SAFETY AND LIABILITY IN STEM EDUCATION LABORATORIES: using case law TO INFORM POLICY AND PRACTICE

INTRODUCTION
The size and type of equipment found in technology and engineering education laboratories has changed considerably over the past few decades. Today’s laboratories are equipped with smaller and less powerful machines that are not as intimidating as the machines of the past, posing a problem because modern machines are still extremely dangerous if not used properly. Current technology and engineering education curricula focus on smaller-scale projects, computer-intensive work, design and modeling activities, and simulations (Haynie, 2009). However, there is still potentially hazardous equipment in technology and engineering education laboratories that is essential for delivering the “hands-on, minds-on inquiry instruction” (Pennsylvania Department of Education [PDE], 2012, p. 2) fundamental to technology and engineering education. Safety is a critical issue that must be addressed at all levels of technology and engineering education: “Labs of today are less safe, the students of today are inadequately instructed in safety, and the teachers of today simply do not have adequate experience with equipment to lead students safely” (Haynie, 2008, p. 97).

In the state of Utah, an average of 160 students per year were injured in technology and engineering education laboratory accidents. An average of 86 school days were missed each year by students due to school laboratory accidents, and over half (56%) of the accidents injured students’ fingers. Band saws accounted for 13% of the equipment involved in laboratory accidents, table saws 11%, and sanders 4% (Utah Department of Health, 2007). These statistics from the state of Utah...
SAFETY AND LIABILITY

illustrate the harsh reality that accidents do occur in technology and engineering education laboratories. Many STEM educators have the “it can’t happen to me” attitude regarding accidents involving them or their school (PDE, 2012). The reality is that accidents can happen to anyone, even at award-winning schools such as Sowers Middle School. In 2010 a student’s parents from this Blue Ribbon School in Huntington Beach, CA, sued the school after their son severed his thumb using a band saw in a technology and engineering education class (Burris, 2010).

In addition to permanent physical injury, laboratory accidents are costly for individuals and schools. Barrios, Jones, and Gallagher (2007) analyzed 455 court cases occurring from 1996-2002 in which P-12 school districts were sued for an injury occurring on school property. The average time from accident to settlement or trial was four years. Two-thirds of the cases resulted in the schools paying an award. Barrios et al. (2007) also found that the mean award when a school was found liable was $562,915. Lacerations had an average award of approximately $228,000, tendon, cartilage, or ligament damage $300,000, and amputation just over $1 million. Learning from case law (the decisions of the courts) to help avoid a potential lawsuit can save time, money, and other costly measures that are important with today’s tight budgets (Janosik, 2005).

For the purpose of this article, the term STEM educators will be used in reference to teachers, administrators, supervisors, and higher education faculty members who work in science, technology, engineering, and mathematics (STEM) education fields. This article applies to STEM educators at all levels, because individuals may be named in a lawsuit despite not being directly involved (Love, 2013a). All STEM educators inherently assume some risk of liability and must be prepared to properly handle these incidents. They cannot predict every accident that may occur, but they can proactively adapt their policies and practices to avoid being found liable in the unfortunate event of an accident.

EMBEDDED IN THE STANDARDS

Both Standards for Technological Literacy (STL) and Next Generation Science Standards (NGSS) call for the safe use of tools in designing solutions to engineering design problems. STL requires students to be able to safely use tools and materials to fabricate solutions to engineering design problems, “The use of tools, materials, and skills that require the use of equipment is embedded throughout STL” (Gunter, 2007, p. 5). Standards 11 and 12 (ITEA/ITEEA, 2000/2002/2007) explicitly mention the need for students to safely use tools and materials:

After they have selected a solution, students should build or construct it to demonstrate the design idea. It is important for the teacher to instill in the students the value of safety when using tools and materials. The building process will give students valuable experience with various skills for handling materials such as measuring, marking, cutting, shaping, assembling, and combining (p. 116).

These standards also mention safety benchmarks throughout each grade band. They specifically mention the correct use of tools, materials, and machines to ensure a safe working environment (ITEA/ITEEA, 2000/2002/2007). Students need to identify and understand how to avoid hazards in various situations in order to be technologically literate (Haynie, 2009; Gunter, 2007; ITEA/ITEEA, 2000/2002/2007).

