Addressing Safety and Liability in STEM Education: A Review of Important Legal Issues and Case Law[1]

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ABSTRACT

Labs of today are less safe, students are inadequately instructed in safety, and faculty members do not have adequate experience to lead students safely (Haynie, 2008). Technology education, career and technical education (CTE), industrial education, engineering education, and science education laboratories are potentially dangerous places, which is why faculty members working in these areas must not only be concerned with student and faculty safety, but also protection against their own liability (Gathercoal & Stern, 1987; Frantz, Friedenberg, Gregson, & Walter, 1996; Hall & Marsh, 2003; Toglia, 2009). Injuries resulting from school laboratory activities are a harsh reality due to the hands-on design-based learning that is the cornerstone of science, technology, engineering, and mathematics (STEM) education. Despite potential injuries, 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).

Studying and following developing case law can serve as a viable means for institutions, administrators, and faculty members potentially to prevent an accident and to avoid being found liable. STEM education teacher preparation programs must adequately prepare pre-service and in-service teachers and administrators through coursework, professional development, and developing case law. Being proactive about potential litigation will save time, money, and other costly measures that are important considering today's tight budgets and trying to prevent losses (Janosik, 2005). This article examines current legal cases regarding classroom and laboratory safety issues for grades P-16 STEM education programs. In addition, strategies for managing these risks and reducing liability will be discussed.

Keywords: STEM education, liability, case law, safety, technology education

BACKGROUND

Integrative science, technology, engineering, and mathematics (STEM) education is defined as, "the application of technological/engineering design based pedagogical approaches to intentionally teach content and practices of science and mathematics education concurrently with content and practices of technology/engineering education. Integrative STEM education is equally applicable at the natural intersections of learning within the continuum of content areas, educational environments, and academic levels" (Wells & Ernst, 2012, para. 2). Therefore, in this article technology, engineering, and design education (TED) will encompass technology education, CTE, and industrial education to represent the T in STEM due to their considerable amount of (intentionally) integrative instruction (Herschbach, 2011), their curricular alignment with STEM initiatives (Asunda, 2011), and their high risk of liability (Frantz et al., 1996). This article examines current legal cases regarding classroom and laboratory safety issues for grades P-16 STEM education programs. In addition, strategies for managing these risks and reducing liability will be discussed.

The Utah Department of Health (2007) reported that on average, 160 students are injured and 86 school days are missed because of school shop (laboratory) injuries every school year in the state of Utah alone. The most common piece of equipment involved in school laboratory injuries was the band saw, which accounted for 13% of the reported injuries (Utah Department of Health, 2007). Also, laboratory safety extends beyond the school building to workplaces where students apply their educational experiences. Storm (1993) drew many parallels between safety in school laboratory settings and industry, specifically financial and productivity losses resulting from an accident. The National Institute for Occupational Safety and Health (Bergeson et al., 2002) reported that every year 6,000 Americans die from workplace injuries, 6

million people suffer from nonfatal workplace injuries, and injuries alone cost the U.S. economy more than $110 million. An incident could occur at any institution or school; thus, it is a best practice to remain proactive about legal issues (Janosik, 2005) related to STEM education.

Current TED laboratories use smaller scale equipment that is less powerful and intimidating than machines used during the industrial arts era (Haynie, 2009). Despite not being as powerful or intimidating, faculty members (all educators) and students may not be properly trained in their safe operation, resulting in injuries and lawsuits. Haynie (2008) believes that "The 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" (p. 97). This risk poses a threat to students, faculty members, administrators, institutions, and school districts. To avoid being found liable, administrators and faculty members in STEM education teacher preparation programs should stay informed regarding the latest lawsuits occurring in STEM education classrooms at the P-16 grade levels.

LITERATURE REVIEW

The common misconception of administrators and faculty members is that these type of accidents (e.g., eye injuries, lacerations, amputations, and other permanent injuries resulting from STEM education classroom and laboratory activities) will not happen to them or occur at their school (Pennsylvania Department of Education [PDE], 2012). The reality is that these accidents occur at all types of schools more often than administrators and faculty would like to believe. In 2007 Barrios, Jones, and Gallagher conducted a study analyzing 455 cases from 1996-2002 in which P-12 schools or school districts were sued for an injury sustained on school property. They found that on average, cases took nearly four years from incident to trial or settlement. Approximately two thirds of the cases resulted in schools paying an award because of a verdict directed for the plaintiff or a settlement. The mean award was $562,915, although Barrios et al. (2007) admitted that the award amounts were highly skewed.

