HEARING Safety Across Agricultural Education:
A Three-Study Evaluation of Student Perceptions and Understanding of HEARING Safety

by

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A dissertation submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Doctor of Philosophy

Auburn, Alabama
May 4, 2024

Keywords: agricultural mechanics, hearing safety, safety climate, safety culture,
school-based agricultural education, university-based agricultural education

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ABSTRACT

The behavior relating to safety practices seen in agriculture, especially involving hearing, highlights a critical concern when examined. This dissertation reviews three studies focusing on the attitudes, perceptions, and safety practices regarding sound concerns and hearing protection use in agricultural mechanics laboratories. These studies collectively emphasize the gap in students' understanding and application of hearing safety practices, despite the known risks associated with high decibel (dB) exposure from tools in an agricultural setting.

The first study examines the inconsistency between students' perceptions of noise levels and the actual dB output of tools within a university-based agricultural mechanics laboratory. By incorporating both direct and indirect exposure through project-based learning and informational posters, correct identification of hearing protection used based on their own identified thresholds improved. The data indicated a narrowing perception gap, demonstrating an increase in the recognition of decibel outputs compared to one’s perceived willingness to use hearing protection.

Continuing this investigation, the second study builds on the project by examining students' safety practices within a university-based agricultural mechanics setting. Despite alignment with the National Institute for Occupational Safety and Health's recommended hearing protection threshold, a concerning disconnect between intention and practice was revealed, highlighting the need for further education and research on knowledge and application gap.

The third study extends this research into a school-based agricultural education setting, emphasizing the knowledge gap among secondary-students regarding hearing protection. While the study confirmed an improvement in students' understanding and intended behavior towards hearing safety through indirect exposure, the variation in intended and proper use of hearing

protection for commonly used power tools suggests an inadequacy in the safety educational process or lack of accepted safety culture among these students.

Together, these studies highlight the need for targeted curriculum development in agricultural education to address hearing safety awareness and practice. Through the use of direct and indirect exposure, reflective learning, and continuous reinforcement of safety practices, there is potential to significantly enhance the safety culture across agricultural education, ultimately reducing the risk of hearing loss and empowering safer agriculturalists.

DEDICATION AND ACKNOWLEDGEMENTS

Clare, you have been our rock and captain throughout this journey. Thank you for agreeing to take and keeping me on this ride with you. Auburn may not have originally been in our long-term plans, but this experience has brought us closer to each other and allowed us to explore our strengths and weaknesses through our support for each other. Your passion and creativity are intoxicating, and you make me a better person each day. You are my best friend, awesome wife, and fantastic mom. You make this world a better place through the work you do with the people you encounter. Finishing this process would not have been possible without you. Thank you!

Evee, you were the most unexpected and wonderful surprise of this journey. Your curiosity and wonder push me to be the best role model I can be. I pray that the yield of this experience provides us with the foundation to give you the freedom to do what you want to do and succeed on any path you decide to take.

Mom (Purr-Purr) and Dad (Daideo), your love has been felt no matter where I am at. You instilled in me the value of hard work and unbridled exploration. Thank you for being there thought my highs and lows, and always keeping me honest even if it is just a band concert.

Momma Kate (Nomy) and Edawrd (Papa), thank you for sharing your daughter with me and being a support structure for us! Your love and support have been felt throughout the entire process and we would not have been able to get to the finish line without your support.

I would like to thank my committee chair, Dr. McKibben, for believing in me and supporting my journey starting at Texas A&M University and throughout my time at Auburn University. Your guidance throughout my studies, research, and non-academic endeavors has always been appreciated and taken to heart. I will always remember to have my bag packed and ready for any adventures that may lie ahead.

I would also like to thank my other committee members, Dr. Lindner, Dr. Clemons, and Dr. Chapman, for all the knowledge and wisdom you have shared with me through your courses and advice provided during the dissertation process. Your influence has made the Auburn experience one of a kind and beyond memorable. Thank you for your support and providing a sense of home during my time at Auburn.

To all of those who I have crossed paths with or shared a discussion post with during our time at Auburn, thank you for making this experience a journey that I will look back on fondly. Being a part of such an amazing group of scholars has pushed me to be a better student, teacher, and human being. The thought-provoking questions and incredible advice that has been shared in each and every class we have taken together will be remembered for years to come. The trips and events that we endured provided the space for us to grow and see that it truly takes a village to succeed in a graduate program.

Mom, Dad, Kate, and Edward, thank you for your love and support throughout this process. Clare and I would not have been able to get to where we are today without all you have done for us. We are beyond grateful for all you have done, and we both know how blessed we are to have you all in our lives!

Clare – I owe this success to your love and support! You are my rock and I love you!

CONTRIBUTORS AND FUNDING SOURCES

This work was supervised by a dissertation committee consisting of Dr. McKibben (committee chair), Dr. Lindner (committee member), Dr. Clemons (committee member), and Dr. Chapman (committee member). This dissertation was reviewed by Dr. Rabinowitz (external reviewer).

The data analysis was done under the supervision of Dr. McKibben. All other work for the dissertation was completed by the student independently.

There was no outside financial support for this study.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
CDC	Centers for Disease Control and Prevention
dB	Decibel
dBA	A-weighted Decibels
HPU	Hearing Protection Use
MET	Mere Exposure Theory
NIOSH	National Institute for Occupational Safety and Health
PPE	Personal Protective Equipment
SBAE	School-Based Agricultural Education
TPB	Theory of Planned Behavior

CHAPTER I.
INTRODUCTION

Across agriculture, safety in the training and education of agriculturalists has been a topic of discussion for many years (Choi et al., 2005; Hancock & McKibben, 2024; Masterson, 2018; Matthews, 1968; Miller, 1989). Within agricultural education specifically, there has been a focus on the shortcomings that are found prevalent across the multiple educational levels that include, but are not limited to, School-Based Agricultural Education (SBAE) and post-secondary education (Albritton & Roberts, 2020; Chumbley et al., 2018; Conner et al., 2014; Dyer & Andreasen, 1999; Hancock, 2024; Langley et al., 2018; Saucier et al., 2014). Agricultural education and the larger field of education has seen an increase in active learning techniques being utilized by instructors, which leads to students of all ages actively participating in more and more hands-on learning activities (Akkermans et al., 2020; Langley et al., 2018; Saucier et al., 2014). As these active learning opportunities start to mimic real-world situations more closely, students are exposed to different environments that bring to light new safety concerns (Dyer & Andreasen, 1999; Love et al., 2022; Mazurkewicz et al., 2012; Phipps & Reynolds, 1990). Among these concerns is student and instructor exposure to sound and increased decibel (dB) exposure that they might not normally be exposed to (Bunch, 1937; Franklin, 2008; Hancock et al., 2023; Herren, 2014; Slaydon, 2009; Woodford et al., 1993). This research, through three connected but individual studies, will explore the perceptions and understanding of hearing safety concern areas as well as the personal protective equipment (PPE) use of agricultural education students across the SBAE and post-secondary levels. This exploration will provide insight into the current culture relating to hearing safety, and a foundation for future research and development of hearing safety curricula.

Background

Those involved in agricultural pursuits are often engaged in activities that have heightened safety concerns. These activities may be hazardous largely to their physical body overall, or more specifically focused on a specific area such as eyesight, hearing, or respiratory systems, just to name a few (Frank et al., 2004; McCurdy & Carroll, 2000; McCurdy & Kwan, 2012; Von Essen, 1998). As agriculture engages with more and more automation, so raises the risk associated to a single individual as they are required to become more knowledgeable on the safe practices of a wider range of equipment or tasks associated with their daily activities (Edan et al., 2023; Shutske, 2022).

This increase in needed knowledge typically falls to the agricultural education system to help establish opportunities for individuals to experience or learn about these practices (Hubert et al., 2003; Murphy et al., 1996; Peden et al., 2023). Safety across agricultural education, including SBAE and post-secondary agricultural education, has been of the utmost importance; however, there has been an increase in the need and focus on practical application beyond the scope of traditional production agriculture (Boehlje & Schrader, 1996; Tvrdoň, 2003). This increased focus lends itself to the education of all types of agriculturalists including hobbyists and those who aim to pursue an active career in production agriculture (Martin & Enns, 2017; Rayfield et al., 2013). For those who may only tangentially engage in agriculture, the education of practical hands-on skills provides a framework for lifelong learning and promotes a culture of safety that can influence practices across all subject matters.

Due to this increased focus on practical skills, students engaged in agricultural education are often exposed to opportunities where they are placed in a simulated agricultural environment and are required to actively participate in the learning process (Bernardo, 1993; Wells & Miller, 2020). As students become more actively involved, their experiences require a heightened sense of safety management by the agricultural educators that are leading the instruction. This leads to agricultural educators needing more background and understanding of the proper application of safe practices and working knowledge of a strong culture of safety (Chumbley et al., 2018; Dyer & Andreasen, 1999; Hancock & McKibben, 2024; Hubert et al., 2003). There have been numerous studies that indicate that there is a need for development of training curricula specifically for these educators to meet their increasing requirement of safe practice instruction (Hancock, 2024; Johnson & Schumacher 1989; Langley et al., 2018; Ulrich et al., 2002). This increase requirement has been broken into numerous smaller categories which have been identified, among others, by Dyer and Andreasen (1999). They identified multiple safety areas of concern that agricultural educators encounter, specifically in an agricultural education laboratory, many of which are still areas that are not properly being addressed today. These areas include occurrence of accidents, availability of safety equipment, noise levels, ventilation, and the perceptions and attitudes of safety by teachers, students, and administrators.

Specifically focusing on the hearing safety components described in their research, multiple studies have found that there are still concerns that arise across SBAE and post-secondary agricultural education levels (Bunch, 1937; Franklin, 2008; Hancock et al., 2023; Herren, 2014; Woodford et al., 1993). The sound levels that agriculturalists are exposed to often rise to a level that is harmful to an individual well above the dB deemed appropriate (Beckett et al., 2000; Depczynski et al., 2005; Ehlers & Graydon, 2011; Lander et al., 2007). This real-world concern also migrates into the classroom as SBAE and post-secondary agricultural education simulates these experiences and exposes students to high dB output in a controlled educational setting (Broste et al., 1989; Renick et al., 2009; Woodford et al, 1996). As students and educators are more exposed to the high dB output, they are at higher risk of hearing related injuries and any negative practices that are being engaged in through the course instruction provides a foundation for lifelong behaviors that can be potentially harmful to one's health if not adequately addressed (Chumbley et al., 2019; Hancock & McKibben, 2023; Fellner & Sulzer-Azaroff, 1984; Mullen, 2004).

The National Institute for Occupational Safety and Health (NIOSH) serves by providing research and training information to governing bodies within the Centers for Disease Control and Prevention (CDC) and has provided numerous standards and recommendations relating to hearing safety and noise concerns. The recommended exposure limit that NIOSH recommends is 8 hours at a weighted average of 85 dBA (NIOSH 2018a). This recommendation was proposed by Chan (1998) along with an exchange rate of halving the time of exposure for every increase of 3 dBA. This recommendation indicates that if individuals are exposed to less than an average of 85 dBA over the course of an eight-hour workday, they should not expect to suffer significant hearing loss; however, if the average were at 94 dBA the time work should be limited to would be decreased to one hour. With instruction in an educational setting is often set to no more than a 90-minute window (Queen, 2008), the average exposure limit would be set between 91 dBA and 94 dBA (Chan, 1998) within that time period.

As SBAE and post-secondary agricultural education continue to focus on providing students opportunities to build skills and behaviors in an attempt to better equip them to be successful in the workforce (Easterly et al., 2017; Rateau et al., 2015; Roberts & Ball, 2009), regardless of their chosen career, a discussion is being had on the proper application of instruction and building of a culture of safety to promote said instruction (Chumbley et al., 2018, 2019; Hancock & McKibben 2024; Ulrich et al., 2002). Modeling safe practices is an imperative act that agricultural educators must engage in, to promote said behavior in their students (Bandura, 1977b). Regardless of the safety area that is being modeled, students are being exposed to social and behavioral norms that are being reinforced through the use of active learning strategies (Conner et al, 2013; Daniels, 1989; Dyer & Andreasen, 1999; Harren, 2014). Due to the continued efforts of educating the next generation of safe agriculturalists, the current state of safety instruction and the practices expressed throughout the agricultural education curriculum must be further explored.

Statement of the Problem

As agricultural education instructors increasingly use active hands-on learning activities to supplement curriculum, the safety concerns become more pressing. Dyer and Andreasen (1999) discuss a series of safety concern areas that needed to be addressed, which subsequent studies have shown these areas to only be addressed slightly. In the context of hearing safety, there has been little research conducted specifically on the perceptions and understanding of agricultural students and their instructors. The research that has been conducted shows that there is a perception and knowledge gap regardless of the participants of the studies. This in conjunction with presented research that indicates agriculturalists, including those in the education thereof, are exposed to dB outputs significantly higher than the recommended exposure level, indicates a need to further determine the perceptions, knowledge, and practices of agricultural education students.

Statement of Purpose and Research Questions

The purpose of these studies was to gain insight into the perceptions and understanding that agricultural education students have on hearing related safety areas. These studies were derived from three research questions: (1) What effect does exposure of information have on post-secondary agricultural mechanics students' perceptions of dBs? (2) What impact does exposure of dB information have on post-secondary agricultural mechanics students' hearing related personal protective equipment use? (3) What is the hearing related safety concern perception differences of SBAE students participating in agricultural mechanics or non-agricultural mechanics courses? Each study was personalized with induvial research objectives unique to that study, all of which point back to the overarching research questions.

Theoretical and Conceptual Frameworks

Across the studies presented in this dissertation, two main theories were used as frameworks theoretically and conceptually. Both the Theory of Planned Behavior and the Mere Exposure Theory served as the overarching framework that informed the processes throughout each of the three individual studies.

Theory of Planned Behavior

The Theory of Planned Behavior (TPB) was developed by Ajzen (1991) building off of concepts originally described in the Theory of Reasoned Action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) and echoing additional concepts from Bandura's proposed Social Cognitive Theory (1977a) and Social Learning Theory (1977b). TPB focuses specifically on an individual's intention to perform a given behavior by addressing the motivational factors that influence said behavior. Ajzen (1991) theorized that three driving factors either strengthen or weaken an individual's intentions to engage in a behavior. By examining an individual's Attitude Toward a Behavior, the Subjective Norms of a Behavior, Perceived Behavioral Control, or the interactions thereof, Ajzen (1991) stated that one's intentions and behavior can be determined. In these studies, TPB was utilized as a framework when analyzing results, specifically addressing students' attitudes toward the behavior of hearing related personal protective equipment use.

Mere Exposure Theory

The second theory used, as a conceptual framework, was Zajonc's (1968) Mere Exposure Theory (MET). This theory focuses on the notion that familiarity to an action or object provides a foundation for understanding of said thing. Two main beliefs stem from MET, the first being that as an individual is more exposed something, the processing of barriers is eased. The second main belief being that partiality is directly related to the work needed to process a stimulus (Reber et al., 1998; Vincent et al., 2020). Students, including those in agricultural education, constantly introduce and expose students to new information. These studies explore the exposure of dB output both directly and indirectly through the direct use of tool use and indirect posting of informational posters. Through the framework of MET, examine the associated connections between student willingness to wear hearing PPE and their exposure to dB output information.

Significance of the Studies

The findings of the three studies hope to guide agricultural educators of all levels to further discuss the shortcomings described in current and past research. This research may serve as a foundation for curricular development in and around hearing safety with direct and indirect exposure to dB outputs serving as a key focus. Additional exploration of the findings would also lead further research being conducted in and around the culture of safety for Agricultural Education in regard to current SBAE instruction, the instruction of pre-service SBAE instructors, and post-secondary agricultural mechanics instruction.

Structure of the Studies

To best explore the current climate on hearing safety across agricultural education, three separate studies were conducted as part of an ongoing research project. This three-journal article dissertation, consisting of five established chapters, covers the foundation, findings, discussion, and recommendations from each of the different studies of this related research. Each of the three studies (Table 1.1) are presented as individual articles across separate chapters.

Table 1.1

Summary of Research Design and Methods

Study	Method(s)	Sample	Product(s)
Hearing Education in Agriculture: Re-evaluating Interest, Needs, and Growth	Pretest/Posttest w/ Exposure Control	40 post-secondary students	Participant dB Thresholds
HEARING in Practice	Pretest/Posttest w/ Weekly Reflection & Exposure Control	83 post-secondary students	Participant dB Thresholds & Hearing PPE Use
Knowledge of HEARING	Pretest/Posttest w/ Knowledge Quiz Exposure Control	104 SBAE students	Participant dB Thresholds & Hearing Knowledge

Article I provides findings from the foundational study that identified an established dB threshold for hearing PPE use of university students enrolled in an agricultural mechanics course at Auburn University. The findings of this study prompted and informed the study presented in Article II where separate Auburn University students participating in similar agricultural mechanics courses across two different semesters were asked to provide their dB threshold for hearing PPE use and weekly reports of their PPE use. Article III takes the lessons learned from the studies presented in Article I and II and shifts the focus to SBAE students. This study looks at the differences between agricultural mechanics and non-agricultural mechanics related to their perceptions of dB outputs in an agricultural education setting and knowledge of hearing safety concerns. Article III concludes this dissertation with a summary of the studies, implications determined from the studies, and ends with future research and practice recommendations.

Article I: Hearing Education in Agriculture: Re-evaluating Interest, Needs, and Growth (HEARING)

For the foundational study of the HEARING project, post-secondary students enrolled in a university-based agricultural mechanics course were asked to assist in identifying hearing related safety concern shortcomings within agricultural education. Participation over this semester-long study included 40 students who completed a pre-instruction instrument and 35 students who completed the post-instruction instrument. Between the administration of the two instruments, students were exposed directly and indirectly to dB output via direct tool use and indirect informational poster viewings. Findings of this study focused on the changes in unpaired student responses for their identified threshold to wear hearing protection as well as their ability to properly identify use of hearing protection for a defined set of tools based on their given threshold.

Article II: HEARING in Practice

For the second study in the HEARING Project, students enrolled in university-based agricultural mechanics courses during a two-year period were asked to further assist in the assessment of students' willingness to use/wear hearing protection as it relates to established self-identified dB thresholds to wear hearing protection within agricultural education. This study echoed the methods established in the HEARING study by utilizing a pre- and post-instruction instrument to determine students' perceptions and intentions to use hearing protection. Building on the findings of the HEARING study, weekly reflections were conducted to determine the use of hearing protection by the participants throughout their time participating in the study. Of the 87 students enrolled in the targeted university-agricultural mechanics courses, 83 completed the pre-instruction instrument, 67 completed the post-instruction instrument, and 78 provided usable reflections over the course of the study.

Article III: Knowledge of HEARING

The third study in the HEARING Project shifted the focus from post-secondary students to SBAE students to identify their understanding of hearing related safety issues within an agricultural setting. Using an expanded form of the pre- and post-instruction instruments which included a ten-question knowledge section, 104 and 94 SBAE students respectively completed a pre- and post-exposure instrument. The first portion of both instruments aimed, like the previous studies, to identify the perceptions of hearing related concern areas through provided thresholds and PPE use based on tool selections. The second portion had participating students complete a ten-question quiz that related to hearing safety knowledge. By identifying changes in perceptions and knowledge among different characteristic groupings, this study aimed to determine the current safety climate specifically related to hearing of SBAE students.

Scope of Investigation, Assumptions, and Limitations

These studies focused on agricultural education instruction, specifically agricultural university-based mechanics courses at Auburn University and three Alabama SBAE programs with agricultural mechanics and non-agricultural mechanics course instruction. While there is a focus on agricultural education in a broad sense, these studies were conducted in a narrowly defined sample. No assumptions can be made about the participants' ability to represent a larger community. While the results throughout the studies can provide insight into a larger discussion on hearing safety across agricultural education, the limited sample and scope of the studies does lead to non-generalizable findings.

Definitions of Key Terms

Sound: Auditory sensation evoked by the oscillation in pressure, stress, particle displacement, particle velocity, etc., propagated in a medium with internal forces (e.g., elastic or viscous), or the superposition of such propagated oscillation. (ASA, n.d.)

Noise: Undesired sound. By extension, noise is any unwanted disturbance within a useful frequency band, such as undesired electric waves in a transmission channel or device. (ASA, n.d.)

Decibel: Expression of Sound Pressure Level (SPL). Ten times the base-ten logarithm of the ratio of a time-mean-square sound-pressure signal, in a stated frequency band, for a stated averaging time duration, to the square of the reference value for sound pressure level. (ASA, n.d.)

Threshold: For a given listener and specified signal, the minimum sound pressure level or force level that is capable of evoking an auditory sensation in a specified proportion of trials. Sound reaching the ears from other sources is assumed to be negligible. (ASA, n.d.)

Perception: Expression of perceived noise level. Frequency-weighted sound pressure level obtained by a stated procedure that combines the sound pressure levels in the 24 one-third octave bands with midband frequencies from 50 Hz to 10 kHz. (ASA, n.d.)

