking skills within the workforce is especially evident in agriculture. The industry tasked with feeding, clothing, and fueling society is facing significant challenges both currently and in the future. The United Nations estimated the global population reached 8 billion in November 2022 and projects it to reach 9.7 billion people by 2050 (United Nations, 2022a, 2022b). To meet the demands of the growing population, food production and distribution need to continue to grow and improve. However, doing so may be difficult. Climate change projections and their potential impacts on food production are expected to be significant including: record high temperatures, extreme temperature swings, dry conditions, and an increased prevalence of natural disasters (Intergovernmental Panel on Climate Change, 2022). The Agree report on Food and Agricultural Education in the United States highlighted four key challenges facing the agricultural industry: demand for food; conservation of water, soil, and habitat; improvement of nutrition and health; and improvement of farm and rural livelihoods

(Mercier, 2015). These challenges facing agriculture drive the need for critical thinkers within the industry.

Post-secondary educators in the agriculture field agree the industry needs critical thinkers. There is a prevalence of issues within the industry requiring critical thought, and students should be given the opportunity to develop those skills in agriculture classes (Barkley, 1994). In one survey of post-secondary agriculture educators, critical thinking was recognized as an important skill for post-secondary agriculture students, with some educators identifying it as more important than technical agriculture skills (LaCharite, 2016).

This emphasis on critical thinking skills at the post-secondary level is not unique to agriculture. Critical thinking is typically a key objective for most post-secondary institutions. Post-secondary graduates have more critical thinking skills than their university freshmen counterparts (Anghel et al., 2021). However, only approximately 40% of job openings in 2022 required education beyond high school (U.S. Bureau of Labor Statistics, 2022c). For those entering the industry directly from high school, critical thinking instruction must occur at the secondary level to meet the demands of the industry.

While post-secondary institutions emphasize critical thinking, the K-12 education system has been given the responsibility of eliminating this thinking skill gap through multiple educational reform policies. However, some argue the responsibility lies elsewhere. Robinson (2014) suggests that critical thinking deficits are the result of societal issues and inequalities, rather than poor education systems. He further argues that requiring schools to attempt to alleviate the problem will only widen the gap those inequalities have created because sufficient resources are not being provided to low-income students at home. Regardless of the validity of such arguments, the education system has been tasked with attempting to solve the problem of

improving students' cognitive abilities. Additionally, while societal changes may be most effective in improving critical thinking skills, research has shown that the education system can positively impact students' critical thinking (Al-Khrisha & Mansour, 2021; Bekbayeva et al., 2021; Cheong & Cheung, 2008; Gupta, 2015). This research suggests that schools can improve students' critical thinking skills, thus supporting the need to explore how secondary schools can achieve that goal.

Career and technical education (CTE), including agriculture, food, and natural resources (AFNR) education, is uniquely positioned to lead the advancement of critical thinking education because of the real-world applications that are inherent to the programs. CTE has seen a shift over the past few decades, with an increased focus on academic achievement, particularly since various reform strategies such as *A Nation at Risk* (National Commission on Excellence in Education, 1983) and the No Child Left Behind Act of 2001 (2002) have increasingly emphasized academic rigor. Similarly, the Secretary's Commission on Achieving Necessary Skills released a report in 2000, commonly known as the SCANS report, which called for an increased emphasis on workplace competencies, including thinking skills, in schools to meet the demands of the changing workforce. Daggett (2003) identifies CTE as the key to increasing academic ability, consequently improving critical thinking, because CTE reflects his rigor and relevance framework, which suggests teachers should provide students with the opportunities to apply thinking skills in both predictable and unpredictable real-world applications. With the unpredictable nature of the challenges facing the agriculture and natural resources industries both now, and in the future, AFNR programs provide students with a variety of such real-world experiences, giving these students ample opportunity to apply their newly attained critical thinking skills. While AFNR programs can improve the critical thinking skills of future

agriculturalists, instruction is currently lacking (Velez et al., 2015; Weeks et al., 2020). Despite AFNR educators identifying critical thinking as an important twenty-first century skill, their knowledge and perceived ability to teach it lags (Weeks et al., 2020).

Many researchers have identified strategies that positively impact students' critical thinking skills, including in subject matter courses such as AFNR. However, the fact that new agriculture employees are still lacking in those skills despite education's awareness of such strategies suggests they are not universally used in AFNR classrooms. To improve AFNR students' critical thinking skills, there is a need to identify the current practices used by AFNR educators to impact critical thinking skills. Doing so will also identify which objectives of critical thinking instruction are not being met. Ultimately, this will establish a baseline of critical thinking instruction in AFNR programs that can be explored in further research.

Statement of the Problem

The expectations of the workforce are changing, increasing the pressure put on the education system, particularly CTE programs such as AFNR, to teach critical thinking. In addition to the changing workforce, the agriculture industry is facing the unique challenge of feeding a growing population despite facing significant challenges to food production (Intergovernmental Panel on Climate Change, 2022; United Nations, 2022a, 2022b). Despite a strong need for critical thinkers, new employees in the agriculture industry do not have the necessary skills (Crawford & Fink, 2020).

Although there is extensive research on critical thinking, it has not been studied broadly in AFNR education. Many instructional strategies have been shown to positively affect students' critical thinking skills in a variety of subject matter courses (Al-Khrisha & Mansour, 2021; Bekbayeva, 2021; Burris & Garton, 2007; Cano & Martinez, 1991; Dyer & Osborne, 1996;

Ennis, 2016; Gupta et al., 2015; Simpson & Courtney, 2007). However, the current research also shows the difficulty in teaching critical thinking (Bartholomew & Strimel, 2017; McKendree & Washburn, 2021; Orion & Kali, 2018; Velez et al., 2015). Despite the prevalence of critical thinking instructional strategies available, there is still a shortage of critical thinking skills in the workforce, which highlights the need for an investigation into the strategies AFNR instructors currently use to improve critical thinking skills. Identifying what is currently done provides a baseline for determining what strategies need to be further explored and implemented in AFNR programs to improve students' critical thinking skills for their futures in the agriculture industry.

Purpose of the Study

The purpose of this study was to explore critical thinking in Michigan secondary AFNR programs. This study aimed to gauge how AFNR instructors currently utilize instruction and assessment strategies that are recognized to impact the three objectives of critical thinking instruction: (a) thinking skills, (b) metacognition, and (c) disposition (Swartz & McGuinness, 2014).

Research Questions

1. How do Michigan secondary AFNR instructors define critical thinking?
2. How do Michigan secondary AFNR instructors teach and assess critical thinking in their classrooms?
3. How do AFNR instructors' teaching experiences impact how they teach and assess critical thinking in their classrooms?
4. How does AFNR instructors' preparation impact how they teach and assess critical thinking in their classrooms?

Nature of the Study

An exploratory, sequential mixed methods approach was utilized. The purpose of this approach was to first gather an overview of critical thinking instructional practices across Michigan AFNR programs, before further investigating the practices of AFNR educators who intentionally teach and assess critical thinking in their classrooms through a multi-case study model. Utilizing a mixed methods approach allows a researcher to gather a larger variety of data than one singular method (Fraenkel et al., 2007). Furthermore, the exploratory, sequential mixed methods approach provides an overview of a subject, while also allowing for a deeper investigation into specific aspects of the subject (Creswell & Creswell, 2018). The population for this study was Michigan secondary agriculture, food, and natural resources educators who are currently teaching in AFNR programs during the 2022-2023 academic year. Because of the small population size and to ensure the sample represents the population well, a census of all Michigan secondary AFNR educators was attempted.

To conduct the study, a cross-sectional survey designed specifically for this study first gathered the current practices of Michigan AFNR educators regarding the three objectives of critical thinking instruction: (a) thinking skills, (b) metacognition, and (c) thinking disposition, as identified by Swartz and McGuinness (2014). While many researchers have identified how critical thinking instruction and assessment can be integrated into subject matter courses, no research has been done to see if or how Michigan AFNR educators utilize those strategies in their classrooms. The survey was piloted by the instructors at a career and technical center in western Michigan to identify any misunderstandings or other validity or reliability concerns. The survey utilized both selected-response and open-ended questions to gather a snapshot of current practices while also allowing instructors to elaborate on the practices they currently use.

At the conclusion of the survey, participants were able to self-select for the interviews if they intentionally teach critical thinking skills in their AFNR programs. Participants were selected for the second phase of the study from those who volunteered based on their survey responses indicating their intentional instruction of critical thinking within their AFNR programs. Those instructors were asked to participate in interviews to deepen the understanding of current practices regarding the integration of critical thinking instruction in AFNR. Additionally, the interview responses were used in conjunction with the survey responses to create a consensus definition for critical thinking instruction in AFNR education. A thematic analysis was used to identify common themes within the interview responses.

Significance of the Study

Critical thinking is consistently identified as a necessary, yet lacking skill in today's workforce (Al Kandari & Al Qattan, 2020; Carnevale et al., 2020; D'Antoni, 2019; Evans, 2020; Hart Research Associates, 2015; National Association of Colleges and Employers, 2022). With the increasing population and growing list of challenges facing agriculture today (e.g., record high temperatures, dry conditions, *etc*.), the agriculture industry needs workers with the skills to critically think (Intergovernmental Panel on Climate Change, 2022).

Research has identified successful strategies that can be used by educators to teach critical thinking skills to meet the three objectives of critical thinking instruction: (a) thinking skills, (b) metacognition, and (c) disposition (Swartz & McGuinness, 2014). The findings of this study aim to contribute to the literature by identifying how AFNR educators currently incorporate critical thinking into their curricula, as well as identifying where there are opportunities to implement practices to improve students' critical thinking skills.

Assumptions of the Study

Regarding this study, the following assumptions exist.

1. The sample of participants that will be used in this study represents the target population of Michigan secondary AFNR instructors, and the entire target population will be included in the list of potential participants.
2. Study participants will answer the questions truthfully based on their current teaching and assessment practices and will not be influenced by personal or professional expectations of what their practices should include.
3. Study participants will be honest and accurate in all nominal responses so when the information is used to form groups, the formed groups will be accurate.
4. Participants have a general knowledge and understanding of the term, critical thinking.
5. Critical thinking instructional strategies will be measured by the survey instrument created for and used in this study.
6. Lack of response in the survey will be determined solely by the potential participant's choice to not participate and not due to other circumstances such as limited technology capabilities or survey/question comprehension level.

Limitations of the Study

1. As a Michigan AFNR educator myself, I will be looking at this study through the lens of my own teaching experience. I also am professionally familiar with many of the participants, which may impact responses to any interview questions perceived to have an expected response. I will make every attempt to recognize and eliminate any potential bias, but I recognize that my experiences will influence this research.

2. The quality of participant responses is dependent on their understanding and interpretation of the concept, critical thinking.
3. Instructional and assessment practices used by secondary AFNR instructors will be self-reported in the study, so responses may not be as accurate as observed behaviors. There may be discrepancies in teachers' intentions in teaching and assessing critical thinking and what is done. Determining these differences will not be possible through this study.
4. All Michigan AFNR educators will be potential participants, but they are choosing to participate by filling out the survey. Inherently, responses may be skewed because of who chooses to participate and who does not.
5. Participation in the interviews is based on instructors' perceptions of their own intentional instruction of critical thinking. This could eliminate teachers who successfully incorporate critical thinking instructional practices in their classrooms without recognizing they are doing so.
6. The quality of responses in the interview process is based on the comfort level of the interviewee and their willingness to share openly and honestly about their feelings, perceptions, and classroom practices. Respondents may want to respond in what they perceive to be a professionally or socially acceptable way (Wiersma & Jurs, 2009).

Definition of Terms

The following terms and subsequent definitions were used throughout the study. There are a variety of definitions and interpretations for many of these terms in the literature, therefore defining these terms helps the reader understand how the author interprets and uses the terminology.

Career and Technical Education Course

Career and technical education courses are those courses within one of the 16 Career Clusters funded and overseen by the Carl D. Perkins Career and Technical Education Act (Perkins Collaborative Resource Network, n.d.).

Critical Thinking

The definition of critical thinking that will be used in this study is "reasonable, reflective thinking that is focused on deciding what to believe or do" (Ennis, 2011, p. 1). It has five subskills: analysis, synthesis, evaluation, problem solving, and decision making (Swartz & McGuinness, 2014).

Metacognition

An individual's awareness of their own thinking processes and practices.

Michigan Agriculture, Food, and Natural Resources Program

Courses offered in Michigan secondary schools within the Agriculture, Food, and Natural Resources Career Cluster and fit within the Agricultural/Animal/Plant/Veterinary Science and Related Fields or Natural Resources and Conservation Classification of Instructional Program (CIP) categories.

Secondary Agriculture, Food, and Natural Resources Instructor

Secondary AFNR instructors teach center-based or comprehensive high or middle school-based AFNR courses (6th through 12th grades)**.**

Supervised Agricultural Experiences

Work-based learning opportunities AFNR students complete to learn industry skills outside the AFNR classroom.

Thinking Disposition

An inherent quality of recognizing the need for and having the motivation to habitually use thinking skills.

Thinking Skills

Cognitive processes such as analysis, evaluation, and decision making that are activated to process and recall information and apply knowledge.

Three Circle Model of Agriculture, Food, and Natural Resources Instruction

AFNR programs are expected to include three components: classroom/lab instruction, FFA, and supervised agricultural experiences. These aspects of instruction are expected to be nearly equal components of quality AFNR programs.

Chapter II: Literature Review

The purpose of this study was to identify how Michigan secondary AFNR instructors currently utilize instruction and assessment strategies that are known to impact the three objectives of critical thinking instruction: (a) thinking skills, (b) metacognition, and (c) disposition (Swartz & McGuinness, 2014). This literature review first provides the framework that guides this study. It then explores the scope of research on critical thinking including the range of definitions of critical thinking that exist; instructional practices for teaching thinking skills, metacognition, and critical thinking dispositions; and, finally, assessment strategies for critical thinking through the lenses of general education, CTE, and AFNR education.

Theoretical/Conceptual Framework

To evaluate how secondary AFNR instructors incorporate the instruction and assessment of critical thinking in their classrooms, Swartz and McGuinness (2014) framework for developing and accessing thinking skills and related constructs will be used. The framework was developed after a literature review of more than 700 references from 1998 to 2013. Swartz and McGuinness' framework identifies three objectives for critical thinking instruction regardless of the grade level or subject matter: (a) thinking skills, (b) metacognitive thinking, and (c) thinking dispositions (see Figure 1). It is important to note that in their literature review, Swartz and McGuinness (2014) identified *beliefs about knowledge* as a fourth potential objective for critical thinking. However, they acknowledged it is a relatively new construct in critical thinking research and practice, and therefore, it has not been studied as extensively as the other three objectives identified. Ultimately, they decided not to include beliefs about knowledge as an objective for their critical thinking framework for teaching and assessment. Consequently, it is not included in the framework for this study either.

Figure 1

A Conceptual Framework to Identify Critical Thinking Instructional Practices

An Integrated Research and Practice-Informed Framework for Developing and Assessing Thinking Skills and Related Constructs		
Teaching		
Thinking Objectives	**Principles**	**Practices**
Thinking Skills	• Make thinking organizers explicit • Advance deep thinking challenges • Engage students in collaborative thinking to ensure joint meaning making, interaction, and dialogue	• Teach explicit thinking organizers/strategies in the classroom, graphic organizers, thinking routines • Give students something challenging to think about, more than routine tasks • Prompt students to make thinking visible and public
Metacognitive Thinking	• Prompt students to adopt a strong metacognitive perspective • Teach for transfer of the skillful thinking being learned	• Teach students explicit strategies to plan, monitor, and evaluate their thinking skills. Give time to do this. • Explicitly teaching to facilitate the transfer of learned thinking procedures to other curricular and non-curricular contexts
Thinking Dispositions	• Cultivate thinking dispositions and habit of mind • Generalize the approach from thinking classrooms across all grades in the school	• Teach students explicit strategies to plan, monitor, and evaluate their thinking dispositions. Give time to do this. • Create classroom norms and expectations about thoughtfulness and the habitual use of thinking strategies • Prioritize teachers' professional development and teachers' planning time
Assessment		
Principles		**Practices**

• Align teaching and assessment practices with thinking objectives in the classroom
• Be specific about the performance criteria and standards expected for the use of
  ◦ Thinking Skills
  ◦ Metacognition
  ◦ Thinking Dispositions
• Adopt assessment for learning principles
		• Prompt student performances that display the use of thinking skills, habits of mind, and the efficacy of thinking dispositions
		• Design assessment rubrics and ratings that incorporate
		  ◦ Specific criteria
		  ◦ Appropriate standards
		  ◦ Next Steps
		  ◦ Growth Patterns
		• Share the criteria and standards with students
		• Give feedback and identify next steps
		• Use self and peer assessment to communicate and share standards, promote assessment literacy, and rethinking objectives

Note. From "Developing and Assessing Thinking Skills: Final Report Part 1, Literature Review and Evaluation Framework," by R. Swartz and C. McGuinness (2014)

Thinking Skills

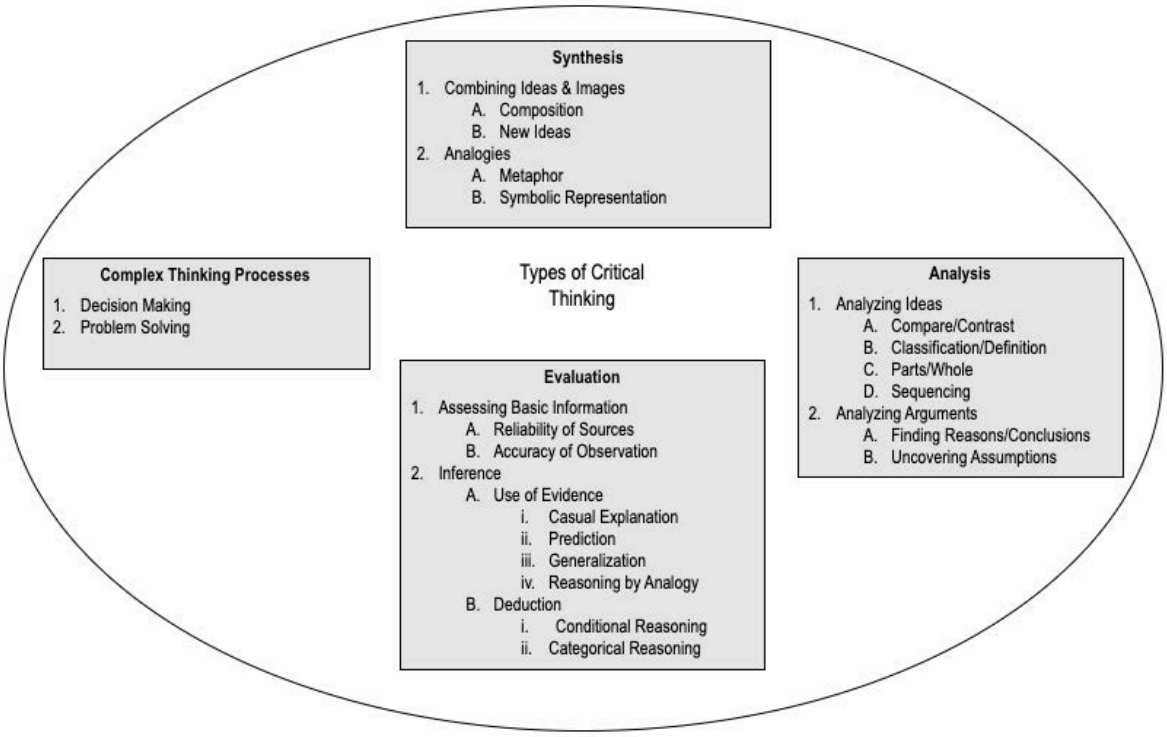
The thinking skills identified and used in the framework are a combination of what many consider the most popular framework in higher order thinking, commonly known as Bloom's taxonomy (Bloom et al., 1956), and Ennis' broader approach to critical thinking (Ennis, 2011). Starting with the three higher order thinking headings in Bloom's original taxonomy: synthesis, analysis, and evaluation, Swartz and McGuinness (2014) incorporated a broader list of thinking skills that may be taught to reflect the full scope of critical thinking more accurately. Swartz and McGuinness acknowledge that Bloom's taxonomy may not be a complete approach to teaching critical thinking skills; therefore, they expand on the three skills identified as higher-order thinking in Bloom's taxonomy and add an additional skill area. Decision making and problem solving are added under a fourth heading, *complex thinking processes*, because of the prominence of both skills in other frameworks.

In addition to the five subskills: analysis, synthesis, evaluation, problem solving, and decision making, this framework incorporates Ennis' lists of thinking tasks (Ennis, 1962, 1987, 1996, 2009, 2011, as referenced in Swartz & McGuinness, 2014). These tasks (e.g. compare and contrast, classification, prediction, *etc*.) are examples of what students should learn to do to improve their thinking skills.

Figure 2 is a model of the thinking skills and subsequent tasks that will be used to represent critical thinking instruction and assessment in this study.

Figure 2

A Model for the Instruction of Thinking Skills and Corresponding Tasks



Note. Adapted from "Important types of thinking that we should teach students to engage in skillfully" (Swartz & McGuinness, 2014) with the addition of complex thinking processes.

Metacognition

The second objective for critical thinking instruction, as identified by Swartz and McGuinness (2014), is metacognitive thinking. The term *metacognition* refers to an awareness of one's own thinking (Chick, 2013). Flavell (1979) is accredited with first introducing the term metacognition in research, although, like many concepts in education, it was previously discussed by Dewey (1916/2018). Since then, many studies have explored how students' metacognitive abilities impact their performance (Bransford et al., 2000; Pintrich, 2002; Zohar & David, 2009). To be able to improve critical thinking, students need to be aware of their thinking

ability (Swartz & McGuinness, 2014). Therefore, metacognitive thinking must be a component of critical thinking instruction.

Thinking Disposition

The final objective for critical thinking instruction in Swartz and McGuinness (2014) framework is thinking disposition. To be critical thinkers, students have to be taught to have certain thinking dispositions as well (Swartz & McGuinness, 2014). The research on critical thinking disposition also traces back to Dewey (1938/2013). Ennis (2011) identified two dispositions critical thinkers must have: care that their beliefs are true and care to understand and present a position honestly and clearly. Ennis (2011) also states that critical thinkers should care about every person as well but considers this disposition to be supplementary rather than foundational to critical thinking. Swartz and McGuinness (2014) emphasize providing students with opportunities to practice critical thinking in order to build their dispositions toward using their critical thinking skills.

A History of Career and Technical Education

The history of career and technical education plays a vital role in the understanding of how critical thinking is viewed and instructed within CTE today. CTE in the United States has developed and transformed dramatically from the early days of apprenticeship in Colonial America. At the post-secondary level, vocational education was organized and federally funded in the 1860s (Gordon & Schultz, 2020). The Morrill Act of 1862 established land-grant universities in nearly every state in the country. The purpose of these land-grant institutions was to provide a practical education for the average person, particularly farmers and machinists. The Morrill Act changed post-secondary education from just a theoretical education by adding the opportunity for a practical, vocational education (Gordon & Schultz, 2020). However, the land-

grant institutions were not ideal for all, especially poor farm families that could not afford the money or time to send their children away to a university for several years. The need for practical education in rural areas continued, which pushed for the establishment of CTE in the secondary setting.

The early twentieth century formed the basis for the version of secondary CTE as we know it today. The legislation, programs, and leaders of this time period created a vocational education system that is mostly still in place today and many of the practices we still use can be traced back to this particular time period. In the early 1900s, CTE, known as vocational education at the time, was established in the secondary school system with funding coming from both the state and federal governments. The public school system now served two roles: providing a liberal education and vocational education. Secondary schools were no longer considered elite institutions that only served a small population. Instead, 60 – 70% of secondary school-aged children now attended school, as compared to the 15% of 1900 (Snyder, 1993). Vocational programs were now offered at both comprehensive high schools as well as in separate technical schools. More than 500,000 students were enrolled in secondary agriculture programs alone (Scott, 2014).

John Dewey, Charles Prosser, and David Snedden were, by far, the most influential leaders in secondary vocational education at the turn of the twentieth century. John Dewey made a significant impact on the development of our education system in general, but also specifically on CTE. Dewey (1916/2018) supported the idea that higher education, including at the secondary level, should not be limited. He felt that education should not be only for the wealthy while everyone else learned a specific skill for one job type (Dewey, 1916/2018). Instead, Dewey (1916/2018) thought vocational education was the tool necessary for public schools to meet the

needs of the expanding school population. To accomplish this, Dewey supported an integrated vocational curriculum where comprehensive high schools would offer both liberal education as well as practical, vocational education. This idea, however, was challenged by two other vocational education leaders of the time period.

Snedden (1910) was the biggest supporter of social efficiency at the turn of the century. The demand for skilled laborers to meet the needs of the rapidly growing industrial economy in the United States was pushing for the education system to do something. Snedden felt that public schools could provide the training needed to get workers prepared to work in this industrial society instead of using traditional apprenticeship practices. Snedden (1910) wrote that CTE was the tool to achieve social efficiency because students who were best qualified for manual labor jobs could take vocational classes while those who were best suited for managerial or executive work could take the academic classes directed toward college preparation. To achieve this goal, Snedden supported dualism, an idea that CTE and academic education should be offered separately in public schools (Miller, 1984).