Barrios et al. (2007) cautioned that the percentages of injuries and settlements retrieved by their legal research database are likely to be smaller than the published numbers because many cases are settled before being filed with a court. Despite settlements being underrepresented, they still account for the most common outcome representing the decision in 40% of the cases. Laboratory or shop injuries were the second least common activity to cause an injury lawsuit, only accounting for 7.6% of the cases. Although this number seems small, it still accounts for permanent injuries and consumption of time and money for the school, which was reported in the mean award amount. The majority, almost 80%, of the injuries occurred to students. About 58% of the time the injury resulted from the negligence to properly supervise. Barrios et al. (2007) reported that amputation resulted in the least amount of cases, but had a mean award of about $1 million. Tendon, cartilage, or ligament damage occurred 5.9% of the time, with a mean reward of about $300,000, and lacerations occurred 10.6% of time, resulting in a mean award of about $230,000. Although this data summarizes injuries within P-12 schools, it shows the significance to proactively prepare pre-service and in-service teachers to be properly trained in safety and liability issues. Despite the permanent damage to the student, it will cost the defendant hundreds of thousands of dollars, sometimes millions. Administrators and faculty members can save countless hours, headaches, and dollars by understanding the law and researching case law to implement precautionary safety measures.

The current educational reform movement has been calling for the integration of STEM education (National Commission of Excellence in Education [NCEE], 1983; American Association for the Advancement of Science [AAAS], 1989; AAAS, 1993; AAAS, 2011; International Technology Association [ITEA/ITEEA], 2000/2002/2007; National Research Council [NRC], 2012). A related question is, who is adequately trained to teach this content in a safe and integrative manner (Wells, 2008)? Most recently, A Framework For K-12 Science Education: Practices, Crosscutting Concepts, And Core Ideas (NRC, 2012) explicitly calls for integrating engineering concepts within the science curriculum. Although hand

and power tools are routinely used by TED teachers to implement engineering concepts in the curriculum, science educators need more instruction in hazard recognition and safety training (Roy, 2012) to successfully implement design-based engineering content using these tools.

TED educators play a vital role in delivering integrative instruction (ITEA/ITEEA, 2000/2002/2007), and Sanders (2012) suggested that they should play a prominent role in delivering integrative STEM literacy. Because most educators are not adequately prepared to teach STEM education simultaneously, collaboration among STEM education instructors is the most promising approach for implementing integrative practices (Wells, 2008).

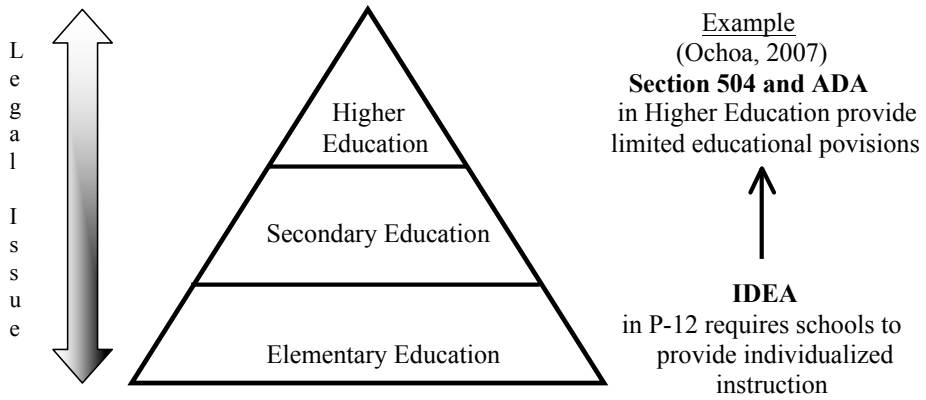
Minors and Adults on College Campuses

Paying attention to changes in the law and following case law resulting from employee and institutional liability is critical in anticipating and planning for potential issues. Employees in higher education may also benefit from following litigation at the P-12 level. Litigation beginning at one educational level may emerge or evolve into legal issues at another educational level. Figure 1 displays the way legal issues can start at one level of the educational continuum and work up to higher education or down to secondary and elementary education (Janosik, 2005).