Active Learning: Instructional activities involving students in doing things and thinking about what they are doing. (Bonwell & Eison, 1991) Techniques include experiential learning, problem-based learning, project-based learning, and simulations among others. (Hancock et al., 2024)

ARTICLE I.
Hearing Education in Agriculture: Re-Evaluating Interest, Needs, And Growth (HEARING)

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Publication Citation

Hancock, G. T., McKibben, J. D., Byrd, A. P., Clemons, C. A., & Lindner, J. R. (2023). Hearing education in agriculture: Re-evaluating interest, needs, and growth. *Journal of Agricultural Safety and Health, 29*(2), 109-120. https://doi.org/10.13031/jash.15331

Abstract

Safety in agricultural laboratories is of the highest concern for teachers and instructors. While there is a known safety concern with hearing in agriculture, it has been identified that there is a deficiency in the attitudes and perceptions relating to the output of decibels of tools in agricultural laboratory settings. This research focuses on hearing and noise levels in an agricultural mechanics laboratory by exposing students directly and indirectly to noise levels through project-based learning and informational posters throughout the laboratory. Pre- and post-course data is used to address students' perception of noise level outputs and willingness to wear hearing protection. Pre-course responses show a disconnect between perceptions of noise levels and the given threshold for wearing hearing protection. This perception gap closed over the semester as post-course responses show an increase in correct tool to threshold responses. The frequency of responses aligned with the National Institute for Occupational Safety and Health's recommended hearing protection threshold also shows growth. While there was still a knowledge gap needing to be addressed, we feel that the exposure through both direct and indirect instruction throughout the course can lead to knowledge gained and perception changed.

Keywords. Agricultural mechanics, Attitudes, Perceptions, Safety.

Introduction

Agricultural education, especially School-Based Agricultural Education (SBAE), focuses on a myriad of differing topics and instructional methods. Due to availability of space or the appropriateness of the subject, agricultural education often utilizes experiential laboratory learning, notably in greenhouses, functional farms, agricultural mechanics laboratories, or other teaching spaces (Franklin, 2008; Herren, 2014; Phipps & Reynolds, 1990). While the focus of utilizing these spaces is on enriching the learning environment, it is commonly discussed that student safety in these settings needs to be of the utmost importance (Dyer & Andreasen, 1999; Langley et al., 2018; Saucier et al., 2014). When working with students, there are multiple safety concerns that arise (Chumbley et al., 2018; Dyer & Andreasen, 1999; Roberts & Dyer, 2004; Saucier et al., 2014) including student attitudes toward general safety, ventilation, and noise levels. Hearing loss and noise levels in agricultural laboratories have been a point of scholarship discussion for many years (Bunch, 1937; Woodford et al., 1993). Many studies have concentrated on the high noise level in numerous agricultural fields (Matthews, 1968; Miller, 1989) and have shown consistent decibel (dB) levels well above the National Institute for Occupational Safety and Health (NIOSH) recommendation of 85 dB (NIOSH, 2018a; NIOSH, 2018b). Even though hearing safety is a known concern, anecdotal evidence points toward a disconnect between students' understanding of dB readings and the long-term hearing effects working in agricultural environments can cause.

With this increased focus on laboratory instruction, specifically in agricultural mechanics, how agricultural educators engage with these safety concerns should be at the forefront of their minds. By engaging in hands-on learning opportunities, there is a need to emphasize the safety concerns associated with the lessons being presented. Roberts and Dyer (2004) discuss the importance of proper management of a laboratory in agricultural education. Their study determined that out of forty characteristics, care of students is the most important to be an effective instructor.

When active learning opportunities are presented in an engaging and safe manner, students' attitude positively changes on the subject (Osborne & Dyer, 2000). Clarke (2010) identifies that one's perception is motivated by multiple aspects of the safety climate presented in a learning or workspace. There is a gap in the perception of one's occupational safety climate and their perception of safety concerns (Clarke, 2006). One of the critical aspects of a healthy and safe environment is the competency of students and workers (Daniels, 1989; Flin et al., 2000). When safety is a main concern for agricultural educators, identifying and measuring a program's safety climate leads to educational success. With the witnessing of a renewed focus on hands-on learning (Akkermans et al., 2020), agricultural educators must remember the importance of safety in agricultural mechanics curricula (Johnson & Schumacher, 1989; Rudolhpi & Retallick, 2015; Ullrich et al., 2002). With the increased engagement within agricultural mechanics laboratories, ensuring students are engaging in safe and meaningful activities (Langley et al., 2018) is exceptionally prevalent for today's agricultural instructors.

Prospective and Conceptual Framework

This study's perspective framework began from the discussions within Dyer and Andreasen's (1999) study on industrial safety among organizations and the multiple aspects relating to safety deficiencies within agricultural education. Dyer and Andreasen (1999) identified fifteen safety deficiencies in agricultural laboratories ranging from ventilation to noise levels. They claim that hearing and hearing safety has been an issue in the agricultural mechanics laboratory for decades. Agriculture teachers historically have had a higher instance of hearing loss than comparable groups (Burke, 1987, as cited in Dyer & Andreasen, 1999) with a high frequency of hearing loss over 25 dBs hearing level (Woodford, Lawrence, & Bartrug, 1993, as cited in Dyer & Andreasen, 1999). Dyer and Andreasen state that “noise levels typically found in agricultural mechanics laboratories constitute a nuisance, affect performance, and may be dangerous to students and teachers” (1999, p. 50). They indicate that due to high noise levels outside the laboratory setting, necessary efforts need to be made to protect from student and instructor hearing loss. Their parting question relating to hearing focuses on determining the effects of cumulative noise on an individual’s hearing.

Building further on Dyer and Andreasen’s study, Langley et al. (2018) evaluates influences and perceptions relating to personal protective equipment (PPE) in agricultural mechanics laboratories. Langley et al. (2018) express that hearing safety, while necessary, is not highlighted to the same degree as other forms of safety. They continue by indicating that hearing and breathing PPE are not as available or prevalent as PPE for eye safety. Langley et al. also mention that more than 33% of the Missouri agricultural mechanics laboratories examined did not have hearing safety PPE available for student use (2018). Their focus on the use and perception of PPE, along with Dyer and Andreasen's focus on safety deficiencies, provide the perspective framework for our direct study on hearing safety concerns in the agricultural mechanics laboratory.

With this established perspective, the theory of planned behavior (Ajzen, 1991) is used as a conceptual frame for this study. This theory, which adds to the concepts as described from the theory of reasoned action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975), further addresses components within an individual’s behavioral control. By focusing on an individual’s attitude toward a behavior, subjective norms, and perceived behavioral control, the theory of planned behavior aims to show an individual's intention and subsequent behavior (Figure 2.1).

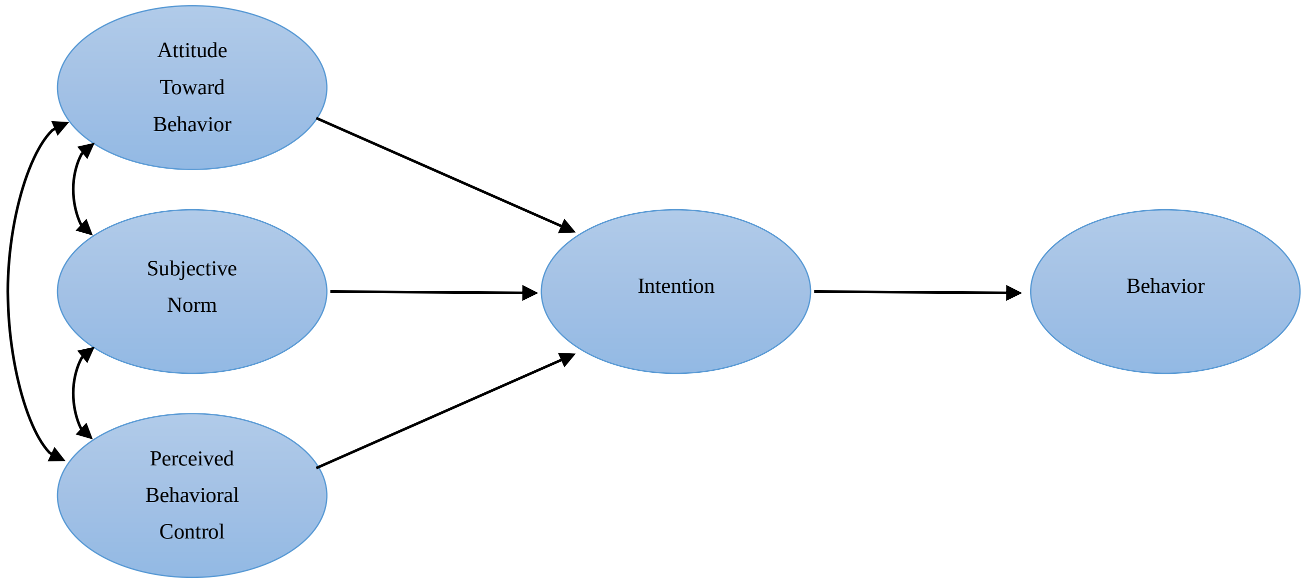

Figure 2.1. *Theory of Planned Behavior (Derived from: Ajzen, 1991)*

Ajzen (1991) takes an individual's intention to perform a given behavior and addresses the motivational factors that influence it. These driving factors either strengthen or weaken the intentions that are key components for the decision to engage in a specific behavior. Ajzen theorizes perceived behavioral control, defined as "people's perception of the ease or difficulty of performing the behavior of interest" (p. 183), and its connection with behavioral intention. Ajzen further discusses that perceived behavioral control can be an influencer on the level of difficulty due to an individual's perceptions of actions and circumstances of a behavior.

The theory of planned behavior takes a combination of these perceived behavioral controls alongside their intentions to provide a predictable outcome for actual behavior. Ajzen (1991) generalizes Bandura's framework of self-efficacy through the relationships of beliefs, intentions, and behaviors. He echoes aspects of Bandura's social cognitive theory and social learning theory, emphasizing that learning occurs through cognitive processes in a social setting using observational and direct instruction through exposure to both positive and negative stimuli (1977a, 1977b),

The theory of planned behavior also adds the influence of attitude toward a behavior and subjective norms on the intentions for behavioral outcomes (Ajzen 1991). Ajzen (1991) describes attitude toward a behavior as either the positive or negative evaluation of a behavior in question by an individual. A positive or negative attitude toward a specific behavior reaffirms intentions which will affect the outcome of actual behavior. Adding the last component relating to subjective norms, a clearer indicator for intentions can be made. Ajzen (1991) theorizes that a combination of influential factors forms an individual’s intentions. Subjective norms are the social prediction factors that consider an individual's perceived social pressures relating to a given behavior. Taking into account social pressures, positive or negative attitudes, perceptions relating to difficulty of tasks, or a combination thereof, provides a framework for identifying intentions with considerations to behavioral outcomes.

Purpose and Objectives

The purpose of this study is to assess and identify student understanding and perceptions of hearing related concerns in an agricultural mechanics setting. Understanding that hearing safety is a major concern across agricultural education, this study assesses student population in an agricultural mechanics course. To better promote hearing safety for Auburn’s Agriscience Education courses, this study aims to evaluate current perceptions of university students. The following objectives guide this study:

1. Determine the willingness to wear hearing protection while in an agricultural laboratory/workspace.
2. Establish the perception of dB output of power tools used in an agricultural

laboratory/workspace.

3. Identify understanding of safety concerns relating to hearing perceptions and noise levels outputs in an agricultural laboratory/workspace.

Materials and Methods

Due to the hearing safety gap seen in agricultural mechanics classrooms, this research aims to identify the perception and understanding of noise levels and impairments by students who are actively involved in agricultural mechanics educational courses at the university level. Participant population was selected due to the nature of the course instruction. This sample population provides insight to both former students at the secondary level and potential future agricultural science instructors. This population also provides insight into future course updates for Auburn. Perception and understanding growths are shown through examining responses from both the pre- and post-questionnaire. The pre-instruction questionnaire was sent electronically to all students and was available the first week of instruction. The post-instruction questionnaire was available electronically the last weeks of instruction sent alongside reflective assignments and course wrap-up discussion. This research utilizes data collected from these questionnaires to first document students' willingness to wear hearing protection for specific selected power tools used in the laboratory. Participants then identify their dB output threshold for wearing hearing protection.

Instruction of the class then focuses on projects that promote and utilize these tools throughout the semester. While no tools are specifically required for project completion, the direct and indirect use of the specified tools for this study provides environmental exposure to their dB output. Students are also indirectly exposed to NIOSH recommended exposure limits and tool dB outputs (NIOSH 2018a, 2018b) through informational posters (Figure 2.2) hung in high visibility locations throughout the laboratory and classroom.

Figure 2.2. *Poster used in laboratory indicating NIOSH recommended exposure limit and tools with decibel output.*

At the end of the semester, participants complete the post-course questionnaire where they re-identify their noise level threshold for wearing hearing protection alongside indicating which tools they would or would not wear hearing protection while in use.

By examining students' perceived dB threshold and willingness to wear hearing protection per specific tool use, insight to participant perceptions of noise levels in an agricultural mechanics laboratory can be determined. Correct response rates groupings are created based on taking the participants dB threshold and then assessing their responses on their willingness to wear hearing protection. A participant's dB threshold is used as the correct response limit and their individual responses are compared to this limit for accuracy. With six specified tools, there are seven groupings (zero through six correct responses) that participants are sorted into.

For our pre-course evaluation, students across four sections of an introductory level career and technical education agricultural mechanics course (*N* = 40) at Auburn were evaluated during the fall 2021 semester through an anonymous questionnaire. At the end of the course, the same instrument is utilized to capture change in perception and knowledge relating to hearing health concerns. Due to changes in student population over the course of the semester, the total participation slightly declined (*N* = 35). As both instruments were collected anonymously, the frequency in responses across the study were not a reviewable point of focus. For this study, due to the low number of responses, a statistical analysis was not conducted.

Instrumentation

Both the pre- and post- instruments used for the collection of data are based on CDC-NIOSH guidelines. Students are asked if they would or would not wear hearing protection when using a series of commonly used power tools (Handheld Circular Saw; Powered Hand Drill; Angle Grinder; Impact Wrench; Powered Miter Saw; Pneumatic Nail Gun) without being told the average dB level of that tool. Participants then indicate, on a table, the level at which they would wear hearing protection based on a given dB level (1 = Always; 2 = 60 dB; 3 = 70 dB; 4 = 80 dB; 5 = 90 dB; 6 = 100 dB; 7 = 110 dB; 8 = 120 dB; 9 = 130 dB; 10 = 140 dB; 11 = Never). The first portion of this questionnaire is used to determine participants' willingness to wear hearing protection while utilizing tools in the agricultural laboratory. The second portion is then used to determine participants' perception of overall dB output in a laboratory setting.

The pre-test is sent to students in the first week of the course via an online questionnaire. The post-test is sent during the final examination week after the students are excused from campus via the same online questionnaire.

In between pre- and post-questionnaires, the learning environment is altered through environmental and visual exposure via posters and course lessons. Students are exposed to the visual poster described in Figure 2.2 as well as the course objectives being structured in an intentional manner to allow for the exposure to specific tools to be utilized by the students. Students are required to complete a series of projects constructing three items that utilize wood, metal, and the combination of both. Over the course of the semester, students are both directly and indirectly exposed to the noise levels of the tool used through the completion of these projects. During the course of the semester, students are also indirectly visually exposed to the noise levels through posters hung throughout the laboratory consisting of the tools and their dB outputs alongside the NIOSH recommendation of hearing protection threshold. Students are never directly taught on these dB outputs or recommendations, but the strategic placing of these posters in high trafficked areas (central location within the laboratory and next to door between classroom and laboratory) maximized the indirect exposure across the entirety of the semester.

Results

Participants indicate they would wear hearing protection for a majority of the power tools listed (Table 2.1). The one outlier is the Powered Hand Drill where only eight of the participants state they would wear hearing protection even though the average noise output is recorded as 93 dB, which is above the NIOSH recommendation of using hearing protection with any equipment producing more than 85 dB (NIOSH, 2018a, 2018b). When compared beside the data from our post-evaluation, there is an increase in percentages across all tools but only a slight increase due to the frequency of use of hearing protection per tool. This poses the question of the need for further instruction per dB output per tool or the reflection on the actual output per tool used.

Table 2.1
Would Wear Hearing Protection per Power Tool

	Pre-Evaluation (*N* = 40)		Post-Evaluation (*N* = 35)	
Power Tool (Output*)	*f*	%	*f*	%
Angle Grinder (101 dB)	28	70.00	28	80.00
Powered Miter Saw (107 dB)	27	67.50	27	77.14
Handheld Circular Saw (108 dB)	25	62.50	26	74.29
Impact Wrench (106 dB)	24	60.00	26	74.29
Pneumatic Nail Gun (120 dB)	22	55.00	21	60.00
Powered Hand Drill (93 dB)	8	20.00	8	22.86

Note. *All decibel outputs are found on CDC's NIOSH Noise Levels of Power Tools (2018b).

When asked at which dB level the participant would wear hearing protection when working with powered equipment, 19 indicate they would wear hearing protection at or below NIOSH recommendations (Table 2.2). Nineteen other participants indicate that they would wear hearing protection, however above the recommended level. Two participant responses show they that would not wear hearing protection at any dB level.

Table 2.2 also shows the post-course responses to participants' dB threshold for wearing hearing protection. More frequently, students are either in the category above or below the NIOSH 85 dB recommendation. There is also a decrease in the responses above the NIOSH recommendation, but most importantly, there are no participant response for never wearing hearing protection.

Table 2.2
Decibel Threshold Indicated to Use Hearing Protection

	Pre-Evaluation (N = 40)		Post-Evaluation (N = 35)	
Threshold	f	%	f	%
Always	7	17.50	7	20.00
60 dB	2	5.00	1	2.86
70 dB	2	5.00	1	2.86
80 dB	8	20.00	11	31.43
90 dB	13	32.50	12	34.29
100 dB	5	12.50	1	2.86
110 dB	1	2.50	1	2.86
120 dB	0	0.00	1	2.86
130 dB	0	0.00	0	0.00
140 dB	0	0.00	0	0.00
Never	2	5.0	0	0.00

Note. line indicates NIOSH recommended decibel threshold of 85 dB (2018a).

Looking across responses to both sections of the pre- and post-questionnaire, a clearer picture begins to form. At the beginning of the semester, our participants appear to have a disconnect between the dB output of tools and their threshold for wearing hearing protection (Table 2.3). Only seven of the participants accurately indicate they would wear hearing protection for all six tools compared to their threshold of dB output. 19 participants accurately match four or more tools, while three inaccurately matched all six tools to their dB threshold. This leads to the average correct response rate of 59% (M = 3.55, SD = 1.82).

Table 2.3
Pre-Evaluation Accuracy of Hearing Protection Responses Compared to Decibel Threshold Responses

Decibel Threshold	Frequency of Accurate Responses						
to Use Protection	0	1	2	3	4	5	6
Always	0	0	0	1	2	2	2
60 dB	1	0	0	0	0	1	0
70 dB	0	0	0	2	0	0	0
80 dB	0	1	0	3	0	2	2
90 dB	2	0	5	2	0	2	2
100 dB	0	1	1	1	0	2	0
110 dB	0	0	1	0	0	0	0
Never	0	0	0	0	1	0	1
Totals (n)	3	2	7	9	3	9	7
Percentages (%)	7.50	5.00	17.50	22.50	7.50	22.50	17.5

Note. N = 40; line indicates NIOSH recommended decibel threshold of 85 dB (2018a).

This perception gap appears to begin to close over the course of the semester as the data indicates an increase in the correct responses for the post-evaluation (Table 2.4). The average correct response rate increases to 66% (M = 4.00, SD = 1.76), and there is an increase in frequency for four and six accurate responses. While there is a rise in the frequency of one accurate response, there is also a decrease from the zero accurate response category that helps support the recognition of perception gained.

Table 2.4
Post-Evaluation Accuracy of Hearing Protection Responses Compared to Decibel Threshold Responses

DB Threshold to Use Protection	Frequency of Accurate Responses 0	1	2	3	4	5	6
Always	0	0	0	0	1	1	5
60 dB	0	0	0	0	0	1	0
70 dB	0	0	0	1	0	0	0
80 dB	0	1	2	1	2	3	2
90 dB	1	2	0	2	3	3	1
100 dB	0	0	1	0	0	0	0
110 dB	0	1	0	0	0	0	0
120 dB	0	0	0	0	0	1	0
Never	0	0	0	0	0	0	0
Totals (*n*)	1	4	3	4	6	9	8
Percentages (%)	2.86	11.43	8.57	11.43	17.43	25.71	22.86

Note. N = 35; line indicates NIOSH recommended decibel threshold of 85 dB (2018a).