Charles Prosser, a student of Snedden's, had similar views as Snedden when it came to vocational education. He was also a big proponent of social efficiency, supporting the idea of dualism in CTE (Gordon & Schultz, 2020). His philosophy included the idea that CTE should meet the need for skilled workers in various technical industries. Prosser's writings and advocacy for vocational education pushed for the establishment of CTE legislation at the state and federal levels.

While Snedden's, Prosser's, and Dewey's writings were written more than 100 years ago, this debate over CTE's role in education has persisted (Dougherty & Lombardi, 2016). The philosophies of Snedden and Prosser have persevered within CTE more consistently than

Dewey's, particularly the idea of dualism. CTE is typically seen as a practical education that focuses on teaching technical skills for students entering the workforce (Hyslop-Margison & Armstrong, 2004). Because of this focus on technical skills, CTE has historically categorized cognitive skills, such as critical thinking, with transferable employability skills rather than recognizing their reliance on content knowledge. This categorization has historically limited the direct instruction of critical thinking within most CTE programs (Hyslop-Margison & Armstrong, 2004).

On the other hand, some authors have pushed for the integration of critical thinking into experiential learning such as CTE. For example, Kolb (1984) experiential learning model has influenced critical thinking instruction by providing a structure for reflection after an experiential learning experience. Building on Kolb's model, Daggett (2000) developed the Rigor/Relevance Framework. In addition to Kolb's model, Daggett's framework also builds on Bloom et al. (1956). The Rigor/Relevance Framework provides teachers with a foundation for developing experiences for students to use their knowledge in increasingly complex applications (Daggett, 2000). While these models are used in education, their application within CTE has not been consistent.

Whereas most of CTE has focused on technical skills, AFNR education has historically taught those technical skills through a problem-solving approach (Moore & Moore, 1984). Based on Dewey's concepts of reflective thinking, agriculture education's problem-solving instructional process includes the teacher's introduction of a problem followed by the students' exploration and ultimate formulation of solutions through a variety of strategies (Phipps et al., 2007). While supporters promote that this approach improves the thinking skills of students, there was historically little research to support this method of instruction (Flowers & Osborne,

1987). Similarly, Moore and Moore's (1984) summary of research determined there was not enough empirical evidence available at that time to support its widespread use in agricultural education. The use of this problem-solving approach as an instructional method for critical thinking today will be explored further later in the literature review.

The Shifting Focus toward Critical Thinking

According to the World Economic Forum (2016), the world is currently in the fourth industrial revolution, characterized by frequent and dramatic changes in technology that are arriving at a rate never before seen. These technological advances are driving changes in workforce expectations. As the world of work has evolved, employers' have placed an increased emphasis on transferable cognitive and social skills because of their concern employees do not demonstrate enough adaptability for the frequent changes expected in the future workforce (Bughin et al., 2018).

According to Georgetown University's Center on Education and the Workforce, 96% of industries see critical thinking as very important or extremely important for success within their industry (Carnevale et al., 2020). In another survey by the National Association of Colleges and Employers (2022), employers rated problem solving as one of the most essential skills of new employees. A 2015 study by the Hart Research Associates asked students to rank themselves on a variety of cognitive and social skills. They then asked employers to also rank their new hires on the same skills. In the area of critical/analytical thinking, 66% of students said they were well prepared, while only 26% of employers agreed. Similarly, 59% of students thought they were proficient in analyzing/solving complex problems, but only 24% of employers agreed (Hart Research Associates, 2015).

Employers within the AFNR industry agree that critical thinking skills are lacking. A survey conducted by the Association of Public & Land-Grant Universities collected input from 11,428 employers, university alumni, faculty, and students representing the agriculture and natural resources fields (Crawford & Fink, 2020). The purpose of the study was to identify the critical skills employers have determined need to grow in the industry. In total, eleven areas were identified as needing growth, with three representing subskills of critical thinking: identifying and analyzing problems, realizing the effects of decisions, and transferring knowledge across situations (Crawford & Fink, 2020).

Despite the clear need for these cognitive skills and the common use of the name twenty-first century skills to describe them, some argue that these skills are not needed any more today than they were 100 years ago (Christodoulou, 2012). However, changes in the workforce over the past century suggest otherwise. The workforce has more than doubled in the past 50 years, growing from 62,208,000 in 1950 to 162,825,000 in January 2022 (Toosi, 2002; U.S. Bureau of Labor Statistics, 2022a). While an overall increase in population has played a role in this growth, the demographics of the workforce have also changed. People are entering the workforce earlier and staying longer, and more women are now employed than 100 years ago (U.S. Bureau of Labor Statistics, 2022b). The manufacturing industry, one of the largest employers in the early 1900s, is now at the lowest level of employment it has been since before World War II (Rose, 2021). Computer and information technology jobs have increased significantly with tech workers making up more than 7% of the workforce; automation has grown exponentially (The Computing Technology Industry Association, 2022). Fewer jobs are available to those workers who have not completed high school; 32% of jobs in 1973 didn’t need a high school diploma while only 12% of jobs fit that description today (Carnevale et al., 2020). The percentage of

people attending some college or earning a college degree has risen dramatically and now makes up the largest percentage of the workforce (U.S. Bureau of Labor Statistics, 2021a). Moving positions has also become more common, with the average employee now having more than 12 jobs in their career (U.S. Bureau of Labor Statistics, 2021b). These shifts have impacted how employees work, expanding the expectations that employers have of their employees and increasing the emphasis on non-technical skills that transfer among positions for a significant portion of the workforce. Furthermore, research suggests future changes to the workforce, including an increase in automation and artificial intelligence, will further increase the emphasis on cognitive and social skills rather than industry-specific technical skills (Deloitte Access Economics, 2017).

The changing dynamics of work have also driven a shift in CTE. Starting in 1996, a collaboration of the United States Department of Education, the Office of Vocational and Adult Education, the National School-to-Work Office, and the National Skills Standard Board ultimately established the career clusters framework (Gordon & Schultz, 2020). Designed to represent the range of occupations that exist, there are 16 career clusters in the framework. In 2012, the National Association of State Directors of Career Technical Education Consortium, along with 42 states, the District of Columbia, and multiple industry-based organizations collaborated on the Common Career Technical Core, which developed a set of technical standards and career ready practices for each of the career clusters (Advance CTE, n.d.).

Michigan started addressing the push for more academic rigor in CTE even earlier. In the early 1990s, Michigan educators and Michigan Department of Education personnel developed a new curriculum for AFNR education using the term *Agriscience* to reflect the increased integration of science into the coursework (Elliot et al., 1991). The focus of the new agriculture

and natural resources curriculum was to develop critical thinking, decision making, and problem solving while improving basic skills such as reading and writing (Elliot et al., 1991).

Likewise, in 2013, the new Michigan standards for AFNR programs were released, with an emphasis on thinking skills (Michigan Department of Education, 2013). The thinking skills and subskills such as evaluate, compare, develop, assess, and define are common throughout the list. While continuing to define the technical expectations of AFNR programs, these standards also emphasize the skills students need to become critical thinkers.

At the national level, The National Council for Agricultural Education addressed the push for CTE programs to increase their academic rigor by developing national agriculture content standards that were also cross walked with the core content standards in 2009. Within these standards is a list of career-ready practices that address multiple critical thinking concepts. The following list of career-ready practices all refer to thinking skills (The National Council for Agricultural Education, 2015).

- CRP.02.01 Use strategic thinking to connect and apply academic learning, knowledge, and skills to solve problems in the workplace and community.
- CRP.02.02 Use strategic thinking to connect and apply technical concepts to solve problems in the workplace and community.
- CRP.05.01 Assess, identify, and synthesize the information and resources needed to make decisions that positively impact the workplace and community.
- CRP.05.02 Make, defend, and evaluate decisions at work and in the community using information about the potential environmental, social and economic impacts.
- CRP.06.01 Synthesize information, knowledge, and experience to generate original ideas and challenge assumptions in the workplace and community.

- CRP.06.02 Assess a variety of workplace and community situations to identify ways to add value and improve the efficiency of processes and procedures.
- CRP.06.03 Create and execute a plan of action to act upon new ideas and introduce innovations to workplace and community organizations.
- CRP.07.01 Select and implement reliable research processes and methods to generate data for decision making in the workplace and community.
- CRP.07.02 Evaluate the validity of sources and data used when considering the adoption of new technologies, practices, and ideas in the workplace and community.
- CRP.08.01 Apply reason and logic to evaluate workplace and community situations from multiple perspectives.
- CRP.08.02 Investigate, prioritize, and select solutions to solve problems in the workplace and community.
- CRP.08.03 Establish plans to solve workplace and community problems and execute them with resiliency.

In 2018, the Strengthening Career and Technical Education for the 21st Century Act, more commonly known as Perkins V, was signed into law (Perkins Collaborative Resource Network, n.d.). Perkins V is the reauthorization of the Carl D. Perkins Act originally passed in 1984, which provides federal funding for CTE (Perkins Collaborative Resource Network, n.d.). In response to the changes addressed in Perkins V, the education system within the state of Michigan has implemented a process to reorganize CTE standards from segments into competencies (M. Forbush & A. McKim, personal communication, October 3, 2022). When fully implemented, Michigan CTE programs will report student growth through Perkins Course Competencies. While every CTE pathway will develop their own competencies for the technical

skills within their programs, the career ready practices were organized into competencies that will be consistent for all CTE programs. One of the four new competencies for the career ready practices is to demonstrate problem solving (M. Forbush & A. McKim, personal communication, October 3, 2022). This sets the expectation that all CTE programs, including AFNR, teach and assess problem solving, which is a subskill of critical thinking.

These changes in the expectations for CTE, including AFNR programs, over the past 30 years demonstrate the shift that has and continues to occur in CTE. While CTE will continue to value and teach the essential technical skills necessary in the workforce, educators recognize the need for additional cognitive and social skills such as critical thinking. Understanding the most effective way to incorporate critical thinking to meet all demands placed on CTE, while maintaining a high-quality technical education, is crucial for CTE's continued success in the twenty-first century.

Defining Critical Thinking

While critical thinking is identified as an essential skill by employers and educators alike, it is difficult to truly measure, partly because few agree on a definition. The concept of critical thinking is accredited to John Dewey although he also refers to it as reflective thinking, thinking, and reflection in his writings. Dewey's (1910/2011) definition of critical thinking is the "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends" (p. 6).

Building on Dewey's definition, Edward Glaser (1942), who co-authored the Watson-Glaser Critical Thinking Appraisal, defines critical thinking as "an attitude of being disposed to consider in a thoughtful way the problems and subjects that come within the range of one's experience; knowledge of the methods of logical inquiry and reasoning; and some skill in

applying those methods" (p. 5). While the terminology used is different, the definition's meaning is nearly the same as Dewey's definition.

Ennis, one of the leading researchers on critical thinking has been using and advocating for the following definition for more than 30 years, "critical thinking is reasonable, reflective thinking that is focused on deciding what to believe or do" (Ennis, 2016). This definition introduced the concept of decision making as an aspect of critical thinking.

In 1990, a Delphi research study conducted by Facione formed the foundation for a consensus definition from 46 critical thinking experts. Facione (1990) study expanded the definition of critical thinking to identify it not only as a skill, but as a disposition as well.

> We understand critical thinking to be purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as the explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based (Facione, 1990, p. 3).

Despite the creation of that consensus definition, researchers have continued to develop their own definitions. Some define critical thinking solely by the subskills commonly attributed to it. For example, Coon (1995) suggests critical thinking is defined as "the ability to evaluate, compare, analyze, critique, and synthesize information" (p. 27). Similarly, many researchers believe the upper three levels of the cognitive domains identified by Bloom et al. (1956) are critical thinking: analysis, synthesis, and evaluation (Duron et al., 2006). Furthermore, Angelo (1995) said critical thinking is "the intentional application of rational higher-order thinking skills, such as analysis, synthesis, problem recognition and problem solving, inference, and evaluation" (p. 6).

While metacognition is an important aspect of critical thinking for many, it has not been universally included in definitions. A definition commonly attributed to Richard Paul and Linda Elder, authors of the Paul-Elder Critical Thinking Framework, introduced metacognition as a component of critical thinking:

> Critical thinking is that mode of thinking – about any subject, content, or problem – in which the thinker improves the quality of his or her thinking by skillfully taking charge of the structures inherent in thinking and imposing intellectual standards upon them (Foundation for Critical Thinking, 2019)

Within career and technical education, varying definitions have been used in research. While not explicitly a definition, Kerka (1992) identifies "the ability to think creatively, make decisions, solve problems, visualize, reason, analyze, interpret, and know how to learn" (p. 2) as skills typically associated with critical thinking. Internationally, Ronnlund et al. (2019) defined critical thinking as "an ability to *reflect*, *analyse*, and *question*, and to see things from *different perspectives*" (p. 303).

Within AFNR education, few studies have offered their own definition of critical thinking, instead choosing to utilize a definition previously provided in the research. Some researchers in AFNR education have chosen to utilize Facione's 1990 definition based on the Delphi study (Friedel et al., 2008a, 2008b). AFNR education's focus on problem solving is evident in some authors' use of definitions that include the term. For example, in a study on cognitive tendencies in AFNR programs, Lamm et al. (2011) used a definition by Rudd et al. (2000), "a reasoned, purposive, and introspective approach to solving problems or addressing questions with incomplete evidence and information, and for which an incontrovertible solution is unlikely" (p. 5). However, the definitions used in AFNR education research are not consistent.

Furthermore, while critical thinking is expected in Michigan's AFNR programs, no specific definition of critical thinking within AFNR exists.

The confusion over the definition of critical thinking is also apparent when comparing industry and academic definitions of the skill. Academically, while varying definitions exist, most agree that critical thinking relates to evaluation and analyzing ideas (Facione, 1990; Friedel et al., 2008a, 2008b; Glaser, 1942; Lamm et al., 2011; Wentzel, 2014). On the other hand, employers typically connect critical thinking with creating new, original ideas (McCadden & Davis, 2014), which some academics may align more closely with one step of the problem-solving process or creative thinking, rather than critical thinking (Hodges, 2019).

The differences seen in the definitions of critical thinking potentially reflect both the context of the author and the body of research that influenced the definition. While this study will utilize Swartz and McGuinness (2014) framework for critical thinking instruction, the definition of critical thinking that will be used is "reasonable, reflective thinking that is focused on deciding what to believe or do" (Ennis, 2011, p.1). The framework reflects many of the concepts identified in the various definitions of critical thinking and includes thinking skills, metacognition, and thinking disposition.

Teaching Thinking Skills

Despite critical thinking's frequent categorization as a transferable twenty-first century skill (Magno et al., 2010; Partnership for 21st Century Learning, 2016; Weeks et al., 2020), some research suggests it, like many cognitive skills, is not easily transferable to new contexts (Gray & Orasanu, 1987). Perkins and Salomon (1989) have challenged that view, instead suggesting that general cognitive skills can be transferred if the conditions are right during the instruction of

those skills. Examples of such conditions included: using analogies, developing explanations, generalizing rules, and practicing (Perkins & Salomon, 1989).

The debate over the transferability of cognitive skills beyond the context it is taught in continues today. In an article that reviewed 700 studies on the transferability of cognitive skills, Billing (2007) concluded there is more evidence to support the transferability of cognitive skills such as critical thinking than against. However, those cognitive skills rely on domain-specific knowledge (Billing, 2007). Hyslop-Margison and Armstrong (2004) also argue the importance of content knowledge for critical thinking. Providing students with a list of steps to think critically is useless if the student does not have the content knowledge necessary to apply those steps (Hyslop-Margison & Armstong, 2004). Furthermore, students must be shown how problems relate to each other within a topic to learn how to apply their cognitive skills appropriately (Billing, 2007). Similarly, Glaser (1984) determined critical thinking is best taught within the subject matter within which it will be applied rather than as a separate skill.

To employ critical thinking instructional methods within subject matter instruction, Ennis (1989b) summarized two strategies: immersion and infusion. The immersion method allows students to deeply engage with a subject matter, but critical thinking principles are not made explicit in the course (Ennis, 1989b). On the other hand, the infusion method provides explicit direction on how to critically think within a subject (Ennis, 1989b). CTE has historically used the immersion method for incorporating critical thinking instruction (Hyslop-Margison & Armstrong, 2004). Zahner (2022) states critical thinking is an essential skill necessary to prepare CTE students for career success, but it is rarely explicitly taught or assessed in CTE. The Association for Career and Technical Education (2018) also recognizes critical thinking as

essential but identifies it as an employability skill that is essential in any career path, which further suggests the immersion approach has been typical within CTE.

Hyslop-Margison and Armstrong (2004) argued the heuristic approach to critical thinking education is insufficient, particularly in career and technical education (CTE). Moreover, they argue that CTE regularly uses the immersion, or heuristic, approach to critical thinking instruction because it is commonly categorized with employability skills. However, critical thinking's reliance on content knowledge necessitates the use of explicit methods for its instruction (Hyslop-Margison & Armstrong, 2004). Similarly, Folkers (2011) identifies the career ready practices listed in the Common Career Technical Core, including many critical thinking concepts, as standards that are intended to be infused within CTE programs at increasing levels of complexity. Through the Delphi study that established a consensus definition for critical thinking, Facione (1990) also concluded critical thinking should be explicitly taught within classes, even if their ultimate purpose is not to teach critical thinking. Ennis (2016) further supports this idea that the use and instruction of critical thinking must be explicit, at least until most students are regularly using the skills in a course.

Within AFNR, Weeks et al. (2020) studied agricultural education teachers' perceptions of the importance of teaching twenty-first century learning skills, their knowledge of the skills, and their perceived ability to teach them. They found while agricultural educators identified critical thinking as the second most important twenty-first century skill to teach, their knowledge of critical thinking and their perceived ability to teach it lagged (Weeks et al., 2020).

Regardless of whether the chosen method utilizes an immersion or infusion strategy, there are a variety of instructional methods that have been studied in an attempt to understand their impact on students' cognitive skills with mixed results. Simpson and Courtney (2007)

identify questioning, small group activity, role-play, and debate as four instructional strategies for critical thinking. McKeachie et al. (1986) suggest instruction should focus on discussion, problem solving, and verbalization of metacognitive strategies. The following offers an overview and summary of the research available for the common methods utilized by general education, CTE, and AFNR instructors to improve students' critical thinking skills. The majority of studies utilize a general critical thinking assessment that measures a variety of subskills to evaluate students' skills. However, instead of looking at critical thinking broadly, some studies specifically looked at how instructional strategies impacted students' abilities to perform the specific subskills of critical thinking. While researchers have included various subskills under critical thinking (Angelo, 1995; Bloom et al., 1956; Coon, 1995), this study will specifically explore the subskills identified by Swartz and McGuinness (2014) in their model for the instruction of thinking skills: synthesis, analysis, evaluation, and the complex thinking processes of problem solving and decision making. This model is based on the higher-order thinking skills identified in Bloom's taxonomy (Bloom et al., 1956).

Project-Based Learning

Project-based learning (PBL), a teaching strategy that has gained popularity in recent years both in CTE and academic courses, has supporters that promote it teaches critical thinking skills (Magnify Learning, 2022). PBL is a framework used by many instructors to give students the opportunity to gain knowledge and skills by researching and solving an authentic problem. PBL supporters tout that PBL provides students with the opportunity to learn through inquiry, develop critical thinking and communication skills, work in a team, and even collaborate with non-school based stakeholders (Magnify Learning, 2022). Ennis (2016) suggested PBL as one method that could be utilized to teach critical thinking. However, implementing PBL in the

classroom requires a shift in teaching and assessment strategies. When that shift occurs successfully, research has demonstrated that PBL may effectively teach critical thinking skills in the classroom.

Al-Khrisha and Mansour (2021) studied the impact of a PBL learning strategy on the critical thinking skills of 10th-grade students in an agricultural education course in Jordan. A statistically significant difference was found between the control group and the experimental group, with the experimental group receiving instruction using a PBL approach scoring higher on the critical thinking post-test (Al-Khrisha & Mansour, 2021). However, the study does not provide information on the specific instructional strategies used in the PBL process, so it is unknown if this instruction included an explanation or discussion of thinking skills or metacognition.

Similarly, Burris and Garton (2007) studied the effectiveness of PBL methods on improving the critical thinking skills of secondary agriculture students in a quail management unit, as assessed on the Watson-Glaser Critical Thinking Appraisal. The study found PBL was more effective in improving students' critical thinking scores on that assessment than students who received instruction on the same topic through supervised study. However, the content knowledge of the agricultural topic was lower in the PBL students than in the supervised study students after instruction (Burris & Garton, 2007). Notably, the teachers involved in this study received specific instruction on how to implement the PBL strategy in their classroom. Neither the specific teaching strategies used to employ PBL nor what was included in the professional development were specified by the authors.

Inquiry-Based Learning

Similar to PBL, inquiry-based learning (IBL) gives students authentic learning opportunities that allow for the active involvement of the student in the learning process. One of the goals of IBL is to promote critical thinking among students (National Research Council, 2000). In its basic form, IBL has four steps: students develop questions, those questions are researched in class, students present what they have learned, and finally students reflect on their methods, strategies, and learning (Wolpert-Gawron, 2016). The emphasis is put on students' independent exploration of questions, rather than having an instructor provide them with information.

At the post-secondary level, Gupta et al. (2015) studied how a heuristic IBL instructional approach impacted students' critical thinking skills in a chemistry laboratory course. The study found that students who received instruction using the heuristic IBL approach had scores in critical thinking that were statistically significantly higher than students who were taught with a traditional method. However, it is important to note that the IBL approach used in this study also included discussion and collaborative teams, two instructional methods also known to improve critical thinking (Bekbayeva et al., 2021; Ennis, 2016; Loes & Pascarella, 2017; Simpson & Courtney, 2007). The control group did not employ these instructional strategies. The impact of the use of those strategies on the experimental group's performance in Gupta et al. (2015) was not determined.

In 2009, the National Council for Agricultural Education developed the Curriculum for Agricultural Sciences Education (CASE) to improve agricultural education (Curriculum for Agricultural Sciences Education, 2011). The mission of CASE is "to impact student career readiness by empowering teachers with improved instructional practices and relevant curricula

sustained by professional development" (Curriculum for Agricultural Sciences Education, 2023). CASE utilizes an inquiry-based instructional approach, using a cyclical lesson sequence that focuses on activities, projects, and problems. The CASE model requires professional development at in-person or virtual institutes before implementation of the curriculum (Curriculum for Agricultural Sciences Education, 2023). Velez et al. (2015), assessed students' perceptions of their critical thinking ability before, during, and after completion of a CASE course at four Oregon high schools. The authors found no difference between students' perceptions of critical thinking between the three assessments. Interestingly, when scores for students from each school were separated, two schools showed slight gains in the students' perceptions of critical thinking, while two showed slight decreases (Velez et al., 2015). This suggests additional factors beyond the curriculum, including the school, instructors, or alignment to the CASE model, can influence students' perceptions of their critical thinking ability. A clear limitation of this study is the reliance on students' self-perceptions of their abilities, rather than assessed or observed abilities. Additionally, the study was conducted in the first year of CASE implementation across the country, so there potentially has been significant changes to the professional development, suggested instructional strategies, and curriculum since then. Finally, the study does not specify if the CASE curriculum includes any strategies specific to critical thinking other than its stated use of an IBL approach.

Problem-Solving Approach

According to the AFNR and science educators sampled in Parr and Edwards (2004), the problem-solving approach that is common in agricultural education is pedagogically similar to inquiry-based learning. However, because of its prevalence in AFNR education research and its

existence well before the term, inquiry-based learning, was used, the problem-solving approach is going to be explored separately in this literature review and study.

The problem-solving approach has endured since agricultural education was started in the early 1900s. This teaching approach was first introduced in the initial teacher preparation programs for agriculture teachers that were established after the passing of the Smith-Hughes Act in 1917 (Moore & Moore, 1984). Since then, the Handbook on Agricultural Education in Public Schools, which emphasizes this problem-solving approach, has been commonly used in agriculture teacher preparation programs since it was first written in 1965 (Phipps et al., 2007). Even slightly more modern texts, such as Newcomb et al. (2004), recommend this approach. In the Handbook on Agricultural Education in Public Schools, Phipps et al. (2007) claim the problem-solving approach is an effective teaching method to stimulate interest in the subject matter and to teach thinking skills. While varying methods exist, most authors suggest the problem-solving approach has a learning cycle that consists of an interest approach, exploring sources, arriving at a solution, testing the solution, and evaluating results (Parr & Edwards, 2004). This approach differs from the similarly named and sometimes confused, project-based learning, because project-based learning is taught on a large scale to solve a significant real-world problem, while the problem-solving approach can be used on a much smaller scale in nearly any context. For example, a project-based learning unit may identify and attempt to solve an erosion problem near the school's playground, while the problem-solving approach might be used to calculate a better feed ration for a theoretical flock of sheep.

A few studies have addressed how the problem-solving approach impacts students' critical thinking skills. Dyer and Osborne (1996) determined the problem-solving approach was more effective in improving agriculture students' problem-solving abilities than a teacher-

centered approach, regardless of learning styles. Since problem solving is a complex thinking subskill of critical thinking, this strategy's success in improving problem solving suggests it may improve students' overall critical thinking ability as well. However, the authors acknowledge their study's limited ability to be generalized because of their sample size and purposive selection of participants. Furthermore, Dyer and Osborne (1996) do not clarify if the problem-solving assessment used in the study is a generic test or one based on the subject matter. This absence limits our understanding of how this approach may improve students' critical thinking skills in agriculture.