Janosik (2005) cautioned higher education employees to interpret P-12 case law with great care. Judges will draw differences between P-12 children who are normally minors and are required to participate in schooling until the age of 16 and college students who are legal adults if 18 years or older. Students who are legal adults are usually deemed able to think for themselves and can exercise free choice (Janosik, 2005). The lines become blurred when a college freshman is 17 years old (still a minor) despite the majority of students at an institution being legal adults. A different legal process and care of duty may be applied toward minors.

At the P-12 1evel, faculty members assume some of the rights and duties of the parents, also known as in loco parentis (Kigin, 1983). However in higher education, and sometimes in secondary education, in loco parentis is not applicable because of the age and maturity of the students (Hall & Marsh, 2003). Paying attention to the case law for both minors and adults may prove beneficial. Knowing the law for students with disabilities will also be helpful, because

Figure 1. Safety and Liability in STEM Education



Anticipating legal issues in Education. Legal issues on the left can move up or down the educational continuum in the triangle. The example on the right shows future implications to provide more provisions for students with disabilities, which is slowly emerging from P-12 into higher education. Adapted from personal communication with S.M. Janosik, September 13, 2012.

these students may require a care of duty regardless of age and special accommodation. Legal rulings at the higher education level may differ from those at the P-12 level; however, important information can be drawn from examining rulings at both levels.

Tort Liability

Injuries to students in a STEM education classroom are classified as tort liability, also referred to as tort law. Kaplin and Lee (2007) define tort law as follows:

> 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).

Although tort liability has a broad range, negligence is the most common claim brought against institutions and faculty members for injuries sustained in a STEM education classroom (Toglia, 2009). In addition, Ferguson, Ford, and Bumgarner (2010) claimed that common tort cases involving higher education institutions are instructor negligence in laboratory settings. Negligence occurs when an employee or institution breaches the duty to protect students from foreseeable harm, if an employee or institution fails to act on a situation, or if an employee or institution's actions contributed to the plaintiff's injury (Owen, 2007). An institution is generally liable for tortious acts committed by employees acting within the scope of their job responsibilities. For example, if a student, an employee, or an invitee (an individual that an institution entitles or permits to be on its property) is injured as a result of a careless or wrongful act of an employee, the institution may be liable (Kaplin & Lee, 2007).

When students or other invitees are injured resulting from on-campus instructional activities, they may file negligence claims against either the institution or the employee. Individual employees may be liable if they committed the tortious act, directed it, or participated in its commission. Both the employee and institution may be liable if an employee commits a tort while representing the institution and is acting within the scope of the authority delegated by the institution. However, an employee may be personally liable and the institution not liable if the employee committed a tort while acting outside scope of delegated authority (Kaplin & Lee, 2007).

Strict liability is another type of tort that can be brought against either an institution or its employees. Strict liability is defined as, "the legal responsibility for damages, or injury, even if the person found strictly liable was not at fault or negligent" (Batten, 2010, p. 403). This means that the defendant (institution or employee) could be found not responsible, but asked to pay the plaintiff to make up for the loss in the incident.

The Shotgun Theory of Litigation

In a tort lawsuit, the plaintiff's attorney will frequently use "shotgun litigation." In this case, the plaintiff will file suit against "anyone even remotely connected to an incident to ultimately find a 'deep pocket' defendant liable or to force a settlement from that deep pocket even when there is no liability" (Phillips, 1986, p. 699). This could involve bringing suit against the institution, administrators, employees, third-party companies (e.g., machine manufacturer), and possibly other students. The judge will determine who can be put on trial. The motive for plaintiffs to sue anyone involved is to find someone who is liable and will owe money to the plaintiff. Administrators or employees at an institution may find their names in a lawsuit even if they were not directly involved. It is important for administrators and employees to be aware of what is going on at their institution so they do not end up being found liable for an incident that they could have prevented.

Immunity is Not Always an Option

Immunity means that the institution or employee cannot be sued according to state statutes. Many employees are misled into believing that they are shielded from lawsuits due to governmental or sovereign immunity. Immunity is narrowly defined and has numerous exceptions (Toglia, 2009). Even in the case where governmental immunity is granted to an institution, students may still sue individual employees for their negligence (Schimmel, Fischer, & Stelleman, 2008).