Discussion & Conclusions

When examining data for our first objective, it is determined that students in introductory-level agricultural mechanics courses at Auburn have a misunderstanding of dBs, dB output, and the effects dBs can have on one's hearing. Through our pre-course questionnaire, it is first noted that many of the tools are identified as noise concerns by a majority of the respondents, but only eight respondents indicate they would wear hearing protection while using a powered hand drill (95 dB) even with the dB output being above the NIOSH recommended level of 85 dB. The tool most commonly deemed to need hearing protection while in use was the angle grinder, which is the second quietest tool with an average output of 101dB. The significant increase (n = 20) between the two quietest tools raises the question of students' perception of noise in the laboratory. Comparing the data to the post-course questionnaire, there are still these same trends, but overall, the percentage of participants identifying their willingness to wear hearing protection increased across all six tools. Close to three-quarters of the participants indicate that they would wear hearing protection for four of the tools (Handheld Circular Saw, Angle Grinder, Impact Wrench, and Powered Miter Saw), and all had higher percentages than the highest response rate from the pre-course questionnaire. This shows an increase in intention to use that can be related back to the exposure to a new subjective norm and an increase in participant Attitudes toward the use of hearing protection. With this increase in intention, there should be a subsequent change in the exhibited behaviors for the participants.

To address our second objective, participants' responses to their threshold for wearing hearing protection and their frequency of correctly responding if they would or would not wear hearing protection for specific tools are focused on. Pre-course questionnaire data shows that 19 respondents indicate they would wear hearing protection under NOISH's recommendation (85 dB) and 21 (52.5%) indicate the use of hearing protection in the choices either just above or below the recommended threshold line. One of the worrying responses were the two participants stating they do not wear hearing protection at all. A commonality across all participants arose when reviewing the individual threshold to tool use response. 21 (52.5%) participants inaccurately respond to wearing hearing protection for three or more tools per their stated threshold level. While there were seven participants who are able to accurately match the use of hearing protection to their given threshold, only four of the seven indicate a measurable threshold of 80 dB or 90 dB. The post-course questionnaire provides positive insight as there is a significant percentage increase to 65.7% of the responses on the NIOSH recommendation line. Over 91% ($n = 32$) of the participants specify they would wear hearing protection at or below the recommendation line after their exposure throughout the course of the semester. When comparing the two portions of the post-course questionnaire data, there is an average increase in the correct responses for hearing protection per tool to the given dB threshold. This shows a positive change relating to the participants' attitude and perceived behavioral control. Pre-course participants averaged correct responses for three and a half tools while the post show an increase to four tools. Even though a majority incorrectly identify three or more tools to stated threshold in the pre-course evaluation, almost two-thirds of the participants correctly identify more than four or more tools in the post-course, with almost half of all responses correctly identifying all tools or just missing one. Of the eight participants who had correctly identified all six tools, three were participants who provided a threshold above the "Always" category, and they are all in the 80 dB and 90 dB threshold categories. These positive trends shed light on the participants' understanding of the hearing concerns within the laboratory and their new intentions relating to their identified thresholds, thus tying into the third objective.

The third objective relating to known agricultural laboratory/workspace hearing and noise level safety concerns can be addressed by examining the informational data as a whole. It was identified before this study that there is a need to address these concerns, and data shows that the environmental exposure that our students experience did have a positive impact. Through either the use of indirect and direct exposure of the use of tools during hands-on project-based learning, visual information found on posters placed strategically across our laboratory, or a combination thereof, there is a reportable increase in knowledge and correct perception of noise levels and hearing safety concerns in our students. Students not only show an understanding of tool noise level outputs but also awareness of a need to wear hearing protection in agricultural laboratory settings. This positive change could lead to more hearing safety behaviors displayed by students as their positive attitude should reaffirm their intentions which would affect the outcome of their behavior. The overall increase in percentages for the correct response of tool to threshold provides us with the basis for continued growth with this project's objective.

At the beginning of the semester, students showed they understand the need for hearing protection, albeit at differing levels, but are unsure how loud commonly used tools are in our laboratories. Through their exposure in their working environment, there is a change in perception and outlook as students were better able to identify tools at or above their hearing protection threshold. We attribute this increase to the course and visual exposure of the noise levels throughout the semester. While there were increases shown, there are still identifiable gaps that need to be addressed. Not all students had significant breakthroughs and were able to identify all tools to dB threshold, nor were all students at or below the NIOSH recommended exposure limit of 85 dB. We attribute this to the difficulty of the behavioral performance, which could be due to the lack of understanding regarding the correct dB levels of the equipment. This leads us to ask, would those students have a different outlook on hearing safety if they concretely knew the dB correct levels? We aim to address these safety concerns through changes in course instruction and discussions surrounding students' understanding of their working environment. This could include direct lessons related to dB outputs of tools used throughout the course, projects with dB reading requirements, or more thorough instruction on the safety climate and expectations within the course. As this study has shown an increase in intentions due to the direct and indirect exposure to hearing safety concerns, it is important to capitalize on student positive changes and reflect the attitude, social norm, and perceived behavioral changes in order to provide opportunities that help students identify transformations in both intentions and behavior regarding hearing safety.

Future Research Question and Application

We acknowledge a need for further instruction and research relating to hearing safety in agricultural mechanics. The instruction and research need to focus on helping students identify the level of dB output from tools in the workspace and an increase in awareness of hearing safety concerns. We aim to discern efficient ways for raising awareness of potential hearing hazards and garner interest in the prevention of hearing loss.

A future research opportunity would expand this study to multiple sites and universities to increase our sample size for statistical analysis and provide opportunities for control and variable groups. The variable groups would use visual aids indicating dB output posted throughout the Mechanics Lab to supplement the use of tools throughout a semester in introductory-level agricultural mechanics courses. The control group would conduct similar courses as usual without visual aids during the same period to determine if students show an increased understanding when exposed visually to noise levels.

ARTICLE II.

HEARING in practice

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Abstract

Across School-Based Agricultural Education, specifically agricultural mechanics, safety in laboratory instruction is a significant concern. While hearing safety has been discussed for numerous years as a shortcoming, it has been identified that attitudes and perceptions of sound and noise within agricultural settings are not aligned. This research continues the work of the previous HEARING study (Hancock et al., 2023) to focus on student understanding of and application of safety culture within an agricultural mechanics environment. Through the use of direct and indirect exposure to noise levels, students reflected on and identified their use and intended use of hearing protection. Pre- and post-instructional data aided in establishing student's thresholds to use proper personal protective equipment, as well as identify their perceptions of the decibel (dB) outputs for commonly used power tools in the agricultural laboratory setting. Pre-course and post-course data show a wide range of intended thresholds and understanding of dB outputs. Course reflections alarmingly show a disconnect between intention and practice as many students do not utilize hearing protection. While the frequency and accuracy of threshold responses aligns with the National Institute for Occupational Safety and Health's recommended hearing protection guidelines, the self-reported hearing protection use results are concerning. While there was still a knowledge and application gap needing to be addressed, we feel that the continued exposure through both direct and indirect instruction lead to increased knowledge.

***Keywords*:** agricultural mechanics; hearing safety; perceptions; safety instruction; willingness.

Introduction

School-Based Agricultural Education (SBAE), specifically in courses concentrating on agricultural mechanics, focuses on a multitude of different topics that are directly related to safety both in and outside of a classroom. Due to space restraints, appropriateness of the subject, or comfortability of the instructor, these topics often utilize active learning techniques and laboratory instruction (Akkermans et al., 2020; Bernardo, 1993; Hancock et al., 2024; Phipps & Reynolds, 1990; Wells & Miller, 2020). As these spaces and methods are used more commonly, the discussion relating to student safety also increases (Albritton & Roberts, 2020; Dyer & Andreasen, 1999; Langley et al., 2018; Saucier et al., 2014). Active teaching methods, as well as laboratory settings, can lead to lessons and opportunities where multiple safety concerns may arise (Chumbley et al., 2018; Love et al., 2022; Roberts & Dyer, 2004; Saucier et al., 2014). With lessons that focus more on active student engagement, student attitude and awareness toward safety concerns including, but not limited to, hearing loss and noise levels have been identified as key points of discussion within scholarship for many years (Bunch, 1937; Franklin, 2008; Hancock et al., 2023; Herren, 2014; Woodford et al., 1993). In specific regards to hearing within agriculture, there have been multiple studies concentrated on noise level and decibel (dB) output concerns within the larger scope of agricultural fieldwork (Depczynski, 2005; Masterson, 2018; Matthews, 1968; Miller, 1989). These studies have shown that agricultural work, both inside and outside the scope of agricultural mechanics, is often conducted well above the National Institute for Occupational Safety and Health (NIOSH) recommendation of 85 dB (Chan, 1998; NIOSH, 2018a; NIOSH, 2018b).

While there have been studies conducted on hearing safety within agricultural education (Broste et al., 1989; Hancock et al., 2023; Slaydon, 2009; Woodford et al., 1993; Woodford et al., 1996), there are still numerous instances of anecdotal evidence that indicated a disconnect between students' understanding of dB output and the long-term effects on hearing that can occur while working in agricultural environment (Hancock & McKibben, 2023). Roberts and Dyer (2004) discuss proper laboratory management and emphasize the safety concerns presented by hands-on learning opportunities. Their study further determined that out of 40 characteristics, care of students is the most important to be an effective instructor. Osborne and Dyer (2000) acknowledge that students’ attitude positively changes when active learning methods are presented in an engaging and safe manner. Utilizing these active learning techniques within the laboratory environment can help bridge the perception gap, Clarke (2006) identified relating to one’s occupational safety climate and safety concerns. Clarke (2010) further connected the presentation of a learning space’s safety climate to one’s motivation and perceptions of safety concerns. Building the competency of both students and instructors is a critical step in the foundation of a healthy and safe learning environment (Albritton & Roberts, 2020; Daniels, 1989; Flin et al., 2000) and leads to educational success for an agricultural mechanic program. As we renew the focus on hands-on learning (Akkermans et al., 2020; Peden et al., 2023), it is important for instructors to devote time to building a well-defined safety climate within their curricula (Johnson & Schumacher, 1989; Rudolphi & Retallick, 2015; Ullrich et al., 2002) and ensure students are engaging in safe and meaningful activities (Easterly et al., 2017; Langley et al., 2018; Rateau et al., 2015).

Theoretical Framework

Upon reviewing the foundational texts for this study (Dyer & Andreasen, 1999; Hancock et al., 2023), the identified safety concerns within agricultural mechanics needed to be addressed. Students operate in a risk-taking world and do not understand the consequences associated with foregoing safety procedures (Hubert et al., 2003). Students, as part of their school community, are exposed to the actions of others, mainly their peers (Bandura, 1977b). This constant exposure can lead to the adoption of culture-normative objects and habits. Taking this into mind, a review of Zajonc's (1968) Mere Exposure Theory (MET) led to its use as the theoretical framework for this study.

Zajonc discusses that familiar art, tastes, actions, and language can provide a platform or foundation to individuals that give a "warm glow" when one is in its presence. Out of this logic, he developed the MET and shaped this theory by two main beliefs. The first is that increased exposure eases barriers to processing a stimulus, and the second is the reduction of processing effort or time increases fondness (Reber et al., 1998; Vincent et al., 2020). Vincent et al. (2020), stated that the theory is often called the familiarity principle and states that people tend to remember and develop a preference for things with which they are more familiar. This principle is empirically supported by the relationship between frequency and meaning (Zajonc, 1968). Vincent et al. (2020) extended the MET theory to the classroom by discussing the power of MET to affect change in students' cultural understanding and behavior. This study aimed to utilize MET to better understand connections associated with student willingness to adhere to a culture of safety by wearing hearing protection in effort to provide additional insight into student motivations within the agricultural mechanics laboratory.

Purpose and Objectives

The purpose of this study was to better assess students' willingness to use wear hearing protection as it relates to established self-imposed thresholds within an agricultural mechanics laboratory. The HEARING project (Hancock et al., 2023) initially identified that students, through direct and indirect exposure, better distinguished a need to use hearing protection in reference to their own established thresholds. This study aimed to put lessons learned from that study into practice to promote hearing safety and identify reported use of hearing protection by university students in introduction agricultural mechanics courses over the 2022 and 2023 fall semesters. Three objectives guided this study:

1. Establish student threshold for use of hearing protection in an agricultural mechanics setting;
2. Identify student perceptions of dB outputs relating to tool use in an agricultural mechanics setting;
3. Determine student willingness to wear personal protective equipment relating to hearing safety in an agricultural mechanics setting.

Methods

To help mitigate the safety gap in the agricultural mechanics lab and better instruct students on the need for the use of hearing protection, two semesters of students enrolled in introduction to agricultural mechanics course in participated in a multi-faceted study. This population was chosen first, to provide insight on former SBAE students and future secondary agricultural mechanics teachers' perceptions of hearing related issues. Second, this population provides direct feedback on best practice for the development of a culture of safety within university courses in an agricultural mechanics laboratory. Across both semesters, 87 students were enrolled in, and 83 students completed the introduction to agricultural mechanics course.

The first portion of this study utilized pre- and post-course evaluations relating to participant's perceptions of noise levels and hearing protection thresholds. These instruments utilize the CDC-NIOSH established guidelines (Chan, 1998; NIOSH, 2018a, 2018b) and were developed and distributed through Qualtrics. The pre-course instrumentation was distributed electronically during the first two weeks of the course during the introduction and safety portion of the instruction. Of the 87 students enrolled in the course, 83 completed the instrument providing a response rate of 95.40%. The instrument asks participants to reflect on the last time they used specific tools (Handheld Circular Saw; Powered Hand Drill; Angle Grinder; Impact Wrench; Powered Miter Saw; Pneumatic Nail Gun) and identify if they wore hearing protection during that use. Participants were then asked to identify the dB output threshold level they would start wearing hearing protection at (1=Always; 2=60 dB; 3=65 dB; 4=70 dB; 5=75 dB; 6=80 dB; 7=85 dB; 8=90 dB; 9=95 dB; 10=100 dB; 11=105 dB; 12=110 dB; 13=115 dB; 14=120 dB; 15=Never). The remaining questions were used as characteristic data identifiers for the participants. The post-course instrument repeated the questions of the pre-instruction instrument and was electronically distributed during the last two weeks of the semester as students complete all work in the laboratory and focused on the final course reflection assignments. Of the 83 students who completed the course, 67 completed the post-course evaluation resulting in a response rate of 80.72%. The tool list for the first question on both evaluations was presented in random order and without dB information to help mitigate instrumentation effect. The dB threshold question did place the NIOSH recommended threshold (85 dB) slightly off center; however, its proximity to the middle of the range is noted.

Between the two instrument administrations, course instruction focused on active learning techniques that promoted the use of the tools from the identified list. While there were no explicit requirements to use specific tools for project completion, the lack of alternative tool availability aimed to increase participant exposure to dB output either through direct or indirect use. The exposure also aimed to provide insight into and understanding of dB levels within an agricultural mechanic environment. In addition to the tool use exposure, at the halfway point in the semester, students were indirectly exposed to NIOSH recommended limits and tool dB outputs (Chan 1998; NIOSH 2018a, 2018b). This was done through two 48” X 48” informational posters (Figure 3.1) being hung in a prominent central location within the laboratory and adjacent to a door that leads between the classroom and laboratory. During the indirect exposure phase, instruction and project completion continued as normal. Instructors did not directly instruct on the informational posters nor hearing safety curriculum, but placement was chosen to encourage the viewing by students regardless of their activity in the classroom or laboratory.

Figure 3.1. *Poster used in laboratory indicating NIOSH recommended exposure limit and tools with decibel output.*

The second portion of this study focused on participant identification of PPE use where, throughout the semester, students provided weekly reflections on the content of the course, a common best practice in experiential learning (Kolb, 2014). Among the reflection was an open-ended question asking, “What Personal Protective Equipment did you wear today?” Examples of

Safety Glasses, Respiratory Protective Equipment, and Ear Plugs were given in the question as a means to prompt reflection on different PPE use. Responses from the reflections were coded into “Eye Protection” and “Hearing Protection” by the research team with all other PPE responses (Closed Toed Shoes, Long Pants, etc.) being reviewed but not analyzed for this study. Participants who failed to complete at least 50% of the reflections (no responses or excused reflections) were removed from this portion of the study. Due to the nature of the exclusions, of the 83 students who completed the course, 78 student reflections were used for the analysis resulting in a participation rate of 93.98% across both semesters. Across the participating students, the average age was between 18 and 25, most identified as male, agricultural major, with some to no experience in an agricultural mechanics setting.

Results

To establish hearing protection use (HPU) thresholds, participants were asked to indicate at which dB level they would start wearing hearing protection given a scale from 60 dB to 120 dB with the options for always and never being present on either end respectively. Table 3.1 shows the responses for both the pre- and post-course evaluations. During the pre-course evaluation, participant responses were centered at the NIOSH recommendation of 85 dB with 54.22% of the respondents indicating a HPU threshold within 5 dB of the recommended dB level. While the post-course evaluation responses dropped to 37.31% for the same range, the overall indicated HPU threshold for responses averaged slightly lower than the pre-course responses with a higher percentage of “Always” responses (Δ = 4.89%) and lower percentage of “Never” (Δ = -1.83%) responses. The change score for “Always” and “Never” led to a percent change of 23.88 percent and -38.06 percent respectively indicating that “Always” increased by nearly 25 percent from the pre-course to post-course responses while "Never" decreased by nearly 40 percent.

Table 3.1
Participant Indicated Decibel Threshold Response for Use of Hearing Protection

Decibel Threshold to Use Protection	Pre-Evaluation[1] *f*	Pre-Evaluation[1] %	Post-Evaluation[2] *f*	Post-Evaluation[2] %
Always	17	20.48	17	25.37
60 dB	0	0.00	2	2.99
65 dB	0	0.00	0	0.00
70 dB	1	1.20	4	5.97
75 dB	3	3.61	2	2.99
80 dB	9	10.84	6	8.96
85 dB	16	19.28	15	22.39
90 dB	20	24.10	4	5.97
95 dB	4	4.82	4	5.97
100 dB	6	7.23	5	7.46
105 dB	1	1.20	1	1.49
110 dB	0	0.00	3	4.48
115 dB	1	1.20	1	1.49
120 dB	1	1.20	1	1.49
Never	4	4.82	2	2.99

Note. [1]*n* = 83; [2]*n* = 67; NIOSH recommends decibel threshold of 85 dB (2018a)

Specifically looking at the HPU threshold responses from 60 dB to 120 dB, participants indicated in the pre-course responses an average HPU threshold of 88.63 dB (*SD* = 8.71) while the post-course averaged 87.81 dB (SD = 13.03). This difference (Δ = -0.82) from pre- to post-course shows little indication of the overall nature of the responses, as Table 1 shows an increase of responses at or below the NIOSH recommendation of 85 dB (Δ = 13.24%).

When evaluating the use of hearing protection per tool, respondents were asked to indicate their use of hearing protection during their last encounter with each specific tool. Table 3.2 shows the overall use for the pre-course and post-course evaluation data regarding the use of hearing protection for specific tools. Responses that indicated no previous encounters with a specific tool were not used in the evaluation. Therefore, the pre- and post-course responses for each tool have differing sample sizes for this specific evaluation. The highest response percentage for use of hearing protection across both evaluations was for the "Angle Grinder" even though it is the second lowest dB output tool (101 dB) on the list. The highest dB output tool, "Pneumatic Nail Gun" (120 dB), had the largest increase of indicated hearing protection use ($\Delta = 26.37\%$), while the lowest dB output tool, "Powered Hand Drill" (93 dB), had the largest allowable increase of a factor of 1.89 ($\Delta = 11.42\%$). Table 2 further shows that there was an average increase of 17.27 percent of use of hearing protection between the two evaluations across all tools.

Table 3.2
Did Use Hearing Protection for Specific Tools

	Pre-Evaluation[1]		Post-Evaluation[2]	
Tool (Pre *n*, Post *n*)*	*f*	%	*f*	%
Angle Grinder (67, 55)	30	44.78	35	63.64
Handheld Circular Saw (76, 66)	30	39.47	35	53.03
Impact Wrench (69, 53)	23	33.33	27	50.94
Pneumatic Nail Gun (65, 56)	20	30.77	32	57.14
Powered Hand Drill (78, 66)	10	12.82	16	24.24
Powered Miter Saw (72, 66)	29	40.28	37	56.06

Note. *Participants who indicated previous encounter with the tool. [1]*M* = 33.58%, *SD* = 10.36%; [2]*M* = 50.84%, *SD* = 12.54%

When reviewing the response "had not directly used tool", "Powered Miter Saw" saw the largest decrease ($\Delta = -11.76\%$) with a percent change of 88.74 percent. "Impact Wrench" responses increased by 23.88 percent ($\Delta = 4.03\%$).

When comparing the responses of "Did Wear Hearing Protection" for each specific tool to a participant's indicated threshold, an accuracy score was determined (Table 3.3). For example, if a participant indicated why would wear hearing protection at 100 dB but indicated they did not wear hearing protection the last time they encountered a Powered Miter Saw (107 dB), this was coded as inaccurate. The accuracy for "Pneumatic Nail Gun" had the highest increase of 79.38 percent (Δ = 26.87%), while the accuracy for “Handheld Circular Saw” had the lowest increase of 28.31 percent (Δ = 13.04%). An average 42.43 percent increase (Δ = 17.64%) of overall accuracy across the list of tools was seen from the pre- to post-course evaluation.