Cano and Martinez (1991) studied the critical thinking skills of agriculture students and determined agriculture students scored higher on the Watson-Glaser Critical Thinking Assessment than students of science, English, and social sciences. Because the problem-solving approach was especially prevalent in agricultural education during the timeframe of the study, the author suggests the increase seen in agriculture students may be due to the problem-solving instructional approach (Cano & Martinez, 1991). However, the author recognizes the study does not provide data to support this suggestion.

On the other hand, Flowers and Osborne (1987) studied the problem-solving approach's impact on students' abilities to answer low-level and high-level cognitive questions in a vocational agriculture class in Illinois and compared those students' results to students taught the same material with a teacher-centered approach. The authors found the problem-solving approach was neither more nor less effective than the teacher-centered approach on improving students' test scores, regardless of the level of questions. However, students taught with the problem-solving approach were able to maintain their cognitive ability more effectively than those taught with the teacher-centered approach (Flowers & Osborne, 1987).

Interestingly, one argument against the use of the problem-solving approach is its reliance on students' background knowledge and their ability to relate the course content to real-world applications outside of class such as through students supervised agricultural experiences (Moore & Moore, 1984). This is supported by the research that indicates critical thinking also depends on students' background knowledge and ability to apply the skills in real-world settings (Billing, 2007; Glaser, 1984; Hyslop-Margison & Armstrong, 2004).

Discussion

Another instructional strategy identified in the literature as having an impact on critical thinking is the use of discussion both in the classroom and virtually. Multiple studies have identified discussion as a successful teaching strategy to improve critical thinking skills (Ennis, 2016; Simpson & Courtney, 2007).

Bekbayeva et al. (2021) found when an instructor incorporated the analysis and discussion of challenging topics in an agriculture classroom, students' scores on a critical thinking test improved over students who did not attend a class with those activities. Furthermore, students from all achievement levels on the pre-assessment were able to improve on the critical thinking assessment. Newstreet (2008) found similar results in a government class using guided discussion.

Cheong and Cheung (2008) studied how asynchronous online discussions impacted the critical thinking skills of boys in a secondary school in Singapore. In this small study, 24 participants' responses on an online discussion forum were evaluated using a critical thinking model. The authors then surveyed participants on their perceptions of using the online forum for discussion. While 92% of participants claimed the online format increased their need to critically think about the subject over an in-person discussion, the authors determined that 57% of

discussion forum responses were at a level considered to demonstrate critical thinking when compared to a critical thinking framework that differentiated between surface level and in-depth thinking skills (Cheong & Cheung, 2008).

Other Instructional Practices

While the previously discussed strategies are, by far, the most commonly researched instructional strategies for critical thinking, there are a variety of other strategies that have been identified in the literature that are not as commonly studied.

Loes and Pascarella (2017) found collaborative learning had a positive impact on critical thinking skills in college students. In this study, the collaborative learning opportunities included study groups outside of class, group projects assigned outside class time, and having students serve as instructors within the class. Interestingly, the most growth was seen in White, academically low students. Collaborative learning was found to have a slight negative impact on Black students' critical thinking. Furthermore, collaborative learning's impact on critical thinking lessened as a student's ACT score increased, suggesting the strategy is less effective for academically high performing students (Loes & Pascarella, 2017). Because collaborative learning typically expects and requires discussion among teammates, there is potential that the benefits seen here from collaborative learning could also be attributed to the use of discussion.

The National FFA Organization, the career and technical student organization for AFNR programs, provides students with opportunities for career exploration and leadership development. Latham et al. (2014) investigated if involvement in FFA impacted students' critical thinking skills. While studying members of chapters that were awarded three-star ratings by the Texas FFA Association, the authors measured senior FFA members' critical thinking scores on the Watson-Glaser Critical Thinking Appraisal. The authors used Beyer's (1987) theory on

critical thinking instruction in agriculture programs to compare their critical thinking scores to the general population of high school students (Latham et al., 2014). Beyer's (1987) theory on critical thinking in agriculture education suggests FFA involvement provides an opportunity for agriculture students to apply their critical thinking skills. The results of this study indicated that the FFA members in these programs demonstrated low critical thinking skills, scoring between the 20th and 25th percentile of the assessments' norm group (Latham et al., 2014). On the other hand, a regression analysis identified a positive correlation between FFA involvement in leadership contests and FFA members' critical thinking abilities. However, it does not explore what potentially caused that specific FFA event to correlate with a higher critical thinking ability.

Metacognition and Critical Thinking

Metacognitive ability is an important aspect of critical thinking, particularly in supporting the transfer of critical thinking skills beyond the context they were originally taught in (Swartz & McGuinness, 2014). In other words, a student must be aware of how they are thinking in order to be able to transfer those skills beyond the immediate situation. Furthermore, metacognition is necessary to achieve the deep level processing necessary for critical thinking (Kuhn & Dean, 2004). Multiple studies have found that instruction in thinking skills can improve the students' critical thinking and their metacognitive ability.

Chen (2020) conducted a case study at a Taiwanese university to determine if thinking skill instruction improved students' metacognition in a course specifically designed to build students' thinking skills. The researchers found a statistically significant difference in metacognitive ability between the participants who received thinking skill instruction and those who did not. Ku and Ho (2010) also studied the interaction of metacognition and critical thinking

at the post-secondary level. In this small study, students were split into low- and high-performing critical thinking groups based on a pre-assessment. While thinking disposition and academic achievement were controlled for, the authors measured the level of metacognition that was demonstrated when the participants were completing a variety of high-level thinking tasks. The students who demonstrated the highest levels of critical thinking also engaged in more metacognitive activity (Ku & Ho, 2010). Both studies suggest the explicit instruction of thinking skills can improve metacognition.

On the other hand, a study by Pate and Miller (2011) found that using a metacognitive strategy improved students' ability to problem solve in a secondary CTE course. To improve metacognition, students were provided regulatory self-questioning prompts to guide them during a problem-solving assessment after receiving instruction on how to use the self-questioning prompts. Students who received and used the self-questioning prompts scored higher on the problem-solving assessment than those who did not receive the instruction or prompts (Pate & Miller, 2011). Since problem solving is a subskill of critical thinking, this suggests the metacognitive strategy, self-questioning, may positively impact other critical thinking subskills.

Heijltjes et al. (2014) assessed how instruction impacted students' ability to reason, specifically how to avoid biased reasoning. Using explicit critical thinking instruction which included video explanations of critical thinking and modeling metacognitive processes followed by practice of those processes, the authors found these strategies had a statistically significant impact on students' reasoning skills. Reasoning is an aspect of inferencing, which is a form of the critical thinking subskill, evaluation (Swartz and McGuinness, 2014). Since this study specifically measured reasoning, it is impossible to determine if the metacognitive instructional practices used in the study improved other critical thinking skills. However, it suggests modeling

the thinking process may influence other critical thinking subskills and warrants further investigation.

At the junior high level, Preus (2012) found that focusing on improving students' higher order thinking through authentic instruction simultaneously improved students' metacognitive abilities. However, it is important to note the instructors who participated in this study and the author attribute much of their success to supportive administration, opportunities for collaboration and professional development, and a culture for higher order thinking throughout the school (Preus, 2012). Alternatively, Orion and Kali (2018) found that focused instruction on metacognition improved the thinking skills of junior high students in an Earth science class. These findings suggest that students' metacognitive ability and thinking skills can both be improved regardless of which objective is the focus of instruction.

Some research has found that teacher characteristics play a significant role in the development of students' metacognitive abilities. Orion and Kali (2018) found student growth in thinking skills was dependent on their teacher's enthusiasm, scientific background, and openness to using innovative methods. Similarly, the teachers in Preus' 2012 study acknowledged that their access to professional development and collaborative meetings was key to their success in advancing students' critical thinking. These findings suggest school culture and access to professional development may limit an instructor's ability and interest in employing strategies to improve students' critical thinking.

McKendree and Washburn (2021) studied how secondary AFNR educators perceived metacognition and facilitated its learning after participation in professional development on metacognitive teaching strategies. The authors found that teachers had an increased understanding of their own metacognition following the professional development but struggled

to utilize the strategies within the classroom to improve students' metacognition (McKendree & Washburn, 2021). While not specifically studying metacognition in relation to critical thinking, this study demonstrates the difficulty that may arise when teaching metacognition in an AFNR classroom to improve critical thinking.

Critical Thinking Dispositions

The final objective of critical thinking instruction identified by Swartz and McGuinness (2014) is to develop students' critical thinking disposition. A disposition toward critical thinking includes the motivation and inclination to think critically in situations that warrant it, rather than using other strategies such as guessing (Facione & Facione, 1997). Irani et al. (2007) identified three subsidiary dispositions that encompass thinking disposition: engagement, cognitive maturity, and innovativeness. Research has identified strategies that can be used to develop students' thinking dispositions (Burbach et al., 2012; Tiwari et al., 2006).

In their 2014 study on the critical thinking skills of economics students, Heijltjes et al. studied how students' dispositions impacted their critical thinking skills. The authors found students' initial critical thinking dispositions predicted pre-test critical thinking scores. Furthermore, all students, regardless of critical thinking disposition scores, were able to benefit from instruction of critical thinking skills (Heijltjes et al., 2014).

Although the author uses the term, behavior, rather than disposition, Chen (2020) found instruction in thinking skills improved students' critical thinking dispositions. After receiving instruction in critical thinking skills, participants recognized and identified ways that their critical thinking dispositions had also changed including an increased awareness of others' opinions in a discussion and more careful consideration of responses. Similarly, Tiwari et al. (2006) found the use of problem-based approach in a nursing program had a positive impact on

students' thinking dispositions. These studies suggest strategies commonly used for teaching critical thinking skills may also positively impact students' thinking dispositions.

Within AFNR education, Friedel et al. (2008b), studied the impact of explicit instruction of critical thinking skills on students' critical thinking dispositions in a post-secondary biotechnology course. Critical thinking instruction was found to not influence the thinking dispositions of students. On the other hand, Burbach et al. (2012) found that providing professional development on critical thinking instruction to agricultural professors had a positive impact on their students' critical thinking dispositions. However, the professional development included a variety of topics (e.g., overtly teaching critical thinking and dispositions, lesson preparation, and student evaluation), so it cannot be determined which aspect of that professional development and subsequent instruction was responsible for the improvement in students' thinking dispositions (Burbach et al., 2012).

Critical Thinking Assessment

The instruction of critical thinking poses many challenges in a classroom, but the assessment of those skills may be even more difficult, according to the literature. Most research on critical thinking measures the skill using an assessment designed specifically for critical thinking, such as the Watson-Glaser Critical Thinking Appraisal (Watson & Glaser, 1952) or the Cornell Critical Thinking Tests (Ennis, 1989a). However, when attempting to measure critical thinking within a subject matter course, assessments designed specifically for critical thinking with generic questions aren't practical. Instead, assessments need to be able to assess students' critical thinking skills within the subject matter, while also being practical for the instructor. While some educators have identified specific strategies informally (such as Heyck-Williams, 2017), limited research is available on assessments that are specific to subject matter.

According to Ennis (2016), assessment of critical thinking skills requires both formative and summative assessment. Formative assessments identify the needs and abilities of the students, while the summative assessments determine the students' accomplishments in critical thinking during a course (Ennis, 2016). However, implementing those assessments can be difficult especially because of the open-ended nature of most questions that would require critical thinking (Boss, 2012).

The Next Generation Science Standards (NGSS) and its subsequent instructional and assessment expectations provide an example of subject matter assessments that also measure critical thinking skills (Next Generation Science Standards, n.d.). Instead of expecting students to complete low order thinking skills such as memorization on assessments, the NGSS expects students to apply their knowledge while using scientific practices that include critical thinking skills. Example assessments within the NGSS framework expect students to complete a variety of tasks such as making sense of data, using data to solve a problem, or evaluating a claim about a phenomenon (Next Generation Science Standards, 2018). The key component of a NGSS assessment is that it must engage students in applying knowledge while also engaging in scientific thinking. Because many of Michigan's AFNR programs have courses that meet the NGSS requirements, those programs may be able to utilize NGSS assessment strategies in their courses.

Angelo (1995) suggests the use of classroom assessment techniques to assess critical thinking in classrooms. Classroom assessment techniques are strategies that can be used by teachers to determine what students know and how well they are learning (Angelo & Cross, 1993). Because most classroom assessment techniques require students to reflect on and explain their learning, they foster metacognitive abilities in students (Angelo, 1995). Importantly, the

author points out that the strategy of classroom management is rarely important. Instead, the emphasis must be on explicitly modeling and discussing the critical thinking skills instructors want to see (Angelo, 1995).

While the literature on critical thinking instruction is extensive, the research on how to assess those skills lags behind. Even when studying critical thinking within a subject, most research uses a generic critical thinking test to assess students' skills. When looking at assessments to use within a subject, such as AFNR, the emphasis is on developing and using authentic assessment strategies that require students to demonstrate their content knowledge along with their critical thinking skills (Cano & Martinez, 1991; Friedel et al., 2008a; Latham et al., 2014). Furthermore, regardless of strategy, critical thinking assessment must include consistent modeling and feedback so students can identify what and how they are or are not demonstrating the expected critical thinking skills.

Summary

The existing literature on critical thinking has produced a variety of definitions for the term which tend to fall within one of three objectives for critical thinking instruction and assessment: (a) thinking skills, (b) metacognition, and (c) thinking disposition (Swartz & McGuinness, 2014). Moreover, the research has also identified effective strategies that can be used in subject matter courses, such as AFNR, to impact those objectives. Furthermore, the research has acknowledged that critical thinking instruction must take place within the context it is going to be used. Despite this knowledge of how to improve critical thinking skills in AFNR, the critical thinking skills of both new employees and those entering post-secondary institutions are below employers' desired levels. The prevalence of literature on critical thinking instructional practices with the continued deficiency of critical thinking skills illustrates a need

for a comprehensive investigation into instructors' current use of the practices that are known to impact students' thinking skills, metacognition, and thinking dispositions. By gathering the current practices of AFNR instructors, this study aims to explore how AFNR instructors are currently incorporating those practices and to identify the gaps that can be addressed to improve AFNR students' critical thinking skills.

Chapter III: Methods

The purpose of this study was to explore critical thinking in Michigan secondary AFNR programs. This study aimed to identify how AFNR instructors currently utilize instructional and assessment strategies that are known to impact the three objectives of critical thinking instruction: (a) thinking skills, (b) metacognition, and (c) disposition (Swartz & McGuinness, 2014). Furthermore, the study hoped to gather practices and strategies used by AFNR instructors that may not fall within the scope of the framework. This chapter will describe the methods that were used in the design of the study, as well as how data were collected and analyzed. The following questions form the basis for this study:

1. How do Michigan secondary AFNR instructors define critical thinking?
2. How do Michigan secondary AFNR instructors teach and assess critical thinking in their classrooms?
3. How do AFNR instructors' teaching experiences impact how they teach and assess critical thinking in their classrooms?
4. How does AFNR instructors' preparation impact how they teach and assess critical thinking in their classrooms?

To answer each of the research questions posed in this study, a non-experimental, exploratory, sequential mixed methods approach was used. According to Lichtman (2013), a mixed methods approach is a pragmatic compromise between qualitative and quantitative approaches. Mixed methods research allows the researcher to gather a larger variety of data than either quantitative or qualitative methods alone (Fraenkel et al., 2007). The exploratory, sequential mixed methods approach first uses a quantitative approach to collect data, and then the results of the subsequent qualitative methods are used to further explain the initial results

(Creswell & Creswell, 2018). The first phase of this study was both quantitative and qualitative, utilizing a cross-sectional survey to gather a snapshot of the current practices of Michigan AFNR educators. According to Wiersma and Jurs (2005), cross-sectional surveys collect data from a sample at a single point in time. The second phase of the study utilized a qualitative methodology to deepen the understanding of the current instructional practices of Michigan AFNR educators. Qualitative studies provide an in-depth view and understanding of human experiences (Lichtman, 2013). While the survey gathered input from a broad sample of AFNR educators, the interviews further explored intentional critical thinking practices in a small sample of AFNR programs.

A purely quantitative approach was considered for this study. However, that would limit participants to pre-determined responses which would be inappropriate for fully understanding what AFNR instructors currently do regarding critical thinking. If solely open-ended questions were used to remove this limitation, there is a concern that written responses may not provide the context necessary to fully understand the response. Furthermore, the quantitative approach taken in this study allows for statistics to be used to provide a general overview of current practices and to identify if AFNR instructors' preparation or prior experiences influence their critical thinking instructional practices.

Alternatively, a purely qualitative approach was also considered. However, one of the purposes of this study is to see Michigan AFNR instructors' current critical thinking instructional practices. If only the qualitative approach is used, the time constraints of interviewing and managing the volume of data would limit the number of participants, which would not meet the goals of the study. Therefore, the mixed methods approach was deemed most appropriate for the study. Furthermore, a mixed methods approach allows for triangulation of the data. According to

Wiersma and Jurs (2005), triangulation is the process of using two or more techniques or sources to allow for corroboration of the data.

Phase 1: Survey

The purpose of phase one was to identify the current practices of Michigan secondary AFNR educators. Phase one gathered how AFNR instructors currently utilize instruction and assessment strategies that meet the three objectives of critical thinking instruction: (a) thinking skills, (b) metacognition, and (c) disposition (Swartz & McGuinness, 2014).

Research Methodology

This phase utilized a cross-sectional survey format that included both quantitative and qualitative questions to identify current practices in Michigan's AFNR programs. A survey is a method of data collection that is utilized when a researcher wants to determine how an event or phenomenon occurs without needing to control behaviors (Yin, 2018). This method also allows for the data to be used to describe a population or event (Fowler, 2014). However, by incorporating a qualitative aspect to the survey, participants can expand on their responses, deepening our understanding of the current practices used in Michigan's AFNR programs.

Subject Selection and Description

Secondary AFNR educators currently teaching in the state of Michigan served as the population for this study ($N = 151$). The 2022-2023 directory of Michigan AFNR educators, which is produced annually by the Michigan FFA Association, served as the source of the list of the population. According to Patten and Newhart (2018), determining an appropriate sample size is based on population size and variability of the sample. With a population of 151 AFNR teachers in Michigan, a target sample size was 108 (Patten & Newhart, 2018). Prior national research has identified that AFNR educators historically have low response rates on surveys sent

via email (Fraze et al., 2003). However, this may not be true with Michigan AFNR instructors. While Weeks et al. (2020) conducted a study among national AFNR instructors that had only an 18% response rate, Forbush et al. (2022) had a 71.94% response rate on their survey distributed to all Michigan AFNR instructors. To best gather a broad view of the practices in all AFNR programs, a census of all Michigan secondary AFNR instructors was attempted. A census will best provide an overview of the instructional strategies in all AFNR programs, instead of limiting those strategies to only those identified by a limited, pre-determined sample (Patten & Newhart, 2018).

Instrumentation

For phase one, the researcher created a self-administered, digital survey. This method provides the best opportunity to reach the largest portion of the target population, as opposed to other methods such as phone or in-person surveys (Fowler, 2014). The survey collected AFNR educators' current practices regarding (a) thinking skills, (b) metacognition, and (c) thinking disposition. The questions, which were based on the critical thinking framework from Swartz & McGuinness (2014), can be found in Appendix A. The survey created for this study used a combination of selected-response and open-ended questions. The selected-response questions explored how often AFNR instructors intentionally utilize strategies that improve students' critical thinking. Providing a list of specific, acceptable responses helps all participants perceive the questions similarly (Fowler, 2014). There were 24 survey questions that asked the participants to rate their attitude toward statements regarding their intentional teaching practices on a five-point Likert-type scale, Strongly Disagree (1), Disagree (2), Neither Agree nor Disagree (3), Agree (4), and Strongly Agree (5), which was first presented in Likert (1932). A

Likert-type scale is an attitude scale that measures the respondent's tendency toward a behavior or action (Taherdoost, 2019).

When using a continuum scale such as this, the responses are dependent on the participants' understanding of the response options (Fowler, 2014). However, it can be assumed that, generally, a person who selects *strongly agree* for a statement on a teaching strategy tends to have a more favorable view of that teaching strategy than a teacher that selects *agree* (Fowler, 2014). The size of a Likert scale can range from two to 11 points (Taherdoost, 2019). A five-point scale was chosen because of its frequency in literature and its convenience of use for respondents. The final selected-response question asked participants to select the teaching strategies they use within their programs from a pre-determined list based on the literature.

On the other hand, open-ended questions allow for teachers to provide their input in a way that could be limited with a selected-response question (Fowler, 2014). For example, teachers provided the strategies they use to teach critical thinking subskills. Selected-response questions would limit those strategies to only those previously identified by the researcher, therefore, open-ended questions were used. Five questions asked teachers to share the specific practices they use to teach or assess critical thinking and its subskills or to elaborate on previous answers. Finally, one question asked for teachers to share their definition of critical thinking within AFNR. This question was placed at the beginning of the survey to prevent unintentionally influencing participants' definitions.

The survey also collected demographic information on the participants including: years of AFNR teaching experience, years of AFNR industry experience prior to teaching (not including experience gained during college or while teaching), type of school currently teaching at, grades currently teaching, the CIP codes that are part of the AFNR program where the

participant currently teaches, FFA region, the instructor's route to teaching, and gender. This information allowed the researcher to accurately describe the sample that completed the survey and to ensure the sample represented the target population of AFNR instructors (Fowler, 2014). Furthermore, these demographics were used to address Q3 and Q4, which looked at how AFNR teachers' preparation for teaching and prior experiences influence their critical thinking instructional and assessment practices. Respondents were asked if they were currently teaching AFNR education to verify they were in the population identified for this study. Responses were anonymous.

To protect the rights of all participants as human research subjects, approval was gained from the Institutional Review Board before data was collected. On March 10, 2023, approval from the Institutional Review Board was received, which can be found in Appendix B. The guidelines of the Institutional Review Board and this study's application were followed throughout the course of the research study.

To measure the validity of the survey, two measures were taken that are both forms of judgmental validity. Judgmental validity uses professional knowledge and judgement to assess how well the instrument meets its intended purpose (Patten & Newhart, 2018). To measure content validity, a pilot study was conducted with CTE instructors at the career-tech center where the researcher is employed. Since AFNR is a subset of CTE, the pilot study subjects were similar to the target population. The CTE instructors were asked to provide feedback on the survey, particularly on misunderstandings and unclear directions or questions (Wiersma & Jurs, 2005). A panel of researchers from the University of Wisconsin-Stout reviewed the survey, which assessed both content and face validity. Feedback from the panel was used to improve the validity of the survey.

The survey's reliability was measured as well. External reliability identifies the generalizability of the study and the extent to how well other researchers could repeat this study (Wiersma & Jurs, 2005). Attempting to survey a large percentage of Michigan AFNR educators that will reflect the scope of educators in the state ensured external reliability (Patten & Newhart, 2018). To further strengthen the reliability of the study, non-response bias was assessed.

Data Collection Procedures

The link to the survey, that was designed on the Qualtrics online survey platform, was sent to all potential participants via email. The initial email with the invitation to participate, along with a description of the research and a link to the survey was sent in mid-March 2023 (Appendix C). The list of potential respondents was reduced from the initial 151 to 147 because of incorrect email addresses that could not be delivered. Mistakes in three additional email addresses could be identified and were fixed. Because the survey was completed anonymously, two follow-up emails were sent to all potential participants. Follow-up emails were sent in late March 2023 and early April 2023, approximately one week apart (Appendix D). Emails were addressed to participants and sent individually to improve the response rate (Fowler, 2014). The first question on the survey confirmed participants' willingness to participate and listed the expectations and concerns of participation, according to the University of Wisconsin–Stout's Institutional Review Board's application and guidelines. All survey results were kept behind password protection, to which only the researcher had access.

The final page of the survey allowed for survey participants to volunteer to also participate in phase two of the study. Volunteering for the second phase of the study eliminated anonymity for those participants. However, all responses were kept behind password protection. Furthermore, identifying information was removed before results were shared. The parameter for

qualification included current status as a secondary AFNR educator in the state of Michigan and self-identifying as an instructor that intentionally teaches critical thinking in their AFNR program.

Data Analysis

Once survey data collection was complete, the data were imported from Qualtrics into the Statistical Package for the Social Sciences program. Descriptive statistics were used to represent the sample and summarize the results including mean, frequencies, and standard deviations. Pearson correlations were calculated to compare teachers' years of AFNR teaching experience and years of AFNR industry experience to their attitudes toward critical thinking instruction and assessment strategies. Furthermore, a one-way analysis of variance was calculated to compare the type of school where the instructors currently teach to their attitudes toward critical thinking instruction and assessment strategies. Finally, the relationship, if any, between teachers' route to teaching and their attitudes toward critical thinking instruction and assessment strategies was analyzed using a *t*-test analysis.

For the qualitative data collected through the survey, a hybrid method of deductive and inductive coding was used. Deductive coding is used when previous research can be used to determine initial coding (Elo & Kyngas, 2008). When beginning the analysis process, the framework that outlines the objectives for critical thinking instruction and assessment from Swartz & McGuinness (2014) was used. Next, inductive coding was used to identify additional codes that fell outside those identified by the framework (Elo & Kyngas, 2008). After the initial coding was complete, the researcher reviewed the codes and modified them to clarify and removed redundancies. If two different codes were used for the same points, the names of codes

were adjusted. The six steps of coding, as defined by Lichtman (2013), were used as the basis for this process.