Next Generation Science Standards (NGSS) explicitly calls for the integration of engineering content and practices within the science curriculum. A Framework for K-12 Science Education (NRC, 2011) provided the blueprint for developing the NGSS. It called for crosscutting concepts that unify the study of science and engineering, resulting in design and construction phases that require the use of hand and power tools (Roy, 2012). NGSS acknowledges that the goal of engineering is to design rather than create a solution. They also recognize that students must engage in the design process, which involves “developing a design plan, producing and testing models or prototypes, selecting among alternative design features to optimize the achievement of design criteria, and refining design ideas based on the performance of a prototype or simulation” (Achieve, 2013, p. 11). Parallels between this and Standards 8, 9, 10, and 11 in the STL document can be made since they both emphasize designing, creating models and prototypes, experimentation, troubleshooting, and redesigning to solve problems.

Hand and power tools are often needed to adequately address the construction of prototypes for engineering design-based learning (DBL) activities. However, science teachers need more education in hazard recognition and safety training to implement the use of hand and power tools for constructing solutions to engineering problems (Roy, 2012). This lack of training evokes a greater chance for a school or STEM educator to be held liable in the event of an accident. Technology and engineering educators have more training and experience with the use of hand and power tools than science educators (Roy, 2012). This is one area where technology and engineering educators can serve as a valuable resource to STEM education. Technology and engineering educators can share their tool and machine safety expertise with science education to safely integrate STEM
concepts embedded within engineering DBL activities. In addition, technology and engineering educators have the potential to fabricate more advanced engineering design prototypes due to their access to special tools and materials. In order to promote a safe learning environment, STEM educators must first understand the laws associated with liability.

UNDERSTANDING TORT LIABILITY
Injuries that individuals sustain from an accident in a STEM education laboratory will be deemed tort liability, which Kaplin and Lee (2007) defined as:

A civil wrong, other than a breach of contract, for which courts will allow a remedy. A tort claim generally involves allegations that the institution, or its agents, owed a duty to one or more individuals to behave according to a defined standard of care that the duty was breached, and that the breach of that duty caused injury to the individual(s) (p. 87).

There are several grounds for tort liability, but the most common one in STEM education laboratory accidents is negligence (Toglia, 2009). A person is negligent when, "without intending any wrong, he or she commits an act or fails to act to prevent an occurrence that under the circumstances an ordinary prudent person ought reasonably to foresee will expose another person to unreasonable risk or harm" (Gathercoal & Stern, 1987, p. 7). The key phrase of that definition is "an ordinary prudent person ought reasonably to foresee." The courts will determine what the average person should be able to foresee and use that as the standard to judge a STEM educator’s actions. STEM educators who act reasonably and use good common sense regarding laboratory safety can decrease their chances of being found negligent (PDE, 2012). It is also important to remember that to be found negligent, a duty of care (duty to protect against unreasonable risks) between either the instructor and student, or the school and student must be proven. P-12 faculty members have an increased duty to protect students, because they usually assume the rights and duties of a student’s parent, commonly referred to as in loco parentis. It is their duty to provide a safe learning environment and protect students against any danger an ordinary person should be able to foresee.

Another type of tort liability often seen in laboratory accidents is called strict liability. Strict liability is when a court finds a school or STEM educator not responsible for the accident, but still orders him/her to pay the injured party an award to help offset costs incurred from the accident (e.g., medical costs). The court is acknowledging that no one is legally responsible because the incident was an unforeseeable accident, but the injured party is granted a monetary award for his or her losses.