Table 3.3
Correct Identification of Specific Tools for Did Use Hearing Protection to Indicated Threshold

	Pre-Evaluation[1]		Post-Evaluation[2]	
Tool (Pre *n*, Post *n*)*	*f*	%	*f*	%
Angle Grinder (67, 55)	35	52.24	39	70.91
Handheld Circular Saw (76, 66)	35	46.05	39	59.09
Impact Wrench (69, 53)	28	40.58	31	58.49
Pneumatic Nail Gun (65, 56)	22	33.85	34	60.71
Powered Hand Drill (78, 66)	23	29.49	29	43.94
Powered Miter Saw (72, 66)	34	47.22	41	62.12

Note. *Participants who indicated previous encounter with the tool. [1]*M* = 41.57%, *SD* = 7.88%; [2]*M* = 59.21%, *SD* = 7.97%;

To best determine the participants perceptions of the dB output of tools in the agricultural mechanics laboratory, a review of the overall accuracy of a respondent, percentage of accurate “did wear hearing protection” responses to their indicated threshold while removing any “had not directly used tool” responses, was carried out. This was done for both evaluations, pre- and post-course.

Responses for the pre-course evaluation provided a 42.27% average accuracy with 0% and 100% accuracy being the two most common results (Table 3.4). When looking at the HPU thresholds from 60 dB to 120 dB, 0% had the highest frequency (f = 23, 38.98%) which is more than the combined frequency of responses of 40% or higher (f = 20, 33.90%). Only four respondents (6.78%) with an indicated HPU threshold between 60 dB and 120 dB scored 100% accuracy with an additional five (8.74%) scoring between 80% and 99% accuracy. The average accuracy when looking at the 60 dB to 120 dB HPU threshold range came out to 31.05 percent accuracy (*SD* = 32.99%) across all tools.

Table 3.4

Pre-Evaluation of Overall Accuracy for Did Use Hearing Protection to Indicated Threshold

Decibel Threshold to	Frequency of Accurate Responses						
Use Protection	0%	1-19%	20-39%	40-59%	60-79%	80-99%	100%
Always	3	0	0	4	1	1	8
60 dB	0	0	0	0	0	0	0
65 dB	0	0	0	0	0	0	0
70 dB	1	0	0	0	0	0	0
75 dB	2	0	0	0	0	0	0
80 dB	4	1	1	2	0	0	0
85 dB	6	1	2	1	2	2	2
90 dB	7	1	5	2	2	1	1
95 dB	3	0	0	0	0	0	1
100 dB	0	3	2	1	0	0	0
105 dB	0	0	0	0	1	0	0
110 dB	0	0	0	0	0	0	0
115 dB	0	0	0	0	0	1	0
120 dB	0	0	0	0	0	1	0
Never	0	0	0	0	0	0	4
Totals (*f*)	26	6	10	10	6	6	16
Percentages (%)	32.50	7.50	12.50	12.50	7.50	7.50	20.00

Note. n = 80, M = 42.27%, SD = 38.65%

Table 3.5 shows the accuracy frequency for the post-course evaluation. The overall alignment of HPU threshold and the HPU per tool encounter increased 13.42 percent (%Δ = 31.75) between the two evaluations. This mirrored the larger 17.81 percent increase (%Δ = 57.36) of the HPU threshold responses from 60 dB to 120 dB. There were still seven (10.61%) respondents who indicated a threshold of "Always" and scored below a 100% accuracy for their "Did wear hearing protection", five (7.58%) of which scored between 40 and 99 percent.

Table 3.5

Post-Evaluation Did Use Hearing Protection Accuracy to Indicated Decibel Threshold Response

Decibel Threshold to	Frequency of Accurate Responses						
Use Protection	0%	1-19%	20-39%	40-59%	60-79%	80-99%	100%
Always	2	0	0	2	2	1	9
60 dB	1	0	0	0	0	1	0
65 dB	0	0	0	0	0	0	0
70 dB	2	0	0	1	0	1	0
75 dB	0	0	0	0	1	0	1
80 dB	1	1	1	0	0	1	2
85 dB	3	0	1	2	3	4	2
90 dB	1	0	2	0	1	0	0
95 dB	4	0	0	0	0	0	0
100 dB	0	2	2	0	0	0	1
105 dB	0	0	0	1	0	0	0
110 dB	0	0	0	1	0	1	1
115 dB	0	0	0	0	0	1	0
120 dB	0	0	0	0	0	1	0
Never	0	0	0	0	0	0	2
Totals (*n*)	14	3	6	7	7	11	18
Percentages (*%*)	21.21	4.55	9.09	10.61	10.61	16.67	27.27

Note. $n = 66$, $M = 55.69\%$, $SD = 38.41\%$

When comparing the pre- and post-course evaluations, both the overall and 60 dB to 120 dB HPU threshold range scores all increased in the 60 to 100 percent accuracy ranges. Overall the 80 to 99 percent accuracy group saw an percent increase of 122.22 percent ($\Delta = 9.17\%$) and the 0 percent accuracy and 1 to 19 percent accuracy groups saw the largest percentage decrease of 34.73 percent and 39.39 respectively ($\Delta = -11.29\%$; $\Delta = -2.95\%$).

The accuracy in responses for those indicating a HPU threshold in the 60 dB to 120 dB range showed increases of 145.83 percent and 115.10 percent for the 80 to 99 percent accuracy ($\Delta = 12.36\%$) and 100 percent accuracy ($\Delta = 7.80\%$) groups respectively. A combined 22.35 percent decrease in the 0 to 39 percent accuracy ranges all provided percentage changes of 26.25

percent (20-39% Δ = -4.45%), 36.54 percent (1-19% Δ = -3.92%), and 35.87 percent (0% Δ = -13.98%).

Having established the perceptions of dB output and intention of hearing protection use, the willingness of the participants to follow through with the use of proper PPE needed to be determined. This was done through weekly reflections which were coded to determine the frequency of use for “Eye Protection” and “Hearing Protection” of each student-participant. Table 3.6 shows the weekly reported use of the different PPEs with an indicator of when the introduction of the indirect exposure began.

Table 3.6
Weekly Reported Use of Personal Protective Equipment

Course Week (*n*)	Eye Protection				Hearing Protection			
	f	*Mf*	%	*M%*	*f*	*Mf*	%	*M%*
Week A (69)	64		92.75		10		14.49	
Week B (57)	45		78.95		6		10.53	
Week C (69)	61		88.41		12		17.39	
Week D (60)	58		96.67		12		20.00	
Week E (68)	66		97.06		8		11.76	
Week F (42)[1]	33		78.57		4		9.52	
Pre-Indirect Exposure		54.50		88.73		8.67		13.95
Week G (59)	56		94.92		4		6.78	
Week H (61)	55		90.16		11		18.03	
Week I (37)[2]	33		89.19		4		10.81	
Week J (59)	51		86.44		5		8.47	
Week K (61)	57		93.44		5		8.20	
Week L (57)	52		91.23		4		7.02	
Post-Indirect Exposure		50.67		90.90		5.50		9.89
Totals (699)	631	52.58	90.27	89.82	85	7.08	12.16	11.92

Note. N = 78; [1]*Semester B* participants not in class; [2]*Semester A* participants not in class.

The use of “Eye Protection” averaged 89.82 percent (*SD* = 5.83%) across all reported weeks. This is a difference of 77.90 percent from the average use of Hearing Protection (M = 11.92%, *SD* = 4.32). The weeks that showed the most PPE use was Week D (96.67%, 20.00%), and the least PPE use was Week F (78.57, 9.52), both of which were pre-indirect exposure, through the signs being placed. When looking at the differences between the pre- and post-poster data, “Eye Protection” use had a 2.44 percent increase (Δ = 2.16%) of 88.73 percent (*SD* = 7.61%) to 90.90 percent (*SD* = 2.77%) while “Hearing Protection” use had a 29.14 percent decrease (Δ = -4.06%) of 13.95 percent (SD = 3.76%) to 9.89 percent (*SD* = 3.87%).

A further exploration of the data shows that, individually on average, participants wore eye protection 90.57 percent (*SD* = 14.77%) of the time while only wearing hearing protection 12.22 percent (*SD* = 20.90%) of the time (Table 3.7). There were no students who indicated they did not wear “Eye Protection” with 65 participants (83.33%) wearing them at least 80 percent of the time. There were only two (2.56%) participants who indicated that they wore “Hearing Protection” the entire semester with 65 (83.33%) wearing it less than 30 percent of the time. Only three (3.85%) participants wore hearing protection 80 percent of the time or more and one of those students accounted for 11.63 percent of the total time hearing protection was worn by all students across both semesters.

Table 3.7
Percentage of Weeks Personal Protective Equipment Was Worn by a Participant

	Eye Protection[1]		Hearing Protection[2]	
	f	%	*f*	%
100%	45	57.69	2	2.56
90-99%	8	10.26	0	0.00
80-89%	12	15.38	1	1.28
70-79%	5	6.41	0	0.00
60-69%	5	6.41	0	0.00
50-59%	1	1.28	0	0.00
40-49%	0	0.00	5	6.41
30-39%	2	2.56	5	6.41
20-29%	0	0.00	5	6.41
10-19%	0	0.00	14	17.95
1-9%	0	0.00	1	1.28
0%	0	0.00	45	57.69

Note. *n* = 78; [1]*M* = 90.57%, *SD* = 14.77%; [2]*M* = 12.22%, *SD* = 20.90%

Discussion & Conclusions

Overall, the data that was collected and analyzed for this study provides an interesting dichotomy of determinations. On one hand, there is a positive and hopeful outlook on student understanding of the dB output of equipment in an agricultural mechanic laboratory; however, there is an opposite outlook on the concerns of the follow through and practice of utilizing hearing protection even in the face of their won contrary knowledge that they should. Reviewing the data to determine the next steps should be done by going through each of the project's stated objectives.

The data identified to address the first objective for this study "establish student threshold for use of hearing protection in an agricultural mechanics setting" shows that when presented with a range of 60 dB to 120 dB in 5 dB intervals with "Always" and "Never" present, participants trend toward the NIOSH recommended threshold of 85 dB. The increased use at or below the NIOSH threshold shows that students are better aware of some noise output and can accurately state a perceived threshold that is within the standards as the course progresses. While there were some increases to specified HPU thresholds above the recommended 85 dB, the overall decrease in the average HPU threshold within 60 dB to 120 dB and positive changes among the specified HPU of "Never" and "Always" show encouraging trends when establishing thresholds for the participants.

Taking the idea of established personal thresholds for hearing protection use a step further, data needed to be analyzed to address the second objective for this study, "identify student perceptions of dB outputs relating to tool use in an agricultural mechanics setting." Preliminary data supports that students are better able to perceive the dB output of tools when compared to their identified HPU threshold. While the Powered Hand Drill (93 dB) had the largest allowable increase, the post-course evaluation still showed a use of hearing protection of less than 25 percent while all other tools were above 50 percent. Specifically looking at the accuracy of response per tool, the positive trend continues as there is an overall increase across each of the tools of nearly 20 percent. This is also echoed when looking at the overall scores for each HPU threshold where the higher accuracy groups showed increases, sometimes doubling, and the lower accuracy groups showed large percentage decreases.

Reviewing these results with MET in mind, there are multiple factors that can be contributing to these results. Throughout the semester students were exposed to the different tools through direct exposure of encountering and using the specific tools. They were also indirectly exposed to the NIOSH recommendation and recorded sound level data through posters hung in strategic placements throughout the laboratory and classroom spaces. As students became more aware of the noise and decibels different tools produce, there was an exposure to direct dB output alongside visual cues (i.e. posters) showing how loud that output should be. Seeing an increase in the accuracy of hearing protection use per tool encounter and decrease in the average HPU threshold between the 60 dB to 120 dB range for the participants, the exposure students have, both directly and indirectly, positively influenced their perceptions of dB outputs relating to equipment in an agricultural mechanics setting. In short, they became more accurate in their understanding of what tools they should wear hearing protection based on their own prescribed HPU threshold.

While there were positive signs to this point in the data, the perceptions shown by the participants do not necessarily align with their practical applications. Looking at the data relating to the final objective for this study, “determine student willingness to wear personal protective equipment relating to hearing safety in an agricultural mechanics setting,” a concerning trend arose. Again, with MET in mind and the positive results on the perception portion of the study, there should be a similar if not only slightly less positive outcome for the willingness to wear hearing protection, but the results of the data also showed something different.

The weekly reports showed a concerning tendency for agricultural mechanic students to not wear hearing protection a vast majority of the time. While there was an expectation that hearing protection would be lower than eye protection due to the nature of the learning environment, the near 80 percent difference is a call for significant concern especially with the nature of the reflective nature of the data. Expectations were for eye protection to be at or above the 90 percent mark that was established; however, hearing protection was projected to be closer to 50 percent due to the nature of the projects and student expectations with an additional 25 percent increase if students wore hearing protection in accordance with the NIOSH recommendations. The 30 percent to 60 percent decrease between expectations and reality shows that there are significant discrepancies in the understanding and habits of students engaging in agricultural mechanics. They seem to know they should wear hearing protection, but just are not doing it.

While there were some weeks post-placement of the posters that showed increased engaged PPE use, overall PPE stayed relatively the same (Eye Protection) or showed decreased use (Hearing Protection). MET indicates that there should be an increase throughout the semester as exposure is introduced. While the perceptions of dB output showed these positive trends, the practical application and willingness to wear these PPEs did not. Even when accounting for individual students, there were repeated indicators that could be associated with the actual use of hearing protection as it related to the exposure of different dB output information. While there were multiple students (n = 2, 2.56%) who wore hearing protection throughout the semester, the apparent lack of willingness to wear hearing protection by the majority (*n* = 45, 57.69%) at any point during the semester is of major concern.

Reflecting across all three objectives, there are two key takeaways that need to be addressed, both of which highlight the same need in the agricultural mechanics curriculum. There is a clear understanding by the participants that safety is a key concern and the willingness and practical application when relating to eye protection is followed through. Even though there is a perceived understanding of the noise level concerns, the follow-through by the participants is highly concerning. While MET would indicate that the exposure, both directly and indirectly, to the noise levels in the agricultural mechanics space should produce an increase in the use of hearing protection, this is unfortunately not what happens. The years of educational curricula and social normativity for wearing, or the expectations to wear, eye protection cannot be overlooked. The tangible and easily identifiable mishaps of eye related injuries allows for the educational curricula surrounding eye protection to be more easily grasped by students of all ages. While there are numerous identifiable actions and activities that can express how loud things are, the cognitive leaps associated with these experiences to a tangible outcome can be abstract in nature.

If the perceptions of dB output are being affected by the exposure both directly and indirectly throughout the semester, the main question remains of the lack of transition to practical application by the students. The course these participants engaged with is not necessarily designed with an in-depth safety module that spends weeks on each of the different safety concerns within agricultural mechanics. Prior knowledge of the student base is a pivotal aspect to the safety approach the course is founded on, with enough focus on basic safety and proper PPE use to complete the tasks and learning objectives of the course. While this approach has shown to produce an adequate use of eye protection, specified instruction on the lesser used PPE categories may be the answer to help establish a higher use rate. This study shows that through exposure to the dB levels of tools does have a positive effect on student's knowledge and perceptions, there is a strong indication that there are key components missing to our standard instruction that would help put those perceptions into action.

Future Research and Application

Reflecting on the outcome of this study, there is a clear need for further research into the culture of safety within agricultural mechanics. While agricultural education has been successful in the foundation of proper eye protection use, evaluations of the disconnect between other safety areas need to be conducted. A larger understanding of the overall culture of safety would be an ideal starting point and should focus on where SBAE is currently at in relation to the larger agricultural sector. A review of current standards and practices by industry partners could provide a baseline for SBAE instruction as it relates to safety. One key component that should be addressed when discussing the culture of safety within SBAE is the end goal of these safety practices. If agricultural mechanics courses are aiming to produce the next generation of industry workers, best practices within the agricultural sector may be the key focus when developing curricula.

This study also highlights a need for specified curriculum development on hearing safety concerns and practices thereof. Echoing the success of eye safety, curriculum should focus on taking the abstract and providing concrete experiences to assist in student understanding. While SBAE has used numerous techniques that have focused on real-life images, videos, and accounts to express the potential end results of improper eye protection use, this may be difficult for hearing protection as the negative effects are typically unseen. Utilizing research and providing hard figures/examples may be the key to unlocking concrete experiences for hearing safety education. SBAE instructors typically provide or require eye protection for their students, a push for classroom sets of hearing protection or the strategic placement of the protection could also strongly influence student use moving forward. Regardless of the decision that may be made, the next step of focusing on safety culture is clear and necessary.

ARTICLE III.
Knowledge of HEARING

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Abstract

Safety related to hearing in agriculture, more specifically School-Based Agricultural Education (SBAE), is a significant concern. Safety as a topic within SBAE has been a discussion for numerous years, as instruction places students and instructors in situations, inside and outside the laboratory, where exposure to potential unsafe practices is heightened. Hearing related safety topics, while identified as a shortcoming, has a need for targeted research in SBAE settings. Previous research has identified that the attitudes and perceptions of noise levels are at a considerable deficiency across agricultural education settings. The HEARING project (Hancock et al., 2023) focused on post-secondary agricultural education student understanding and application of hearing safety culture within an agricultural environment. This study continues this research in a SBAE setting and utilizes direct and indirect exposure to noise levels in a typical SBAE class. Through pre- and post-exposure data collection, students established their personal thresholds to use hearing protection, as well as identify their use of hearing protection for commonly used power tools in the agricultural setting. The data shows a wide range of intended thresholds and understanding of decibel outputs. While the frequency and accuracy of threshold responses closely align with the National Institute for Occupational Safety and Health's recommended hearing protection threshold (85 dB), the future use per tool results are concerning. There is still a knowledge gap within the SBAE participants that needs to be addressed; however, the indirect exposure shows to have positively influenced understanding and subsequent behavior surrounding hearing safety.

***Keywords*:** agricultural education**;** agricultural mechanics; safety culture; safety instruction.

Introduction

Discussions surrounding the instruction of topics in School-Based Agricultural Education (SBAE) have been focused often on safety aspects both in the classroom and laboratory. While there have been multiple studies specific to the teaching of agricultural mechanics, SBAE instructors often utilize laboratory-based instruction, based on the topic's appropriateness or instructor's comfortability, as it lends itself to the use of active learning techniques (Dyer & Andreasen, 1999; Hancock et al., 2024; Mazurkewicz et al., 2012; Phipps & Reynolds, 1990). This growth in active learning and use of these laboratory spaces has led to an increased need for the discussion of student safety (Chumbley et al., 2019; Dyer & Andreasen, 1999; Langley et al., 2018; Saucier et al., 2014). It is in response to this rise of active learning techniques that has also led to the exploration of safety concerns in SBAE and adjacent instruction (Chumbley et al., 2018; Roberts & Dyer, 2004; Saucier et al., 2014; Wells & Miller, 2020). While agricultural education lessons continue to focus more on active student engagement, specific safety related topics, such as hearing loss and noise level concerns, have been identified as key research topics for many years now (Bunch, 1937; Franklin, 2008; Hancock et al., 2023; Herren, 2014; Woodford et al., 1993). Outside of the educational sphere, sound and noise level concerns have long been a point of discussion within the larger scope of agricultural fieldwork (Choi et al., 2005; Matthews, 1968; Miller, 1989; Renick et al., 2009; Von Essen & McCurdy, 1998), and these studies have indicated that agricultural work is often conduced in spaces where the noise level and decibel (dB) output is well above the National Institute for Occupational Safety and Health (NIOSH) recommendation of 85 dB (Chan, 1998; NIOSH, 2018a, 2018b).

A common finding throughout the continued research focusing on hearing safety in agricultural education is the anecdotal evidence that points to a disconnect between students' understanding of noise levels and the long-term effects that one may experience being exposed to high dB output environments (Broste et al., 1989; Hancock et al., 2023; Woodford et al., 1993; Woodford et al., 1996). Roberts and Dyer (2004) conducted a study focusing specifically on laboratory management and identified 40 characteristics important to agricultural education instructors related to safety concerns that arise from hands-on learning opportunities. They highlight that of these characteristics, the participating instructors identified the care of student being the most important area of concern in their laboratory instruction. Osborne and Dyer (2000) examined active learning methods and determined that, when presented in an engaging and safe manner, these opportunities were more positively viewed by students and their attitudes towards the topic was positively changed. Building off of these findings, the use of active learning techniques could be an answer to the occupational safety climate and concerns gap Clarke (2006) identified in which they further explored (2010) and found connections between the presentation of and motivations for safety concerns. Clarke (2010) determined that to have positive effects on individuals' motivation and perceptions of safety concerns within their environment, they must first be properly presented with an established safety climate for said working and learning environment. It is the building of this climate among the instructor and students that is crucial in the foundation of a safe and healthy learning environment (Daniels, 1989; Flin et al., 2000; Hancock & McKibben, 2024) and will lead to educational success for an agricultural education program. With the continued rise in use of hands-on learning (Akkermans et al., 2020; Franklin; 2008; Hancock et al., 2024; Peden et al., 2023), it is imperative that SBAE instructors work with their students to establish and discuss the safety climate within their curricula and program (Hancock & McKibben, 2024; Johnson & Schumacher, 1989; Rudolphi & Retallick, 2015; Ullrich et al., 2002) to ensure that students are not only interacting with safe activities (Langley et al., 2018; Mazurkewicz et al., 2012; Rateau et al., 2015), but stewarding future generations of safe agriculturalists who are best prepared to tackle the challenges they will face in an increasingly louder world.