Step 1. Initial coding. Going from responses to summary ideas of the responses

Step 2. Revisiting initial coding

Step 3. Developing an initial list of categories

Step 4. Modifying initial list based on additional rereading

Step 5. Revisiting categories and subcategories

Step 6. Moving from categories to concepts

Phase 2: Interviews

The purpose of phase two was to deepen the understanding of how teachers utilize instructional methods to teach and assess critical thinking within AFNR programs. The intention of this phase of the study was to give participants more freedom in their responses, allowing them to go outside the scope of the study's framework.

Research Methodology

The second phase of this study utilized a qualitative research method to deepen the understanding of the survey responses. Qualitative methods include narrative research, phenomenology, grounded theory, case studies, ethnography, and historical research (Fraenkel et al., 2007). The multiple case study methodology focuses on determining why a practice has been chosen, how it is implemented, and what results from its implementation (Yin, 2018). Using multiple case studies rather than a single case study provides a more substantial understanding of the subject matter (Yin, 2018). Through this methodology, this study attempted to determine why AFNR instructors have chosen the critical thinking instruction and assessment strategies they have, how they implement those strategies, and their perception of the results of those strategies.

Personal interviews were conducted with the volunteers from phase one of the study. Personal interviews gather explanations of events in a way that a survey alone cannot (Yin, 2018). Furthermore, personal interviews allow for the researcher to ask for clarifying information on any unclear responses (Yin, 2018). Many case study methods were not considered for this study because they are inappropriate for this study's questions. For example, archival records, documentation, and physical artifacts all require some type of physical documentation, but those are not appropriate for identifying teachers' practices (Yin, 2018). On the other hand, direct observations were considered. However, the time required to observe practices that may be taught over the course of weeks or months was impractical for this study.

Subject Selection and Description

Participants in phase one of the study served as the population of potential participants for phase two. At the completion of the survey, participants were able to volunteer for an interview. The question on the survey that asked for interview volunteers listed parameters for participation. Participants were required to be AFNR educators in the state of Michigan during the 2022-2023 school year. The second parameter for participation included self-identifying as an instructor that intentionally incorporates critical thinking in their instruction.

The average qualitative study sample size is thirteen (Patten & Newhart, 2018). However, a multiple case study methodology does not have a typical sample size. Instead, Yin (2018) recommends that a study using a multiple case study research design should base its final sample size on the data collected. As individual case studies are completed, the data will direct how many further samples are needed (Yin, 2018). If conflicting data are found, the number of case studies should increase; if data are replicated repeatedly, the researcher can choose to stop data collection (Yin, 2018). For this study, the target sample size for phase two was between four and

eight instructors. The variables collected in phase one, including years of AFNR teaching experience, years of AFNR industry experience prior to teaching (not including experience gained during college or while teaching), type of school currently teaching at, grades currently teaching, the CIP codes that are part of the AFNR program where the participant currently teaches, FFA region, the instructor's route to teaching, and gender, were not controlled. Instead, the emphasis of phase two was to use a purposive sample by identifying and interviewing AFNR educators who proactively teach critical thinking in their AFNR instruction (Patten & Newhart, 2018). A factor that clearly differentiates qualitative methods such as interviewing from quantitative methods is the purposeful selection of participants (Lichtman, 2013).

Instrumentation

For the second phase of this study, the researcher developed an interview protocol (Appendix E). A semi-structured interview process was used that provided for a conversational atmosphere while still focusing the interview on the topic (Yin, 2018). Semi-structured interviews include the development of a basic set of questions that serve as a starting point and a format that will be followed with all interviewees (Lichtman, 2013). According to Wiersma and Jurs (2005), some consider the interviewer to be the instrument in qualitative research. Since data collection is ongoing throughout the interview process, the researcher makes vital decisions as to who to interview and what information is gathered, which ultimately impacts the scope of data collected (Wiersma & Jurs, 2005). Furthermore, interviews can have personal bias if the interviewer provides their viewpoint too often (Merriam & Tisdell, 2016). Therefore, the purpose of the semi-structured interview protocol was to give consistency to the interview process. The interview protocol consisted of ten open-ended questions with the flexibility of using probing questions to gather additional follow-up data after the initial questions were answered if the

topics within the probing questions were not already addressed in their responses. One question asked for the interviewees to select the definition of critical thinking in AFNR that best fit their viewpoint from a predetermined list that was designed from the survey responses. The remaining interview questions were derived from the framework on critical thinking instruction and assessment written by Swartz and McGuinness (2014) as well as the research presented in the literature review. The questions intentionally did not address responses from the survey to prevent leading the interviewees. An exception was the first question that focused on creating a consensus definition for critical thinking within AFNR. The interviews questions also did not ask about any specific critical thinking subskills or abilities to also prevent unintentionally leading participants.

To improve the quality of the interview process, a panel of University of Wisconsin-Stout researchers reviewed the interview questions to assess the face and content validity of the interview protocol. The interview protocol and email communication were included in the University of Wisconsin-Stout Institutional Review Board approval process that occurred before interviews were conducted.

Capta Collection Procedures

The data, which may be better identified as capta, were collected from the selected sample of participants through personal interviews. Capta describes the opinions or beliefs of participants that are actively collected through an event such as an interview (Drucker, 2011). The researcher contacted each participant that volunteered for the interview and was chosen to participate through email to schedule an interview via the Zoom online platform. The online platform was chosen so participation was not limited geographically. The Zoom platform also allowed the interviewer and interviewee to stay in a place they were comfortable to decrease the

environment's influence on responses. Online platforms have increased in popularity since the Covid-19 pandemic; 74% of working adults who regularly use videoconferencing tools such as Zoom or Microsoft Teams for work are still comfortable with regular videoconferencing (Igielnik, 2022). In the email, the interviewer thanked the participant for volunteering, explained the purpose of the study, identified what data were to be collected, outlined the interview process, clarified approximate time expectations, and offered interview time suggestions (Appendix F). After the participant chose an interview time, an email with the time and date of the interview and the link to the Zoom meeting was sent before the interview (Appendix G). A copy of the permission form for participation was also included (Appendix H).

The recording feature of Zoom was used to record interviews. The transcription feature of Zoom was also used to duplicate this information in case recordings or transcriptions were lost. The transcription automatically created by Zoom was used as the initial transcription. The researcher used the audio recording to edit the transcription for accuracy. Identifying information was removed from the transcripts and participants were given pseudonyms of Respondent A, Respondent B, *etc*. A directory of participants and their pseudonyms was kept separately from the interview transcripts. All transcripts and the directory of pseudonyms were kept behind password protection to which only the researcher had access.

During the interview, the researcher started with gaining consent to be recorded. Then the interviewer read the consent form and collected permission to conduct the interview. The researcher shared the estimated length of the interview. The researcher built rapport with the interviewee through casual discussion of common experiences such as FFA contests and typical teaching experiences in an attempt to alleviate social desirability bias because of the researcher's professional familiarity with the participants (Ary et al., 1996; Lichtman, 2013).

The interview protocol was followed for each interview. As interviewees responded to questions, the interviewer asked follow-up and probing questions to gather more information. The final question asked was “Do you have anything you want to add that we have not talked about?” as suggested by Lichtman (2013) to gather additional information. The researcher ended the interview with a review of how the interview will be used in the research and by thanking the interviewee for their participation.

Capta Analysis

Capta were first winnowed to remove all words that are not valuable to the research (Creswell & Creswell, 2018). According to Creswell and Creswell (2018), winnowing is the process of eliminating aspects of capta that is unnecessary for its analysis. Care was taken to not change the intentions of the participant when removing words and phrases. The transcripts were then combined into a single document for thematic analysis. The purpose of a thematic analysis is to take a potentially cumbersome amount of qualitative data and reduce it to a usable and purposeful volume (Lichtman, 2013). Coding was used to identify themes or potentially important topics within the data. Codes were then categorized with the initial codes listed as subcategories. Codes and potential themes were re-evaluated to combine or edit where appropriate. The categories were used to identify themes among the capta (Lichtman, 2013). A summary was written for each theme using the context of this study and the capta. Then, important information was collected for each theme including how many respondents discussed the theme, if there were contradictory thoughts on the theme, and main ideas identified in the capta that fit within that theme.

Interview capta were analyzed using a modified cross-case synthesis process (Yin, 2018). The purpose of a cross-case synthesis is to retain the integrity of each case that is part of the

study and then identify similarities and differences between cases (Yin, 2018). While a typical cross-case synthesis would summarize each case individually to identify the practices specifically identified by the interviewee and determine if any practices were not identified, this practice was not done in this study to prevent unintentionally identifying phase two participants (Yin, 2018). Interview responses were compared to identify teaching and assessment practices that were consistent among cases. Finally, gaps in teachers' responses were also explored.

Limitations

The researcher acknowledges the following limitations of the study that will determine the generalizability of the research.

1. The study is limited to current AFNR educators in the state of Michigan.
2. Capta collected during the interview is limited to only those who participated in that phase of the study because of the intentional selection of participants.
3. This study does not incorporate all aspects of the conceptual framework used by Swartz and McGuinness (2014) because of the extent of the framework, possibly eliminating potentially important aspects of how AFNR instructors teach critical thinking.
4. In phase two of the study, the familiarity of the researcher to the interviewees may be a source of bias. Social desirability bias is a concern because the interviewees know the researcher and may not be completely honest if their answers are not viewed favorably, in their opinion. (Ary et al., 1996).
5. The small sample size of this study may have limited the statistical power of the analyses done.

6. This study focuses on AFNR classroom and laboratory instruction and does not explicitly explore critical thinking in two other components of agricultural education: FFA and supervised agricultural experiences. This may limit the potential understanding of the full scope of critical thinking instruction in AFNR education.

Summary

This study utilized an exploratory, sequential mixed methods approach to collect AFNR teachers' opinions on critical thinking instruction. A mixed methods approach was chosen for this study because it provides a pragmatic compromise of quantitative and qualitative research. All AFNR instructors in the state of Michigan during the 2022-2023 academic year served as the population for this study. Two phases were used: phase one used a self-administered survey that included both selected-response and open-ended questions, while phase two utilized interviews in a multiple-case study approach.

Phase one included a survey that was sent to all potential participants to gather an overview of the instructional practices of AFNR educators in regard to critical thinking. Appropriate statistical analyses were used to analyze the quantitative data collected in phase one, and a combination of deductive and inductive coding was used for the open-ended responses on the survey. Phase one participants were asked to volunteer for phase two of the study on the last question of the survey.

Phase two included a semi-structured interview protocol to deepen the understanding of the data collected in phase one and to expand on the understanding of the practices of Michigan AFNR educators in relation to critical thinking. Participants who volunteered through the survey were reviewed and invited to participate in the interview if they met the parameters of the sample. An interview protocol was written, which allowed for consistency across the interviews.

A list of open-ended interview questions was used as a starting point for the interviews, but flexibility allowed for follow-up and probing questions, if needed. Interviews were conducted via an online videoconferencing tool, and the interview was recorded. The transcripts underwent a thematic analysis to identify themes and subthemes within the capta.

Chapter IV: Presentation of the Findings

The purpose of this study was to explore critical thinking in Michigan secondary AFNR programs. This study aimed to identify how AFNR instructors currently utilize instructional and assessment strategies that are known to impact the three objectives of critical thinking instruction: (a) thinking skills, (b) metacognition, and (c) disposition (Swartz & McGuinness, 2014). This chapter will present the results of the two phases of the study. The following questions form the basis for this study:

1. How do Michigan secondary AFNR instructors define critical thinking?
2. How do Michigan secondary AFNR instructors teach and assess critical thinking in their classrooms?
3. How do AFNR instructors' teaching experiences impact how they teach and assess critical thinking in their classrooms?
4. How does AFNR instructors' preparation impact how they teach and assess critical thinking in their classrooms?

Data for this study was collected in Spring 2023. In phase one of the study, a survey was sent to all Michigan secondary AFNR instructors. Follow-up emails were sent to all potential participants. The survey gathered participants' input on their integration of instructional methods to teach and assess critical thinking within their AFNR programs. The final question on the survey asked for participants to volunteer for phase two of the study. A total of five interviews were conducted.

Chapter four is organized into four sections: an overview of the response rates, demographics of the study participants, an explanation of how the data was analyzed in both

phases, and the results of each phase of the study. The results are organized based on the research questions.

Respondents and Response Rates

The population for this study included all secondary AFNR instructors in the state of Michigan during the 2022-2023 academic year (*N* = 151). Seventy-three teachers (48%) completed at least a portion of the survey. Seventy-two (47.7%) of the respondents agreed to participate in the study by answering affirmatively to the first question confirming their status as a current secondary AFNR instructor in the state of Michigan. Since all participants were able to skip any question of their choosing, the response rates for each question differed. Each of the selected-response questions had between 52 and 56 respondents (34.4 - 37.1%), while the open-ended questions received between 40 and 52 responses. Fifty-two participants (34.4%) finished the survey. The number of respondents and response rates can be found in Table 1.

Table 1

*Respondent Levels and Response Rates of Survey Based on Population (*N *= 151)*

Participation level of survey respondents	Number	Response rate
Responded to the question asking for confirmation they are currently secondary AFNR instructors in Michigan	73	48%
Agreed to participate in the study	72	47.7%
Finished the survey	52	34.4%

To eliminate the threat of nonresponse error, which decreases the external validity of a study, mean responses of early versus late respondents were compared to identify nonresponse error, if present (Lindner et al., 2001). Those that did not respond to the original email requesting participation were considered representative of those who did not respond at all. Of the 24 variables tested, only one comparison, “I give feedback on their critical thinking skills,” had a

statistically significant difference (p = .039) between the early respondents (M = 3.85, SD = 1.14) and late respondents (M = 3.83, SD = .79). Because only one comparison showed a statistically significant difference, non-response bias is not considered a concern for the sample.

For the second phase of the study, participants were chosen based on the descriptions of their critical thinking instruction and assessment they provided in the open-ended survey questions. Therefore, those who did not complete the open-ended questions on the survey were removed from the potential sample. Nine potential participants were contacted to schedule an interview. Three potential participants did not respond to the initial email or subsequent emails to schedule a meeting during the interview timeframe of the study. One potential participant responded they were no longer able to participate due to health concerns. Five instructors participated in the interviews.

Demographics

The following section first includes the demographic data that was collected through the survey followed by a brief description of each of the interview respondents.

Survey Demographics

The demographic information collected during phase one of the study included: years of AFNR teaching experience, years of AFNR industry experience prior to teaching (not including experience gained during college or while teaching), type of school currently teaching at, grades currently teaching, the CIP codes that are part of the AFNR program where the participant currently teaches, FFA region, the instructor's route to teaching, and gender. Each of the demographics are discussed in further depth in this section.

Years of AFNR Teaching Experience. Of the 52 participants who provided their years of AFNR teaching experience on the survey, the mean was 12.04. The range was one to 31 years.

More than half of respondents (29) had ten years of AFNR teaching experience or less. The largest group (11.5%) included teachers with only one year of AFNR teaching experience. Results can be seen in Table 2.

Table 2

Survey Participants' Years of AFNR Teaching Experience

Years of AFNR teaching experience	Frequency	%
1	6	11.5
2	2	3.8
3	3	5.8
4	4	7.7
5	3	5.8
6	1	1.9
7	3	5.8
8	2	3.8
9	2	3.8
10	3	5.8
11	1	1.9
12	1	1.9
13	1	1.9
14	0	0
15	1	1.9
16	0	0
17	0	0
18	0	0
19	5	9.6
20	1	1.9
21	1	1.9
22	3	5.8
23	2	3.8
24	1	1.9
25	2	3.8
26	1	1.9
27	1	1.9
28	1	1.9
29	0	0
30	0	0
31	1	1.9

Note. Four respondents declined to answer the years of teaching experience question.

Years of AFNR Industry Experience. Survey participants were asked to share how many years of experience they had working in the AFNR industry before teaching. Respondents were asked to exclude any years of experience accumulated while in their undergraduate program and while simultaneously teaching. The range of responses was from zero to 30, with a mean of 8.05 years. The largest group of respondents did not have any industry experience (16.7%). Results can be seen in Table 3.

Table 3

Survey Participants' Years of AFNR Industry Experience

Years of AFNR industry experience	Frequency	%
0	7	16.7
1	4	9.5
2	3	7.1
3	1	2.4
4	0	0
5	4	9.5
6	3	7.1
7	0	0
8	3	7.1
9	0	0
10	6	14.3
11	0	0
12	1	2.4
13	0	0
14	1	2.4
15	2	4.8
16	0	0
17	0	0
18	2	4.8
19	0	0
20	3	7.1
21	1	2.4
22	0	0
23	0	0
24	0	0
25	0	0
26	0	0
27	0	0
28	0	0
29	0	0
30	1	2.4

Note. Forty-two participants responded to this question, while fifty-two respondents answered all other demographic questions. Since respondents were allowed to skip any question on the survey, this question may have been skipped by the remaining ten respondents because they did not have any years of AFNR industry experience outside of those accumulated during their undergraduate degree and/or while teaching.

School Type. Participants were asked to share the type of school they taught in during the 2022-2023 school year with three options provided: career-tech center; comprehensive high/middle school; and county or local CTE consortium. Table 4 summarizes these results. Fourteen participants (26.9%) identified that they taught at a career-tech center, 32 participants (61.5%) taught at a comprehensive high/middle school, and six participants (11.5%) taught within a county or local CTE consortium.

Table 4

Type of Schools Where Participants Currently Teach

School type	Frequency	Percentage
Career-Tech Center	14	26.9%
Comprehensive High/Middle School	32	61.5%
County or Local CTE Consortium	6	11.5%

Grade Levels Taught. The survey asked participants to share what grade levels they taught during the 2022-2023 school year. Participants were able to select as many responses as appropriate for their teaching situation. All 52 participants (100%) who completed the demographic portion of the survey taught 11th and 12th grade students. Only a small portion of the participants taught middle school grades. Results are reported in Table 5.

Table 5

Grade Levels Taught by Survey Respondents in 2022-2023 School Year

Grade levels taught	Frequency	Percentage
6th	2	3.8%
7th	8	15.4%
8th	11	21.2%
9th	33	63.5%
10th	37	71.2%
11th	52	100%
12th	52	100%

Note. Participants were able to select more than one response.

Program CIP Codes. Survey participants were asked to share the Classification of Instructional Program (CIP) code for their program. A program's CIP code determines the AFNR standards that are taught within the program. Most participants (92.3%) taught in programs with the 01.0000 Agriculture, Agricultural Operations, and Related Sciences CIP code. Other CIP codes included: Applied Horticulture and Horticultural Operations (3.8%); Animal Health and Veterinary Sciences (7.8%); Natural Resources and Conservation (9.6%); and Biotechnology (1.9%). Some programs had more than one CIP code. Results can be seen in Table 6.

Table 6

CIP Codes for Survey Respondents' AFNR Programs in 2022-2023 School Year

Program CIP code	Frequency	Percentage
01.0000 Agriculture, Agricultural Operations, & Related Sciences	48	92.3%
01.0601 Applied Horticulture & Horticultural Operations	2	3.8%
01.0903 Animal Health & Veterinary Sciences	4	7.8%
03.0000 Natural Resources & Conservation	5	9.6%
26.1201 Biotechnology	1	1.9%

Note. Participants were able to select more than one response.

FFA Region. The survey asked participants to share the Michigan FFA region in which they taught to ensure all regions were represented in the survey. Figure 3 provides a map of the FFA regions in Michigan. Twelve participants were from Region I (23.1%), while Region II had five participants (9.6%). Region III had seven participants (13.5%), and nine participants (17.3%) were from Region IV. Region V had the largest number of participants (14), which was 26.9% of the respondents. Finally, Region VI had five participants (9.6%).

Figure 3

A Map of Michigan Divided by FFA Regions

Note. From Michigan FFA Regions by Michigan FFA Association, 2022, (https://michiganffa.org/association/regional/). Copyright 2022 by Michigan FFA Association.

Survey Participants' Routes to Teaching. On the survey, participants were asked to select the most appropriate response describing how they entered the teaching career in AFNR.

Options included: attending a post-secondary institution for AFNR education or similar degree and securing a teaching certificate before beginning to teach; attending a post-secondary institution for a non-AFNR education degree and securing a teaching certificate before beginning to teach; and completing an alternative path to teacher certification (such as entering the profession from industry and receiving annual authorization). Most participants (71.2%) attended a post-secondary institution for AFNR education or a similar degree and secured a teaching certificate before beginning to teach. Twelve teachers (23.1%) completed an alternative path to teacher certification, while three participants (5.8%) attended a post-secondary institution for a non-AFNR education degree and secured a teaching certificate before beginning to teach. Results are summarized in Table 7.

Table 7

Routes Instructors Have Taken to AFNR Education (AFNRE)

Instructors' routes to teaching	Frequency	Percentage
Attended a post-secondary institution for AFNRE or similar degree and secured a teaching certificate before beginning to teach	37	71.2%
Attended a post-secondary institution for a non-AFNRE degree and secured a teaching certificate before beginning to teach	3	5.8%
Completed an alternative path to teacher certification (such as entering the profession from industry and receiving annual authorization)	12	23.1%

Gender. The final demographic collected on the survey was the gender of the participants. Forty (76.9%) of the participants were female, while 12 (23.1%) of the participants were male.

Interview Respondents

Respondent A teaches AFNR at a career-tech center with between five and ten years of AFNR teaching experience. They teach in a program with the 03.0000 Natural Resources and Conservation CIP code that is open to 11th and 12th grade students.

Respondent B works at a comprehensive middle/high school and teaches 6th through 12th grade students. The program falls under the 01.0000 Agriculture, Agricultural Operations, and Related Sciences CIP code. Respondent B has more than 20 years of AFNR teaching experience.

Respondent C teaches at a career-tech center. The career-tech center serves both 11th and 12th grade students, and is within the 01.0000 Agriculture, Agricultural Operations, and Related Sciences CIP code. They have more than 20 years of AFNR teaching experience.

Respondent D is an AFNR teacher at a comprehensive high school who teaches 9th through 12th grade students. The program is within the 01.0000 Agriculture, Agricultural Operations, and Related Sciences CIP code. Respondent D has less than five years of teaching experience.

Finally, Respondent E teaches AFNR to 11th and 12th grade students at a career-tech center. The program is within the 01.0000 Agriculture, Agricultural Operations, and Related Sciences CIP code. They have between five and ten years of AFNR teaching experience.

Item Analysis

The quantitative survey results and the qualitative results from the survey and interviews were analyzed separately using appropriate analyses for each type of data. The quantitative and qualitative results were used to address the applicable research questions. These results are based on the 56 respondents who answered at least a portion of the survey questions and the five participants who participated in the individual interviews.

The quantitative results of this study were analyzed using appropriate statistical tests. Participants were asked to rate how much they agree or disagree with statements regarding their intentional teaching practices on a five-point Likert-type scale: Strongly Disagree (1), Disagree (2), Neither Agree nor Disagree (3), Agree (4), and Strongly Agree (5). The means and standard deviations were calculated for each of the selected-response questions. Responses were then compared to appropriate demographic data using Pearson Correlations, *t* tests, and one-way analysis of variances (ANOVA) tests in an attempt to answer each of the research questions.

After the quantitative results were analyzed, the qualitative survey results were examined using a thematic analysis process. Qualitative survey responses were first coded using a deductive coding method based on the three objectives of critical thinking instruction and assessment identified in Swartz and McGuinness (2014) framework and other literature on critical thinking. Then, inductive coding was used to determine if any additional themes were present (Lichtman, 2013). The following steps demonstrate the coding process used (Lichtman, 2013).

Step 1. Initial coding. Going from responses to summary ideas of the responses

Step 2. Revisiting initial coding

Step 3. Developing an initial list of categories

Step 4. Modifying initial list based on additional rereading

Step 5. Revisiting categories and subcategories

Step 6. Moving from categories to concepts

Research Study Results

The quantitative and qualitative study results are organized based on the study's research questions. RQ1 utilizes qualitative data from both phases of the study, RQ2 includes both

qualitative and quantitative results, while RQ3 and RQ4 utilize only quantitative results from phase one of the study.

Research Question 1

Research question 1 asked, “How do Michigan secondary AFNR instructors define critical thinking?” The survey asked participants to share their own definitions of critical thinking within the context of agriculture, food, and natural resources. Fifty-eight participants provided definitions, which can be found in Appendix I. To reduce the number of options provided to the interview participants to a manageable number, these definitions were categorized based on similar themes such as problem solving, decision making, and Bloom’s taxonomy. Then, the provided definitions were reduced and combined to write a summary definition for each of the categories. Attempts were made to keep the integrity of the participants’ definitions while condensing the number of definitions down to a manageable number for interview participants to review. The list of potential definitions for critical thinking within AFNR was attached to the email sent prior to the interview.

During their respective interviews, each participant was asked to determine which definition or combination of definitions best describes critical thinking in AFNR. Table 8 provides the list of seven abridged definitions that were provided to the interview participants as potential critical thinking definitions within AFNR and depicts how often each definition was selected by an interview participant.