For example, under section 8541 of the Pennsylvania Judicial Code (1980), local government agencies (such as schools) are generally immune from tort liability; however, this is not absolute. Section 8542 of the Pennsylvania Judicial Code (1980) states that an injured party may recover in tort from a local agency if there is negligence in several areas. One of those areas is real property, which refers to the buildings or fixtures on the government agency's property. Fixtures can sometimes refer to equipment in a STEM education laboratory as is shown in the cases described later in this article. Real property negligence is not applicable where there is no defect or condition of the agency's real property that causes an injury. This interpretation of governmental immunity will also be seen in many of the cases presented later in this article.

Immunity laws are different in every state, so it is important for employees and institutions either to thoroughly understand the laws in their area (Roy, 2009) or to seek legal counsel to make sure they are in compliance with the laws. Ignorance is not a defense against a tort liability suit. Because governmental immunity is not always applicable, employees and institutions must educate themselves and others on how to avoid being negligent and found liable. One way to avoid being found liable is to review case laws and make the proper adjustments at one's institution.

CASE LAW

Lawsuits relating to STEM education programs and facilities can be found in the newspaper, scholarly journals, and in academic legal research databases, as shown in Table 1. It is seemingly impossible for an individual to research every case related to STEM education, so Janosik (2005) suggested nine methods to stay abreast of important legal cases (Table 2).

Examining STEM Education Case Law

One of the fundamental cases in science education liability is Usher v. Upper Saint Clair School District (1985). In this case an instructor dropped a chemical beaker that splashed flaming fluid on a student's face. The student (Usher) alleged that the instructor was negligent in failing to take adequate measures to control the area surrounding the experiment. The court ruled that the instructor failed to control the students, not the area of the experiment; therefore, immunity was granted to the instructor and the school.

Eleven years later an accident at Georgia Tech occurred (Niles v. Board of Regents, 1996) when a doctoral student sustained injuries resulting from mixing chemicals inside a metal canister that exploded. The student graduated summa cum laude with an undergraduate degree in chemistry and spent hundreds of hours in the lab prior to this incident. The student sued Georgia Tech and the Board of Regents, but the

Table 1. Sources for Finding STEM Education Case Law

Source	Example(s)
In The News	Local and national newspapers, professional association newsletters, radio, local and national television news stations.
Scholarly Journals	*The Chronicle of Higher Education* *Science Teacher* (published by NSTA) *The Technology and Engineering Teacher* (published by the ITEEA) *Journal of School Health* *NASPA Journal* Other journals not listed
Academic Legal Research Databases	FindLaw (a free resource) – (Thomson Reuters, 2013a) LexisNexis – (Reed Elsevier Inc., 2013) Westlaw – (Thomson Reuters, 2013b)

Table 2. Staying Abreast of Important Legal Cases

Method	Action
Seek Expert Advice	Use expertise of others at your institution (e.g., attorneys, risk managers)
Subscribe to Periodicals	Invest in high-quality periodicals that address contemporary strategic issues.
Identify Topics	Create a manageable list of hot topics.
Involve Staff	Delegate responsibilities to include staff.
Search the Internet	Use the internet to search effectively.
Monitor Agendas	Follow the activities of federal, state, and local officials to identify shifts in agendas.
Follow Groups	Track the activities of special interest groups.
Network with Others	Build personal networks with informative people.
Share New Findings	Disperse new legal developments in a brief and effective manner.

court ruled in favor of the Board of Regents. They claimed that neither the university nor the professor were required to warn the student about mixing chemicals since he had a degree in chemistry, and there was no evidence that a lab safety course would have prevented the accident.

Fast-forward another 13 years to another case (Heuser ex rel. Jacobs v. Community Insurance Corporation, 2009) in which an eighth grade student sustained a cut while using a scalpel to dissect a flower in science class. His parents sued the school for negligence because he was the third student that day to sustain a cut from a scalpel in that class. The court ruled in favor of the student, finding that no precautionary measure was taken in response to the open and obvious danger of the scalpels. The instructor had the option to pick one precautionary measure over another but instead chose to do nothing, resulting in the school district being found liable.