STRATEGIES TO ADDRESS TORT LIABILITY
Strategies to proactively address liability before a summons (notice to appear in court) is served, as well as how to defend against liability once a lawsuit has been initiated, can be found in Figure 1. Risk management is a proactive approach that can help prevent or minimize a school or STEM educator’s losses (Toglia, 2009). It provides financial stability for a school, can improve morale and employee performance by reducing worries about liability, and allows the school to show its concern for potential injuries (Kaplin & Lee, 2007). Risk avoidance is avoiding the activity all together, and risk retention involves hiring another party to assume the risk of the activity, or insuring against the activity. STEM educators cannot always rely on insurance provided by their school and would be wise to invest in their own individual insurance policy. ITEEA offers a professional liability insurance plan at a minimal cost ($99 per year) compared to the fees associated with a lawsuit. STEM educators can also purchase a “business pursuits” endorsement or rider on their homeowner’s insurance policy to act as professional liability coverage. Lastly, risk control involves putting restrictions on an activity in an attempt to control the high-risk portions of that activity (Love, 2013a).

Despite being proactive and attempting to manage risk, accidents do happen, and can result in a lawsuit. In the event that a school or STEM educator is sued for a laboratory accident, there are a few defenses to prove they were not liable. Assumption of risk is when the student assumes reasonable risk prior to the activity (not feasible if the school or STEM educator fell below the established standard of care that an ordinary person should be able to foresee), and contributory negligence is when the injured party’s own negligent actions contributed to his or her injury (often not applicable in P-12 if dealing with a minor who is deemed not to have known better). Comparative negligence occurs when a court determines the injured party and the school or STEM educator were both liable. When this occurs, the injured party’s award will be based upon the percentage that the court determines the school or STEM educator responsible for (they will be ordered to pay for that percentage of the losses resulting from the accident). The last defense is immunity, which most STEM educators are misled to believe will always protect them from being found liable. According to state statutes (state laws), immunity protects a school and its employees from being held liable for accidents within the scope of their job description. Immunity was created by the government to allow governmental agencies (e.g., schools) and their employees to perform their
SAFETY AND LIABILITY

daily duties without being liable for every incident occurring within the scope of their daily tasks. Immunity varies from state to state and often has numerous exceptions, so STEM educators must be knowledgeable about the immunity laws unique to their area (Love, 2013a). Sections 8541 and 8542 of the Pennsylvania Judicial Code (1980) are great examples of how narrowly defined immunity can be in certain states. In Pennsylvania, if an attorney can prove that the piece of equipment a student sustained an injury from is part of the physical school building, the school can be held liable. Schools should use rulings from case law within their jurisdiction to avoid liability, and better position themselves in the event of an accident.

RESOURCES TO RESEARCH CASE LAW
STEM educators no longer have to go to the library and sort through stacks of books to research legal information. They have access to this information via the Internet and would be wise to take advantage of this opportunity to inform their practice and policies. It would not be time-efficient for a STEM educator to research every case related to STEM education laboratory accidents. However, Janosik (2005) and Love (2013a) identified strategies used to stay abreast of important emerging legal cases. Administrators and department chairs should involve faculty and staff to help research important cases, and then discuss their findings with their department or school. Subscribing to high-quality periodicals and searching Internet databases are also excellent methods of finding case law. Examples of high-quality periodicals can be found in Love, (2013a) and a list of quality Internet resources for researching legal definitions, laws, and cases can be found in Table 1. Black’s Law Dictionary (The Law Dictionary, n.d.) also provides an app for multiple mobile devices if individuals desire legal information at their fingertips.

METHODS TO RESEARCH CASE LAW
Permuth and Mawdsley (2006) provided a detailed list of steps for how to conduct a legal search using legal databases and Internet search engines. Conducting a search using case search databases such as FindLaw, LexisNexis®, and Westlaw® requires

starting with the proper terminology, which can be found in the case law (see Figure 2) summary within legal databases. When reading the case summary there will be similar cases listed within the explanation of the court’s ruling. These cases will be cited as the previously established precedent or standard that the court used to make their ruling. Each cited case will normally have a link to its summary, or it can be easily researched in a case search database using the party names.

When using a case search database or an Internet search engine, it is critical to know the proper techniques for phrasing a search. Using quotations for exact phrases can help narrow the results. It is important to remember the variety of terms that could be used to find case law related to STEM education. When the author conducted searches, some terms in the case law such as “shop class,” “wood shop,” “table saw,” and “band saw” helped produce results for accidents that occurred recently in technology and engineering education classrooms. The courts did not differentiate between shop class and technology education, and that terminology is sometimes what they used in their explanation of the verdict. Conducting a Boolean search by using the words “AND,” “OR,” and/or “NOT” between search terms is also critical in narrowing down search results for legal cases (Permuth & Mawdsley, 2006).