Table 8

Provided Definitions of Critical Thinking in AFNR and How Often They were Selected by Interview Participants

Item	Potential definitions of critical thinking in AFNR	Frequency
A	Ask questions, obtain information, and apply knowledge to solve problems.	1
B	Evaluate information to make informed decisions considering how those decisions affect agriculture, natural resources, and other fields.	1
C	Make connections between AFNR topics and other disciplines using higher order thinking such as creating, evaluating, and analyzing.	3
D	Consider a topic and use background knowledge and deductive reasoning to develop a deeper understanding of the topic.	1
E	Gather information, form a hypothesis or idea, and create an action plan based on the information.	1
F	Analyze and evaluate issues as they are presented.	0
G	Synthesize and process information to form a conclusion or opinion based on information.	1

Note. Interview participants were able to select more than one definition.

Each of the interview participants selected a different definition or combination of definitions from the list provided in Table 8. Participant A selected “make connections between AFNR topics and other disciplines using higher order thinking such as creating, evaluating, and analyzing” as the best definition for critical thinking in AFNR. Similarly, Participant B also chose definition C in addition to definition G, “synthesize and process information to form a conclusion or opinion based on information.” On the other hand, Participant C selected a combination of definition D, “consider a topic and use background knowledge and deductive reasoning to develop a deeper understanding of the topic,” and definition E, “gather information, form a hypothesis or idea, and create an action plan based on the information.” Participant D selected a single definition as the best option, “evaluate information to make informed decisions considering how those decisions affect agriculture, natural resources, and other fields.” Finally, Participant E selected a combination of definition A, “ask questions, obtain information, and apply knowledge to solve problems” and definition C, “make connections between AFNR topics

and other disciplines using higher order thinking such as creating, evaluating, and analyzing." Based on the participants' selections, the consensus definition is:

> *Critical thinking in AFNR*: to make connections between AFNR topics and other disciplines using higher order thinking such as creating, evaluating, and analyzing.

Research Question 2

Research question 2 asked, "How do Michigan secondary AFNR instructors teach and assess critical thinking in their classrooms?" The second research question utilizes data from both the survey and the interviews. The responses to those questions are organized based on the three objectives in Swartz and McGuinness' (2014) critical thinking instruction and assessment framework: thinking skills, metacognition, and thinking dispositions.

Survey Results. The survey data supporting the second research question includes both selected-response and open-ended questions. Survey participants were asked to share their attitudes toward 24 statements regarding critical thinking instruction and assessment. Participants were then asked to provide specific examples of how they teach each aspect of critical thinking. The results are organized by thinking skills, metacognition, and thinking dispositions. The section ends with an overview of the instructional strategies used by participants.

Thinking Skills. Survey participants were asked to share their attitudes toward 16 statements regarding teaching and assessing critical thinking and its subskills: decision making, problem solving, analyzing, synthesizing, and evaluating. When responding to the statement "in my AFNR courses, I intentionally teach students to critically think about AFNR-related topics," the mean response was $M = 4.22$ ($SD = 0.71$). The most frequent skill taught by participants was to "compare and contrast two or more items" ($M = 4.50$, $SD = 0.76$). The second most frequently taught skill was to "assess the reliability of sources" ($M = 4.29$, $SD = 0.80$). The two critical

thinking skills relating to complex thinking processes, to “make decisions in AFNR” (*M* = 4.23, *SD* = 0.71) and to “solve problems in AFNR” (*M* = 4.23, *SD* = 0.81), were tied for the third most frequently taught skill by participants. On the other hand, the least commonly taught skill was to “create sequences (such as a decision tree or timeline) based on provided information” (*M* = 3.63, *SD* = 0.91). Table 9 provides the means and standard deviations for each skill. The skills are organized by means, from high to low.

Table 9

*Survey Participants' Use of Strategies for Critical Thinking Skills Instruction (*n = *52)*

Item	Critical thinking skills	Mean (*M*)	Standard deviation (*SD*)
	In my AFNR courses, I intentionally teach students to...		
5	Compare and/or contrast two or more items	4.50	0.76
11	Assess the reliability of sources	4.29	0.80
3	Make decisions in AFNR	4.23	0.71
4	Solve problems in AFNR	4.23	0.81
14	Use logical reasoning to develop conclusions about a subject based on current knowledge	4.20	0.70
13	Use evidence effectively (such as to develop an explanation or to make a prediction)	4.18	0.69
6	Classify and/or define items based on shared qualities or characteristics	4.16	0.89
10	Examine their own assumptions about a subject	4.13	0.66
7	Break a challenging or substantial concept into parts to understand its relationship to the whole concept	4.02	0.70
12	Assess the accuracy of an observation	4.02	0.81
15	Combine thoughts or concepts to compose new ideas or solutions	4.02	0.80
9	Analyze arguments to identify and evaluate the evidence used to make the argument	3.88	0.74
17	Use symbols to create a model representing a complex idea (such as a cycle or process)	3.80	0.88
16	Use metaphors to explain complex ideas (such as when problem solving)	3.64	0.82
8	Create sequences (such as a decision tree or timeline) based on provided information	3.63	0.91

After sharing their attitudes toward teaching each of the critical thinking subskills and tasks, participants were asked to expand on their responses and provide examples. The higher order thinking skills, analysis, evaluation, and synthesis were the most common skills mentioned by the participants.

Eight participants shared that they utilize strategies to teach students to analyze. In particular, in an attempt to teach analysis, participants teach students to analyze ideas, find

reasons or conclusions, uncover their own assumptions, classify, and compare or contrast two or more ideas. One participant shared, “I use the ag issues career development event and discussion meet prompts to get my students researching the pros and cons of certain current issues. During this time, we discuss responsible research and how ethics can sway our perspectives.”

Similarly, ten participants stated they use strategies to teach students evaluation skills, particularly prediction, reasoning, inferencing, and evaluating their own observations. One participant stated, “I use a lot of questioning to help teach critical thinking. I think formative assessment is also important, especially when providing feedback on Claim/Evidence/Reasoning problems.” The claim, evidence, reasoning model suggested by this participant provides multiple opportunities for students to demonstrate evaluation skills such as using evidence and reasoning. Multiple participants shared they use research projects to teach students to utilize the evaluative skill of inference by using evidence to draw conclusions for their research.

Finally, ten survey participants also shared they teach students to synthesize information. The synthesis skills that survey respondents teach include combining ideas and images to create new ideas and using analogies, symbols, or metaphors to represent a complex idea. Examples of strategies used by teachers to teach these skills include using Venn diagrams or concept maps, creating timelines for agricultural practices, and creating models to represent complex ideas. One teacher wrote, “I utilize metaphors quite often to create better understanding of a complicated process or subject.”

While the most common thinking skills discussed by participants were the higher order thinking skills previously discussed, multiple survey participants also shared how they teach decision making and problem solving. Participants utilize hands-on projects to give students opportunities to make decisions. For example, one participant has their students design and build

chicken pens and spring garden cold frames to give them the opportunity to make decisions to accomplish the project. To best teach problem solving, multiple teachers shared that they use real-life situations that arise in the school barn or greenhouse to give students opportunities to problem solve.

Participants were also asked two selected-response questions on the survey to determine their attitudes toward assessing students' abilities to critically think in their AFNR programs. When given the statement, "In my AFNR courses, I intentionally assess students' abilities to critically think," the mean response was $M = 3.55$ ($SD = 0.85$). When prompted with "I give students feedback on their critical thinking skills," the mean response was $M = 3.83$ ($SD = 0.88$).

To expand on participants' responses on assessment, the survey also asked for teachers to share the methods and strategies they used to assess critical thinking. Thirty-eight participants shared their strategies for prompting student performances of thinking skills. Most participants utilized hands-on or real-life scenarios to have students apply their thinking skills in order to address the question. One participant stated, "students may have to measure, diagram, report on how to improve a plot of land, read a map, *etc*." on their hands-on assessments, while another shared, "we do scenario-based testing, like checking our insect tape, scouting, and then solving a pest problem using the IPM [Integrated Pest Management] methods that were taught." Other strategies that were provided include utilizing research projects, FFA contests, labs, sketching models or diagrams, holding classroom discussions, and utilizing thought questions on agricultural issues. On the other hand, four participants acknowledged that their current assessment practices do not incorporate assessing students' critical thinking abilities.

Furthermore, teachers were asked how they give students feedback on their critical thinking skills. Two major themes arose from the responses: feedback type and student confidence.

Two types of feedback were shared by participants: verbal and written. The most common method of giving feedback was verbal feedback (n = 27). Most participants shared that they use verbal feedback more often when students are performing a skill and when feedback needs to be immediate. Using student/teacher meetings is another form of feedback used, allowing the teacher to prompt students with questions regarding their thinking and performance. On the other hand, written feedback is more often used when students are completing a written assignment, or a long-term project was completed. Rubrics were a common form of written feedback provided by the participants.

The second theme that arose from the responses that was not based on the original framework or literature review was student confidence. Multiple teachers discussed the importance of using praise and positive feedback for students in an attempt to build confidence in their critical thinking. When asked to share their feedback strategies, one teacher stated, “I make a big deal of their accomplishments and remind them to be proud of themselves.”

Metacognition. The second objective of critical thinking instruction according to Swartz and McGuinness (2014) is to develop students’ metacognition. Participants were asked four scaled-response questions relating to metacognition. The statement regarding the development of students’ metacognition participants agreed with most was “when teaching critical thinking in my classes, I verbalize the thinking processes” (M = 4.00, SD = 0.86). On the other hand, the statement that participants agreed with the least was “I explicitly teach students how to monitor

and evaluate their thinking in my AFNR courses" (*M* = 3.27, *SD* = 0.87). All four statements regarding students' metacognition can be seen in Table 10.

Table 10

Survey Participants' Use of Strategies for the Development of Students' Metacognition (n = 52)

Item	Strategies for developing students' metacognition	Mean (*M*)	Standard deviation (*SD*)
21	When teaching critical thinking in my classes, I verbalize the thinking processes.	4.00	0.86
27	I expect students to monitor and evaluate their thinking in my AFNR courses through reflection.	3.63	0.86
23	I explicitly teach students how to transfer their thinking skills to new situations.	3.54	0.73
22	I explicitly teach students how to monitor and evaluate their thinking in my AFNR courses.	3.27	0.87

Participants were asked to provide the strategies they use to teach students to monitor and evaluate their thinking. Using reflection, such as journaling, daily check-ins, and self-assessing projects, was the most common method used by participants. Some teachers also shared that they use peer assessment strategies to have students monitor each other's work. Finally, five teachers use modeling to teach students to monitor and evaluate their thinking. Modeling strategies shared by participants included talking through their thought processes and demonstrating what a process should look like.

Similarly, the survey asked participants to share the opportunities they give students to practice or transfer their critical thinking skills. Examples that were provided fit within three areas: hands-on experiences, discussion/debate, and scenarios. The most common (*n* = 17) strategy utilized by teachers is to use hands-on AFNR projects including both classroom-based projects and supervised agricultural experiences. One teacher stated:

> We take certain steps to assess an animal's health and to deduce what the problem might be for our sickly steer. [We] can use those same steps but in a different way for our plants in the greenhouse…we don't do anything new, just a new problem to solve using those same deductive thinking steps.

The next most common strategy used by teachers to give students the opportunity to practice or transfer their critical thinking skills is presenting students with real-world scenarios to work through. For example, one teacher shared, "students are presented with a novel problem that requires the same sort of thinking pattern. We may work as a whole class or in small groups to propose and evaluate possible solutions to a given problem." Another teacher shared that they use real-life scenarios that demonstrate how there rarely is one best answer for every situation. Similarly, a teacher utilizes a plant help center where students research and provide answers to plant care, gardening, floral, or landscaping questions posed by school staff.

The third area that was identified was utilizing discussion or debate to give students the opportunity to practice or transfer their critical thinking skills. Teachers utilize mock discussion meets, guided peer conversations, and class debates to have students practice thinking critically and developing their metacognition.

Finally, when teachers were asked how they assess critical thinking, seven teachers provided examples of how they assess students' metacognition. Examples of metacognition prompts used include reflection assignments after a project, requiring students to explain their thinking of an action and outcome, and journaling. One teacher shared, "watching the way students move and think through the process provides me with data that informs me whether or not they understand the concept [and] are using their critical thinking skills."

Thinking Disposition. The third objective of critical thinking instruction according to Swartz and McGuinness (2014) is to develop students' thinking dispositions toward critical thinking. Participants were asked two questions regarding their use of strategies that intend to develop students' dispositions toward thinking critically. The first strategy to develop students' thinking dispositions, "I give students opportunities to practice critical thinking in my AFNR classroom" (M = 4.29, SD = 0.72), was used more frequently than the second strategy, "I give students opportunities to transfer their critical thinking skills to new situations in my AFNR classroom" (M = 3.96, SD = 0.82).

When teachers were asked to share their strategies for teaching critical thinking, two teachers shared strategies for developing students' thinking dispositions. Both teachers discussed utilizing observations, models, and questioning methods to teach students to ask "why" when something happens. Furthermore, when asked to share strategies for assessing critical thinking, three teachers shared strategies for assessment that build students' thinking dispositions. For example, one teacher shared they used questioning prompts to "allow for students to develop their own opinions and thoughts about concepts in an open and comfortable space."

Instructional Methods. The final selected-response question on the survey was to determine if participants utilize any of the instructional methods that are known or are thought to potentially influence critical thinking. Participants were given four methods that were previously identified through the literature review: project-based learning, inquiry-based learning, the problem-solving approach, and discussion. The most common method utilized by participants is project-based learning (n = 39), while the least common was the problem-solving approach (n = 34). The frequency of each approach can be seen in Table 11.

Table 11

*Instructional Strategies for Critical Thinking used by Survey Participants (*n = *45)*

Strategies	Frequency	Percentage
Project-Based Learning: includes identifying an authentic issue, researching how to solve the issue, collaborating with stakeholders, presenting solutions, and implementing the solution	39	86.7%
Inquiry-Based Learning: includes developing questions researching those questions, presenting new learning, and reflecting on learning	37	82.2%
Problem-Solving Approach: includes presenting a problem, exploring sources, arriving at a solution, testing the solution, and evaluating results	34	75.6%
Discussion: requires small or large groups of students to hold conversations on class subject matter	37	82.2%

Note. Participants were able to select more than one response.

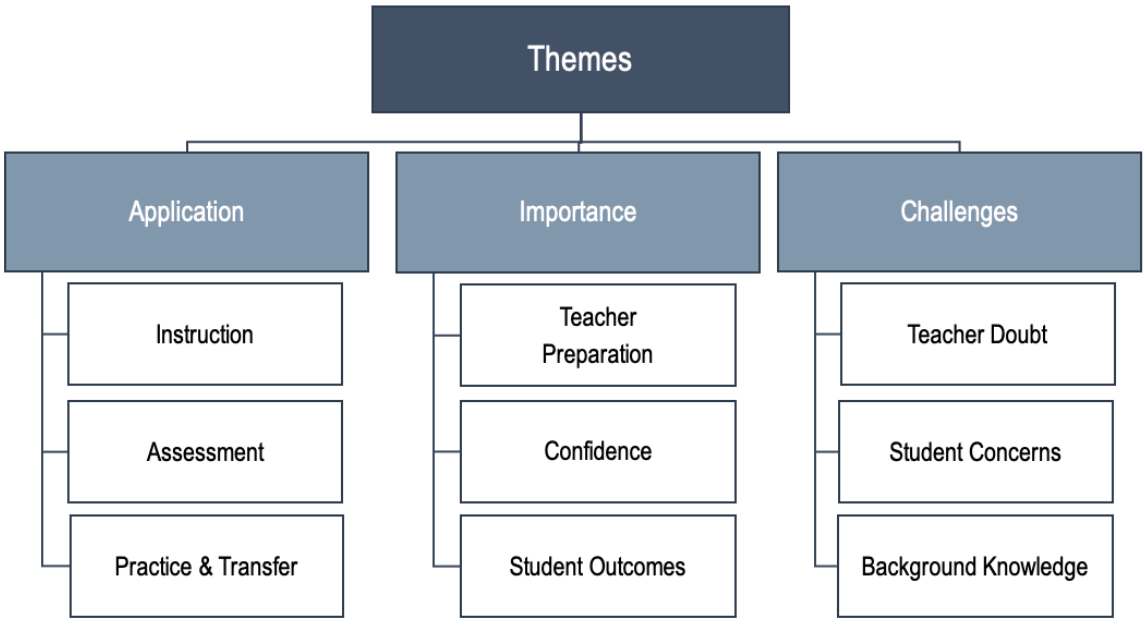
Additionally, eleven participants responded to the survey question asking them to share additional instructional methods they use to teach critical thinking, although seven participants only confirmed their use of the provided methods seen in Table 11. Four participants provided additional methods. These methods include allowing students to ask questions about a topic and then research to find out more, utilizing the Agriscience fair, and facilitating industry interactions and feedback. One teacher shared, “FFA chapter meetings are excellent teachers of critical thinking. [It is] similar to ‘Discussion’ listed above, but typically not about specific technical content, but rather solving problems related to community outreach or leadership activities.”

Interview Results. To further answer RQ2, phase two participants were asked open-ended questions on each of the critical thinking objectives via individual online interviews. These responses were first coded using Swartz and McGuinness’ 2014 framework. Then, deductive coding was used to identify themes within the interview responses that were not previously discussed. An example of this coding process can be found in Appendix J. While some codes were similar to those identified in the survey responses, those that emerged from the

interview responses were predominantly beyond the scope of the original framework, although the theme of application and its subthemes predominantly fit within the framework. Three themes emerged: application, importance, and challenges. The organization of each theme and their subthemes can be seen in Figure 4.

Figure 4

Themes and Subthemes that Emerged from the Interview Responses



Application. During the interviews, the respondents shared various examples of how they implement critical thinking instruction and assessment in their AFNR programs. These examples fell under three subthemes: instruction, assessment, and metacognition.

The first subtheme that emerged under the theme, Application, was *Instruction*, which included instruction of thinking skills, metacognition, and thinking dispositions. Most strategies that were discussed were for teaching thinking skills, while teaching metacognition and thinking dispositions were only mentioned occasionally. While the survey responses focused on explicit

strategies, the interview responses emphasized how the respondent implemented the strategy. For example, Respondent A shared that they used simple research projects to teach students to start thinking critically by encouraging students to design research around basic variables while giving the student the freedom to think through the process independently. By giving them flexibility during their research project, Respondent A hopes to encourage students to start developing their ability to critically think. Similarly, Respondent D shared one strategy for evaluating data such as from a graph. To teach the skill to students, Respondent D walks them through how to read and understand the units on a graph before teaching them how to read and interpret the data provided.

While respondents shared many examples of how they teach and model thinking skills, addressing students' metacognition and thinking dispositions were rare during the interviews. Respondent A shared they taught students to use metacognitive techniques within reading assignments, and Respondent C modeled the metacognitive process by regularly thinking out loud so students could learn the process. Furthermore, Respondent C encourages students to develop their thinking dispositions by intentionally not giving students the answer to a question so they have to find the answer themselves.

The second subtheme under Application that emerged from the interview responses was *Assessment*. Many of the respondents have not spent much time on how to assess, ultimately using an informal process to assess students' critical thinking skills. Respondent A shared:

> I think it comes out in the gradebook, but it's not something I directly assess. It's probably more of an informal manner in talking with students. A lot of times in agriscience fair projects, things go wrong. So, talking it through with them, 'why do you think this might be happening? Why do you think you're getting these results?' and if

> they're able to kind of address some of that independently more and more as the year goes on, I think that really demonstrates the growth of some of those critical thinking skills.

Respondents B, C, and D also said they assess critical thinking through discussions with the students by asking them to share their reasoning and evidence behind a decision they made. It is common for the participants to use this strategy particularly when students were completing tasks or projects in the school barn or greenhouse. For example, Respondent B shared that they utilize the Michigan FFA Broiler Project to give students the opportunity to solve potential problems that may arise such as with the chicks' pen temperature.

The final subtheme that emerged under the Application theme is practice and transfer. Giving students the opportunity to practice their critical thinking skills and transfer those skills to other situations helps develop their metacognitive abilities. Giving students the opportunity to practice and transfer their critical thinking skills was one of the most common topics in the interviews. All five respondents gave examples of this practice, particularly when discussing hands-on experiences in the school barn, greenhouse, and laboratories. Respondent C shared:

> I like to think of it that whenever we have a hands-on opportunity, we evoke critical thinking. I mean, we can teach the content, but when they actually have to physically do and then they have to choose to adapt or change to have a successful outcome, we are letting them critically think through that process like the chicken contest. We [teachers] already know what to do to tweak and change and adjust to make it be successful. It's seeing them learn what they need to reach those same outcomes.

Furthermore, Respondent E shared how allowing students to struggle in the barn or greenhouse provides them with an opportunity for growth so they do not provide students with

specific directions on how to do something when possible. Instead, they explain the end result of what needs to be done and allow the students to figure it out themselves. Similarly, Respondent A shared how they can see students' critical thinking grow over the course of the year:

> I think they do get better at troubleshooting things as the year goes on. You know, we have fish tanks. They'll walk in right away, do a water test, and realize all the nitrate levels are high. I don't really have to say anything or direct them to figure out what those water test results mean. They just know what needs to be done and do it.

Importance. The importance of teaching critical thinking surfaced regularly throughout the interviews. The discussion and stories around the importance of critical thinking could be organized into three subthemes: teacher preparation, student outcomes, and confidence.

First, many of the respondents shared their prior experiences that emphasized the importance of teaching critical thinking in their AFNR courses. Respondent B shared that their upbringing on a farm helped them develop their critical thinking skills because they had to analyze and problem solve situations that arose in day-to-day management of the farm. Furthermore, Respondents A, D, and E all shared that the training they received and was modeled for them in undergraduate and graduate coursework developed their critical thinking skills although Respondent D and E also shared that, while it was in their AFNR teacher preparation coursework, it is difficult to incorporate during the first few years of teaching because of the time it takes to meet all of the other expectations on teachers.

The importance of critical thinking as a student outcome also arose throughout the interviews. Participants emphasized the importance of critical thinking, mentioning a growing need for the skill among students. Respondent A called critical thinking "one of the most important things we hope students walk away with," while Respondent C said "if they never

learn anything else from my program, if they learn how to think and they learn how to be informed consumers…this world is going to be a better place. That's kind of my hope for them." Similarly, Respondent E emphasized their increased focus on critical thinking as they have gained teaching experience:

> As I've taught a little bit, I actually see, and especially after Covid, it's almost like huge red flags to us on a daily basis. It's not that I need them to know the gestation period of a pig anymore…I think the older you get, the more critical it becomes to you that you need to teach critical thinking for students.

The final subtheme that arose under the Importance theme was confidence, although many teachers also see students' lack of confidence as a challenge to teaching critical thinking and thus, it could be categorized under that theme as well. Similar to the survey responses, the participants discussed the importance of building students' confidence when they're expected to critically think. Respondents B and E stressed the value of positive reinforcement for students. Both mentioned that students struggle with a lack of willingness to try because they don't want to fail, and positive feedback helps build the students' confidence so they're more willing to try. Respondent B shared some of the success they've had building confidence this year, "They will answer now in front of other students, whereas before it was 'well, I got it wrong'." Furthermore, Respondent B shared positive feedback they provided students after those students held a successful class discussion,

> "You were able to tell us what you had, not feel bad about what you had, and then take answers from myself and other students to add to what you have, you know, for a full understanding of it."

Challenges. The final theme that was seen in the interview responses was the challenges AFNR teachers face when trying to incorporate critical thinking instruction and assessment in their programs. The subthemes that developed were teacher doubt, student concerns, and background knowledge.

Nearly all respondents expressed their doubts on how to teach critical thinking regularly in the interviews. Respondent A voiced their concern over critical thinking instruction in general, "I'm never sure if I'm doing it right." On the other hand, sometimes that doubt arose around specific aspects of critical thinking instruction and assessment. For example, when asked if critical thinking was included on rubrics used in their program, Respondent A shared, "I don't know if it should be, or could be, and that's something I re-evaluate every year on various different rubrics, but I don't think it really is on it." Similarly, Respondent B questioned if they have taught students to transfer their critical thinking skills to new situations, "I don't think I purposely have, not because I've thought to do that." Furthermore, Respondent C shared, "Not and know that I'm doing it. I just think it's really cool when it appears" when asked if they focus on a specific critical thinking subskill in their instruction.

The second subtheme that arose under the challenges theme was student concerns, which included concerns over time, safety, and pushback. Respondent A summarized the balance required to give students the opportunity to build the skill within time and safety restrictions.

> "You want them to tackle it so really making sure that you're allowing them that space, that opportunity, and time to be able to think it through on their own and it's a careful balance between providing them the support they need to be able to, you know, when sometimes there's timeframe issues or there's safety issues. So, making sure you're

staying within those constraints, but also again allowing them that freedom and flexibility to be able to think it through on their own."

A lack of time was also one of the reasons Respondent E focused their critical thinking instruction in their land lab rather than within all class content. "That [the land lab] is the one thing that they have all year that is constant and that I can really see growth. We're moving subjects so fast that I can't really see a ton of growth within each unit." Furthermore, Respondents D and E both shared how teachers' time could limit critical thinking instruction, especially for less experienced teachers who must focus on meeting the other expectations of teaching. As a teacher with less than five years of teaching experience, Respondent D said, "I don't think I pay enough attention to know if [students' critical thinking] really changes significantly because I'm trying to look for other changes like just general understanding first."

While students' time and safety were the most common forms of student concerns voiced by participants, pushback was also highlighted by multiple participants. Respondent B shared "they hate it, they hate it, they hate it, they hate it" when discussing how they questioned students regularly and declined to provide an answer right away. Similarly, Respondent E vented, "I guess my biggest frustration is when they just decide not to do it or to stall, without asking for help."