A more recent case (Grammens v. Dollar, 2010) involved another eighth grade student in a science class who suffered an eye injury while launching a two-liter soda bottle with water and air pressure. When the bottle lifted off the launch pad and the student removed the pin that held the bottle in place, the pin struck the student in the eye. The student's father sued the instructor, the school principal, and the school superintendent, alleging the injury was the result of a violation of the county board of education's eye protection policy. The trial court granted immunity to all of the defendants because the negligence claims were discretionary and protected from personal liability under official immunity. The Court of Appeals agreed that the superintendent and principal qualified for immunity; however, it ruled the instructor should not be granted immunity because the eye protection policy was mandatory, not discretionary. On appeal, The Supreme Court of Georgia ruled that because the term "explosive materials" did not appear in the county's eye protection policy, it was the instructor's discretion to use safety glasses for the bottle rocket activity and the instructor was granted immunity from personal liability. The school district was encouraged to rewrite their safety glasses policy with greater detail.

There have been many cases involving TED education due to the nature of the high-risk equipment used in the profession. One case (Fontenot v. State ex rel. Department of Education, 1994) involved the student's father

suing the State of Louisiana Department of Education, Pelican Mutual Insurance Company, Horace Mann Insurance Company, the instructor, and the school board for a table saw accident that injured his 14-year-old son who had special needs. The instructor had demonstrated the use of the table saw and observed students individually to ensure that they had mastered skills in its use. The student (Fontenot) was adjusting the guide fence when someone distracted him by calling his name, causing his hand to slip into the still-turning blade. The instructor had not left his immediate teaching area or abandoned his supervisory duty. The instructor and his insurer settled with the Fontenots. Fontenot's father also brought suit against the school for placing his son in a class that was not appropriate for his son's disability, but the court ruled his son was appropriately placed.

In 2002, Cureton v. Philadelphia School District, involved a 13-year-old student (Cureton) who permanently disfigured his right index finger while cleaning a scroll saw. The instructor informed students to keep the machines clean, and Cureton was granted permission to clean the saw. After cleaning the saw, Cureton reached across the saw and turned it on, which resulted in his untucked shirttails getting caught in the saw's pulleys. The pulleys amputated a portion of his finger, which was surgically repaired at a local hospital despite the student suffering permanent deformation and scarring. Cureton's mother originally filed a product liability suit, which she later changed to negligence claims against the school district. The court ruled that the scroll saw was real property and not personal property since the saw was in place since 1987, permanently hardwired through the building, bolted to the floor, and was never removed from the shop. The court used the ruling from Usher v. Upper St. Clair School District (1985) to determine if the negligence was the result of the real property (the saw) or was simply a cleaning accident that went awry. The court found the school district liable since the instructor neglected to turn the main power off when there was foreseeable danger. The instructor gave permission and responsibility to the student to clean the saw, and on prior occasions the teacher turned the power off, but not on this occasion. The school district argued that Cureton was able to comprehend danger and should have known better, but failed to present evidence showing that he was negligent because other classmates did or would do the same thing when cleaning the machine. Cureton was awarded $35,000.

Three years later in Wells v. Harrisburg Area School District (2005) an 11th grade student experienced a kick back on a table saw that hit him in the stomach, causing him to lose his balance and place his hand over the blade. He lost his ring finger, the tips of his thumb and small finger, and sustained serious injury to his middle finger of his left hand. The student was told that the guard could not be used when performing this type of cut, however expert testimony showed that another guard could have been purchased and used during a groove cut for that particular saw. The instructor and district engaged in negligent care by allowing novice students to use a table saw that lacked an adequate safety device. Therefore the court ruled that the school district created a dangerous condition of the real property (table saw) that caused the student's injuries. The student was awarded $240,000.

Just one year later in another Pennsylvania case, LoFurno v. Garnet Valley School District (2006) a 15-year-old 9th grade student caught his fingers on both hands between the belt and table while operating a vertical belt sander. The student (LoFurno) allegedly suffered permanent damage to his right and left index fingers. His parents sued the school claiming that the belt sander was a fixture (real property) with no safety guards or warnings on the sander, and also negligence for not properly supervising and instructing its employees on the proper use of dangerous equipment. The court ruled the sander as real property, but on appeal the decision was reversed. The appellant court granted the school district immunity, ruling that the sander was not realty because it was not bolted down, it could be plugged into any outlet in the room, and the dust collection hose was removable.