Case law search results will be displayed in a format referencing where to locate the hardbound version despite being able to find it digitally. The following is an example:


LoFurno is the plaintiff (injured party seeking compensation), and Garnet Valley is the defendant (being sued), 904 is the volume number of the reporter (book) where the case is found, A.2d is the abbreviation of the Reporter Series (in this case Atlantic Reporter 2nd Series), 980 is the page number where the case can be found, Pa. Commw. Ct. is the abbreviation for the specific court in which the case was decided, and 2006 is the year in which the case was decided.

Sometimes a search will produce multiple results with the same party names, or the party names may be reversed. The reversal of names signifies that the case was appealed;
SAFETY AND LIABILITY

therefore, it is important to pay attention to the date of the decision to ensure the most recent and accurate ruling is being read. The most recent case summary will describe all of the previous appellate decisions within the summary. Understanding this information will help STEM educators quickly find cases and identify important characteristics about each one. In case search databases such as LexisNexis® and Westlaw® there are specific fields to search by party names, topic, or case citation number. LexisNexis® also allows researchers to search for news releases from various resources, which is beneficial in finding accidents that did not go to trial because they were settled out of court. Internet search engines are also a good source for finding information about settlements as discussed later in this article.

Once a case is located, a citator database can be used to search for cases similar in content, ruling, and terminology. KeyCite® is one citator that is available through Westlaw®, and Shepard’s® Citations Service is another one found within LexisNexis®. In LexisNexis® there is a drop-down menu in the upper right corner on every case summary page that allows the researcher to “Shepardize®” the case. This feature uses Shepard’s® Citations Service to find other cases in which the courts cited the same precedent case(s) in their rulings, or similar cases decided within the same jurisdiction.

CASE LAW

Figure 2 lists examples of some notable cases that occurred in STEM education classrooms and laboratories from which much can be learned. Although the cases that occurred in science education are displayed separately from those that occurred in technology and engineering education, the lines between the two subject areas are blurred. There are many science laboratory accident rulings that have informed policy and practice in technology and engineering education. Figure 2 is not an exhaustive list, but rather exemplifies a few significant cases that the author deemed valuable for STEM educators to learn from in order to adjust their practice and policies. Additional science cases can be found at Flinn Scientific, Inc. (2010). More extensive descriptions of some of the cases presented in Figure 2 can be found in Love (2013a) or a case search database.

Fontenot (1994) is the only case listed in Figure 2 in which the defendant settled with the plaintiff out of court. This case went
to trial, but the instructor’s insurance company and the student’s parent reached a settlement before the court reached a verdict. Using Internet search engines to research settlements allows STEM educators to learn about safety in addition to informing policy and practice at their school (Burris, 2010; Byard, 2008; Carmiel, 2002; Von Lunen, 2011). Continually opting to pay a settlement to save time and avoid public exposure is costly for a STEM educator and school.

One emerging case that STEM educators should follow involves University of California, Los Angeles (UCLA) chemistry professor Patrick Harran, who is on trial for felony charges resulting from a laboratory fire that killed his staff research assistant over four years ago. This is believed to be the first such prosecution involving a United States academic laboratory accident (Benderly, 2013). By the time this article goes to press, there may be a ruling on this case as well as new emerging cases critical to STEM education safety and liability.

APPLYING CASE LAW TO POLICY AND PRACTICE
Much can be learned from following emerging case law in all STEM education subject areas. Technology and engineering educators should follow case law as well as safety and liability literature from science education and vice versa. Tort liability for academic laboratory accidents does not differ between subject areas, and courts often do not differentiate between subject areas. A good example is Usher v. Upper St. Clair School District (1985), which resulted from a spilled chemistry class beaker and Tackett vs. Pine Richland School District (2002), which involved a chemistry class explosion. These cases were cited as the established precedent for Pennsylvania school laboratory negligence and immunity in Cureton v. Philadelphia School District (2002), where a technology education student sustained a scroll saw injury.