Finally, students' AFNR background knowledge developed as a challenge facing teachers when trying to teach critical thinking. Similar to students' confidence, developing students' background knowledge could potentially also fall under the theme of importance. However, teachers shared the need for building students' background knowledge before expecting them to critically think, which is why it ultimately is considered a challenge impacting critical thinking instruction. While Respondent B called students' background knowledge in AFNR a "catalyst"

toward their ability to critically think, Respondent E shared the importance of teaching a student enough knowledge to know how something should be before expecting them to be able to recognize and solve problems.

Similarly, multiple teachers shared that young teachers may not have enough background knowledge in all aspects of AFNR themselves yet to be able to critically think on some issues, which may impact their ability to teach critical thinking. According to the respondents, as the teacher gains that knowledge, their ability and desire to incorporate it in class rises.

Research Question 3

Research question 3 asked, "How do AFNR instructors' teaching experiences impact how they teach and assess critical thinking in their classrooms?" Survey participants were asked two questions in the demographic portion of the survey regarding their AFNR teaching experiences: years of AFNR teaching experience (Table 2) and the type of school where the participant teaches (Table 4). The responses from the two demographic questions were compared to the responses from the 24 Likert-types scaled questions.

A Pearson correlation coefficient was computed to assess the relationship between the years of AFNR teaching experience and teachers' attitudes toward critical thinking instructional strategies (see Table 12). A statistically significant difference ($p < .05$) was seen in four comparisons. There was a negative correlation between years of AFNR teaching experience and participants' intentions to teach students to "analyze arguments to identify and evaluate the evidence used to make the argument" (r (50) = -.33, p = .017). Similarly, there was a negative correlation between years of AFNR teaching experience and participants' intentions to teach students to "use logical reasoning to develop conclusions about a subject based on current knowledge" (r (50) = -.33, p = .018). A negative correlation was also identified between years of

AFNR teaching experience and teachers' intentions to teach students to "use metaphors to explain complex ideas (such as when problem solving)" (r (50) = -.34, p = .014). Finally, a negative correlation was identified when comparing years of AFNR teaching experience and teachers' responses to the statement, "in my AFNR courses, I intentionally assess students' abilities to critically think" (r (50) = -.28, p = .043).

To further answer RQ3, an ANOVA test was conducted to determine if the type of school where the participants teach (Table 4) affects their attitudes toward critical thinking instructional strategies. One statistically significant ($p < .05$) difference was seen in the ANOVA results. When the type of school was compared to the following statement, "I expect students to monitor and evaluate their thinking in my AFNR courses through reflection," a difference (p = .035) was found between the groups: career-tech center (M = 3.14, SD = .66), comprehensive high/middle school (M = 3.78, SD = .83), and county or local CTE consortium (M = 4.00, SD = 1.10).

The post-hoc Bonferroni multi-comparison tests revealed the career-tech center group was responsible for the difference between groups, however, there were no significant differences found when the following comparisons were made: career-tech center vs. comprehensive high/middle school (p = .058), career-tech center vs. county or local CTE consortium (p = .113) and comprehensive high/middle school vs. county or local CTE consortium (p = 1.0). Furthermore, the effect size of school type on teachers' attitudes toward expecting students to monitor and evaluate their thinking in their AFNR courses through reflection was low (η^2 = .128). When looking at the type of school's effect on participants' attitudes toward the other 22 critical thinking instructional strategies, no differences were seen between types of schools, which can be seen in Table 13.

Table 12

Assessment of the Relationship Between Years of AFNR Teaching Experience and Teachers' Attitudes Toward Critical Thinking Instructional Strategies using Pearson Correlation Coefficients (n = 52)

Variable	*M*	*SD*	*r*	*p*
In my AFNR courses, I intentionally teach students to…				
Think critically about AFNR related topics	4.22	.71	-.11	.425
Make decisions in AFNR	4.23	.71	.00	.990
Solve problems in AFNR	4.23	.81	-.06	.664
Compare and/or contrast two or more items	4.50	.76	-.24	.082
Classify and/or define items based on shared qualities or characteristics	4.16	.89	-.11	.444
Break a challenging or substantial concept into parts to understand its relationship to the whole concept	4.02	.70	-.00	.982
Create sequences (such as a decision tree or timeline) based on provided information	3.63	.91	-.08	.570
Analyze arguments to identify and evaluate the evidence used to make the argument	3.88	.74	-.33*	.017
Examine their own assumptions about a subject	4.13	.66	-.09	.549
Assess the reliability of sources	4.29	.80	.09	.527
Assess the accuracy of an observation	4.02	.81	-.08	.599
Use evidence effectively (such as to develop an explanation or to make a prediction)	4.18	.69	-.09	.522
Use logical reasoning to develop conclusions about a subject based on current knowledge	4.20	.70	-.33*	.018
Combine thoughts or concepts to compose new ideas or solutions	4.02	.80	-.10	.496
Use metaphors to explain complex ideas (such as when problem solving)	3.64	.82	-.34*	.014
Use symbols to create a model representing a complex idea (such as a cycle or process)	3.80	.88	-.14	.339
In my AFNR courses, I intentionally assess students' abilities to critically think	3.55	.85	-.28*	.043
When teaching critical thinking in my classes, I verbalize the thinking processes	4.00	.86	-.05	.751
I explicitly teach students how to monitor and evaluate their thinking in my AFNR courses	3.27	.87	-.12	.403
I explicitly teach students how to transfer their thinking skills to new situations	3.54	.73	-.09	.529
I give students opportunities to practice critical thinking in my AFNR classroom	4.29	.72	-.08	.591
I give students opportunities to transfer their critical thinking skills to new situations in my AFNR classroom	3.96	.82	.12	.410
I give students feedback on their critical thinking skills	3.83	.88	.03	.845

Variable	*M*	*SD*	*r*	*p*
I expect students to monitor and evaluate their thinking in my AFNR courses through reflection	3.63	.86	-.26	.062

Note. *$p < .05$.

Table 13

Results of ANOVA Models Assessing the Type of School's Effect on Teachers' Attitudes Toward Critical Thinking Instructional Strategies

Critical thinking instructional strategies	Career-tech center (n = 14)		Comprehensive high/middle school (n = 32)		County or local CTE consortium (n = 6)		F	p
	M	*SD*	*M*	*SD*	*M*	*SD*		
In my AFNR courses, I intentionally teach students to…								
Think critically about AFNR related topics	4.07	.48	4.16	.81	4.60	.55	1.05	.358
Make decisions in AFNR	4.21	.43	4.13	.79	4.50	.84	.70	.504
Solve problems in AFNR	4.29	.61	4.16	.85	4.17	1.17	.12	.89
Compare and/or contrast two or more items	4.29	.73	4.50	.84	4.67	.52	.60	.556
Classify and/or define items based on shared qualities or characteristics	4.43	.76	4.03	.93	3.83	.98	1.30	.283
Break a challenging or substantial concept into parts to understand its relationship to the whole concept	4.07	.62	3.94	.76	4.17	.41	.38	.688
Create sequences (such as a decision tree or timeline) based on provided information	3.57	.94	3.56	.95	3.67	.82	.03	.969
Analyze arguments to identify and evaluate the evidence used to make the argument	3.93	.62	3.81	.82	4.00	.63	.22	.800
Examine their own assumptions about a subject	4.00	.68	4.25	.62	4.17	.41	.79	.459
Assess the reliability of sources	4.00	.78	4.41	.71	4.50	.84	1.67	.198
Assess the accuracy of an observation	3.85	.80	4.00	.84	4.50	.55	1.38	.262
Use evidence effectively (such as to develop an explanation or to make a prediction)	4.07	.73	4.09	.69	4.67	.52	1.91	.159
Use logical reasoning to develop conclusions about a subject based on current knowledge	4.14	.54	4.13	.79	4.50	.55	.72	.491
Combine thoughts or concepts to compose new ideas or solutions	3.93	.62	4.03	.86	3.83	.98	.19	.830

Critical thinking instructional strategies	Career-tech center (n = 14)		Comprehensive high/middle school (n = 32)		County or local CTE consortium (n = 6)		F	p
	M	*SD*	*M*	*SD*	*M*	*SD*		
Use metaphors to explain complex ideas (such as when problem solving)	3.64	.84	3.63	.83	3.83	.75	.16	.851
Use symbols to create a model representing a complex idea (such as a cycle or process)	3.79	.98	3.88	.79	3.83	.75	.06	.946
In my AFNR courses, I intentionally assess students' abilities to critically think	3.50	.86	3.50	.80	3.67	1.03	.10	.902
When teaching critical thinking in my classes, I verbalize the thinking processes	3.71	.99	4.09	.82	4.17	.75	1.07	.351
I explicitly teach students how to monitor and evaluate their thinking in my AFNR courses	3.21	.70	3.31	.93	3.17	.98	.11	.899
I explicitly teach students how to transfer their thinking skills to new situations	3.57	.51	3.56	.80	3.33	.82	.26	.770
I give students opportunities to practice critical thinking in my AFNR classroom	4.43	.65	4.19	.78	4.50	.55	.83	.444
I give students opportunities to transfer their critical thinking skills to new situations in my AFNR classroom	4.07	.83	3.91	.82	4.00	.89	.20	.819
I give students feedback on their critical thinking skills	3.71	.47	3.88	.91	3.83	.88	.16	.855
I expect students to monitor and evaluate their thinking in my AFNR courses through reflection	3.14	.66	3.78	.83	4.00	1.10	3.60	.035*

Note. *p < .05.

Research Question 4

Research question 4 asked, "How does AFNR instructors' preparation impact how they teach and assess critical thinking in their classrooms?" In an attempt to answer RQ4, participants were asked two demographic questions regarding their preparation for teaching: their years of

AFNR industry experience, not including years gained in college or while teaching (Table 3) and their route to teaching (Table 7). The demographic data was compared to the teachers' attitudes toward critical thinking instructional strategies.

A Pearson correlation coefficient was calculated to determine if teachers' years of AFNR industry experience affected their attitudes toward 24 critical thinking instructional strategies (Table 14). A statistically significant difference was found in seven comparisons. As participants gained years of industry experience, they were more likely to "intentionally teach students to make decisions in AFNR" (r (40) = .32, p = .039), "combine thoughts or concepts to compose new ideas or solutions" (r (40) = .32, p = .042), and use "metaphors to explain complex ideas (such as when problem solving)" (r (40) = .31, p = .049). Furthermore, there was a positive correlation between participants' years of AFNR industry experience and their attitude toward the statements, "when teaching critical thinking in my classes, I verbalize the thinking processes" (r (40) = .32, p = .049), "I explicitly teach students how to transfer their thinking skills to new situations" (r (40) = .31, p = .047), "I give students feedback on their critical thinking skills" (r (40) = .35, p = .024), and "I expect students to monitor and evaluate their thinking in my AFNR courses through reflection" (r (40) = .34, p = .029).

Table 14

*Assessment of the Relationship Between Years of AFNR Industry Experience and Teachers' Attitudes Toward Critical Thinking Instructional Strategies using Pearson Correlation Coefficients (*n = *42)*

Variable	*M*	*SD*	*r*	*p*
In my AFNR courses, I intentionally teach students to…				
Think critically about AFNR related topics	4.22	.71	.25	.110
Make decisions in AFNR	4.23	.71	.32*	.039
Solve problems in AFNR	4.23	.81	.19	.233
Compare and/or contrast two or more items	4.50	.76	.10	.520
Classify and/or define items based on shared qualities or characteristics	4.16	.89	.15	.344
Break a challenging or substantial concept into parts to understand its relationship to the whole concept	4.02	.70	.27	.084
Create sequences (such as a decision tree or timeline) based on provided information	3.63	.91	.18	.259
Analyze arguments to identify and evaluate the evidence used to make the argument	3.88	.74	.19	.220
Examine their own assumptions about a subject	4.13	.66	.24	.124
Assess the reliability of sources	4.29	.80	.01	.929
Assess the accuracy of an observation	4.02	.81	.23	.143
Use evidence effectively (such as to develop an explanation or to make a prediction)	4.18	.69	.27	.082
Use logical reasoning to develop conclusions about a subject based on current knowledge	4.20	.70	.14	.386
Combine thoughts or concepts to compose new ideas or solutions	4.02	.80	.32*	.042
Use metaphors to explain complex ideas (such as when problem solving)	3.64	.82	.31*	.049
Use symbols to create a model representing a complex idea (such as a cycle or process)	3.80	.88	.06	.712
In my AFNR courses, I intentionally assess students' abilities to critically think	3.55	.85	.28	.070
When teaching critical thinking in my classes, I verbalize the thinking processes	4.00	.86	.32*	.041
I explicitly teach students how to monitor and evaluate their thinking in my AFNR courses	3.27	.87	.30	.054
I explicitly teach students how to transfer their thinking skills to new situations	3.54	.73	.31*	.047
I give students opportunities to practice critical thinking in my AFNR classroom	4.29	.72	.11	.482
I give students opportunities to transfer their critical thinking skills to new situations in my AFNR classroom	3.96	.82	.16	.317
I give students feedback on their critical thinking skills	3.83	.88	.35*	.024

Variable	*M*	*SD*	*r*	*p*
I expect students to monitor and evaluate their thinking in my AFNR courses through reflection	3.63	.86	.34*	.029

Note. *$p < .05$.

Additionally, the participants' routes to teaching (Table 7) were also compared to the teachers' attitudes toward critical thinking instructional strategies. Because of the limited sample size of teachers who attended a post-secondary institution for a non-AFNR education degree and secured a teaching certificate before beginning to teach ($n = 3$), those participants were combined with teachers who completed an alternative path to teacher certification such as entering the profession from industry and receiving annual authorization ($n = 12$) in a non-traditional group when compared to teachers who took a more traditional route and attended a post-secondary institution for AFNR education or similar degree and secured a teaching certificate before beginning to teach ($n = 37$). There were two comparisons that demonstrated a noteworthy numerical, but not statistically significant, ($p < .05$) difference between groups. The teachers who followed a traditional route to AFNR education ($M = 3.86$, $SD = .86$) were less likely to teach students to "assess the accuracy of an observation than the teachers who took a non-traditional route" ($M = 4.43$, $SD = .51$). Alternatively, the group that took a traditional route to AFNR education ($M = 4.00$, $SD = .85$) was more likely to teach students to "combine thoughts or concepts to compose new ideas or solutions" than the teachers who took a non-traditional route ($M = 3.49$, $SD = .87$). One comparison demonstrated a statistically significant difference ($p < .05$). When comparing the attitudes of teachers who took non-traditional routes to AFNR education ($M = 4.07$, $SD = .46$) to teachers who took a traditional route to AFNR education ($M = 3.49$, $SD = .87$), non-traditional teachers were more likely to teach students to "use metaphors to

explain complex ideas (such as when problem solving),” (t (50)= -2.44, p < .001). The results of each t test can be seen in Table 15.

Table 15

Results of t*-Test Analyses Assessing the Effect of the Participants' Routes to AFNR Education (AFNRE) on Their Attitudes Toward Critical Thinking Instructional Strategies (*n *= 52)*

Critical thinking instructional strategies	Traditional route to AFNRE (*n* = 37)		Non-traditional routes to AFNRE (*n* = 15)			
	M	*SD*	*M*	*SD*	*t*	*p*
In my AFNR courses, I intentionally teach students to…						
Think critically about AFNR related topics	4.08	.73	4.40	.63	-1.46	.352
Make decisions in AFNR	4.19	.78	4.20	.56	-.05	.529
Solve problems in AFNR	4.16	.83	4.27	.80	.41	.990
Compare and/or contrast two or more items	4.43	.84	4.53	.64	-.42	.555
Classify and/or define items based on shared qualities or characteristics	4.11	.94	4.13	.83	-.09	.613
Break a challenging or substantial concept into parts to understand its relationship to the whole concept	3.97	.73	4.07	.59	-.44	.526
Create sequences (such as a decision tree or timeline) based on provided information	3.68	.85	3.33	1.05	1.23	.104
Analyze arguments to identify and evaluate the evidence used to make the argument	3.76	.80	4.13	.52	-1.69	.151
Examine their own assumptions about a subject	4.19	.66	4.13	.52	.29	.302
Assess the reliability of sources	4.32	.78	4.27	.70	.25	.800
Assess the accuracy of an observation	3.86	.86	4.43	.51	-2.31	.367
Use evidence effectively (such as to develop an explanation or to make a prediction)	4.27	.59	4.14	.79	-0.74	.965
Use logical reasoning to develop conclusions about a subject based on current knowledge	4.14	.79	4.27	.46	-.61	.437
Combine thoughts or concepts to compose new ideas or solutions	4.00	.85	3.49	.87	-.11	.597
Use metaphors to explain complex ideas (such as when problem solving)	3.49	.87	4.07	.46	-2.44*	<.001
Use symbols to create a model representing a complex idea (such as a cycle or process)	3.76	.86	4.07	.70	-1.23	.297
In my AFNR courses, I intentionally assess students' abilities to critically think	3.38	.79	3.87	.83	-1.98	.74
When teaching critical thinking in my classes, I verbalize the thinking processes	3.89	.94	4.27	.59	-1.43	.375

Critical thinking instructional strategies	Traditional route to AFNRE (n = 37)		Non-traditional routes to AFNRE (n = 15)			
	M	*SD*	*M*	*SD*	*t*	*p*
I explicitly teach students how to monitor and evaluate their thinking in my AFNR courses	3.22	.82	3.40	.99	-0.69	.567
I give students opportunities to practice critical thinking in my AFNR classroom	4.22	.79	4.47	.52	-1.14	.714
I give students opportunities to transfer their critical thinking skills to new situations in my AFNR classroom	4.03	.80	3.80	.86	.91	.303
I give students feedback on their critical thinking skills	3.78	.82	3.93	1.03	-.55	.433
I expect students to monitor and evaluate their thinking in my AFNR courses through reflection	3.57	.80	3.80	1.01	-.88	.413

Note. $*p < .05$.

Summary

This chapter detailed the results of the study with four main sections: an overview of the respondents, a description of the respondents' demographics, a summary of how the results were analyzed, and the results of each phase of the study, which were organized by the research questions. A statistical analysis of the quantitative data, which were collected through an online survey, was conducted to determine both descriptive statistics and to calculate appropriate comparisons between data.

Qualitative data were collected through open-ended questions on the survey and through five semi-structured interviews. The purpose of the qualitative data was to provide more insight into the critical thinking instructional strategies of Michigan AFNR teachers. The survey responses provided support and examples for the quantitative survey responses, while the data from the interviews were analyzed using a thematic analysis process. Three themes arose from the interview data: application, importance, and challenges.

Chapter V: Discussion, Conclusions, and Recommendations

The purpose of this exploratory, sequential mixed methods study was to explore critical thinking in Michigan secondary AFNR programs. This study aimed to identify how AFNR instructors currently utilize instructional and assessment strategies known to impact critical thinking. Swartz and McGuinness' (2014) framework forms a basis for this study. The framework is built around three objectives of critical thinking instruction: thinking skills, metacognition, and disposition. The following research questions form the basis for this study:

1. How do Michigan secondary AFNR instructors define critical thinking?
2. How do Michigan secondary AFNR instructors teach and assess critical thinking in their classrooms?
3. How do AFNR instructors' teaching experiences impact how they teach and assess critical thinking in their classrooms?
4. How does AFNR instructors' preparation impact how they teach and assess critical thinking in their classrooms?

To best answer these questions, two phases were conducted in the spring of 2023. In phase one, a survey was sent to all Michigan secondary AFNR instructors. The survey gathered participants' input on how they teach and assess critical thinking in their AFNR classrooms through both selected-response and open-ended questions. The survey also allowed participants to volunteer for phase two. In phase two, five participants were interviewed to further gather their experience with how they incorporate critical thinking in their AFNR programs.

Chapter five is organized into three sections: a discussion of the study's results within the existing literature, an examination of the conclusions formed through this research, and the

recommendations for the utilization of this research in Michigan AFNR education and further research.

Discussion

This section examines the research study results and their connection and placement within the existing literature on critical thinking instruction and assessment. This discussion is organized by research question. For each question, the results are summarized, and the connection to the literature is discussed.

Research Question 1

Research question 1 asked, “How do Michigan secondary AFNR instructors define critical thinking?” How to define critical thinking has been an enduring question within literature since Dewey first introduced the concept in his writings more than 100 years ago (Dewey, 1910/2011). There are a variety of definitions cited within critical thinking research that include definitions written by Glaser (1942), Ennis (2016), Bloom et al. (1956), and Facione (1990), among others. Despite the availability of such definitions, especially Facione’s consensus definition which was based on the feedback of 46 researchers, the chosen definition for each new study regularly still differs. Because of this discrepancy in the understanding of what critical thinking actually is, defining critical thinking within the context of AFNR education was an important first step in understanding how AFNR educators teach and assess critical thinking in their programs.

Phase one survey participants were asked to share their own definitions of critical thinking within the context of AFNR education. Fifty-eight participants provided definitions, which were categorized and reduced to a manageable number of definitions that were then provided to phase two participants for further evaluation. The definition chosen by the most

phase two participants, to make connections between AFNR topics and other disciplines using higher order thinking skills such as creating, evaluating, and analyzing, shares similarities with multiple definitions found within the literature. The inclusion of higher order thinking skills in the definition reflects Bloom's updated taxonomy and the multitude of definitions that utilize that concept (see Coon, 1995; Duron et al., 2006; Ennis, 1992; Kerka, 1992, for examples). The definition also reflects some of Swartz and McGuinness (2014) framework, although the higher order thinking skill, creating, is used in the definition rather than the skill of synthesizing, which is seen in both the original Bloom's taxonomy and Swartz and McGuinness' framework (Bloom et al., 1956; Swartz & McGuinness, 2014). The emphasis on the higher order thinking skills in the definition is reflective of the frequency of their familiarity and usage in education.

There is a noticeable absence of problem solving and decision making in the definition, which are both complex thinking processes and critical thinking subskills included in this study's conceptual framework. Interestingly, teachers had more positive attitudes toward teaching decision making (M = 4.23, SD = 0.71) and problem solving (M = 4.23, SD = 0.81) in their AFNR courses than 11 other provided critical thinking instructional strategies in phase one of the study. The absence of problem solving in the consensus definition, in particular, is especially noteworthy since more than half of phase one respondents included the term in their provided definitions, but after they were condensed and summarized, only one phase two participant chose the definition incorporating problem solving. On the other hand, the problem-solving instructional approach is historically common in AFNR education and is used by 75.6% of study participants (n = 34).

The limited number of phase two participants (n = 5) may have had an impact on how many participants chose each definition. Furthermore, the selective nature of phase two may

have had an unintentional impact on the selected definition, since no attempts were made to select phase two participants as a representative sample of phase one participants.

Research Question 2

Research question 2 asked, “How do Michigan secondary AFNR instructors teach and assess critical thinking in their classrooms?” This research question was exploratory in nature. While Swartz and McGuinness (2014) framework forms a foundation for the questions that were asked of participants, the purpose of this research question was to see how AFNR teachers incorporate critical thinking in their programs, even if their chosen strategies do not fit within the provided framework. Therefore, to best encompass all aspects of the results, the discussion of this research question is organized by the themes that emerged through the qualitative phase of the study: application, importance, and challenges.

Application. The first theme that emerged from the interviews was based on how participants implemented instructional and assessment strategies to develop students’ critical thinking skills. Three significant subthemes emerged that fit within this theme: instruction, assessment, and practice and transfer. Each of the subthemes will be discussed individually because of their substantial and thought-provoking results.

Instruction. Overall, the results indicate Michigan secondary AFNR instructors have favorable attitudes toward teaching students’ thinking skills, particularly: making decisions, solving problems, and evaluating. While teachers had favorable attitudes toward all statements focused on abilities under the subskill, analysis, there was less consistency among the means of the responses for those statements. Furthermore, AFNR teachers had the least favorable attitudes toward teaching students to synthesize, overall, although they were still positive. Interestingly, AFNR teachers were least favorable and least consistent in their attitude toward teaching

students to create sequences, which may be due to either a misunderstanding of the concept or lack of knowledge on how to teach students to develop that skill.

While responding more favorably to analysis and evaluation statements than synthesis statements, participants actually shared a nearly equal number of examples of strategies applying to each of the subskills on the open-ended survey questions. Slightly higher standard deviations were calculated for the synthesis statements, such as “use metaphors to explain complex ideas,” than most of the analysis and evaluation statements, which indicates slightly more variation in teachers’ attitudes toward those statements. Ultimately, this suggests some teachers may misunderstand which abilities fit within the synthesis subskill, but they are still teaching those abilities.

A notable difference between the various aspects of the results is an emphasis on problem solving and decision making. While more than half of respondents defined critical thinking in terms of problem solving on the survey and responded highly favorably toward teaching problem solving and decision making, the higher order thinking skills were discussed more often than both problem solving and decision making in the open-ended responses. Furthermore, problem solving was the skill most often mentioned during the interview phase of the study. As previously noted, the problem-solving approach has been historically common in AFNR education as an instructional strategy and most participants self-identified that they used the strategy. While some literature suggests problem solving is a separate skill from critical thinking, this study’s results support Swartz and McGuinness’ (2014) framework that identifies problem solving as a subskill of critical thinking. Interestingly, decision making was commonly combined with problem solving during participants’ discussion of how critical thinking was applied in their AFNR programs.