Learning from Case Law

Many of the cases presented involved middle and high school students whose parent or guardian brought suit against the school because these people were financially responsible for the medical bills of that child. Contributory

negligence was used as a defense in Niles v. Board of Regents (1996) because the court looked at the student's age and experience in the chemistry lab to decide that he was negligent for performing a task he should not have performed. This defense may not have been valid if the student were a minor or had little experience in the chemistry lab. The variety of tools and processes that brought about these lawsuits shows the vast range of safety preparation and knowledge that STEM educators must possess. Roy (2011) emphasized the importance of educating pre-service and in-service teachers about how to safely use and teach about the tools in the lab.

These cases illustrate that no case is clear-cut. A great deal depends on the evidence presented and precautions taken by the institution and the faculty member. Many of the defendants in the Pennsylvania cases were granted immunity when a piece of equipment was deemed personal property or realty under state law. In Cureton v. Philadelphia School District (2002) the court ruled the scroll saw was real property, but in LoFurno v. Garnet Valley School District (2006) the school's belt sander was not deemed real property. The arguments the defendants in Garnet Valley School District case used to establish their belt sander as personal property were different than the arguments used in the Cureton case. The significance of the LoFurno case is it now allows school attorneys an opportunity to cite it when trying to obtain immunity by proving a machine is not real property. This creates more opportunities for school districts in the same jurisdiction to be granted immunity in future cases.

Understanding case law as verdicts emerge allows faculty members and institutions to make the proper adjustments to their facilities and teaching practices. The Wells case serves as a reminder for faculty members and institutions to check and make sure the proper safety guards are in place and working. The Fontenot v. State ex rel. Department of Education (1994) case should make faculty members more aware of what types of students they are letting use dangerous machinery that requires advanced skills. Grammens v. Dollar (2010) encourages institutions or school districts to check the wording of their safety policies.

Regardless of the tools used in the classroom, sometimes what faculty members do or do not do can determine if they and/or the school is at fault. In Cureton v. Philadelphia School District (2002) although the student had his shirt untucked and voluntarily reached across the saw to turn the power on, the faculty member was at fault for allowing the student to clean the machine and not turning off the main power supply as he had done numerous times before. In Heuser ex rel. Jacobs v. Community Insurance Corporation (2009) the faculty member took no precautions to address the continual danger of the scalpels (e.g., use scissors, have the instructor perform cuts) so the school district was found liable.

As new cases are decided, faculty members and institutions need to adapt their pedagogy and policies to address the changes in the law. More recently, Western Carolina University reviewed case law and used a risk assessment model to document and gain insight into developing a safety program for their engineering technology laboratories (Ferguson et al., 2010). Using recent case law to be proactive about potential hazards may take time and money to implement, but is quicker, cheaper, and less stressful than the litigation process resulting from an accident. Dealing with a legal issue after a summons has been served is not cost effective (Janosik, 2005). Being proactive about potential litigation will save time (personal and instructional), money, and reputations (Storm, 1993).

Case law pertaining to negligence resulting in injury of students in higher education environments is limited; however, the courts have established precedence in areas that offer insight for faculty members and administrators to develop laboratory safety guidelines and procedures (Ferguson et al., 2010). As new cases emerge, faculty members, administrators, and institutions should pay attention to the outcome of the cases. New rulings in tort liability cases may open up doors to increased liability for faculty members and institutions. College administrators need to be alert for important changes in the law. Focusing only on case law and emerging issues is only one portion of the education enterprise, which provides a limited view of legal issues that may be developing (Janosik, 2005). Most important, legal cases

should serve as a learning tool for STEM educators. Faculty members and institutions cannot predict or prevent every accident, but they can implement proper systems to try to avoid being held liable if a similar incident happens at their institution.