Conceptional and Theoretical framework

The foundational texts for this study (Dryer & Andreasen, 1999) identified numerous safety concerns within agricultural education that needed to be addressed. Numerous studies have been conducted that have demonstrated a continued need to focus on the education and preparation of SBAE instructors relating to these concerns (Chumbley et al., 2018; Hancock et al., 2023; Langley et al., 2018; Roberts & Dyer, 2004; Saucier et al., 2014). Since SBAE students operate in a world where consequences related to decisions being made in a risk-taking world have tangible consequences, it is imperative that SBAE instructors help educate these students on the outcomes of forgoing safety procedures (Hubert et al., 2003; McCurdy & Kwan, 2012; Renick et al., 2009). As more and more hands-on activities are being engaged in (Akkermans et al., 2020; Hancock et al., 2024; Wells & Miller, 2020), students are exposed to the actions of their peers, educators, and themselves. Zajonc's (1968) Mere Exposure Theory (MET) conceptually lends itself to the exposure SBAE students are presented with as these exposure opportunities may lead to the adoption of safe culture-normative habits. Building off of MET, Ajzen's (1991) Theory of Planned Behavior (TPB) drives this study as the social-normative changes expected by MET should influence the intention and subsequent behavior of SBAE students being exposed to hearing related safety concerns and procedures.

Zajonc (1968) discusses that external stimuli can provide an opportunity for individuals to experience a strong internal awareness. Out of this logic, he developed MET which is shaped by two main beliefs. The first of these beliefs is that as exposure increases, barriers of processing stimuli are easier to overcome. Zajonc further believed that a reduction of effort or time needed to process something would lead to an increase in fondness of said thing (Reber et al., 1998; Vincent et al., 2020). MET, often called the familiarity principle, establishes that as an individual becomes more familiar with something, they develop a preference for and an ability to remember that specific item or topic of information (Vincent et al., 2020). Zajonc (1968) establishes that it is this principle in which the relationship between frequency and meaning are empirically connected. This understanding is what Vincent et al. (2020) used to extend the MET theory to the SBAE classroom in which they discussed the power exposing students to different topics has, as it affects change in students' cultural understanding and behavior.

Building off of the established perspective and conceptional theory of MET, Ajzen's (1991) TPB was selected to help guide the theoretical framework for this study. This theory, which builds on the concepts of Ajzen's theory of reasoned action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975), by addressing the components that individuals interact with within their behavioral control. TPB focuses on three components that an individual interacts with, their *Attitude Toward a Behavior*, the *Subjective Norms* surrounding a behavior, and one's *Perceived Behavioral Control*. Ajzen (1991) discusses how these three components interact with and influence an individual's intention to engage in a specific behavior and subsequently follow through with that intention by exhibiting that behavior (Figure 4.1).

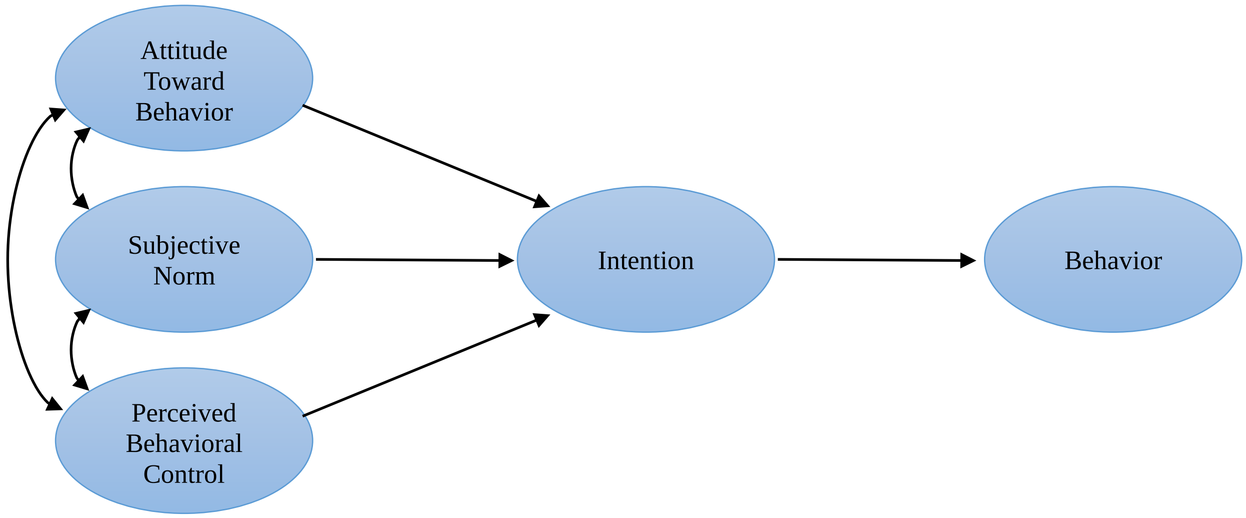

Figure 4.1. *Theory of Planned Behavior (Derived from: Ajzen, 1991)*

Reflecting on the interplay of the three influencing components, Ajzen's defined *Perceived Behavioral Control* as "people's perception of the ease or difficulty of performing the behavior of interest" (p. 183) which can be influenced by the educational setting one is interacting with. TPB states that driving factors, such as *Perceived Behavioral Control*, can strengthen or weaken one's intentions to engage with a specific behavior. As one engages in activities that promote exposure to a specific behavior, their perceptions of their own control on that behavior will be influenced. It is important to take into consideration students' initial *Perceived Behavioral Control* as it can lead to unintentional barriers if not properly addressed (Ajzen, 1991). This is in part to TPB's self-efficacy connection to Bandura's framework of Social Cognitive Theory (1997a) and Social Learning Theory (1997b). Ajzen's TPB emphasizes the importance of one's relationships regarding shared beliefs, intentions, and behavior. Ajzen further builds off of Bandura's theories (1977a, 1997b) by acknowledging that learning is a cognitive process that takes place in a social setting. Individuals use observational skills and are influenced to learn through direct and indirect instruction as they are exposure to both positive and negative stimuli (Ajzen, 1991, Cook et al., 2017).

Another influencer theorized by Ajzen (1991) is one's *Attitude Toward a Behavior*, which is described as either a positive or negative evaluation of a behavior by an individual. This component engages an individual's past and present experiences, which has affected their attitude either positively or negatively, as an affirmation of one's intentions to engage in a specific behavior. Lastly, *Subjective Norms* are a social prediction factor that takes into account the perceived social pressures relating to a given behavior in an individual's sphere of influence. Ajzen theorized that it is the direct influence of or combination of social pressures, positive or negative attitudes, perceptions relating to difficulty of tasks that can be used as a framework for identifying an individual's intentions to affect their behavioral outcomes.

This study, influenced by the foundational studies, conceptual framework of the MET, and theoretical framework of TPB, aims to better understand SBAE student's perceptions and intentions to adhere to a culture of safety by wearing hearing protection. There has been a call to action in meeting the safety needs of SBAE students (Dryer & Andreasen, 1999) which has yet to have been met (Hancock et al., 2023). By examining student's perceptions of dB outputs and future use of hearing protection while providing direct and indirect exposure to the sound level concerns in an agricultural setting, the influences of MET and TPB hopes to provide additional insight into student understanding, perceptions, and future behavior surrounding hearing protection safety within an agricultural setting.

Purpose and Objectives

The purpose of this study was to identify SBAE students' understanding of hearing related safety issues within an agricultural setting. The HEARING project (Hancock et al., 2023) has identified that individuals, through direct and indirect exposure, have a perception of needed use for hearing protection based on one's established threshold. This study aims to expound on previous studies in this project focusing on SBAE students. Four objectives guide this study:

1. Establish SBAE student threshold for use of hearing protection in an agricultural setting;
2. Determine SBAE student willingness to wear personal protective equipment relating to hearing safety in an agricultural setting;
3. Identify SBAE student perceptions of dB outputs relating to tool use in an agricultural setting;
4. Determine differences among SBAE students' knowledge and perceptions of hearing related safety concerns in an agricultural setting.

Methods

Three SBAE programs active in agricultural mechanics were approached to participate in a pre- and post-instrument study focusing on hearing related safety knowledge and perceptions. Selection for participation was contingent on the presence of at least one agricultural mechanics course and one non-agricultural mechanics course being taught during the semester of the study. Due to non-standardized course listings across districts, any academic level of coursework was approved for involvement in the study. The three programs that were selected are located within populations ranging from rural to suburban and employ either one or two teachers. Each program selected two classes, one agricultural mechanics focused and another non-agricultural mechanics focused, where 104 students completed the pre-exposure instrument and 94 students completed the post-exposure instrument. Their demographics are described in Table 4.1.

Table 4.1
Demographics of Student Participants

	Pre-Exposure		Post-Exposure	
Subgroup	*f*	%	*f*	%
Course				
Agricultural Mechanics	49	47.12	49	52.13
Non-Agricultural Mechanics	55	52.88	45	47.87
School				
School A	41	39.42	37	39.36
School B	32	30.77	32	34.04
School C	31	29.81	25	26.60
Gender				
Male	83	79.81	73	77.66
Female	20	19.23	18	19.15
Classification				
Freshman	14	13.46	11	11.70
Sophomore	43	41.35	41	43.62
Junior	33	31.73	29	30.85
Senior	14	13.46	13	13.83
Previous Ag Mech Experience				
None	17	16.35	9	9.57
One or Two Courses	69	66.35	68	72.34
Three or More Courses	18	17.31	17	18.09

This study utilized pre- and post-exposure evaluations that were developed through Qualtrics, using the CDC-NIOSH established guidelines (NIOSH, 2018a, 2018b), and were distributed in person upon receiving the necessary approval. The instrument first asked students to indicate if they intend to use hearing protection the next time they encounter a specific tool in use, given a list of tools (Handheld Circular Saw; Powered Hand Drill; Angle Grinder; Impact Wrench; Powered Miter Saw; Pneumatic Nail Gun). The students were then asked when they would start wearing hearing protection by indicating a dB output threshold (1 = Always; 2 = 60 dB; 3 = 65 dB; 4 = 70 dB; 5 = 75 dB; 6 = 80 dB; 7 = 85 dB; 8 = 90 dB; 9 = 95 dB; 10 = 100 dB; 11 = 105 dB; 12 = 110 dB; 13 = 115 dB; 14 = 120 dB; 15 = Never). The tool list for the first question was presented in random order and without dB output information to help mitigate instrumentation errors. The dB threshold question did place the NIOSH recommended threshold (85 dB) slightly off center; however, its proximity to the middle of the range is a limitation that may have influenced some of the participant's responses.

The second portion of the evaluation contained ten multiple-choice questions, derived from Slaydon's (2009) study, relating to hearing safety and concerns (Table 4.2). The questions from the original study were re-evaluated to determine the appropriateness of the question and answer as it relates to the hearing safety information presently available. The remaining questions were used as demographic data identifiers for the students.

Table 4.2
Hearing Safety Quiz Questions

Question	Correct Answer
According to the National Institute on Deafness and Other Communication Disorders, how many people over the age of twelve in the United States suffer from some form of hearing loss in both ears?	30,000,000 people
How does the CDC classify hearing loss?	Mild, Moderate, Severe, Profound
Which of the following is NOT a basic type of hearing loss that the CDC recognizes?	Bioneural
Excessive ear wax build-up often leads to what kind of hearing loss?	Temporary
What is an Audiogram?	Sound Level Graph
Who performs hearing screenings?	Audiologist
Frequencies covered during audiometry should include:	250 Hertz to 8000 Hertz
What is a decibel?	A logarithmic unit of sound level
A typical rock concert produces and maintains a decibel level of:	110 dB
Which of the following is NOT a cause of hearing loss?	Someone screaming loudly in your ear one time

The pre- and post-exposure instruments were nearly identical with the post-exposure evaluation having an additional question in which students were to identify the location of any hearing related posters or memorabilia that was located in the agricultural education classroom and/or laboratory. The pre-exposure instrument was distributed during the last week of October upon the approval of the site principle, program instructor, and University IRB. Students were provided with a parental consent form that was collected prior to the completion of the study and any students who did not return the form was excused from the study.

Between the two instrument administrations, participating SBAE instructors were instructed to conduct class as normal. Agricultural mechanics course instruction was determined prior to the study to be focused on active learning techniques that promoted the use of the tools from the identified list. The exposure of the tools in an agricultural mechanics laboratory aimed to provide a better understanding of dB levels for the students participating in an agricultural mechanics course. To assist in the exposure to dB output information students taking either the agricultural mechanics or non-agricultural mechanics courses were indirectly exposed to NIOSH recommended limits and tool dB outputs (NIOSH, 2018a, 2018b). Two 48” X 48” informational posters (Figure 4.2) were hung in each of the participating program’s agricultural education laboratory and classroom. Instructors were told to not directly instruct on the informational posters nor hearing safety curriculum, as the placement was decided to encourage the viewing by students regardless of their activity in the classroom or laboratory.

Figure 4.2. *Poster used in laboratory indicating NIOSH recommended exposure limit and tools with decibel output.*

The post-exposure instrument was distributed during the last week of the semester for each of the programs. Due to the age of the secondary student population, IRB required that no identification markers were used to pair the pre- and post-exposure instruments per individual. This does mean that statistical analysis was limited; however, this allowed for more students to participate in the study and removed a barrier of exclusion for students who were not present during either portion of the study. As such all results are not generalizable beyond the scope of the study. All analysis was completed using SPSS 29.

For the first objective, student responses were initially evaluated to determine each individual's threshold. Using the responses within a defined range, 60 dB to 120 dB, an average was determined for both the pre- and post-exposure evaluations. Objective two looked solely at the responses for future use of hearing protection for each tool. To better understand the differences between the direct and indirect exposure, responses were evaluated by comparing the different course types, agricultural mechanics and non-agricultural mechanics, as the agricultural mechanics students were directly exposed to the sound output of the tools on the list. The third objective was evaluated by taking each individual's identified hearing protection use threshold and coding their response of future hearing protection use for each tool to correct or incorrect based on the tool's dB output (Table 4.3). For example, if a student indicated they would start wearing hearing protection when the decibel level reached 100 dB, and indicated they would wear wear hearing protection when encountering a tool that produces 100 dB or higher, that would be coded as correct. If the same student indicated they would not wear hearing protection for the same tool, that would be coded as incorrect.

Table 4.3
Hearing Protection Use Per Tool to Indicated Threshold Coding Examples

Hearing Protection Response	Tool DB Output to Threshold	Coding Result
Yes	Higher (110 dB > 100 dB)	Correct
Yes	Equal (100 dB = 100 dB)	Correct
Yes	Lower (90 dB < 100 dB)	Incorrect
No	Lower (90 dB < 100 dB)	Correct
No	Equal (100 dB = 100 dB)	Incorrect
No	Higher (110 dB > 100 dB)	Incorrect

The fourth objective took the averages across the demographic data for both the hearing protection use per tool in relation to an individual's threshold and the knowledge quiz to determine if any statistical differences existed. The data was first categorically sorted and then analyzed using T-tests to determine statistical differences between the pre- and post-exposure instruments. Due to the nature of the data either increasing or decreasing between the two instruments, a one-tailed test was conducted, and significance was determined one sided. Effect sizes were also analyzed and were determined using Cohen's *d* (Cohen, 1998) Looking at the categories individually, the data was then analyzed using Fisher's exact test to determine any associations between the accuracy of responses and the categories themselves. Based on suggestions by Field (2018), due to the number of categories leading to incalculable results, a Monte Caro (Mooney, 1997) simulation was conducted, and the results of the Fisher's exact test was determined based on 1,000,000 sampled tables. Lastly, the data was then analyzed using either a t-test or analysis of variance (ANOVA) based on the number of groupings each category consisted of. Each category was analyzed for both accuracy types and effect sizes were determined based on either Cohen's *d* (Cohen, 1988) or eta squared (η^2) (Cohen, 1988; Field, 2018; Miles & Shevlin, 2001) based on the appropriateness of the conducted test.

Results

The data was first reviewed to identify the dB threshold at which the participating students would start wearing hearing protection. Table 4.4 shows the overall results across the pre-exposure and post-exposure evaluations. While there was a decrease (Δ = -10.31%) in "Always" responses and a slight increase (Δ = 1.88%) in "Never" responses, the defined range (60 dB to 120 dB) saw between a -2.48% and a 4.77% difference in overall response percentage change.

Table 4.4
Student Indicated Decibel Threshold Response for Use of Hearing Protection

DB Threshold to Use Protection	Pre-Evaluation[1] *f*	Pre-Evaluation[1] %	Post-Evaluation[2] *f*	Post-Evaluation[2] %
Always	23	23.08	12	12.77
60 dB	2	1.92	2	2.13
65 dB	2	1.92	0	0.00
70 dB	3	2.88	1	1.06
75 dB	2	1.92	3	3.19
80 dB	10	9.62	7	7.45
85 dB	10	9.62	12	12.77
90 dB	14	13.46	12	12.77
95 dB	4	3.85	7	7.45
100 dB	5	4.81	9	9.57
105 dB	9	8.65	6	6.38
110 dB	3	2.88	7	7.45
115 dB	1	0.96	3	3.19
120 dB	7	6.73	4	4.26
Never	8	7.69	9	9.57

Note. [1]*n* = 104; [2]*n* = 94

Looking further into the defined range for averaging an overall threshold among the pre- and post-exposure responses, there was a 1.96 dB increase from 92.08 dB (*SD* = 15.09) to 94.04 dB (*SD* = 13.54) both nearly ten times the 85 dB limit. At both thresholds, the NIOSH recommended exposure limit would be one and half hours and one hour respectively (Chan, 1998).

Breaking the responses into the two respective course types, *agricultural mechanics* and *non-agricultural mechanics*, slight differences begin to appear (Table 5). While both course types saw a decrease in *Always* responses, the agricultural mechanics students (Δ = -16.33%) decreased 3.37 times as much as the non-agricultural mechanics students (Δ = -4.85%). Both the agricultural mechanics and non-agricultural mechanics responses increased by nearly two percent from the pre- to the post-exposure evaluation.

Table 4.5
Student Indicated Decibel Threshold Response for Use of Hearing Protection by Course Type

DB Threshold to Use Protection	Agricultural Mechanics Pre[1] *f*	%	Agricultural Mechanics Post[2] *f*	%	Non-Agricultural Mechanics Pre[3] *f*	%	Non-Agricultural Mechanics Post[4] *f*	%
Always	14	28.57	6	12.24	10	18.18	6	13.33
60 dB	1	2.04	2	4.08	1	1.82	0	0.00
65 dB	1	2.04	0	0.00	1	1.82	0	0.00
70 dB	0	0.00	0	0.00	3	5.45	1	2.22
75 dB	1	2.04	1	2.04	1	1.82	2	4.44
80 dB	2	4.08	3	6.12	8	14.55	4	8.89
85 dB	5	10.20	7	14.29	5	9.09	5	11.11
90 dB	5	10.20	4	8.16	9	16.36	8	17.78
95 dB	1	2.04	5	10.20	3	5.45	2	4.44
100 dB	1	2.04	7	14.29	4	7.27	2	4.44
105 dB	7	14.29	3	6.12	2	3.64	3	6.67
110 dB	3	6.12	5	10.20	0	0.00	2	4.44
115 dB	0	0.00	1	2.04	1	1.82	2	4.44
120 dB	5	10.20	1	2.04	2	3.64	3	6.67
Never	3	6.12	4	8.16	5	9.09	5	11.11

Note. [1]*n* = 49; [2]*n* = 49; [3]*n* = 55; [4]*n* = 45;

For the students in an agricultural mechanics course, the average threshold for the defined range decreased 2.74 dB from 96.72 dB (*SD* = 15.84) for the pre-exposure responses to 93.97 dB (*SD* = 13.31) for the post-exposure responses indicating an exposure increase from 38 minutes to one hour (Chan, 1998). While this decrease was not excessive, the overall decrease was better result than the increase of 5.74 dB from 87.57 dB (*SD* = 12.82) for the pre-exposure threshold average to the post-exposure threshold average of 94.12 dB (*SD* = 13.80) for the non-agricultural mechanics students which would lead to an exposure decrease from four hours to just less than one hour.