Many technology and engineering education laboratory accident rulings have been used as the established precedent for later technology and engineering education cases. In the Wells (2005) case, Cureton (2002) was cited as the precedent; and in the LoFurno (2006) case, Cureton (2002) and Wells (2005) were cited as the precedents for immunity. This exemplifies how current court decisions are often based upon previous rulings, making it crucial to follow emerging case law. STEM educators who follow case law like the examples in Figure 2 can learn

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**Figure 2.** Notable STEM education cases.

- Scott v. Independent School District No. 709, 256 N.W.2d 485 (Minn. 1977).
SAFETY AND LIABILITY

Valuable lessons. In the Heuser (2009) case, the instructor was found liable after failing to make any modifications or closely supervise multiple students who sustained scalp injuries during a biology lab. The Fontenot (1994) and Grammens (2010) cases demonstrated the “shotgun theory of litigation.” This theory is often used in hopes of finding anyone with deep pockets even remotely connected to an accident to be found liable or forced into a settlement. STEM administrators and supervisors may be named in a lawsuit because of their administrative duties. It is wise for individuals in these positions to take the proper precautions to avoid being found liable for accidents that occurred under their leadership (Love, 2013a). Fontenot (1994) should be used to inform teachers about student supervision and the caution that must be exercised when determining which students are allowed to use tools and machines in the laboratory. In Cureton (2002) the school district was not granted immunity, but in LoFurno (2006) the school district was granted immunity. Both cases occurred in Pennsylvania, but in LoFurno the school district convinced the court that their belt sander was not real property (part of the school building structure) since it was portable. Hence, it qualified for immunity under Section 8542 of the Pennsylvania Judicial Code (1980). Pennsylvania STEM educators can use this to reevaluate the equipment in their laboratory (Love, 2013b). The Steve Mullis (1998) case took eight years to resolve from the date of the accident, exemplifying the amount of time (personal and instructional), money, and reputations that can be salvaged by being proactive about potential litigation (Love, 2013a; Storm, 1993). Grammens (2010) would urge states, schools, and STEM educators to reexamine the wording in their safety policies. Courson (2002) and Wells (2005) showed STEM educators the importance of maintaining the proper working safety guards on all equipment. It is critical to remember that laws and rulings are unique to the state and local areas where they were decided. Although STEM educators can benefit from reviewing all case law, they must make sure they are abiding by the laws and policies specific to their area. Instructors should consult their school administrators, school attorney(s), and state supervisor with questions about the laws in their area.

Various types of accidents will occur that are not specifically stated within the law. In these special circumstances, some courts will default to any accepted standards or guidelines to be used as the precedent. For example, in the Commonwealth of Pennsylvania, the Safety Guideline document (PDE, 2012) for science, technology, and engineering educators produced by the Pennsylvania Department of Education could be viewed as the accepted standard in unique cases (Love, 2013b). It is important that states and schools have extensive safety resources and policies that are frequently updated to reflect new developments in the law. This can be used to help inform STEM educators about safety and liability and possibly serve as a legal precedent depending on a court’s decision.

and features, students often have trouble making connections between the tools and machines shown in videos and the actual tools and machines in a laboratory. Therefore, it is recommended that teachers still demonstrate how to safely use the specific tools and equipment in their laboratories. It is important for teachers to remember that these are safety guidelines and recommendations; hence not all criteria may apply to the tools or machines in every laboratory. Selecting the best resources or carefully adapting premade resources to reflect specific laboratory environments is critical in helping students better understand laboratory safety.

Many state department of education websites, along with technology and engineering education state association websites, have free information and resources regarding liability laws and laboratory safety. Examples of these include the Technology and Engineering Education Association of Pennsylvania website (TEEEP, 2013) and the Maryland State Department of Education (MSDE, 2006). TEEAP (2013) has an entire safety resources section that provides links to the Office of Occupational Safety and Health Administration (OSHA) website, as well as the PDE Safety Guide for Technology Education and Elementary Science Education (PDE, 2013). This free safety guide is an invaluable resource that provides information regarding safety considerations for general safety, laboratory design, materials and chemicals, tools and equipment, a sample school safety policy, laboratory inspection checklist, and accident report forms. Also in this document are safety guide sheets for specific...
SAFETY AND LIABILITY

tools and machines with correlating quizzes. The safety guide sheets serve as good resources to post near tools and machines in the lab as safety reminders for students to view before they use them. Many states have replicated this guide because of its usefulness. Maryland created the Technology Education Facilities Guidelines (MSDE, 1994/2006) and revised it in 2006 to assist in the planning of facilities that promote technologically literate teaching and learning. Contacting the supervisor for technology and engineering education in your state is also valuable for answering questions and finding resources that are state specific.