TORT LIABILITY

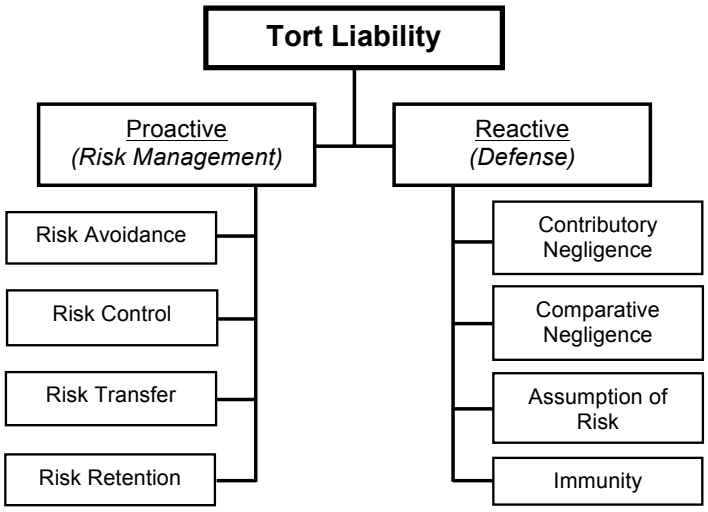
Best Practices to Avoid Tort Liability

According to Kaplan and Lee (2007) risk management can help stabilize the institution's financial condition over time and improve the morale and performance of faculty by alleviating their concerns about personal liability. Kaplin and Lee (2007) suggested four major methods of risk management to avoid legal liability: (a) risk avoidance, (b) risk control, (c) risk transfer, and (d) risk retention (Figure 2). Risk avoidance is the best method to reduce liability because the activity is avoided or eliminated due to foreseeable liability concerns (Toglia, 2009). Sometimes a risk cannot be avoided; therefore, other methods such as risk control can be implemented. Risk control is when restrictions are created to reduce the frequency or severity of exposure to liability.

Risk transfer could involve methods such as purchasing liability insurance and the use of waivers (Kaplan & Lee, 2007). Unfortunately institution and union insurances may not be enough, and sometimes these exclude hazardous activities undertaken by STEM education employees. An individual liability insurance policy, such as the one offered through the ITEEA is added protection in the event that litigation is brought against an individual. Another option is for STEM education employees to purchase a "business pursuits" endorsement or attach a rider to their homeowners insurance, which acts as professional liability coverage (Toglia, 2009). Individual liability insurance policies are usually fairly inexpensive, especially if they are ever needed to cover legal fees associated with a lawsuit. Institutions and faculty members should check with their school to ensure what type of liability insurance they have and what it covers prior to the event of an accident. Risk transfer could also involve hiring a private company to maintain the equipment in a laboratory. However, transfer of risk is not a universal defense for all institutions facing litigation (Toglia, 2009).

The last method to avoid liability is risk retention because the insurance cost is too high, the expected losses are minimal, or the probability of risk is extremely small. Institutions and employees must decide the probability and cost of a potential lawsuit before they approve the activity and take any precautions. In the event that a lawsuit is brought against an institution or employee, there are certain defenses that can prevent them from being found liable.

Figure 2. Addressing Tort Liability in STEM Education



Defenses Against Tort Liability

The four defenses against tort lawsuits are (a) contributory negligence, (b) comparative negligence, (c) assumption of risk, and (d) immunity (Figure 2). Contributory negligence results when the student's own negligent action contributed to his or her injury. Most experts believe this defense is of little value when a minor is involved (Toglia, 2009). Comparative negligence allows juries to find the degree to which each party is negligent, authorizing recovery based on the degree of fault (Gathercoal & Stern, 1987). For example, a court can determine what percentage the defendant was liable and ask that person to pay for a percentage of the damages. Assumption of risk is when a participant engages in an activity that involves a risk and is deemed to have assumed the risks inherent in the activity (Hall & Marsh, 2003). The assumption of risk is dependent upon the age, maturity, experience, and familiarity with the risk, despite any signed waiver. Assumption of risk is usually not a viable defense in a negligence claim if an employee fell below the standard of care (Gathercoal & Stern, 1987).

The last defense is immunity, which was previously discussed. It is important to note that immunity varies from state to state (Kaplin & Lee, 2007), therefore employees and institutions must know immunity laws specific to their state. Despite the defenses described previously, employees should always act within their job description and good faith to avoid being liable for an accident. The best defense against a tort is anticipating legal issues by reviewing case law and keeping current on any changes in the law (Janosik, 2005).