When looking at the individual dBs, 24 (48.98%) of the agricultural mechanics course students and 29 (52.73%) of the non-agricultural mechanics course students indicated their threshold to be at or below the NIOSH Recommendation (2018a) of 85dB. Both the agricultural mechanics course (Δ = -10.20%) and the non-agricultural mechanics course (Δ = -12.73%) responses in this range decreased on the post-exposure evaluation to 19 (38.78%) and 18 (40.00%) respectively.

Moving from the identification of threshold to the future use of hearing protection per the given set of tools, a wide range of perceived use was provided. Table 4.6 highlights that three tools (*Angle Grinder, Handheld Circular Saw, Power Miter Saw*) were recognized across both the pre- and post-exposure at or near the majority for future use of hearing protection.

Table 4.6
Student Indicated Response for Will Use Hearing Protection for Specific Tools

	Pre[1]		Post[2]	
Tool	*f*	%	*f*	%
Angle Grinder	52	50.00	44	46.81
Handheld Circular Saw	52	50.00	48	51.06
Impact Wrench	29	27.88	28	29.79
Pneumatic Nail Gun	25	24.04	21	22.34
Powered Hand Drill	9	8.65	13	13.83
Powered Miter Saw	51	49.04	42	44.68

Note. [1]*M* = 34.94%, *SD* = 15.87%; [2]*M* =34.75%, *SD* = 13.70%

The overall average of future use stayed relatively the same across the pre- and post-exposure evaluations (Δ = -0.18%); however, the *Powered Hand Drill* did see an increase of 59.81% (Δ = 5.18%) of the 8.65% (*f* = 9) the largest percentage change across all tools. The three tools that resulted in a decrease in responses all were less than a ten percent decrease from the pre- to the post-exposure evaluation.

When breaking down responses into the course types, a division begins to become apparent. Table 4.7 establishes that the agricultural mechanics students showed a decrease in future hearing protection use only for the *Powered Miter Saw*. This is a juxtaposition to the non-agricultural mechanics students where the responses showed an increase in future hearing protection use only for the *Powered Hand Drill*.

Table 4.7
Student Indicated Will Use Response by Course Type

	Agricultural Mechanics				Non-Agricultural Mechanics			
	Pre[1]		Post[2]		Pre[3]		Post[4]	
Tool	*f*	%	*f*	%	*f*	%	*f*	%
Angle Grinder	22	44.90	22	44.90	30	54.55	22	48.89
Handheld Circular Saw	25	51.02	27	55.10	27	49.09	21	46.67
Impact Wrench	10	20.41	14	28.57	19	34.55	14	31.11
Pneumatic Nail Gun	10	20.41	13	26.53	15	27.27	8	17.78
Powered Hand Drill	4	8.16	8	16.33	5	9.09	5	11.11
Powered Miter Saw	22	44.90	21	42.86	29	46.67	21	46.67

Note. [1]*M* = 31.63%, *SD* = 15.97%; [2]*M* = 35.71%, *SD* = 13.05%; [3]*M* = 37.88%, *SD* = 16.21%; [4]*M* = 33.70%, *SD* = 14.93%

The overall average future use of hearing protection percentage increase of 12.90% (Δ = 4.08%) for the agricultural mechanics students across both evaluations while the non-agricultural mechanics students responded with a percentage decrease of 11.02% (Δ = -4.18%). Both groups responded with low to middling future use across all six tools; however, the agricultural mechanics students saw the most change across the two evaluations.

Further evaluating the data, student responses were coded for the correct identification of hearing protection use based on their identified threshold. Table 4.8 shows the frequency of correct responses for the future wearing or not wearing of hearing protection based on an individual's perceived dB threshold.

Table 4.8
Correct Identification of Specific Tools for Will Use Hearing Protection to Indicated Threshold

	Pre-Evaluation[1]		Post-Evaluation[2]	
Tool	*f*	%	*f*	%
Angle Grinder	61	58.65	63	67.02
Handheld Circular Saw	64	61.54	64	68.09
Impact Wrench	41	39.42	44	46.81
Pneumatic Nail Gun	31	29.81	30	31.91
Powered Hand Drill	36	34.62	45	47.87
Powered Miter Saw	63	60.58	58	61.70

Note. [1]*M* = 47.44%, *SD* = 13.14%; [2]*M* = 53.90%, *SD* = 12.94%

The average correct response for all of the tools increased 13.63% (Δ = 6.46%) and all tools saw an increase in correct responses. The *Powered Hand Drill* resulted in largest increase at 38.30% (Δ = 13.26%) while the *Powered Miter Saw* resulted with the smallest at 1.86% (Δ = 1.13%).

Table 4.9 reviews the data by course type and echoes the overall results with both the agricultural mechanics and non-agricultural mechanics responses increasing in correctness across all tools. When looking at individual tools, the *Pneumatic Nail Gun* and *Powered Miter Saw* both saw decreases in correct responses by non-agricultural mechanic (Δ = -3.84%) and agricultural mechanics students (Δ = -6.12%) respectively.

Table 4.9

Correct Identification Hearing Protection Use to Indicated Threshold by Course Type

	Agricultural Mechanics				Non-Agricultural Mechanics			
	Pre[1]		Post[2]		Pre[3]		Post[4]	
Tool	*f*	%	*f*	%	*f*	%	*f*	%
Angle Grinder	27	55.10	31	62.27	34	61.82	32	71.11
Handheld Circular Saw	33	67.35	33	67.35	31	56.36	31	68.89
Impact Wrench	18	36.73	20	40.82	23	41.82	24	53.33
Pneumatic Nail Gun	13	26.53	17	34.69	18	32.73	13	28.89
Powered Hand Drill	21	42.86	25	51.02	15	27.27	20	44.44
Powered Miter Saw	30	61.22	27	55.10	33	60.00	31	68.89

Note. [1]*M* = 48.30%, *SD* = 14.22%; [2]*M* = 52.04%, *SD* = 11.53%; [3]*M* = 46.67%, *SD* = 13.51%; [4]*M* = 55.93%, *SD* = 15.47%

Correct responses for the *Pneumatic Nail Gun* increased the most for the agricultural mechanic students at 30.77% (Δ = 8.16%) which was outshone by the correct responses for the *Powered Hand Drill* by non-agricultural mechanics students which increased 62.69% (Δ = 17.17%). On average, correct responses for each tool for non-agricultural mechanic students resulted in a 21.81 percent increase (*SD* = 22.16%) which is nearly double the 10.96 percent increase (SD = 13.12%) of the agricultural mechanics students.

When reviewing the correct responses by each individual response rather than by tool, no frequency of accurate responses arose to a point of recognition. When evaluating based on individual threshold responses, multiple areas of concern surfaced. Table 4.10 shows the individual accurate response frequencies for the pre-exposure evaluation in relation to the threshold that was identified by said individual.

Table 4.10

Pre-Evaluation of Overall Accuracy for Will Use Hearing Protection to Indicated Threshold

DB Threshold to Use Protection	Frequency of Accurate Responses						
	0	1	2	3	4	5	6
Always	5	3	1	4	5	2	4
60 dB	0	0	1	1	0	0	0
65 dB	0	1	0	0	0	1	0
70 dB	0	0	1	0	1	0	1
75 dB	0	0	1	1	0	0	0
80 dB	1	1	3	3	2	0	0
85 dB	1	1	3	3	2	0	0
90 dB	5	1	2	2	3	1	0
95 dB	1	0	1	0	2	0	0
100 dB	0	4	0	1	0	0	0
105 dB	0	3	2	2	2	0	0
110 dB	0	0	3	0	0	0	0
115 dB	0	0	0	0	0	1	0
120 dB	0	1	0	0	1	5	0
Never	1	0	0	0	0	0	7
Totals (*f*)	14	15	18	17	18	10	12
Percentages (%)	13.46	14.42	17.31	16.35	17.31	9.62	11.54

Note. *n* = 104, *M* = 2.85, *SD* = 1.89

One key point of concern is the 21 participants (20.19%) who had less than six accurate responses while indicating that they would always or never wear hearing protection. Only one (0.96%) participant was able to accurately identify hearing protection use for all six tools while providing a measurable threshold. Twenty-one (20.19%) other participants who indicated a threshold between 60 dB and 120 dB did accurately identify hearing protection use for either four or five of the six tools.

These points of concern are addressed in the reviewing of the post-exposure evaluation data, which Table 4.11 highlights. The accuracy of the responses for the individuals indicating a threshold of *Always* or *Never* showed positive signs as only seven respondents (7.45%) were not able to accurately identify future hearing protection for all six tools which resulted in a decrease (Δ = -11.78%) between the evaluations.

Table 4.11
Post-Evaluation of Overall Accuracy for Will Use Hearing Protection to Indicated Threshold

DB Threshold to Use	Frequency of Accurate Responses						
Protection	0	1	2	3	4	5	6
Always	2	0	1	2	1	1	5
60 dB	0	1	0	0	1	0	0
65 dB	0	0	0	0	0	0	0
70 dB	0	0	0	0	1	0	0
75 dB	0	0	1	1	1	0	0
80 dB	0	1	1	2	1	0	2
85 dB	7	0	0	3	0	1	1
90 dB	3	2	0	5	1	1	0
95 dB	2	2	2	1	0	0	0
100 dB	0	2	1	3	3	0	0
105 dB	0	2	0	0	3	1	0
110 dB	0	0	2	0	3	2	0
115 dB	0	0	0	0	0	3	0
120 dB	0	0	0	0	0	4	0
Never	0	0	0	0	0	0	9
Totals (*n*)	14	10	8	17	15	13	17
Percentages (%)	14.89	10.64	8.51	18.09	15.96	13.83	18.09

Note. *n* = 94, *M* = 3.23, *SD* = 2.05

A total of three students (3.19%) were able to accurately identify hearing protection use for all six tools while providing a threshold between 60 dB and 120 dB, and 26 students (27.66%) were able to accurately identify hearing protection use for four or five of the six tools within the same range. One concerning result was the increase (Δ = 6.49%) of students that had zero out of six accurate responses while indicating a threshold of 85 dB. To determine any differences between responses among and outside the course types, average accuracy scores were calculated for a series of subgroups as shown in Table 4.12.

Table 4.12

Accuracy for Use of Hearing Protection to Indicated Threshold by Categorical Subgroups

	Pre		Post		Change	
Subgroup (*pre-n*, *post-n*)	*M*	*SD*	*M*	*SD*	Δ	% Δ
Course						
Agricultural Mechanics (49, 49)	2.90	1.81	3.12	2.04	0.22	7.59
Non-Agricultural Mechanics (55,45)	2.80	1.97	3.36	2.07	0.56	20.00
Gender						
Male (83, 73)	2.92	1.96	3.19	2.09	0.27	9.25
Female (20, 18)	2.65	1.57	3.61	1.94	0.96	36.23
Classification						
Freshman (14, 11)	2.29	1.59	3.27	1.62	0.98	42.79
Sophomore (43, 41)	2.91	1.70	3.17	1.94	0.26	8.93
Junior (33, 29)	3.03	2.17	3.38	2.23	0.35	11.55
Senior (14, 13)	2.79	2.08	3.08	2.47	0.29	10.39
Previous Ag Mech Experience						
None (17, 9)	2.47	1.81	3.00	2.50	0.53	21.46
One or Two Courses (69, 68)	2.86	1.84	3.46	1.91	0.60	20.98
Three or More Courses (18, 17)	3.17	2.18	2.47	2.24	-0.70	-22.08
Posters						
Identified (n/a, 44)	-	-	3.77	2.16	-	-
Not Identified (n/a, 50)	-	-	2.76	1.84	-	-
Total (104, 94)	2.85	1.89	3.23	2.05	0.38	13.33

Note. Accuracy is correct hearing protection use related to threshold responses out of 6 tools

Accuracy in responses increased across all subgroups outside of the respondents who identified having *Three or More Courses* focusing on agricultural mechanics which saw a 22.08% decrease (Δ = -0.70). *Freshmen* saw the largest increase at 42.79% (Δ = 0.98) followed closely by *Female* participants with a 36.23% increase (Δ = 0.96). When comparing the across the classifications of the participants, *Senior* students scored the lowest on the post-exposure evaluation which also echoed the results of the students who indicated taking *Three of More Courses* compared to those who had *None* or *One or Two Courses.* Only able to be identified on the post-exposure evaluation, participants who were able to identify posters scored, on average, one point higher than those who were not (Δ = 1.01) and the highest across all groupings of the participants scoring 0.54 higher than the overall average. Taking the results of the ten-question hearing safety quiz, averages were determined across the same groupings to determine any differences or comparisons (Table 4.13).

Table 4.13
Accuracy for Quiz Questions by Categorical Subgroups

	Pre		Post		Change	
Category (*pre-n, post-n*)	M	SD	M	SD	Δ	% Δ
Course						
Agricultural Mechanics (49, 49)	3.43	1.49	3.65	1.70	0.22	6.41
Non-Agricultural Mechanics (55,45)	3.49	1.48	3.96	1.33	0.47	13.47
Gender						
Male (83, 73)	3.36	1.46	3.78	1.55	0.42	12.50
Female (20, 18)	3.85	1.53	4.06	1.55	0.21	5.45
Classification						
Freshman (14, 11)	3.71	1.49	3.73	1.74	0.02	0.54
Sophomore (43, 41)	3.33	1.39	3.44	1.38	0.11	3.30
Junior (33, 29)	3.70	1.65	4.41	1.55	0.71	19.19
Senior (14, 13)	3.07	1.27	3.62	1.56	0.55	17.92
Previous Ag Mech Experience						
None (17, 9)	3.53	1.42	3.78	0.67	0.25	7.08
One or Two Courses (69, 68)	3.46	1.53	3.79	1.60	0.33	9.54
Three or More Courses (18, 17)	3.39	1.38	3.82	1.67	0.43	12.68
Posters						
Identified (n/a, 44)	-	-	4.05	1.49	-	-
Not Identified (n/a, 50)	-	-	3.58	1.53	-	-
Total (104, 94)	3.46	1.47	3.80	1.54	0.34	9.83

Note. Accuracy is correct multiple-choice responses out of 10 questions

Juniors score the highest among all groupings and had the largest increase at 19.19% (Δ = 0.71) and was 16.05% higher than the average (Δ = 0.61) while *Sophomores* scored the furthest from the average with a decrease of 9.47% (Δ = -0.36) leading to the largest gap among groupings at 28.20% (Δ = 0.97). Previous agricultural mechanics course experience had little effect on the outcome of the quiz as all groupings scored within a 1% difference of the average and a 1.06% difference (Δ = 0.04) amongst themselves. Lastly, students who were able to identify the posters scored 13.13% higher (Δ = 0.47) than those who did not.

The accuracy data was first reviewed to see if the increase or decrease in the accuracy of hearing protection use and quiz among the categorical subgroupings from the pre- to the post-exposure instrument was statistically significant (Table 4.14).

Table 4.14
T-tests of Pre- and Post-exposure data by categorical subgroups

	Hearing Protection			*Quiz*		
Category (df)	*t*	*p*	*d*	*t*	*p*	*d*
Course						
Agricultural Mechanics (96)	0.58	.28	.12	0.70	.24	.14
Non-Agricultural Mechanics (98)	1.34	.09	.28	1.64	.05*	.33
Gender						
Male (154)	.85	.20	.12	1.74	.04*	.28
Female (36)	1.69	.05*	.55	0.41	.34	.13
Classification						
Freshman (23)	1.53	.07	.62	0.02	.49	.01
Sophomore (82)	0.66	.25	.15	0.38	.35	.08
Junior (60)	0.62	.27	.16	1.76	.04*	.45
Senior (25)	0.33	.37	.13	1.00	.16	.39
Course Experience						
None (24)	0.62	.27	.26	0.49	.31	.20
One or Two Courses (135)	1.87	.03*	.32	1.24	.11	.21
Three or More Courses (33)	-0.93	.18	-.32	0.84	.20	.29
Total (196)	1.38	.08	.20	1.57	.06	.22

Note. *Statistical significance determined at ≤ .05; *p*-value calculated one sided

Participants that indicated that they were female and those who indicated they had taken one or two agricultural mechanics courses saw a significant increase in hearing protection use accuracy between the two instruments, while the individuals who identified as males, juniors, and/or those in non-agricultural mechanics courses saw a statistical increase on quiz accuracy. The change between the two instruments for hearing protection use accuracy had a small to medium effect size for the participants who participated in one or two courses while female participants had a medium to large effect size. As for the quiz differences, the participants who identified as male, juniors, and in a non-agricultural mechanics course saw small to medium effect sizes. Participants who identified as freshmen saw an increase that, while not statistically significant, had a medium to large effect size when looking at the differences of pre- and post-exposure accuracy of hearing protection use.

When comparing the expected results to the actual results of the data related to accuracy Hearing Protection Use and Quiz using Fisher's exact test, no statistically significant associations were determined across the pre- and post-exposure instruments (p = .44; p = .11). The data was then reviewed by subgroups (Table 4.15), with all groups were again reviewed using Fisher's exact test. Due to the nature of the comparison for *Classification* to the accuracy data, a Monte Carlo (Mooney, 1997) simulation of 1,000,000 sampled tables was used to determine the exact results across both exposure analysis (Field, 2018).

Table 4.15
Fisher's Exact Test Results Between Categorical Subgroups and Accuracy Data

	Pre-Exposure		Post-Exposure	
	HP Correct	Quiz Correct	HP Correct	Quiz Correct
Category	p	p	p	p
Course	*.75*	*.35*	*.91*	*.34*
Gender	*.44*	*.59*	*.96*	*.76*
Classification[1]	*.22*	*.10*	*.46*	*.04**
Course Experience	*.61*	*.31*	*.14*	*.62*
Poster	–	–	*< .01**	*.36*

Note. *Significance determined at ≤ .05; [1]based on 1000000 sampled tables

No significant associations were determined for the pre-exposure data; however, it was determined that on the post-exposure instrument, an individual's classification had a significant association to the number of questions they scored correctly, and one's ability to identify specific informational posters had a significant association on their number of correct responses to hearing protection used based on their identified threshold.

To investigate the differences among different characteristics of the participating students, T-test and analysis of variance analyzations (ANOVA) were conducted, when appropriate based on the nature of the category, for both the pre- and post-exposure data. Table 4.16 presents the results of the t-tests conducted on the binary categorical characteristic data specific to the average accuracy in hearing use responses. Both Course and Gender categories saw an inversion of highest average between their groups with *Male* and *Agricultural Mechanics* students scoring higher on the pre-exposure instruments and Female and Non-agricultural mechanics students scoring higher on the post-exposure instrument.

Table 4.16
T-test Results for Hearing Protection Use Accuracy by Categorical Subgroups

	Pre-Exposure				Post-Exposure			
Category	df	*t*	*p*	*d*	df	*t*	*p*	*d*
Course	102	*-0.26*	*.79*	.05	92	*0.55*	*.58*	.11
Gender	101	*-0.56*	*.57*	.14	89	*0.77*	*.44*	.20
Poster	–	–	–	–	92	*2.46*	*.02**	.51

Note. *Significance determined at ≤ .05

Echoing the findings of Fisher's exact test, neither the course an individual was participating in nor their gender had a statistically significant effect on their accuracy for determining future hearing protection use. The 50 individuals who identified the informational posters (*M* = 3.77, *SD* = 2.16), compared to the 44 who did not (*M* = 2.76, *SD* = 1.84), were significantly better able to accurately identify use of hearing protection per a set of tools compared to their given threshold, t(92) = 2.46, p < .05.

When evaluating the accuracy of quiz responses comparatively based on the same categorical data, no significant indicators were determined (Table 4.17). Female students

(*M* = 3.85, *SD* = 1.53; *M* = 4.06, *SD* = 1.55), despite scoring higher than male students (*M* = 3.36, *SD* = 1.46; *M* = 3.78, *SD* = 1.55) on both the pre- and post-exposure instruments did not show significant differences for either.

Table 4.17
T-test Results for Quiz Accuracy by Subgroups

	Pre-Exposure				Post-Exposure			
Category	df	*t*	*p*	*d*	df	*t*	*p*	*d*
Course	102	*0.21*	*.83*	.04	92	*0.95*	*.34*	.20
Gender	101	*1.33*	*.19*	.33	89	*0.67*	*.50*	.18
Poster	–	–	–	–	92	1.48	.14	.31

While not significantly affecting the quiz accuracy for the post-exposure instrument, there was a noticeable difference in the students who identified the posters compared to their counterparts with a small to medium effect size. Similarly, *Gender* played a similar role for the pre-exposure assessment also showing that it had a non-significant small to medium effect size.

Shifting to categorical groupings that are non-binary, an ANOVA was conducted on each category for both the pre- and post-exposure instruments. Table 4.18 shows the results of the ANOVAs conducted when looking at the accuracy in responses for hearing protection use.