A common strategy that was presented by participants for the instruction of thinking skills was utilizing the agriscience fair. This method was most commonly associated with the thinking skill, evaluation. While none of the participants explicitly called their process inquiry-based learning (IBL), the agriscience fair meets the principles of IBL. Furthermore, most participants self-identified that they utilized IBL in their AFNR programs. Utilizing IBL as a method of critical thinking instruction supports the results found by Gupta et al. (2015). However, some participants indicated they were not able to teach students how to conduct an agriscience fair project in the way they would like to due to time constraints. If this constraint limits the exploratory nature of the agriscience fair project, the benefit of using the agriscience fair as a component of IBL for critical thinking instruction may not be seen which could warrant further exploration.

Intriguingly, more AFNR teachers self-identified that they utilized project-based learning (PBL) as a critical thinking instructional method in their programs than any other provided strategy, which aligns with the literature on PBL as a critical thinking instructional strategy (Al-Khrisha & Mansour, 2021; Burris & Garton, 2007; Ennis, 2016). However, when asked to provide examples of how they teach critical thinking, only one participant gave a strategy explicitly associated with the principles of PBL. Whether this discrepancy is due to how the study's questions were asked or because AFNR teachers don't actually implement the strategy as much as they perceive themselves should be explored further.

Finally, noticeable finding within the Instruction subtheme was how minimally teachers discussed explicit instruction of metacognitive abilities. Teachers indicated less favorability toward explicitly teaching students "how to transfer their thinking skills to new situations" and teaching students "how to monitor and evaluate their thinking" than they had toward explicitly

teaching thinking skills. On the other hand, teachers responded more favorably toward expecting students to monitor and evaluate their thinking than they did for explicitly teaching students how to do so. This comparison is intriguing and may be due to CTE's tendency toward using an immersion method for incorporating critical thinking in programs (Ennis, 1989b; Hyslop-Margison & Armstrong, 2004; Zahner, 2022). Critical thinking is regularly identified as an employability skill within CTE, which are typically seen as essential, but not explicitly taught (Association for Career and Technical Education, 2018). However, much of the same research indicates the immersion method is less effective for actually developing students' critical thinking skills than an infusion method that explicitly teaches the skill (Ennis, 1989b; Facione, 1990; Hyslop-Margison & Armstrong, 2004). For those that provided examples of how they taught these metacognitive skills, the most common was through modeling. Reflection, a form of student monitoring, was mentioned frequently throughout the survey and interviews. Similarly, AFNR teachers viewed verbalizing the thinking processes as a strategy for modeling metacognition as highly favorable.

Assessment. The second subtheme that developed under the application theme was assessment. AFNR teachers identified favorable attitudes toward assessing students' critical thinking skills, although less favorably overall than instructing students' critical thinking skills. Multiple participants shared they either didn't directly assess critical thinking, but it was able to be assessed in other ways such as in hands-on or real-world assessments or that they didn't assess critical thinking at all. For those that said they assessed critical thinking in their programs, the most common methods used were formative, informal student-teacher discussions and short reflections, which are similar to the classroom assessment techniques suggested by Angelo (1995). A few teachers mentioned the use of a claim, evidence, reasoning summative assessment

strategy that is suggested in the Next Generation Science Standards (2018). With this strategy, students have to make a claim, use evidence to support that claim, and explain their reasoning behind their choice. Ennis (2016) suggests the utilization of both formative and summative strategies to best determine students' critical thinking skills. However, the minimal presence of either assessment style presented in this study's results do not echo their importance reflected in the found literature. However, this may be due to the lack of extensive research on critical thinking assessment strategies in classrooms.

Practice and Transfer. The final subtheme that developed in the research results was practice and transfer. Most examples provided by teachers through the interview phase of the study fit within this subtheme. Agriscience programs are abundant with opportunities for students to practice critical thinking skills, particularly in school-based agriculture facilities such as land labs, barns, and greenhouses. The most common critical thinking subskill that was expected of students to practice in the agriculture facilities was problem solving. Interestingly, teachers viewed giving students opportunities to "practice critical thinking" and to "transfer their critical thinking skills" more favorably than explicitly teaching students to transfer their thinking skills to new situations. Similar to the comparison found between teaching and expecting students to monitor and evaluate their thinking in the *Instruction* subtheme, these conflicting results may reflect CTE's inclination toward an immersive approach to critical thinking (Ennis, 1989b; Hyslop-Margison & Armstrong, 2004). On the other hand, the emphasis on practicing and transferring critical thinking to new situations in AFNR is supportive of literature also concluded critical thinking skills can be successfully transferred from the context in which they're taught (Billing, 2007).

Intriguingly, when teachers were discussing using the school's agriculture facilities to provide students with opportunities to practice and transfer their critical thinking skills, the term *hands-on* was used extensively as a descriptor for the type of work the students were doing while applying their critical thinking skills. While not within the scope of this research, this presents a question worth exploring on if the hands-on technique used by many of the teachers to practice critical thinking actually does provides the opportunity to do so, or if it is reflective of the lower order thinking skill, application, which has students use information in a new situation (Bloom et al., 1956). While the newly learned information is being transferred to the new task in the agriculture facility, is critical thinking itself being utilized or transferred?

The opportunities that AFNR instructors provided for students to practice and transfer critical thinking mostly fell within the classroom and laboratory component of AFNR education's three circle model of instruction. While a few teachers mentioned the other two components of AFNR instruction, FFA and supervised agricultural experiences, it wasn't commonly discussed among responses, although the study did not explicitly explore this. Because FFA and supervised agricultural experiences are significant components of AFNR programs and the literature supports using these additional components to improve students' critical thinking, this could be interesting to explore further (Beyer, 1987; Latham et al., 2014).

Importance. The second theme that contributes to the understanding of how Michigan AFNR instructors teach critical thinking is importance. There are three aspects: teacher preparation, confidence, and student outcomes, although the subthemes of confidence and student outcomes provide the most thought-provoking results.

Michigan AFNR teachers stressed the importance of critical thinking throughout the study, which is reflective of an increased emphasis on critical thinking in CTE and AFNR (see

Carnevale et al., 2020; Crawford & Fink, 2020, for examples). Furthermore, Weeks et al. (2020) similarly found AFNR instructors saw critical thinking as one of the most important skills for students to learn in a nationwide study.

Many Michigan AFNR teachers suggested confidence is a concept that plays an integral role in critical thinking. Critical thinking and confidence work together, each influencing the other. Building students' critical thinking skills requires building their confidence first, and ultimately, as students become critical thinkers, their confidence grows. While this concept was not explored in the found literature, it suggests a potential opportunity for future study.

Challenges. The final theme that developed in the study, challenges, includes three subthemes: teacher doubt, student concerns, and background knowledge. Because of the substantial and thought-provoking findings of each subtheme, they will be discussed individually.

Teacher Doubt. Weeks et al. (2020) found in a nationwide study, that despite AFNR instructors' certainty that teaching critical thinking was vitally important in their programs, their ability and confidence to do so lagged behind. This concept was also seen through this study's results. Many AFNR teachers are unsure of the best strategy to use to teach critical thinking, or if what they are doing is effective in doing so. Interestingly, teachers' attitudes toward the utilization of critical thinking instruction and assessment strategies were highly favorable, overall, despite this indication of doubt prevalent in the study. Speculatively, two factors may play a role in understanding why teachers struggle to feel confident in teaching critical thinking. First, many teachers indicated they struggled to utilize assessment strategies for determining if students were learning critical thinking skills. Without the feedback that would come with assessment, it is understandable that a teacher would struggle to know if their practices are

effective. Second, many teachers utilize immersion strategies for critical thinking instruction, so students are expected to learn or discover critical thinking independently when provided with ample opportunity (Ennis, 1989b). However, this approach may leave teachers questioning their students' abilities. Furthermore, this strategy is generally considered less effective at improving students' critical thinking skills in the literature (Hyslop-Margison & Armstrong, 2004).

Student Concerns. Swartz and McGuinness' (2014) framework do not address potential struggles that may arise with students when attempting to implement critical thinking instruction in a classroom. This absence is sorely obvious when presented with the variety of concerns that teachers had when trying to teach critical thinking. Time, safety, and pushback were the three concerns most commonly addressed by AFNR teachers, although a lack of time was the most common struggle mentioned. Swartz and McGuinness' framework (2014) suggests that generous time should be provided for students to practice their critical thinking skills. However, AFNR teachers shared that time can be a limiting factor because it takes students more time to "figure it out" than a teacher, in many cases. The consistency of opportunities to practice critical thinking provided by the agriculture facilities was also impacted by time limitations. The heuristic nature of many teachers' strategies may increase the time needed for critical thinking instruction, although additional research would be needed to identify if there is a connection. Additionally, the need to build students' background knowledge before expecting them to critically think also may limit the time available for this process.

Background Knowledge. The final subtheme that emerged through the theme, challenges, was background knowledge. Both the teacher and students' background knowledge were discussed, although students' background knowledge was emphasized by teachers. Background knowledge was not addressed on the study's survey, but it presented frequently in

the interviews. AFNR teachers feel background knowledge is vitally important to building students' critical thinking skills, which is comparable to multiple studies that also emphasized the need for building students' background knowledge before they can critically think about a topic (Glaser, 1984; Hyslop-Margison & Armstrong, 2004).

Research Question 3

Research question 3 asked, "How do AFNR instructors' teaching experiences impact how they teach and assess critical thinking in their classrooms?" RQ3 and RQ4 expand on the second research question to see if additional factors may influence how AFNR teachers implement critical thinking instruction. To understand how teachers' experiences may influence how they teach critical thinking in their AFNR program, RQ3 attempts to determine if teachers' years of AFNR teaching experience or the type of school where they teach has influenced their attitudes toward critical thinking instructional and assessment strategies. The type of school where an AFNR instructor teaches was not found to significantly impact their attitudes toward critical thinking instruction although there was an indication that teaching at a career-tech center influences teachers to expect students to monitor and evaluate their thinking through reflection more often than teachers who work at comprehensive high schools or CTE consortiums. The small size of the groups may have influenced this result, which warrants further investigation.

Surprisingly, a negative correlation was found between AFNR instructors' years of AFNR teaching experience and their attitudes toward four of the 24 critical thinking instruction statements. As a teacher gains AFNR teaching experience, they are less likely to teach students to analyze arguments, use logical reasoning, and use metaphors. Similarly, as teachers gained AFNR teaching experience, they identified as less favorable toward assessing students' critical thinking skills.

Interestingly, the idea that an emphasis on the importance of critical thinking increases as a teacher gets older was presented by multiple teachers in the survey, despite the contradiction with the quantitative results previously discussed. Less experienced teachers indicated that they struggled to teach critically think because of their focus on other important tasks, while more experienced teachers said they have an increased focus on critical thinking as they get older because of their gain in perspective. Instructors' teaching experience was not explored in the literature for this study, but these contradictory results merit further investigation. One potential explanation may be teachers' increased ability to critically think themselves as they gain experience, thus increasing their standard for what critical thinking instruction needs. Therefore, their perception of how well they are teaching it may change. On the other hand, teachers may choose to emphasize other skills as they gain experience, consequently decreasing their emphasis on critical thinking.

Research Question 4

Research question 4 asked, "How does AFNR instructors' preparation impact how they teach and assess critical thinking in their classrooms?" Similar to RQ3, this research question attempts to determine if additional factors influence AFNR instructors' attitudes toward critical thinking instruction and assessment. To do this, RQ4 compares both instructors' prior AFNR industry experience and their path to AFNR education to their attitudes toward critical thinking instruction to identify any present relationships.

Interestingly, a positive correlation was found between teachers' years of AFNR industry experience prior to teaching and their attitudes toward seven of the 24 statements regarding critical thinking instruction. One connection between the statements that are impacted by teachers' AFNR industry experience was a focus on metacognition. Teachers with AFNR

industry experience responded more favorably toward verbalizing the thinking process, explicitly teaching their students how to transfer their thinking skills to new situations, giving feedback on students' critical thinking, and expecting students to monitor and evaluate their thinking. With these results, it is reasonable to suggest that as teachers have spent more time working in the AFNR industry, they have gained experience using reflection and other metacognitive thinking strategies and ultimately implement them in their classrooms when they become teachers. However, a connection between metacognition and AFNR industry experience was not explored in the literature for this study, therefore, future examination of this relationship could be valuable to further understand why this connection presented in this study.

The results indicate that teachers who took non-traditional routes to AFNR education are not substantially different than teachers who took traditional routes in their attitudes toward critical thinking, other than those who took non-traditional routes are more likely to teach students to use metaphors to explain complex ideas than teachers who took a traditional route to teaching. The relationship between teachers' routes to teaching and their attitudes toward critical thinking was not discussed in the found literature so examining this comparison could provide an interesting follow-up.

Conclusions

The purpose of this study was to explore how Michigan secondary AFNR instructors teach and assess critical thinking in their programs. Ultimately, the study was successful in identifying Michigan AFNR instructors' practices, challenges, and principles around critical thinking instruction. Furthermore, the study was effective in identifying where Michigan AFNR instructors' practices fit within the research on critical thinking instruction and assessment, particularly their implementation of strategies identified in Swartz and McGuinness' (2014)

framework for critical thinking instruction. While AFNR instructors' understanding of critical thinking was a potential limitation of the study, the abundance of survey and interview responses that both fit within the conceptual framework and the literature indicate that this did not actually limit the study's significance.

Based on the results of this research, it can be concluded that Michigan AFNR instructors utilize a multitude of strategies that are known to effectively improve students' critical thinking. Swartz and McGuinness' (2014) critical thinking framework identifies three objectives of critical thinking: to teach thinking skills, to develop students' metacognition, and to improve students' thinking dispositions. Furthermore, it lists five subskills of critical thinking and provides examples of abilities that fall within the subskills. Based on the results, it can be concluded AFNR instructors utilize strategies meant to teach students thinking skills, improve students' metacognition, and build their thinking dispositions, although teaching thinking skills is substantially more common in their practices than developing metacognition or building thinking dispositions. AFNR instructors have favorable attitudes toward teaching their students to analyze, evaluate, synthesize, problem solve, and make decisions both in the classroom and in their school-based agriculture facilities. They also utilize strategies such as verbalizing the process for students and giving them opportunities to practice and transfer those skills. Furthermore, AFNR instructors set high expectations for their students as critical thinkers and provide feedback to build students' confidence in their ability to critically think.

However, it can also be concluded that Michigan AFNR instructors use some strategies that have been studied within the literature and are generally considered ineffective or less effective than others. As seen as a common practice in CTE in the literature, AFNR instructors sometimes apply immersive strategies for critical thinking instruction, meaning students are

expected to learn critical thinking independently when given the time to do so. However, the literature has also found the immersion method to be less effective than an infusion method that explicitly teaches or verbalizes the skill (Ennis, 1989b; Hyslop-Margison & Armstrong, 2004). Similarly, many AFNR instructors do not formally assess their students' critical thinking skills, which both makes it more difficult for teachers and students to know their abilities and for teachers to understand if their strategies are working effectively. This lack of awareness may be influencing teachers' doubt in their ability to teach critical thinking. Finally, one strategy that appeared, using hands-on applications, should be explored more in-depth because it is not known if it is effective. Many instructors provided students with hands-on applications for practicing their critical thinking skills. However, it is worth investigating if the hands-on aspect of the application actually calls on students' critical thinking skills.

Although some minor differences appeared between teachers based on AFNR teaching experience, AFNR industry experience, routes to teaching, and type of school, AFNR instructors are mostly similar in their instructional strategies and attitudes toward critical thinking. The differences that did arise between these groups suggest further investigation, however, the small sample size of this study may have played a role in not finding more significant results when comparing groups of teachers.

Discrepancies between survey and interview results also present an interesting juxtaposition. While teachers shared more examples of teaching students the higher-order thinking skills of analysis, synthesis, and evaluation on the open-ended survey questions, the interview responses emphasized problem solving. Furthermore, more than half of definitions of critical thinking in AFNR written by survey respondents focused on problem solving, but the definition ultimately chosen by interviewees did not.

Ultimately, this study has identified potential areas where research on critical thinking has not kept pace with the instruction and assessment of critical thinking in AFNR classrooms. The prevalence of experimental research in the literature has identified many strategies that are effective in improving students' critical thinking skills. However, this study's literature review did not identify nearly as many studies that attempt to identify teachers' current practices, the challenges facing teachers when attempting to teach critical thinking, and the best practices for improving how teachers instruct and assess critical thinking.

Recommendations

Two types of recommendations have surfaced from this study: to encourage further research and to build teachers' professional development and practice. This section will discuss the recommendations within each type and the study's findings used to justify those recommendations.

Further Research

Because this study was exploratory in nature, it gathered a broad perspective of AFNR teachers' practices. While utilizing Swartz and McGuinness' (2014) framework on critical thinking as a starting point, the researcher also hoped to identify practices that fall outside the framework. While the study was effective in doing so, it created a variety of interesting findings that merit further examination. Furthermore, future research can explore the aspects of critical thinking instruction and assessment in AFNR programs that were not addressed in this study.

From a broad view, this study's results suggest repeating this exploration with a larger audience including an investigation into differences between teachers based on their experiences and preparation for teaching. This study is representative of Michigan's AFNR instructors; however, it cannot be concluded that the results of this study would reflect those in other states

or regions. While some studies have explored critical thinking in AFNR education nationally, none of the research that was identified have collected teachers' attitudes toward specific practices used by instructors to teach critical thinking nor have they collected examples of how teachers utilize those practices. This recommendation is supported by the results that found small differences between groups of teachers in their attitudes toward critical thinking practices. For example, teachers who took traditional routes to AFNR education and those who took non-traditional routes to teaching only differed significantly in their attitudes toward using metaphors in their teaching. Speculatively, a larger sample size may find more significant differences. Furthermore, modifying this study to expand the number of participants in phase two could improve the results. The differences seen between what was emphasized in the definitions written by survey participants and the emphasis in the definition chosen by interview participants could be identified with a larger sample in phase two since a stronger consensus might be found.

Two significant aspects of AFNR education, FFA and supervised agricultural experiences, were not studied in-depth in this research. While some identified research, such as Moore and Moore (1984) and Latham et al. (2014), explored each of these AFNRE components, they were ultimately not a significant portion of this research because research has focused on the classroom and laboratory aspect of AFNR education. Because FFA and supervised agricultural experiences play a significant role in AFNR education as two components of the three-circle model of instruction and they were both mentioned by participants occasionally in the qualitative phase of the study, exploring their relationship to critical thinking could be beneficial. In particular, because supervised agricultural experiences are typically seen as a way for students to apply the skills they've learned in their AFNR classrooms, it could be interesting

to explore how critical thinking instruction in AFNR classrooms influences students' abilities to critically think in their supervised agricultural experiences.

Finally, when looking at specific themes or ideas that developed in the study, two ideas are worth more exploration. An investigation into *hands-on* applications for critical thinking and their effectiveness could be intriguing. Since the literature on this aspect of critical thinking instruction was not explored for this study, it is unknown if this is an effective strategy used by Michigan AFNR instructors. Taking an in-depth look at what hands-on means for AFNR teachers, identifying if there are differences in hands-on practices used, and determining how effective those practices are at improving students' critical thinking skills could be valuable.

Second, as teachers gained AFNR industry experience before teaching, they differed from teachers without that experience, especially in the area of metacognition. An interesting study could attempt to identify how AFNR industry experience increases teachers' attitudes toward explicitly teaching metacognition in their AFNR classrooms.

Professional Development and Practice

Over the course of the study, AFNR teachers made it clear that critical thinking is an essential skill for their students to develop as they prepare to enter the AFNR industry. However, the study's results also suggest implementation of strategies intending to teach critical thinking may have varying degrees of success. Therefore, professional development opportunities should exist to improve AFNR teachers' confidence and ability to teach critical thinking. Based on the input of participants, providing these opportunities to more experienced teachers, when they have more confidence in the management of their teaching expectations, may provide the most value to Michigan AFNR education. While teachers have favorable attitudes toward teaching all thinking skills in their classrooms, there are some inconsistencies in their attitudes toward the

abilities that fall within each subskill of critical thinking. For example, teachers' attitudes toward comparing and contrasting two items had the highest mean on the survey while creating sequences had the lowest. Both of these abilities fall under the subskill, analysis. Providing teachers with methods for teaching all of the abilities may improve their practices, ultimately.

Furthermore, AFNR teachers had more favorable attitudes toward and provided more examples of teaching thinking skills than they did for developing metacognition or thinking dispositions. When teachers did mention using practices intended for developing metacognition or thinking dispositions, they were often implicit practices intended to have students learn those skills independently. Since literature such as Hyslop-Margison and Armstrong (2004) and Ennis (1989b) have concluded those practices are less effective at teaching critical thinking than explicit strategies, professional development in this area could be valuable. McKendree and Washburn (2021) found that AFNR instructors struggled to implement metacognitive teaching strategies in their classrooms despite professional development that effectively improved their own metacognition, therefore multiple stages of professional development may be necessary to effectively improve this aspect of critical thinking instruction. Furthermore, the study's results indicate that AFNR industry experience has a positive impact on teachers' attitudes toward teaching metacognitive strategies in their classrooms; therefore, further investigation into this connection could lead to potential professional development for teachers to use new strategies for developing students' metacognition.

Ultimately, this study's results provide a few opportunities that could be implemented by AFNR teachers to improve their critical thinking instructional practices. First, AFNR teachers could make their critical thinking instructional practices more explicit for students. While study participants provide ample opportunity for students to practice and transfer their critical thinking

skills, particularly in their school-based agriculture facilities, explicitly teaching those practices first is not as common. Second, utilizing formative assessment strategies can improve two aspects of critical thinking instruction for those that do not already use them. Not only will teachers be able to provide feedback, which is an important aspect of critical thinking instruction according to Swartz and McGuinness' (2014) framework, assessing students' abilities may also decrease teachers' doubts about their strategies for critical thinking instruction.

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Appendix A

Survey Questions

You are invited to participate in the research study described below. Your participation is entirely voluntary, and you may stop your participation or withdraw from the study at any time and for any reason. If you choose to not participate or to stop your participation, there will be no negative consequences to you. Your decision to participate or not in this study will not change your relationship with the researchers or the University of Wisconsin-Stout.

This study is open to current Michigan secondary Agriculture, Food, and Natural Resources educators. The following survey is part of a study on how Michigan secondary agriculture, food, and natural resources (AFNR) instructors incorporate critical thinking instruction and assessment into their AFNR courses.

You will be asked to share how you currently incorporate critical thinking instruction and assessment in your AFNR courses as well as demographic information such as years of teaching experience and age. The survey will take approximately 15 minutes. The researcher does not believe this study will cause you any discomfort or other risk beyond what you would normally experience in your daily life. You will not be asked to provide your name or other personal details on this survey, and you may skip any questions that you are uncomfortable answering. There are no tangible benefits to participants for participating in the study, although the results of this study may positively impact AFNR instruction. Only the researcher will have access to the raw survey data that will be kept behind password protection. Summarized results from this study may be published, but identifying information will not be used. All collected survey responses will be anonymous, and any information collected during this study will be stored on a password protected laptop. Data from this study will not be used in future research projects.

If you have any questions about this study, please contact: Renee Schweitzer - schweitzerr4010@my.uwstout.edu or Debbie Stanislawski (Dissertation Chair) – stanislawskid@uwstout.edu. If you have concerns about this study or your rights as a participant, please contact: Institutional Review Board Chair, University of Wisconsin-Stout, Robert S. Swanson Learning Center #207, (715) 232-4042 or irb@uwstout.edu.

Your participation in this study is entirely voluntary. You may choose not to participate or to stop the study or survey without any adverse consequences to you. However, should you choose to participate and later wish to withdraw from the study, there may be no way to identify your data after it has been submitted. If you are participating in an anonymous survey, once you submit your responses, the data cannot be linked to you and cannot be withdrawn. This study has been reviewed and approved by the University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations for human subject’s research as required by federal law and UW-Stout policies.

By selecting yes below, I affirm that I am a secondary agriculture, food, and natural resources

(AFNR) instructor in the state of Michigan. I agree to participate in this study and understand that I may stop my participation or withdraw my consent at any time during active participation.

a. Yes
b. No

PAGE BREAK

1. Within the context of agriculture, food, and natural resources education, what does *critical thinking* mean to you?

PAGE BREAK

DIRECTIONS: This section is to gather your practices in developing critical thinking in students. The following questions refer to tasks that relate to critical thinking. Please select the extent to which you agree or disagree with the statements below when considering the skills, you teach students.

Likert Scale – Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree

In my AFNR courses, I *intentionally teach students to...*

1. think critically about AFNR-related topics
2. Make decisions in AFNR
3. Solve problems in AFNR
4. Compare and/or contrast two or more items
5. Classify and/or define items based on shared qualities or characteristics
6. Break a challenging or substantial concept into parts to understand its relationship to the whole concept
7. Create sequences (such as a decision tree or timeline) based on provided information
8. Analyze arguments to identify and evaluate the evidence used to make the argument
9. Examine their own assumptions about a subject
10. Assess the reliability of sources
11. Assess the accuracy of an observation
12. Use evidence effectively (such as to develop an explanation or to make a prediction)
13. Use logical reasoning to develop conclusions about a subject based on current knowledge
14. Combine thoughts or concepts to compose new ideas or solutions
15. Use metaphors to explain complex ideas (such as when problem solving)
16. Use symbols to create a model representing a complex idea (such as a cycle or process)

17. What teaching strategies or methods do you use to *teach* critical thinking in your AFNR classes?

PAGE BREAK

Likert Scale – Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree

18. I intentionally *assess* students' abilities to critically think in my AFNR courses.

19. What strategies or methods do you use to *assess* critical thinking in your AFNR classes?

PAGE BREAK

Likert Scale – Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree

20. When teaching critical thinking in my classes, I verbalize the thinking processes.
21. I explicitly teach students how to monitor and evaluate their thinking in my AFNR courses.
22. I explicitly teach students how to transfer their thinking skills to new situations.
23. I give students opportunities to *practice* critical thinking in my AFNR classroom.
24. I give students opportunities to *transfer* their critical thinking skills to new situations in my AFNR classroom.
25. I give students feedback on their critical thinking skills.
26. I expect students to monitor and evaluate their thinking in my AFNR courses through reflection.