FUTURE IMPLICATIONS

Presenting recent case law to pre-service teachers, in-service teachers, and other employees may be a challenge. Simply passing along the information may not assure that the appropriate attention and reflection is given to the cases. Using a case study pedagogical approach can provide employees the chance to put their selves in the classroom situation, discuss the outcomes, and identify things they would have done differently before the final verdict is revealed. This case study pedagogical approach is often implemented in medicine and law schools. In law, new decisions, new cases, and new laws are built upon old decisions (Herreid, 1997). Harvard Law School (2012) uses a case study approach to educate their students. They found that the case study teaching method engages readers in active learning by putting them in the shoes of real people solving real problems. They also found that it is an appropriate teaching method for undergraduate and graduate education, as well as professional development workshops and courses. It elicits dynamic interaction in a real problem-solving scenario.

Most articles have been written recommending safe practices for science and TED faculty members to avoid liability in the event of an accident. Gunter (2007), Haynie (2009), DeLuca & Haynie (2007), Roy (2009), and Toglia (2009) all provide an extensive list of recommendations to create a safe learning environment in the laboratory. The number one recommendation that Haynie (2009) stressed is to have all persons wear safety glasses in the laboratory at all times. Togolia (2009) emphasized implementing safety throughout the curriculum and modeling safe practices, which is also mirrored in Haynie's article stating that safety is a process that is continually reinforced, not an event. Roy (2009) described safety actions for students and safety actions for teachers. He stressed the importance of lab safety training, a student and parent lab safety acknowledgment form, safety tests, MSDS sheets, keeping record of safety lesson plans, keeping record of student attendance during safety lessons, putting safety issues on department meeting agendas, displaying safety signs around the lab, and recording equipment inspections. All of these strategies, if recorded properly, create a paper trail that could be used in a court of law to prove the faculty member and school took numerous precautions to promote a safe learning environment. These articles should be referenced for professional development and safety training of pre-service and in-service teachers.

Ferguson et al. (2010) provided a set of safety recommendations for higher education faculty slightly different than Gunter (2007), Haynie (2009), DeLuca & Haynie (2007), Roy (2011), and Toglia's (2009) recommendations geared toward P-12 teachers. Among the many recommendations, Ferguson et al. (2010)

recommended working with the institution's attorneys to establish a safety plan and conduct workshops to learn the law. Another recommendation they make is to never accept an assignment teaching in a laboratory in which one is not professionally prepared to teach. With the shortage of qualified STEM teachers to fill positions, this recommendation may be one that is often breached. Despite the differences in P-12 and higher education, all of the articles provide valid recommendations that should be followed at all levels. Although employees and institutions cannot prevent being sued, they can take the proper precautions to prove that they did everything they could to avoid foreseeable danger.

CONCLUSION

Since institutions and faculty members cannot predict when they will be sued, it is critical to stay current on developing issues via case law. Bridging the gap between P-12 and higher education is essential to planning for potential legal issues coming down the pipeline (Janosik, 2005). Safety and liability will continue to be an issue for STEM educators. The hands-on design-based learning nature of these courses will carry increased liability compared to many other content areas. This design-based learning methodology that defines STEM education must remain the crux of its pedagogical practices.

Keeping a hands-on design-based learning pedagogy will require STEM education teacher preparation faculty to better prepare pre-service teachers and enhance in-service teachers' knowledge of safety and liability. Instructing pre-service and in-service STEM educators and administrators how to follow developing case law can save time, money, and injuries that result from accidents (Janosik, 2005). STEM educators of all disciplines must be adequately trained to safely implement the types of curriculums that national organizations and councils are requiring STEM educators to use. Safety training has been an essential part of the technology education curriculum for years. TED education must share its expertise in this area with the other STEM education disciplines to assure collaboration among educators who can safely deliver an authentic context for problem solving and transfer of knowledge that makes STEM education unique (Wells, 2010).

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). As Ferguson et al. (2010) suggested, "Tort law is changing constantly; it would be wise for professors to stay abreast of the law by periodically reading law review articles in scholarly journals" (p. 8). Through proper preparation and professional development, faculty and institutions can use case law to stay informed of the newest litigation and adapt their practices accordingly. Modern technology is constantly developing improved devices (Storm, 1993) with new safety considerations to learn. 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.

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[1]*Disclaimer: This article is not intended to replace advice from competent legal counsel. It merely presents cases that recently occurred in STEM education classrooms and shows how institutions and individuals can be proactive in avoiding liability.*