Table 4.18
Analysis of Variance results for Hearing Protection Use Accuracy by Subgroups

	Pre-Exposure				Post-Exposure			
Category	df	F	*p*	η^2	df	F	*p*	η^2
Classification	3, 100	*0.53*	*.66*	.02	3, 90	*0.09*	*.97*	.00
Course Experience	2, 101	*0.59*	*.56*	.01	2, 101	*1.67*	*.19*	.03

No statistically significant differences were determined across either of the instruments; however, *Course Experience* did have a small to medium effect size for the post-exposure instrument and saw the largest variance among both categories and instruments. This is in juxtaposition of the variance among the *Classification* groupings for the post-exposure instrument which saw little to any variance between the grade levels.

When looking at the variance among the two groupings for Quiz accuracy (Table 4.19), *Course Experience* played little to any role in the variation of accuracy for both the pre- and post-exposure instruments. *Classification* had a non-significant result of variance; however, the effect size was medium to large and showed noticeable differences among the grade levels.

Table 4.19
Analysis of Variance results for Quiz Accuracy by Subgroups

	Pre-Exposure				Post-Exposure			
Category	df	F	*p*	η^2	df	F	*p*	η^2
Classification	3, 100	*0.86*	*.46*	.03	3, 100	*2.49*	*.07*	.08
Course Experience	2, 101	*0.04*	*.96*	.00	2, 101	*0.00*	*1.00*	.00

Discussion & Conclusions

Upon reviewing the data, it was first determined to establish the SBAE student threshold for use of hearing protection in an agricultural setting. The overall average, within the defined dB range (60 dB to 120 dB), did increase and, due to the logarithmic nature of dBs, was nearly twice as loud or ten times the NISOH (2018a) recommended limit of 85 dB for an eight-hour period. The decrease in *Always* responses could be due to the increased exposure to the tools, both directly and indirectly, as the students were more aware of the dB output for the tools listed and their own threshold for the dB level, that they deemed appropriate to wear hearing protection for. When comparing the results across the course types, the students participating in an agricultural mechanics course did decrease their overall average hearing protection use threshold, for those who indicated a threshold from 60 dB to 120 dB, and did see an increase in responses within the 60 dB to 120 dB range. While the non-agricultural mechanics students also saw an increase in the 60 dB to 120 dB range responses, their average hearing protection use threshold moved further from the NIOSH recommendation which is a negative result. Reflecting on this study's MET and TPB framework, the indirect exposure via the posters and the direct exposure via the tool use may have played a key role in the positive result seen in agricultural mechanics students.

The lack of direct exposure for the non-agricultural mechanics students may have hindered the effect of the indirect exposure in affecting hearing protection use thresholds. Regardless of the overall movement toward the NIOSH recommendation, the data suggests that further exploration and instruction may be needed to better identify SBAE hearing protection use threshold. Due to the limitation of the data only alluding to the perceptions of hearing protection use, a more practical approach or structured design may provide stronger data to truly determine SBAE student's true threshold to use hearing protection in an agricultural setting.

Secondly, the data was reviewed to determine SBAE student willingness to wear personal protective equipment relating to hearing safety in an agricultural setting. Overall, we found that the study showed little change in future use of hearing protection post-exposure. Individually, each of the tools saw little change with the exception of the *Powered Hand Drill*. While the dB output was not given for the *Powered Hand Drill,* its 93 dB output (NIOSH, 2018b) is above the recommended threshold (NIOSH, 2018a) and therefore an increase in the indication of future hearing protection use was expected. Its low positive response of future hearing protection use is still concerning as only 13.83% of the post-exposure respondents indicated they would use hearing protection while using that tool. Based on the recommended exchange rate provided by NIOSH (Chan, 1988), students should be wearing hearing protection if this tool was to be used consistently during a one-hour period. In conjunction with all other tools, this time allowable period without hearing protection decreases, logarithmically, as the average dB level increases. Much like the identified threshold, the direct exposure to the tools may play a role in the agricultural mechanics students seeing an increase in likely future use across all tools rather than the decrease seen by the non-agricultural mechanics students. The mere exposure of the dB output directly, could play a role in student understanding of how loud the tools are and therefore play a role in affecting the perceived behavior and subsequent intentions of using hearing protection while they are in proximity to that tool in use.

Considering these findings, it is then important to identify the SBAE students' perceptions of dB outputs relating to specific tool use in an agricultural setting. Taking into consideration each individual student's dB threshold to wear hearing protection and looking at their future use of hearing protection in the proximity of each specific tool, determinations of the participant's perceptions of dB outputs was able to be made. The post-exposure data shows that the participating students were better able to identify the correct hearing protection use based on their self-prescribed hearing protection use threshold after the direct and indirect exposure of the dB outputs. While the correctness of the students' answers does not signify proper future use of hearing protection based on the NIOSH recommendations, it does show that students were better able to state their choice to use hearing protection based on their perceptions of dB output, or loudness, of each tool. When comparing the responses by course type, there was no clear indicator that the direct exposure had any more effect on the perceptions of the participants than the indirect exposure which is counter to the results of the second objective.

While the framework for this study would indicate that the additional direct exposure should provide a stronger positive effect on the learning experience for the agricultural mechanics students, it appears that the indirect exposure via the poster may have led to a better overall understanding of the noise levels provided it was visually available to all students. This seems to be further supported when looking at the results presented via threshold groupings. The students who selected the threshold of *Always* or *Never* were better able to identify their future use of hearing protection, which should have been either always or never, on the post-exposure evaluation. Furthermore, more students within the defined threshold range were able to accurately identify four or more of the tools supporting the framework that the direct and indirect exposure has a positive effect on one's perceptions of dB outputs.

Lastly, the results were analyzed to determine differences among SBAE students' knowledge and perceptions of hearing related safety concerns in an agricultural setting. Looking at the perceptions of hearing related safety concerns, all categories showed an increase outside of the individuals who had three or more years of agricultural mechanics course experience. When looking at the students as a whole, both quiz scores and accuracy of hearing protection use noticeably increased; however, neither increase was determined to be statistically significant. Only three indicators were determined to be statistically significant in the change of accurate responses for either the use of hearing protection or quiz; however, none of these indicators were determined significant for both accuracy responses. When looking at the data among each of the instruments by category, the only statistically significant marker was the positive identification of the posters in the classroom and/or laboratory as it relates to the accuracy of hearing protection use.

Reflecting on both MET and TPB, having the only statistical difference on post-test scores being the identification of the informational posters supports the notion that the exposure of said information had a positive effect on the perceptions students had on the dB outputs of tools. This additionally shows that the knowledge gained, or lack thereof, had little effect on their perceptions as the difference was determined for the accuracy of hearing protection use. One interesting finding that needs to be discussed is the lack of differentiation of the results among course, classification, and agricultural mechanics course experience. Both MET and TPB would both indicate that the exposure to hands-on experience or the challenging of one's culture of safety as they are required to adopt the program's culture of safety should lead to a larger separation based on their (1) current exposure to agricultural mechanics coursework, (2) educational experience via their classification, and (3) involvement in more agricultural mechanics courses regardless of their current coursework. While increases in perceptions and knowledge were seen across many of the categories, the comparison to the counterparts or direct decrease in perceptions is a concerning finding from this study.

After looking at the data individually, wholistically, the participating students did show an overall increase in both the knowledge and perceptions of the specified hearing related safety concerns. While there are still many issues that need to be addressed, this study did show that students, when exposed directly or indirectly to dB outputs, are better able to perceive that loudness as it relates to their own understanding. MET and TPB help shape the findings as the indirect exposure, via the viewing and remembering of the informational poster, had the only statistically significant effect on one’s perception and knowledge tested hearing related safety concerns. Taking into account the overall increase of accuracy regarding perceptions and knowledge, the most concerning issue was the lack of true awareness to proper PPE use and the actual intensity of noise that the participating SBAE students were being exposed to.

Future Research and Application

It has been determined that agricultural education, including but not limited to SBAE, has fallen short in the successful implementation of hearing safety culture. While there is still a gap that is in need of being addressed, positive outcomes from numerous studies are a hopeful sign. Reviewing the findings from this study and those that preceded it, there is still work that needs to be done in order to meet the level of success that has been seen in other safety areas such as eye protection. With multiple limitations, the findings are not necessarily generalizable beyond the scope of this study; however, the positive outcomes related to the students’ exposure of relevant information both directly and indirectly is something that can, and should, be further explored. The positive growth outcomes that can be attributed to the direct exposure of tool, indirect exposure of the informational poster, or combination thereof, is exciting to see due to its implications of curricula development that is desperately needed for this specific safety concern. This is due, in part, to the overall lack of understanding of hearing-related concerns by the participating students.

Alongside further research focusing specifically on this knowledge gap, the implications of curricula development cannot be overlooked. There is a clear need for targeted instruction specific to hearing related safety concerns, which may lead to the discovery of other safety areas that need further instructional development as well. The findings indicate that the use of informational posters hung in high-trafficked areas have an effect on students' intentions. Curricula development that focuses on informational supplements should be focused on easy-to-understand concepts that promote proper PPE use through concise explanations of the need and practice. Hearing safety instruction is an area that SBAE can improve on and could be an area that sparks discussions surrounding the overall climate of safety within agricultural education. With numerous practices across multiple areas of safety concern being potentially viewed as "should dos" versus "common practice" by SBAE students, a real discussion should be had by agricultural education to address the overall safety climate accepted by all. The use of eye protection is something that is seen and/or discussed in many, if not all, SBAE programs. If this one area of safety is commonly being addressed, there is little reason as to why others, including hearing, cannot follow in practice.

CHAPTER V.
SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

Chapter V serves as the conclusion of the overall project to date. The following consists of summaries of the project and the three presented articles, overall implications alongside those found within the studies of the articles, and recommendations that were derived from the individual studies as well as those that arose from the connections between the three studies.

Summary

This series of research investigates the current culture of safety surrounding hearing related safety concerns within agricultural education at the secondary, School-Based Agricultural Education (SBAE), and post-secondary levels. The first two studies focused on post-secondary instruction, with the first study serving as the foundation for future research and the second investigating the practical applications expected from the first study. The third study presented focused on SBAE instruction investigating connections between different classroom environments, the types of course instruction, and students' direct and indirect exposure to information as it relates to student knowledge and perceptions of decibel (dB) outputs and hearing safety concerns.

Summary of Article I: Hearing Education in Agriculture: Re-evaluating Interest, Needs, and Growth (HEARING)

Article I presents the process and findings of the study conducted to determine the perceptions of noise levels for students engaged in post-secondary agricultural mechanics coursework. The study was guided by three research objectives: (1) Determine the willingness to wear hearing protection while in an agricultural laboratory/workspace, (2) Establish the perception of dB output of power tools used in an agricultural laboratory/workspace, and (3)

Identify understanding of safety concerns relating to hearing perceptions and noise levels outputs in an agricultural laboratory/workspace.

Through the use of pre- and post-instruction instrumentation with direct and indirect dB exposure elements encountered throughout a course semester, the 40 students who completed the pre-instruction instrument and the 35 students who completed the post-instruction instrument provided an identifiable foundation of the dB threshold at which they would start wearing hearing protection. The individually given thresholds were also used as a marker to determine the accuracy of the perceptions each student had on the dB output of a set of tools by determining if the students were correct or incorrect in their assessment of use of hearing protection based on their identified threshold. The identified threshold and accuracy scores served as the foundation for further needed assessments both at the post-secondary and SBAE levels.

Summary of Article II: HEARING in Practice

Article II's study takes the findings found in Article I's study and not only examines the perceptions previously discussed, but also the practices of students participating in an agricultural mechanics course. This study aimed to assess students' willingness to wear hearing protection and was guided by three research objectives: (1) Establish student threshold for use of hearing protection in an agricultural mechanics setting, (2) Identify student perceptions of dB outputs relating to tool use in an agricultural mechanics setting, (3) Determine student willingness to wear personal protective equipment relating to hearing safety in an agricultural mechanics setting.

For this study, university students enrolled in selected agricultural mechanics courses, across two separate semesters, were selected to participate. Of the 87 students enrolled in these selected courses, 83 completed a pre-instruction instrument, 67 completed the post-instruction instrument, and 78 completed the required number of weekly reflections for participation. The pre- and post-instruction instruments repeated those used in the study presented in Article I, with slight modifications to the presentation as deemed necessary by the research team. Students were directly and indirectly exposed to the dB output of a set of specified tools as per the methods outlined in Article I's study. In addition to the pre- and post-instruction instrumentation, weekly reflections were submitted by participating students where, among a series of questions, PPE use was identified through self-disclosure.

The findings of this study both support the findings of Article I's study and identify an area of significant concern. The positive findings indicate that students again saw an increase in understanding and perceptions of dB outputs and hearing related concerns. The provided hearing protection use thresholds trended toward the recommended threshold and the perceptions/understanding students presented increased as they were better able to determine PPE use based on their own identified dB threshold. While these signs are positive, the results of the weekly reflections show a different perspective on the practical application of hearing protection use. A staggering 80% difference in eye and hearing PPE use was determined with a majority of the students often wearing eye PPE and a majority not wearing hearing PPE at all. This difference and overall lack of hearing PPE use led to the expected hearing PPE use not being met. These findings provided some clarity on the effects that direct and indirect exposure had on the perceptions students had regarding dBs; however, it called into question the culture of safety these students were participating in as the expectations based on their provided perceptions were not being fulfilled in reality.

Summary of Article III: Knowledge of HEARING

The study presented in Article III examined the hearing safety perceptions and knowledge differences of SBAE students in an agricultural mechanics focused course and those in any other SBAE course. By expanding on the previous studies presented in Chapters II and III with the focus on SBAE instruction, this study was guided by four research objectives: (1) Establish SBAE student threshold for use of hearing protection in an agricultural setting, (2) Determine SBAE student willingness to wear personal protective equipment relating to hearing safety in an agricultural setting, (3) Identify SBAE student perceptions of dB outputs relating to tool use in an agricultural setting, (4) Determine differences among SBAE students' knowledge and perceptions of hearing related safety concerns in an agricultural setting.

Three SBAE programs were selected to participate in this study due to their agricultural education course offerings and student engagement. Across the three programs, 104 students completed the pre-exposure instrument and 94 completed the post-exposure instrument. Due to the nature of the study, the design was altered from the previous studies to focus on a more concise timeline of six weeks rather than the full course of instruction. The pre-exposure instrument was provided at the beginning of the last term of the fall semester, students were the indirectly exposed to the dB output through the use of informational posters alongside the direct exposure of active learning with tool use for the agricultural mechanics students, and then the post-exposure instrument was provided at the end of the same term during the last weeks of the fall semester. The instrument design was similar to those used in the studies of Chapters II and III with an additional ten questions that focused on knowledge of hearing related concerns.

The findings of this study showed improvement of both the perceptions students had of dB outputs and their knowledge on hearing safety concerns. While both the accuracy at which students were able to identify hearing protection use based on their provided dB threshold and their knowledge on hearing safety concerns did not increase significantly, both did see improvements. A concerning finding was determined as the calculated threshold average was well outside the recommendation, with the non-agricultural mechanics students moving away from the recommendation across the pre- and post-exposure instruments. Reviewing the post-exposure data did shed light on the effectiveness of indirect exposure as it relates to student perceptions of dB output. The hearing protection use accuracy of students who properly identified at least one of the informational posters they were indirectly exposed to was statistically significant across all statistical analysis conducted for the post-exposure instrument. No other factors showed significant differences for the quiz or hearing protection accuracy on either instrument; however, there were statistically significant changes between the two instruments for three groupings and two statistically significant distributions split between the accuracy and quiz scores.

Implications

Across each of the three studies, the results provided the basis for the discussion and conclusions based on each study's objectives. Upon the review of all three studies, overarching implications arose that echo those that derived from each of the individual studies. Discussion on these implications begins by discussing the implications of each of the presented studies and is followed with the implications that can be determined by looking at the studies as a whole.

Implications of Article I: Hearing Education in Agriculture: Re-evaluating Interest, Needs, and Growth (HEARING)

The first study examined the changes in post-secondary agricultural education students' perceptions of dB outputs across pre- and post-instruction instruments. This study aimed to answer the question of “what effect does exposure of information have on post-secondary agricultural mechanics students’ perceptions of dBs?” Through direct exposure to dB outputs with active hands-on learning, and indirect exposure to dB outputs through informational posters, students were embedded in an environment that promoted the learning and exploration of this hearing safety concern. This study, through instruments that collected data before and after the exposure led to the identification of student participant perceived thresholds for wearing hearing protection, as well as their understanding of their perceptions as determined by their accuracy for future hearing protection use based on their identified threshold. Perceptions of dB output were determined by reviewing the participating students’ indicated dB threshold at which they would start wearing hearing protection. This helps to determine the student’s ability to adequately identify a level at which they would safely be able to wear or not wear hearing protection when completing tasks in an agricultural mechanics environment.

Overall results showed that perceptions were positively affected by the course in which the students participated in as their average threshold shifted toward the NIOSH recommendation and more students indicated a hearing protection use threshold near or below the recommended level on the post-instruction instrument. To determine if this positive change had any effect on student understanding, responses for hearing protection use across a set of tools were used for an analysis using their identified threshold as individual standards. Another positive outcome was determined as students were better able to determine use of hearing protection based on their own prescribed threshold. This indicates that the exposure throughout the course had a positive impact on the students’ understanding of dB output as they were better able to determine, based on their own perceptions of dB output, the use of hearing protection overall. While the change in the participants’ perception and understanding is a positive, the underlying issue of improper hearing PPE use for each individual tool is concerning to say the least. Echoing previous research that has identified a lack of understanding or practice among SBAE instructors (Chumbley et al., 2018; Ulrich et al., 2002), this study also identifies a need for intervention focused on the education of sound and hearing safety concerns.

This intervention should be taken in the form of direct instruction; however, additional instructional techniques may be used as suggested by the findings of this study. The participants' increase in perceptions and understanding cannot be overlooked. The use of indirect exposure through the use of informational posters in conjunction with the direct exposure to the tools had a part to play in the positive change identified in this study. The interactions students have with the information plays a key part in their understanding of the material and supports their perception growth they have of said stimuli. The findings of this study suggest that exposure, directly, indirectly, or a combination of both, to hearing safety material promotes the student's ability to perceive and understand the area of concern better.

Implications of Article II: HEARING in Practice

The second study, being influenced by the findings of the first study, again examined post-secondary agricultural education students' perceptions of dB outputs and added an inspection of participating students indicated weekly PPE use. This study aimed to answer the question of "what impact does exposure of dB information have on post-secondary agricultural mechanics students' hearing related personal protective equipment use?" Exposing students to as similar of an environment as the first study, the direct and indirect exposure of dB outputs was highly considered through intentional poster placement and instructional design. In addition to the previous design, a question was added to a weekly reflection that asked students to provide a list of PPE used during their time in class. The pre-/post-instruction instruments were used to collect data that helped inform discussion on the participating students' perceptions and understanding of dBs while the weekly reflection question was used to determine PPE use behavior.

The first implication that arose from this second study echoes that of the first. The perceptions and understanding of dBs appeared to improve over the course of the semester due to the combination of the direct and indirect exposure students engaged with. Students showed that they were again better able to accurately identify hearing PPE use per a set of identified tools compared to their own indicated dB threshold. The overall threshold also moved closer toward the recommended threshold with fewer students indicating a lack of a threshold at all. Proper PPE use for each tool was still an issue when looking at the post-instruction data. The individual tool use did noticeably increase; however, PPE use was still indicated at a level that is a call for concern due to each of the tools being slightly to well above the recommended threshold. The perception growth that was determined, shows that students are better able to accurately determine PPE use based on their own beliefs. However, the concern arises when taking into account the damage that students may incur by not wearing PPE above the proper dB level. This issue is only compounded when looking at the third implication of the second study, the overwhelming lack of PPE use by the participating students. While the indicated use from the pre- and post-instruction instruments led to a slightly concerning implication, the overall lack of actual hearing PPE use indicated by the participating students is of significant concern. Taking into account the week-to-week course instruction, there was an expectation that eye PPE use would be noticeably higher than hearing PPE use; however, the staggering difference between the two in actuality indicates that there is a gap in the culture that needs to be addressed. Students are more likely to wear eye protection when compared to hearing protection and it may be due to the culture that has been set across agricultural education.

Implications of Article III: Knowledge of HEARING

The third study, being influenced by the findings of the first and second studies, examined perceptions of dB outputs; however, shifted its focus onto secondary SBAE students participating in either an agricultural mechanics or non-agricultural mechanics course. In addition to the perceptions and understanding questions, the participating students' knowledge of hearing related safety concerns was also assessed through the introduction of a ten-question quiz. This study aimed to answer the question of "what are the hearing related safety concern perception differences of School-Based Agricultural Education students participating in agricultural mechanics or non-agricultural mechanics courses?" Students in this study were primarily exposed to dB information indirectly through the use of informational posters. Participating students enrolled in an agricultural mechanics course were also directly exposed to dB outputs through specific tool use during regular course instruction; however, not all students were exposed at the same time or at all due to their content covered or course enrollment. Compared to the studies presented in Articles I and II the timing of the changed to only capture a short period of time during the semester, the design of the instrument was kept consistent with the addition of the additional hearing safety questions. This allowed for perceptions and understanding as well as knowledge to be determined and analyzed across groupings of students pre- and post-exposure.