Just as seen in the case law, science education provides some valuable resources that technology and engineering education would be wise to use to its advantage. The Maryland State Department of Education (MSDE) website provides an online science education safety manual (MSDE, 1999). Within this manual are guidelines for teacher responsibilities, chemical handling, biological science safety, and physics class safety. This could serve as a valuable resource for technology and engineering educators, especially those teaching biotechnology concepts. This manual also provides a great description of tort liability and the legal aspects of laboratory safety, which would be the same for both science and technology and engineering education laboratories. In addition to the MSDE, Flinn Scientific (a science supply company), dedicated a whole section of its website to laboratory safety. This website (Flinn Scientific, Inc., 2013b) offers free online safety course videos for middle and high school science teachers, chemical storage and cleanup procedures, safe laboratory design, and liability information. The frequently asked questions section provides insight into how to handle situations between teachers and students with respect to safety and liability, which would also apply to technology and engineering education.

One resource of particular interest from this website is the science classroom safety and law section, which provides numerous videos that explain a wide range of legal topics using real-life examples. The liability videos feature excellent explanations and advice from Kelly Ryan, a former high school chemistry teacher for 17 years who is now an attorney. Another valuable resource that Ryan provides on this website is a list of 19 science classroom safety court cases (Flinn Scientific, Inc., 2010) from his book (Ryan, 2001), as well as video explanations of these cases and their outcomes (Flinn Scientific, Inc., 2013a). For example, in the Bush v. Oscoda video he talks about a student injury lawsuit occurring after a teacher notified her administration that too many students were being placed in her class. These videos and list of cases provide technology and engineer-

ing educators examples of similar lawsuits they could encounter and can use to inform their practice. All of these resources are valuable for educating pre- and in-service teachers about safety and liability. Using these resources as tools to fuel discussion at departmental or professional development meetings is beneficial for promoting a safer learning environment and reducing the risk of liability.

All of these free resources from Flinn Scientific can be utilized in some capacity by technology educators. Although there will be some concepts that apply specifically to science classrooms, the lines between science and technology and engineering education safety are blurred. This reveals a need for technology and engineering and science educators to collaborate regarding safety and liability for the improvement of student and teacher safety. Both fields can benefit from working together on this issue, specifically concerning safer implementation of engineering content and practices called for by the NGSS. These science education resources raise the awareness of technology and engineering education to create a similar database providing free safety videos, materials, and case law descriptions for teachers, supervisors, administrators, and higher education faculty to prepare safer teachers.

One additional feature that the Flinn Scientific website provides is information and training about the new format for Safety Data Sheets (SDS) [formerly called Material Safety Data Sheets (MSDS)]. SDS sheets are required to be kept on file and readily accessible for all hazardous chemicals and materials in a technology and engineering classroom or laboratory. In order to standardize SDS worldwide so employees could access chemical information more efficiently, OSHA adopted the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) in 2012. This has mandated that all employees who could be exposed to hazardous chemicals (e.g., paint thinner, various types of glue) be trained on the new SDS format by December 1, 2013. Flinn Scientific’s safety website provides this training free of charge and provides a certificate upon completion. It also provides free professional development credit safety courses (teachers should check with their state to confirm they will be accepted toward their professional development hours.) The SDS for a chemical or material can be obtained from the company where it was bought, or from searching the MSDS Solutions website (3E Company, 2013).