27. What strategies do you use to explicitly teach students to monitor and evaluate their thinking?
28. What strategies do you use to give students the opportunity to practice or transfer their critical thinking skills?
29. What strategies do you use to give students feedback on their critical thinking skills?

PAGE BREAK

30. Listed below are four instructional methods that have been commonly identified as having an impact on students' critical thinking skills. Select the methods that you intentionally utilize in your AFNR courses (select all that apply).

    a. Project-Based Learning: Includes identifying an authentic issue, researching how to solve the issue, collaborating with stakeholders, presenting solutions, and implementing the solution.
    b. Inquiry-Based Learning: Includes developing questions, researching those questions, presenting new learning, and reflecting on learning
    c. Problem-Solving Approach: Includes presenting a problem exploring sources, arriving at a solution, testing the solution, and evaluating results)
    d. Discussion: Requires small or large groups of students to hold conversations on class subject matter)

31. What instructional methods, if any, do you use to teach critical thinking that were not identified in the previous question?

PAGE BREAK

Directions: Select the answers that best describe you for the following questions.

1. Including 2022-2023, how many years have you taught agriculture, food, and natural resources (AFNR) education?
    a. Scale from 1 year to 100 years

2. In which type of school do you currently teach?
    a. Career-tech center
    b. Comprehensive high/middle school
    c. County or Local CTE Consortium
    d. Other

3. What grade levels do you currently teach AFNR (select all that apply)?
    a. 6th grade
    b. 7th grade
    c. 8th grade
    d. 9th grade
    e. 10th grade
    f. 11th grade
    g. 12th grade

4. What FFA region do you currently teach in?
    a. Region I
    b. Region II
    c. Region III
    d. Region IV
    e. Region V
    f. Region VI

5. Which of the following scenarios *best* describes your route to teaching?
    a. Attended a post-secondary institution for AFNRE or similar degree and secured a teaching certificate before beginning to teach
    b. Attended a post-secondary institution for a non-AFNRE degree and secured a teaching certificate before beginning to teach
    c. Completed an alternative path to teacher certification (such as entering the profession from industry and receiving annual authorization)

6. How many years of agriculture-related industry experience did you have before beginning to teach (note: do not include years of industry experience during school/college or while teaching)?
    a. Scale from 1 to 100 years

7. The program where you currently teach is in which of the following Classification of Instructional Program (CIP) codes (Select all that apply)?
    a. 01.0000 Agriculture, Agricultural Operations, and Related Sciences
    b. 01.0601 Applied Horticulture and Horticultural Operations
    c. 01.0903 Animal Health & Veterinary Sciences
    d. 03.0000 Natural Resources & Conservation
    e. 26.1201 Biotechnology

8. What is your gender?
    a. Male
    b. Female
    c. Non-Binary
    d. Other
    e. Prefer Not to Say

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The second portion of this study includes further exploring how AFNR instructors intentionally incorporate critical thinking into their instruction through virtual interviews. The interview will take 45-60 minutes and will be conducted over Zoom. If you choose to participate in an interview, your survey responses will no longer be anonymous. However, all identifying information will be removed before data distribution.

If you intentionally teach and assess critical thinking in your classroom and would like to participate in phase two of the study, please check "yes" below. Otherwise, check "no."
A. Yes
B. No

PAGE BREAK

1. First Name
2. Last Name
3. Email Address

Appendix B

Institutional Review Board Approval

INSTITUTIONAL REVIEW BOARD
Office of Research and Sponsored Programs
Robert S. Swanson Learning Center #201
715-232-4042
irb@uwstout.edu

Date: March 10, 2023

PI: Renee Schweitzer

Department: TEACHING LEARNING & LEADERSHIP, GRADUATE STUDENT

Re: Initial - IRB-FY2023-146

Teaching and Assessing Critical Thinking in Michigan Secondary Agriculture, Food, and Natural Resources Programs

Dear Renee Schweitzer,

In accordance with Federal regulations, your project, *Teaching and Assessing Critical Thinking in Michigan Secondary Agriculture, Food, and Natural Resources Programs*, was reviewed by a member of the University of Wisconsin - Stout Institutional Review Board and was determined to be **Exempt** from full review under the below Categories in accordance with Federal Policy for the Protection of Human Subjects (45 CFR 46).

Category: Category 2.(i). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording).
The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects.

You project is hereby approved and deemed exempt from further IRB review for 5 years from March 10, 2023. If a renewal of this approval is needed, it is to be submitted at least 10 working days prior to the expiration date.

Responsibilities for Principal Investigators of UW-Stout IRB-approved research:

1. No subjects may be involved in any study procedure prior to the IRB approval date or after the expiration date.
2. All unanticipated or serious adverse events must be reported to the IRB.
3. All protocol modifications must be approved prior to implementation unless they are intended to reduce risk.
4. All protocol deviations must be reported to the IRB.
5. All recruitment materials and methods must be approved by the IRB prior to being used.
6. Research which involves financial compensation to participants must follow appropriate UW-Stout payment procedures.
7. Consent forms must adhere to UW-Stout IRB standards and indicate that the research has been approved by the UW-Stout IRB as required by federal regulations (see UW-Stout IRB consent form templates for more details).
8. Researchers conducting human subjects' research under an approved exempt category are still ethically bound to follow the basic ethical principles of the Belmont Report, as reflected in the practice of obtaining informed consent from participants and adherence to IRB approved methods.
9. Any modifications to the approved study must be submitted for review through Cayuse IRB. All approval letters and study documents are located within the Study Details in Cayuse IRB.

Thank you for your cooperation with the IRB and best wishes with your project. If you have questions, please contact the IRB office at irb@uwstout.edu or by phone 715-232-4042, and your question will be directed to the appropriate person.

Sincerely,

Michael Mensink, Ph.D.; IRB Chair

University of Wisconsin-Stout Institutional Review Board

Appendix C

Initial Email Requesting Participation in the Survey

Hi <Insert Recipient's Name>,

I hope the spring semester is going well for you and your students!

I am currently studying at the University of Wisconsin - Stout in the Career and Technical Education Ed. D Program. For my dissertation, I am conducting a study that is the culmination of my work in the program. Please find more information about the study below. I would really appreciate your participation in this study!

You have been invited to voluntarily participate in a research study. The title of the study is Teaching and Assessing Critical Thinking Skills in Michigan Secondary Agriculture, Food, and Natural Resources Programs. This study intends to gather your input on how you incorporate critical thinking instructional and assessment practices into your AFNR curriculum. Your response to this survey will help in understanding how Michigan secondary AFNR instructors incorporate critical thinking instruction and assessment in their courses.

While there are no direct benefits from participating, you will be directly contributing to the AFNR education profession. Furthermore, the results of this study may benefit you by ultimately providing you with valuable information on how critical thinking instruction and assessment can be integrated into AFNR programs.

The survey will take approximately 15 minutes to complete. All responses will be kept behind password protection. The survey can be completed anonymously. After completing the survey, you will be asked if you would like to volunteer for the second phase of the study which includes personal interviews further exploring how Michigan secondary AFNR instructors incorporate critical thinking instruction into their programs. Participation in any part of this study is completely voluntary, and you may choose not to participate at any time.

Here is a link to the survey. You can either click on the link or copy and paste the link: <Insert Link>

If you have any questions or concerns, please email me at schweitzerr4010@my.uwstout.edu.

Thank you!

Renee Schweitzer

Appendix D

Follow-Up Email Requesting Participation in the Survey

Hi <Insert Recipient's Name>,

I wanted to follow up to an email request I sent last week to participate in my study on critical thinking in AFNR programs. If you completed the survey, thank you! If you haven't, I would really appreciate your participation if you are able. Please complete the survey by Friday, April 7th. Thank you!

The following is the same information provided in the first email.

I am currently studying at the University of Wisconsin - Stout in the Career and Technical Education Ed. D Program. For my dissertation, I am conducting a study that is the culmination of my work in the program. Please find more information about the study below. I would really appreciate your participation in this study!

You have been invited to voluntarily participate in a research study. The title of the study is Teaching and Assessing Critical Thinking Skills in Michigan Secondary Agriculture, Food, and Natural Resources Programs. This study intends to gather your input on how you incorporate critical thinking instructional and assessment practices into your AFNR curriculum. Your response to this survey will help in understanding how Michigan secondary AFNR instructors incorporate critical thinking instruction and assessment in their courses.

While there are no direct benefits from participating, you will be directly contributing to the AFNR education profession. Furthermore, the results of this study may benefit you by ultimately providing you with valuable information on how critical thinking instruction and assessment can be integrated into AFNR programs.

The survey will take approximately 15 minutes to complete. All responses will be kept behind password protection. The survey can be completed anonymously. After completing the survey, you will be asked if you would like to volunteer for the second phase of the study which includes personal interviews further exploring how Michigan secondary AFNR instructors incorporate critical thinking instruction into their programs. Participation in any part of this study is completely voluntary, and you may choose not to participate at any time.

Here is a link to the survey. You can either click on the link or copy and paste the link: <Insert link>

If you have any questions or concerns, please email me at schweitzerr4010@my.uwstout.edu.

Thank you!
Renee Schweitzer

Appendix E

Interview Protocol

Study
Teaching and Assessing Critical Thinking in Michigan Secondary Agriculture, Food, and Natural Resources Programs

Interviewee Name: _____ School: _____

Interview Date: _____Interview Time: _____

Type of School: _____Grade Levels: _____

Introduction
Thank you for agreeing to meet with me today! *Take time to build rapport through a mutual interest. * You have volunteered to participate in a research study investigating how Michigan secondary AFNR instructors teach and assess critical thinking in their classrooms. You have identified yourself as someone who intentionally teaches critical thinking or its subskills in your AFNR program. During this interview, you will be asked to respond to open-ended questions. If you prefer, you can choose to not answer any of the questions. I will be recording this interview, with your permission. The interview will have four parts: your opinions on how critical thinking should be defined within AFNRE, how you teach and assess thinking skills, how you develop students' metacognition, and how you cultivate students' thinking dispositions. Your responses will be used to highlight best practices of critical thinking instruction in AFNR courses. All responses will be kept confidential, and identifying information will be removed before any results are shared. You have the right to terminate the interview and/or your participation in this study at any time.

Consent
In the email I sent setting up this interview, I included a copy of the consent form. Have you had the opportunity to review that?
Yes: Do you have any questions about the information shared in that?
No: Discuss form before starting.

Demographics
I have a few questions to confirm information about you. *Go through each of the demographic questions above.

Questions
1. During phase one of this study, AFNR instructors across the state of Michigan provided their own definitions for what critical thinking looks like within an AFNR program. I have combined those definitions into the ones on the list I previously emailed you. Were you able to determine which definition best represented your opinion? (If they didn't review them, give them time to do so, be prepared to share your screen with the list).

2. Do you have any suggestions or changes you think need to be made to the definition?
3. Tell me about how you teach critical thinking in your AFNR program.
    a. Probing Question: How often do you teach critical thinking?
    b. Probing Question: What subskills do you focus on?
    c. Probing Question: How do you present this lesson/unit?
    d. Probing Question: What class(es) do you teach critical thinking in?
4. Tell me about how you assess critical thinking in your AFNR program.
    a. Probing Question: How often do you assess students' ability to critically think?
    b. Probing Question: What subskills do you focus on when assessing?
    c. Probing Question: How do you determine if students are learning the critical thinking skills?
    d. Describe how you give feedback on critical thinking.
5. When you teach critical thinking, have you been able to teach students to monitor and evaluate their thinking in your AFNR courses?
    a. Probing Question: How often do you teach students to monitor and evaluate their thinking?
    b. Probing Question: Have you had the opportunity to teach students to transfer their thinking skills in your AFNR courses?
    c. Probing Question: How do you verbalize/explain this to students?
    d. Probing Question: What is the impact of teaching students to monitor/evaluate their thinking in this way?

For the probes above, use their responses to determine which probes to ask. Incorporate their responses into the probe, "I heard you say…"

Conclusion

1. What activities/events led to you teaching critical thinking in this way?

2. Do you have anything you want to add that we have not talked about?

Thank you for participating in this survey. The information you have shared through your responses will be used to describe how AFNR instructors teach and assess critical thinking in their AFNR courses. Identifying information will be removed before any results are shared. If you have any further questions, please contact me at the email address I have used in our previous communication. Thank you.

Appendix F

Interview Scheduling Email

Hi <Insert Recipient's Name>,

Thank you so much for agreeing to participate in phase two of my research study!

Phase two of the study includes individual interviews with teachers who intentionally teach critical thinking in their AFNR courses.

The title of the study is *Teaching and Assessing Critical Thinking Skills in Michigan Secondary Agriculture, Food, and Natural Resources Programs*. Your participation in phase two will help highlight best practices for incorporating critical thinking instruction and assessment in AFNR courses.

While there are no direct benefits from participating, you will be directly contributing to the AFNR education profession. Furthermore, the results of this study may benefit you by ultimately providing you with valuable information on additional methods for integrating critical thinking instruction and assessment into your AFNR program.

The interview will take 45-60 minutes and will be held via Zoom. All responses will be kept behind password protection. All identifying information will be removed before results are distributed.

I would like to schedule the interview in the next two weeks. At the link below is a schedule where you can select a time that works for you.

<Insert Link to Meeting Scheduler>

If none of the times work, please let me know, and we can find a time that does.

If you have any questions or concerns, please email me at schweitzerr4010@my.uwstout.edu.

Thank you!
Renee Schweitzer

Appendix G

Email to Provide Interview Link

Hi <Insert Name>,

Thank you so much for signing up for an interview! Your interview is scheduled for <Insert Date>.

As a reminder, the interview will take 30-45 minutes and will be held via Zoom. All responses will be kept behind password protection. However, as with all online activities, there is an inherent, although unlikely, risk of a data breach. All identifying information will be removed before results are distributed.

There are two documents attached that I would like you to review before the interview if you have time. First, you can find the IRB consent form attached. Additionally, there is a list of possible definitions for critical thinking in AFNR attached. Please review the list and choose the definition or combination of definitions that best represents your opinion. If you have any suggestions for changes, please bring them to the interview.

The link for the interview is below.

<Insert Link>

Thank you,

Renee Schweitzer

Appendix H

Institutional Review Board Interview Participation Information

Your participation in this study is entirely voluntary. You may choose not to participate or to stop the survey without adverse consequences to you. However, should you choose to participate and later wish to withdraw from the study, there may be no way to identify your data after it has been submitted. If you are participating in the survey anonymously, once you submit your responses, the data cannot be linked to you and cannot be withdrawn. If you provide identifying information, once your name is separated from the survey data, the data cannot be linked to you and cannot be withdrawn. Your participation in phase two of the study can be withdrawn at any time.

This study has been reviewed and approved by the University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations for human subject's research as required by federal law and UW-Stout policies.

You have volunteered to participate in this research study. Your participation is entirely voluntary, and you may stop your participation or withdraw from the study at any time and for any reason. If you choose to not participate or to stop your participation, there will be no negative consequences to you. Your decision to participate or not in this study will not change your relationship with the researchers or the University of Wisconsin-Stout.

This study is open to current Michigan secondary Agriculture, Food, and Natural Resources educators.

The following interview is part of a study on how Michigan secondary agriculture, food, and natural resources (AFNR) instructors incorporate critical thinking instruction and assessment into their AFNR courses.

You will be asked to share how you currently incorporate critical thinking instruction and assessment in your AFNR courses. Through a literature review, a framework for critical thinking instruction that includes teaching thinking skills, incorporating metacognition, and cultivating thinking dispositions has been identified. The following interview will gather how you integrate those three aspects of critical thinking instruction into your AFNR curriculum.

The interview will take approximately 45-60 minutes. There is a risk of a data breach with all online use. However, precautions have been made to maintain confidentiality. All data will be stored behind password protection that only the researcher has access to. Names and identifying information will be removed from interview responses. The data from the interviews will be used to highlight the best practices for teaching and assessing critical thinking in AFNR courses and create a consensus definition for critical thinking in AFNR.

If you have questions about this study, please contact Renee Schweitzer at schweitzerr4010@my.uwstout.edu. If you have concerns about this study or your rights as a

participant, please contact the Institutional Review Board Chair at the University of Wisconsin-Stout: Robert S. Swanson Learning Center #207, Menominee, WI 54751, (715) 232-4042, or irb@uwstout.edu.

Appendix I

Definitions for Critical Thinking in AFNR Provided on Phase One Survey

1. Having students analyze a situation with possible outcomes.
2. Students are able to think and apply knowledge beyond a yes or no; correct or incorrect response.
3. Being able to problem solve and think of multiple solutions.
4. The ability to synthesize and process information-to seek an answer that isn't just black and white. To form a conclusion or opinion based on information at hand.
5. The ability to evaluate information and situations, gather facts, and use the information to solve a practical or theoretical problem. Critical thinking evaluates the source and reliability of information, determines what information is needed, accesses the information, and applies it to the problem at hand. Finally, the proposed solution is evaluated for effectiveness.
6. Critical thinking means that students are handed a challenge in which they must develop a solution to an issue or a belief statement backed by science.
7. For students to be able to think independently- evaluating information and creating opinions based on their own experiences and knowledge.
8. Using available information to make the best decisions or series of decisions
9. Critical thinking means that students are able to make decisions about the best course of action when presented with a given scenario in the AFNRE field.
10. Problem solving by applying concepts learned in the classroom to solve problems in their labs and Supervised Agriculture Experiences.
11. Critical thinking means that students take time when evaluating a problem and find a solution that is strengthen either in their gained knowledge or research.

12. Being able to problem-solve to resolve an issue. Think further than face value of things.
13. A student's ability to figure things out on their own, or try to figure things out on their own first before asking for help or being able to know what to do/what is coming next.
14. Being able to be handed a problem and use hands on skill or prior knowledge to solve the problem.
15. Critical thinking means using planning and collaboration to decide the most efficient and sustainable ways to use our natural resources to feed our populations.
16. Being able to look at a problem or a situation and think about and work on a plan of solving the problem
17. In the context of AFNR Education Critical Thinking means to analyze and evaluate facts as they are presented in regard to Agriculture. As an Educator you must decipher which are the important or most relevant issues to educate students on and help guide them to solutions.
18. I believe it is necessary to analyze and evaluate issues that we encounter in AFNR education to arrive at solutions.
19. Being able to solve problems from using background knowledge and asking questions and engaging conversations and background knowledge to get there
20. Seeing a problem and devising a solution which may need to be altered several times before the problem is solved
21. Critical thinking means students can gather information and form a hypothesis about something or an idea and create an action plan based on the information that they have.
22. Thinking on your feet, solving problems
23. Critical thinking means that those that are dealing with ag or natural resources are examining current issues within those fields and coming up with proposed solutions. The proposed

solutions should be considerate of how these solutions affect the ag/nat resource field but also other fields. Students should be using critical thinking skills individually but also in group settings.

24. Students who have to think outside the box. Utilizing first hand learning then applying it
25. It is a key component to success in life and therefore key to the Ag ed content.
26. Critical thinking is an essential skill for agriculture students as it enables them to evaluate information, analyze data, and make informed decisions. critical thinking is a crucial skill for agriculture students to develop as it can help them become more effective problem-solvers and decision-makers in the agricultural industry.
27. Critical thinking to me means thinking outside the box, and using a multitude of skills and resources to solve a problem, especially in ag ed you have to make thousands of split decisions on the spot.
28. The ability to solve a problem or challenge in the most efficient way possible.
29. The ability to look at new information or circumstances and be able to determine a solution.
30. To be able to look at a situation and come up with a solution.
31. Critical thinking means to analyze the situation and use your skill set to find viable solutions to the problem. It means that you are applying what you know and have learned.
32. Using thinking skills that extend beyond the basics. Using multiple aspects to come to a consensus.
33. Using and applying knowledge to an issue to come up with a solution and apply said solution to problem and analysis the result
34. How you assess students. Does it require the student to think about then answer vs fill in the blank answers.

35. Problem solving ability, using information to inform an opinion on a topic or subject. Could include the use of tools, equipment, or simply formulating and intelligent opinion.
36. Reviewing collected data, viewing and recording observations followed by the necessary decision making required to successfully complete a task. The critical thinker would take all possible outcomes into consideration before enacting a process.
37. Presenting students with problems and having them try to find a solution is the biggest critical thinking activity that I can put my students through. I believe that students are not put in uncomfortable thinking situations enough and luckily, AFNR provides very real problems that must have solutions.
38. Problem solving, bringing new ideas
39. Being able to solve problems/issues and sort through information and resources to verify them
40. The ability to analyze a situation or problem and draw conclusions using knowledge previously learned
41. Students trying to discover answers for themselves, such as using the scientific method
42. It means thinking beyond the information that is in front of you. It includes asking questions, seeking more information, and making decisions based on the information provided. Critical thinking includes an application of the material beyond what was presented.
43. To utilize current knowledge. obtain relevant information, or analyze data to formulate conclusions or solve problems.
44. Considering a topic (issue, phenomenon, *etc*.) and using background knowledge and deductive reasoning to develop a deeper understanding of the topic.

45. Critical thinking is a form of higher level thinking, where you take basic knowledge or experiences and apply it to concepts.
46. Higher level thing to solve AFNR problems. Using questions, analysis, and evaluations to make judgments or to find solutions to problems in AFNR education.
47. It's a skill students must develop in order to be successful in the career.
48. Read and analyzing information then making decisions about what to do with it.
49. A thought process that applies concepts at a deeper level to formulate a more advanced solution.
50. I would describe critical thinking as how capable people are at evaluating the bigger picture and digging deeper to understand meaning and contexts.
51. It means teaching students and FFA members to cognitively process the project, program, or assignment to make a best decision in regard to it.
52. Making connections between AFNR topics and other disciplines, professions, or topics; using high orders of Bloom's Taxonomy in AFNR education (creating, evaluating, analyzing)
53. Using the information, you have to make a decision.
54. Problem solving in order to reach a goal.
55. Thinking on own to problem solve
56. Diving deeply into a problem to assess all aspects and develop a possible solution.
57. To problem solve an agricultural issue with the use of analysis, evaluation, deductive reasoning. Given minimal knowledge the students will need to come up with what the exact problem is and come to a reasonable solution.
58. Thinking deeply about the content both from a mental and grand stand-point

Appendix J

Example of Thematic Analysis Process for Interview Responses

Instruction Assessment Practice and Transfer
Teacher prep Confidence Student Outcomes
Student Concerns Background knowledge Teacher Doubt

Raw Capta	Reduction of Raw Capta	Initial Themes	Re-evaluation of Themes/Subthemes	Enduring Themes (Theme = **bold**, subtheme = *italics*)
~~I think we do employ critical thinking in a a few different ways, but probably the the main way first semester is through their~~ Ag or Science Fair projects where they really are, hitting a lot of things on this list like doing the background information and then kind of applying that background information, formulating a hypothesis, troubleshooting how they're going to set up an experiment. That, that definitely takes thinking about the problem and their specific hypothesis, and how they're going to address it through their experimental design. ~~Yeah, sorry. There must be other ways. But you know later, later in the year. I think they do~~ apply critical thinking definitely when they like go out to do a FFA Skills competition or something. They are kind of given an unfamiliar situation and trying to figure out how to, how to solve problems together, how to, how to make the most of that kind of unfamiliar thing.	Ag or Science Fair projects where they really are, hitting a lot of things on this list like doing the background information and then kind of applying that background information, formulating a hypothesis, troubleshooting how they're going to set up an experiment. That, that definitely takes thinking about the problem and their specific hypothesis, and how they're going to address it through their experimental design. apply critical thinking definitely when they like go out to do a FFA Skills competition or something. They are kind of given an unfamiliar situation and trying to figure out how to solve problems together, how to make the most of that kind of unfamiliar thing.	Practice and transfer	Practice and transfer	**Application** – *Practice and Transfer* "There are many ways for students to practice and transfer their critical thinking skills in ag programs – such as Agriscience fair, land labs, etc. – but many of the skills are not initially taught before they're expected to be used."
We do, we do use like some of those metacognitive type techniques within reading assignments and things so, and sort of like almost teaching them those those meta-cognitive techniques as we go through assignments together. I'll do some demos of like how I tackle something unfamiliar, an unfamiliar piece of text, and how I like relate different vocabulary back to things that might be a little bit more familiar or used in more familiar terminology. ~~I don't know if that answered your question completely.~~	we do use like some of those metacognitive type techniques within reading assignments and things so, and sort of like almost teaching them those meta-cognitive techniques as we go through assignments together	Metacognition	Instruction	**Application** - *Instruction*
	I'll do some demos of like how I tackle something unfamiliar, an unfamiliar piece of text, and how I like relate different	Teaching thinking skills	Instruction	**Application** - *Instruction*