Furthering the implications found in the first two studies, the third study echoed the positive growth in perceptions and understanding alongside the issues surrounding the practices of hearing protection use. Like the previous studies, the participating students were better able to identify the use of PPE based on their own prescribed hearing protection use threshold. This would indicate, again, that the exposure, directly and/or indirectly, had a positive impact on the students and their perceptions of how loud the indicated tools are. Unlike the previous studies, the secondary students' hearing protection use threshold did move away from the recommendation; however, it was within a reasonable margin that was not of concern. What was of concern was the apparent lack of PPE use for each of the individual tools. Like the previous studies, PPE use for each individual tool was noticeably lower than expectations due to the dB output of each tool being above the NIOSH safety recommendation. While the first two implications echoed that of the first two studies, the third implication provides clarity to the impact that direct and indirect exposure has on perceptions and behavior. The final study showed that of all grouping indicators, the only statistically significant change was provided by students' ability to identify the informational posters which indirectly exposed the students to the dB outputs. This impact was seen by both those who were enrolled in an agricultural mechanics course and those who were not. This indicates that indirect exposure of the informational posters does positively affect the students' learning environment and can lead to their growth in perception, understanding, and knowledge.

Implications of All Studies

When looking at the discussion and implications across the three individual studies, a series of overarching implications arose. The first implication that was found in all three studies was the positive change in perceptions and understanding, with knowledge also showing an increase in the third study. This theme shows that students were positively affected by the direct exposure, indirect exposure, or combination thereof in relation to their ability to accurately identify when to use hearing protection based on their own indicated threshold for its use. While this positive growth is a sign of personal success, the second theme of improper PPE practices is of significant concern. Across each of the studies, students consistently showed a lack in current or future use of PPE for many, if not all, of the indicated tools. With each of the tools producing dBs above the recommended threshold for PPE use, there was an expectation for students to be more aware of the need to use PPE when working with these tools, which clearly was not met. The last implication seen across each of the studies is that of direct and indirect exposure provided positive impactful opportunities for students to learn, which gives hope to correcting this issue by building off of the growth in perceptions and understanding of the first implication. The learning environment present in each of the studies provided students with the opportunity to engage in activities that directly or indirectly exposed them to dB outputs. These exposure experiences were impactful in their understanding of dBs and had a positive effect on their perceptions.

Recommendations for Future Research

Taking the lessons learned from the three presented studies, a series of future research needs have been identified. Considering the limitations, assumptions, and subsequent findings of each of the presented studies, three specific themes emerged to serve as the foundation of the future research that was presented throughout each of the studies.

Expanded Studies

First, taking into account the increase in understanding and perceptions of dB outputs by the participants in all three studies, future research should include an expansion in sample for the perception portion of these studies to account for the differentiation of sites, participants, and instruction. An expanded scope study, particularly one that spans agricultural education level lines (secondary and post-secondary) across state or national lines, would provide the necessary power for stronger statistical analysis to better generalize the results across agricultural education. The three presented studies provide a foundation for discussion relating to the perceptions, knowledge, and practices of hearing safety concerns; however, further exploration with a larger population would allow for commonalities and generalizations to be made across all agricultural education environments allowing for the development of appropriate curriculum to address any gaps that may be identified.

Informed Redesigns

An informed redesign of the studies that introduces control groups, who are not indirectly exposed to the informational poster, would allow for the analyzation of the effect that exposure has on agricultural education students. Another approach to a redesign would be the assigning of participant identification numbers for the pre- and post-instruction/exposure instruments to allow for better determining the effects the exposure had per each individual throughout each of the studies. The current structure for each of the presented studies is limited in the findings external to the participants due to the lack of control groups and the unpaired pre-/post-instrument design limited the statistical analysis that could be conducted for the studies. By introducing a control group, participant identification, or a combination of both, future studies that build upon the design of the studies presented can better address the hearing related issues that the original studies focused on.

Culture of Safety

A specific area that was not directly addressed in any of the presented studies but arose across all three findings was the potential gap in safety culture across agricultural education. Future research should focus on the culture of safety across different levels of agricultural education specifically focusing how each level of education differs as to best influence curricula development and practical applications by agricultural education instructors. While perceptions of dB outputs were positively influenced by the direct and indirect exposure of course participation and informational instruction, the understanding of those perceptions by the participants of the presented studies proved to be lacking. If the culture of safety surrounding hearing was of a higher significance, there may be a stronger influence on the effects of the different exposure types.

Recommendations for Practice

The presented studies all indicate need for additional instruction on hearing related safety issues. While there were verified increases in the perceptions, understanding, and knowledge throughout each of the studies, the end results were still outside the expected range indicating that the participating students were still needing to improve overall. Reflecting on the recommendations presented within each of the articles, three key areas of improvement were determined for future practice.

Direct Instruction

The first, and most important in this researcher’s eyes, recommendation for future practice is the direct instruction on hearing related concerns for all agricultural education students. This would encompass, but not limited to, the effects that high dB outputs have on one’s hearing, how dB outputs impact the overall noise level in a workspace, and the proper choice and use of hearing related PPE. This style of direct instruction can be found in other safety areas, namely eye related concerns, where the impact and safety mitigation of said concern has impacted students, including the participants of the second study shown through eye protection use, in such a manner that it is a cultural norm to at the very least be cognizant about the use of eye related PPE.

Indirect Exposure

The second recommendation discussed across the three studies is the impact that indirect exposure had on the understanding and perceptions of dB outputs. Specifically shown through the findings of the third study, indirect exposure to the specified tool's dB output provided students who were able to identify the informational posters with a better foundation to determine their future use of hearing protection based on their personal threshold for hearing PPE use. While the perceptions were positively affected, understanding of the long-term effects were not shown to be changed due to the overall lacking future PPE use for each of the tools. The indirect exposure did allow students to better identify at which level they would or would not wear hearing protection; however, without direct instructional exposure on the meaning behind the dB output, proper PPE use still is an area of concern that needs to be addressed. The studies' findings indicate that indirect exposure, through the use of informational posters, does have a positive effect on students learning journey; therefore, the recommendation would be to further explore the use of this type of exposure and its interactions with a more direct instruction on the information that serves as its foundation.

Culture of Safety

One key issue that has been discussed through each of the studies is the concern relating to the defined culture of safety, or lack thereof, throughout agricultural education. As stated in the recommendations for future research, there is a need to identify the culturally accepted practices beyond the scope currently set across each level of agricultural education. Beyond the research previously proposed, current discussions need to take place at the program, state, regional, and national levels regarding the instruction and informed practices of SBAE and post-secondary agricultural education. Upon the determination of a largely accepted upon culture of safety, the development of curricula that focuses on the foundation of and best practices informed by said culture should be pursued. While the larger culture of safety will differ as the scope of instruction becomes narrower due to locality, the curricula should help inform the discussion and decisions to be made at each level of instructional design. The studies presented do not indicate that there is a void of safety culture, rather that the discussions surrounding it need to be bolstered. By taking into account the areas of safety concerns that are not being met, curricula development should aim to make these areas more approachable and should shy away from lecture-based instruction. The exposure effects determined from the presented studies support the use of practical hands-on learning opportunities that expose students to situations that explore the safety concern areas. To better prepare students, of all levels, intentional curricula design must occur in which safety and education growth of students are interconnected to produce successful agriculturalists regardless of the path they chose.

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APPENDICES

APPENDIX A.
Non-Exclusive Permission – ASABE Article

From: Garrett Hancock <gth0028@auburn.edu>
Sent: Wednesday, March 27, 2024 4:25 PM
To: Jeremy Stedman <stedman@asabe.org>
Subject: Non-Exclusive Permission Request - Hearing Education in Agriculture: Re-Evaluating Interest, Needs, and Growth

Howdy,

I am requesting non-exclusive permission to use my published articled "Hearing Education in Agriculture: Re-Evaluating Interest, Needs, and Growth" by **Garrett T. Hancock**, Jason D. McKibben, A. Preston Byrd, James R. Lindner, and Christopher A. Clemons, which was published in Agricultural Safety and Health, 29(2), pages 109-120, in my dissertation currently titled *HEARING Safety Across Agricultural Education: A Three-Study Evaluation of Student Perceptions and Understanding of HEARING Safety*.

Very Respectfully,

Garrett T. Hancock
Agricultural Science Education
Auburn University

5060 Haley Center
Auburn, AL 36849-5218
gth0028@auburn.edu

Ideation – Woo – Adaptability – Includer – Activator
#teachalittleag #gamingintheclassroom
@au_aged

From: Jeremy Stedman <stedman@asabe.org>
Sent: Monday, April 1, 2024 10:38 AM
To: Garrett Hancock <gth0028@auburn.edu>
Subject: [EXT] Re: Non-Exclusive Permission Request - Hearing Education in Agriculture: Re-Evaluating Interest, Needs, and Growth

Good morning!

Thank you for reaching out, and I appreciate your interest in incorporating your published article titled "Hearing Education in Agriculture: Re-Evaluating Interest, Needs, and Growth" into your dissertation titled "*HEARING Safety Across Agricultural Education: A Three-Study Evaluation of Student Perceptions and Understanding of HEARING Safety*."

I am pleased to grant you non-exclusive permission to use the aforementioned article in your dissertation.

Please ensure that proper attribution is provided to the published article within your dissertation, including citation details as per your academic institution's guidelines.
If you have any further questions or require additional information, please feel free to reach out to me.

Good luck with your dissertation!

Thank you,

Jeremy

APPENDIX B.
Hearing Education in Agriculture: Re-evaluating Interest, Needs, and Growth (HEARING) Instrument

Hearing Education in Agriculture:

Re-evaluating Interest, Needs, and Growth

Please read the questions below and answer each of them to the best of your ability.

The information collected from these questions and answers will **NOT** be reflected in your grade for this class or any other class.

	Indicate which of the following tools you would normally wear hearing protection for:	
	Yes	No
Handheld Circular Saw 	☐	☐
Powered Hand Drill 	☐	☐
Angle Grinder 	☐	☐
Impact Wrench 	☐	☐
Powered Miter Saw 	☐	☐
Pneumatic Nail Gun 	☐	☐

Please indicate at which dB level (dB) you would wear hearing protection when working with powered equipment:

- ☐ Always
- ☐ 60dB
- ☐ 70dB
- ☐ 80dB
- ☐ 90dB
- ☐ 100dB
- ☐ 110dB
- ☐ 120dB
- ☐ 130dB
- ☐ 140dB
- ☐ Never

Please answer the following questions that relate to you.

What is your gender?

☐ Male
☐ Female
☐ Non-binary / third gender
☐ Prefer not to say

What is your classification?

☐ Freshman
☐ Sophomore
☐ Junior
☐ Senior
☐ Graduate Student

When mowing the yard, how often do you wear ear protection?

☐ Always
☐ Sometimes
☐ Never
☐ I don't mow the yard

How often do you work with loud equipment?

☐ Daily
☐ Weekly
☐ Monthly
☐ Annually
☐ Never

How often do you use headphones to listen to music or watch videos?

☐ Daily
☐ Weekly
☐ Monthly
☐ Annually
☐ Never

What is your Major?

____

What is your gender?

☐ Male
☐ Female
☐ Non-binary / third gender

APPENDIX C.
HEARING in Practice
Instrument

HEARING in Practice

Please read the questions below and answer each of them to the best of your ability.

The information collected from these questions and answers will **<u>NOT</u>** be reflected in your grade for this class or any other class.

	Thinking back to **LAST** time you used this tool, **DID** you wear hearing protection?	
	Yes	No
Handheld Circular Saw 	☐	☐
Powered Hand Drill 	☐	☐
Angle Grinder 	☐	☐
Impact Wrench 	☐	☐
Powered Miter Saw 	☐	☐
Pneumatic Nail Gun 	☐	☐

	Thinking about the **NEXT** time you will use this tool, **WILL** you wear hearing protection?	
	Yes	No
Handheld Circular Saw 	☐	☐
Powered Hand Drill 	☐	☐
Angle Grinder 	☐	☐
Impact Wrench 	☐	☐
Powered Miter Saw 	☐	☐
Pneumatic Nail Gun 	☐	☐

Please indicate at which dB level (dB) you would wear hearing protection when working with powered equipment:

- ☐ Always
- ☐ 60dB
- ☐ 65dB
- ☐ 70dB
- ☐ 75dB
- ☐ 80dB
- ☐ 85dB
- ☐ 90dB
- ☐ 95dB
- ☐ 100dB
- ☐ 105dB
- ☐ 110dB
- ☐ 115dB
- ☐ 120dB
- ☐ Never

Please answer the following questions that relate to you.

What is your gender?

- ☐ Male
- ☐ Female
- ☐ Non-binary / third gender
- ☐ Prefer not to say

What is your classification?

- ☐ Freshman
- ☐ Sophomore
- ☐ Junior
- ☐ Senior
- ☐ Graduate Student

When mowing the yard, how often do you wear ear protection?

- ☐ Always
- ☐ Sometimes
- ☐ Never
- ☐ I don't mow the yard

How often do you work with loud equipment?

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Annually
- ☐ Never

How often do you use headphones to listen to music or watch videos?

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Annually
- ☐ Never

What is your Major?

____

What is your gender?

- ☐ Male
- ☐ Female
- ☐ Non-binary / third gender

APPENDIX D.
Knowledge of HEARING
Instrument

Knowledge of HEARING

Please read the questions below and answer each of them to the best of your ability.

The information collected from these questions and answers will **NOT** be reflected in your grade for this class or any other class.

The information collected from these questions will **NOT** affect the relationship between you, your teachers, nor Auburn University.

	Will you wear hearing protection next time you use this tool?	
	Yes	No
Handheld Circular Saw 	☐	☐
Powered Hand Drill 	☐	☐
Angle Grinder 	☐	☐
Impact Wrench 	☐	☐
Powered Miter Saw 	☐	☐
Pneumatic Nail Gun 	☐	☐

Please indicate at which dB level (dB) you would wear hearing protection when working with powered equipment:

- ☐ Always
- ☐ 60dB
- ☐ 65dB
- ☐ 70dB
- ☐ 75dB
- ☐ 80dB
- ☐ 85dB
- ☐ 90dB
- ☐ 95dB
- ☐ 100dB
- ☐ 105dB
- ☐ 110dB
- ☐ 115dB
- ☐ 120dB
- ☐ Never

Read the following questions and select the answer you believe is the most correct.

According to the National Institute on Deafness and Other Communication Disorders, how many people over the age of twelve in the United States suffer from some form of hearing loss in both ears?

- ☐ 1,750,000 people
- ☐ 30,000,000 people
- ☐ 11,000,000 people
- ☐ 120,000,000 people

How does the CDC classify hearing loss?

- ☐ Low, Moderate, Average, High
- ☐ Mild, Moderate, Severe, Profound
- ☐ Little, Some, Much, High
- ☐ Temporary, Mild, Acute, Chronic

Which of the following is NOT a basic type of hearing loss that the CDC recognizes?

- ☐ Sensorineural
- ☐ Conductive
- ☐ Bioneural
- ☐ Mixed

Excessive ear wax build-up often leads to what kind of hearing loss?

- ☐ Temporary
- ☐ Permanent
- ☐ Auditory
- ☐ Biological

What is an Audiogram?

- ☐ Farm Equipment Calibration
- ☐ Sound Level Graph
- ☐ Hearing Test
- ☐ Singing Telegram

Read the following questions and select the answer you believe is the most correct.

Who performs hearing screenings?

- [ ] Audiologist
- [ ] Nurse
- [ ] ENT
- [ ] Occupational Health Specialist

Frequencies covered during audiometry should include:

- [ ] -500 Hertz to 500 Hertz
- [ ] 0 Hertz to 8000 Hertz
- [ ] 0 Hertz to 1000 Hertz
- [ ] 250 Hertz to 8000 Hertz

What is a dB?

- [ ] A logarithmic unit of sound level
- [ ] An intensity unit of sound level
- [ ] A frequency unity of sound level
- [ ] A perceived unit of sound level

A typical rock concert produces and maintains a dB level of:

- [ ] 25 dB
- [ ] 90 dB
- [ ] 50 dB
- [ ] 110 dB

Which of the following is NOT a probable cause of hearing loss?

- [ ] High Fever caused by meningitis
- [ ] Prolonged listening at 70% volume with AirPods 3
- [ ] Someone screaming loudly in your ear one time
- [ ] Prolonged riding on a tractor without ear protection

Please answer the following questions that relate to you.

What is your gender?

- ☐ Male
- ☐ Female
- ☐ Non-binary / third gender
- ☐ Prefer not to say

What is your classification?

- ☐ Freshman
- ☐ Sophomore
- ☐ Junior
- ☐ Senior

How many **Agricultural Mechanics** courses (Engines, Welding, Construction, etc.) have you taken? (Include any you are currently taking)

- ☐ None
- ☐ One
- ☐ Two
- ☐ Three
- ☐ Four or More

How often do you wear ear protection when mowing the yard?

- ☐ Always
- ☐ Sometimes
- ☐ Never
- ☐ I don't mow the yard

How often do you use in-ear headphones (earbuds)?

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Annually
- ☐ Never

APPENDIX E.
Hearing Education in Agriculture: Re-evaluating Interest, Needs, and Growth (HEARING) & HEARING in Practice IRB Approval

From: IRB Administration <irbadmin@auburn.edu>
Sent: Thursday, November 4, 2021 9:54 AM
To: Jason McKibben <jdm0184@auburn.edu>
Subject: McKibben Approval Exempt Protocol #21-457 EX 2109, "Agricultural Mechanics Teacher Preparation Evaluation"

Use IRBsubmit@auburn.edu for protocol related submissions and IRBadmin@auburn.edu for questions and information. The IRB only accepts forms posted at https://cws.auburn.edu/vpr/compliance/humansubjects/?Forms and submitted electronically.

Dear Dr. McKibben,

Your protocol titled "Agricultural Mechanics Teacher Preparation Evaluation" was approved by the AU IRB as "Exempt" under federal regulation 45 CFR 46.101(b)(1,2,4).

Official notice:
This e-mail serves as notice the protocol has been approved. By accepting this approval, you also accept your responsibilities associated with this approval. Details of your responsibilities are attached. Please print and retain.

Information Letter:
A copy of your approved protocol is attached. However you still need *to add the following IRB approval information to your information letter(s):* "**The Auburn University Institutional Review Board has approved this document for use from September 28, 2021 to --------- Protocol #21-457 EX 2109, McKibben"**

You must use the updated document(s) to consent participants.

Expiration:
Continuing review of this Exempt protocol is not required; however, all modification/revisions to the approved protocol must be reviewed and approved by the IRB.

When you have completed all research activities, have no plans to collect additional data and have destroyed all identifiable information as approved by the IRB, notify Office of the IRB via e-mail. A final report is **not** required for Exempt protocols.

PLEASE NOTE: If any unfunded, IRB-approved study should later receive funding, you must submit a MODIFICATION REQUEST for IRB review. In the request, identify the funding source/sponsor and AU OSP number. Also, revise IRB-stamped consent documents to include the Sponsor at the top of page 1 and the "Who will see study data?" section of consent documents. (see online template consent documents).

Best wishes for success with your research!

IRB Admin
Office of Research Compliance

APPENDIX F.
Knowledge of HEARING
IRB Approval

From: IRB Administration <irbadmin@auburn.edu>
Sent: Monday, October 16, 2023 2:08 PM
To: Garrett Hancock <gth0028@auburn.edu>
Cc: Jason McKibben <jdm0184@auburn.edu>; Paul Fitchett <pgf0011@auburn.edu>
Subject: Hancock Approval, Exempt Protocol #23-529 EX 2310, "Knowledge in HEARING"

Use IRB Submission Page for protocol related submissions and IRBadmin@auburn.edu for questions and information.

Dear Mr. Hancock,
Your protocol titled "Knowledge in HEARING" has been approved by the IRB as "Exempt" under federal regulation 45 CFR 46.104(b)(1,2). Attached is your approved protocol.
***Be aware the study is not approved for [redacted] until the permission letter is received.**

Official notice:
This e-mail serves as official notice that your protocol has been approved. By accepting this approval, you also accept your responsibilities associated with this approval. Details of your responsibilities are attached. Please print and retain.

Consent documents:
Attached is a copy of your consent form. You must provide a copy for each participant to keep.

Expiration:
Continuing review of this Exempt protocol is not required; however, all modification/revisions to the approved protocol must be reviewed and approved by the IRB.

When you have completed all research activities, have no plans to collect additional data and have destroyed all identifiable information as approved by the IRB, please notify this office via e-mail. A final report is no longer required for Exempt protocols.

PLEASE NOTE: If any unfunded, IRB-approved study should later receive funding, you must submit a MODIFICATION REQUEST for IRB review. In the request, identify the funding source/sponsor and AU OSP number. Also, revise IRB-stamped consent documents to include the Sponsor at the top of page 1 and the "Who will see study data?" section of consent documents." (see online template consent documents).

Best wishes for success with your research!

IRB Administration
Office of Research Compliance