PRACTICAL SAFETY RECOMMENDATIONS FOR LABORATORIES AND CLASSROOMS

There have also been numerous resources published that provide recommendations for safer practices in science and
technology and engineering education laboratories. DeLuca and Haynie (2007), Gunter (2007), Haynie (2009), Roy (2009), and Toglia (2009) all provide practical recommendations that technology and engineering educators should implement in their laboratories. Among these resources, the most noted recommendation is the importance of wearing safety glasses or goggles. Haynie (2009) stresses the importance of all students, teachers, and guests wearing safety glasses in a classroom or laboratory any time there is an individual in the room using a tool or machine. Today’s multipurpose design of technology and engineering education facilities makes it difficult to distinguish between laboratory and classroom; therefore, if any student is using a tool or machine, occupants in the same room must wear eye protection regardless of proximity to the tool or machine. Most state laws require that all occupants in laboratory setting wear eye protection. It is also critical to make sure that the eye protection provided has the American National Standards Institute (ANSI) “Z87” rating. This assures that the glasses are capable of withstanding high-impact levels, which most regular vision glasses cannot handle. The “Z87” label for glasses and goggles is most commonly found on the side of goggles, or on the temples (side pieces that hook around your ears) of glasses.

In addition to safety glasses, Toglia (2009) and Haynie (2009) stress the importance of continually modeling safety and enforcing it, because safety is a process, not a one-time event. Haynie (2009) suggested 12 safety rules that should be common to all laboratories. Roy (2009) recommended that all teachers complete and keep on file the following: evidence of laboratory safety training, signed student and parent lab safety acknowledgment forms, graded safety tests (100% passing score), SDS sheets, dated safety lesson plans, student attendance during safety lessons, and dated equipment inspections performed regularly by the teacher. In addition, Roy suggested putting safety issues on departmental meeting agendas and displaying the proper safety signs near the correlating equipment in the lab. If a teacher performs these tasks correctly, he/she has created a paper trail usable in court to demonstrate the numerous precautions taken to maintain a safe learning and working environment. Lastly, Ferguson et al. (2010) recommended never accepting a teaching assignment in an area in which one is not professionally prepared to teach, and to also work with school attorneys to establish safety procedures, forms, and answer questions about the laws.

CONCLUSIONS
Safety should always be of utmost concern in STEM education classrooms and laboratories (Love & Strimel, 2013). More important than saving the time and money of schools or STEM educators, is saving students from the permanent injury they could sustain from a laboratory accident. Implications of this research indicate the need for well-prepared STEM teacher educators who teach and model safe practices. STEM education administrators and supervisors must ensure that emerging case law is being shared with technology and engineering educators, and that policies are frequently updated to reflect the changes resulting from emerging case law. Informing STEM educators of the most recent safety and liability practices is the responsibility of both the teacher preparation institutions (preservice) and the school districts (in-service) (Roy, 2011). Proper preservice preparation and in-service professional development can inform technology and engineering educators to work more safely and confidently. But just presenting safety through lectures, worksheets, and videos is not enough; safety must continually be modeled. Following emerging case law is one method to help promote safer teaching practices and policies. One way to present case law to pre- and in-service STEM educators is by using a case study approach that is often implemented by medical and law schools (Love, 2013a).

Technology and engineering education must prepare technologically literate students who can use potentially dangerous tools and materials to safely solve the problems of the future. In addition, STEM educators must be more knowledgeable about safety and liability to advocate for such learning environments. Tort liability changes constantly, and it would be beneficial for STEM educators to stay abreast of the law by implementing the strategies discussed in this article. Waiting to deal with a legal issue after a summons has been served is not cost effective (Janosik, 2005; Love, 2013a). Schools and STEM educators must keep hands-on, design based learning pedagogy as the staple of technology and engineering education:

STEM educators cannot fear liability and sacrifice the advantages of laboratory experiences that foster inquiry-based science, and are essential to student learning (Zirkel & Barnes, 2011). Without losing the laboratory learning experiences integral to STEM education, teachers in these fields must adapt to meet the safety requirements of future technologies and train professionals to keep student safety the center of focus. (Love, 2013a)

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SAFETY AND LIABILITY


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*Disclaimer – This article is not intended to replace advice from competent legal counsel. It merely presents cases that recently occurred in STEM education laboratories and shows how P-16 schools and individuals can be proactive in avoiding liability.

This is a refereed article.