

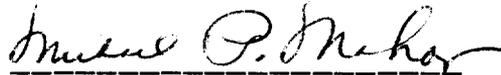
**Laboratory Safety in the High School:
Concerns and Problems**

An Honors Thesis (HONRS 499)

by

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Thesis Director

A handwritten signature in cursive script, reading "Michael P. Mahan", written in black ink.

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Abstract

Laboratory experiments can be both educational and enjoyable for high school students but safety must be a constant consideration. In order to discover how much safety training, time spent teaching safety and problems teachers have concerning safety teachers have, a statewide survey was conducted of Indiana science teachers. The results showed that approximately 25% of Indiana science teachers received no training at the undergraduate level. The survey also showed that chemistry teachers spend more time teaching safety than do teachers in other disciplines of science. Finally, the survey gave a clear indication of some of the problems and concerns facing science education in Indiana's high schools.

Introduction

When teaching, no matter which subject, grade or ability level, I am convinced that students learn more through doing and experiencing rather than by lecture or book work. When addressing the subject of science, labs (especially those that are well thought out and constructed) make many abstract points concrete. However, when performing these laboratory experiments, safety is often ignored or forgotten.

Although I have participated in many labs and have learned how to prepare and set up lab experiments, I felt I lacked training in laboratory safety procedures. Because of this deficit, I felt led to research and study laboratory safety practices. There are thousands of journal and magazine articles reporting lab disasters which paint a hideous picture of lab experiments which have gone amuck. However, there are few articles concerning minor accidents or problems that teachers face everyday.

My primary interest is discovering some of the safety problems that teachers face everyday and what concerns they may have. In order to find an answer, I began by looking for literature and found nothing which truly answered the question. My next step was to personally survey teachers. I began to hypothesize that many teachers

are concerned about laboratory safety but the knowledge to carry out their concerns is lacking. Other teachers simply do not realize the potential dangers that lurk in high school laboratories and therefore do not spend the time and effort necessary. Many of these teachers feel that the only teachers that need to be concerned with lab safety are those in the chemistry department. The risks that threaten all science teachers are both physical in the form of injuries to the students (as well as to the teachers themselves) and economical in the form of law suits. A few of these risks are: chemical exposure (in biology as well as chemistry labs), improper storage of chemicals, labs with animals (bites, scratches and improper dissections) and neglecting to wear goggles (not only when chemicals are involved but when shattering rocks and minerals) . This quest to discover the true situation in the high schools lead me to devote my senior thesis to this topic. In order to further study and answer my question, I decided to send out a state wide survey to all the science teachers in Indiana. As a result of the survey I discovered a wide variety of problems and concerns that face high school science teachers and what percentage of them were trained to deal with these problems that may arise. I also discovered how much time was devoted to lab safety. A copy of my results and findings will be sent to those teachers who requested one.

Methods

As stated in the introduction, I decided to send out a statewide science safety survey. My primary goal in writing the survey was to discover how much laboratory safety training high school teachers have, how much time they spend addressing the subject of safety and some of the difficulties and frustrations they face. I purposely wrote questions that could not simply be answered yes or no but were more open ended in order to discover teachers true feelings. A copy of the survey is included in the appendix. I chose to send out this survey to all 403 high schools in the state of

Indiana. I obtained a list of high schools and their addresses from the Ball State University Admission Office. I sent the survey all over the state because I felt schools in this immediate area were heavily influenced by Ball State University. I also felt a larger area would provide more statistically valid sample. Since the average number of returns for a survey of this type is 20-30%, I felt a large number of surveys was necessary in order to achieve validity. Return envelopes were also included in order to increase the number of surveys returned and thus make it more statistically relevant.

Since I had no convenient as well as economical way of knowing how many science teachers are at each school, I decided to send a cover letter addressed to the head of the science department which contained instructions to copy the survey and distribute them to their science teaching staff. I have talked to several teachers and this procedure is a common way of dispensing surveys in schools. A copy of the cover letter is included in the appendix.

My next step was to have the survey approved by the Ball State Institutional Review Board since all surveys must be approved before they can be sent out. This is to insure that no rights are violated and no emotional harm is done. This required me to write up a proposal and submit it to the Research Office. My survey was approved with no changes or alterations.

After sending the survey out, I had initially planned to allow two weeks after the stated dead line to receive the results but due to bad weather I allowed an extra week since many schools were out of session for an extended period of time.

Results

Of the 403 schools in Indiana, I received surveys from approximately 100 schools. It is impossible to calculate the exact number due to the fact that not every school gave their name or return address. A few schools sent their surveys in separately rather than together in the return envelope which also made determining

the exact number of schools difficult. However, this number gave me a 25% return which allows for statistically relevant data and permits me to draw interpretation and conclusions concerning laboratory safety in the state of Indiana.

From the approximate 100 schools, I received 286 survey forms. From these returns, I discovered that 28.3% or 81 of the teachers had some type of course in laboratory safety. However, most of this training was done on a graduate level. Just as predicted, most teachers, 71.7% or 205 of the teachers, had no formal training, only what had been acquired through experience. A few teachers mentioned attending one or two day workshops which I did not include in the 28.3% which had formal training. Luckily, no teacher reported any major accident but the lack of training points to potential danger on the horizon.

When addressing the topic of time devoted to laboratory safety, a majority of the chemistry teachers did a one to two day unit on laboratory safety and nearly all mention safety before beginning each lab. Some teachers required their students to sign safety contracts, which help to heighten student awareness of lab safety as well as aid in financial protection for the teacher although this protection is not a guaranteed exclusion from law suits. Biology, earth science and physics teachers placed less emphasis on lab safety with very few units taught while relying on a short introduction when they deemed necessary or appropriate. A few teachers, primarily earth science, said they did no labs and therefore did not address safety at all.

The third part of the survey dealt with safety procedures teachers perform that are not related directly to teaching. Many teachers reported doing chemical inventories while several teachers replied that this was the responsibility of the head of the science department. Other teachers did cleaning and went through check lists to test equipment and facilities in the classroom. A large number of these teachers were chemistry teachers although a few physics teachers also mentioned equipment checks as well.

Finally, the last section of the survey dealt with safety problems that teachers felt their school needed to address. The number one problem which was mentioned 52 times was lack of equipment or supplies. Many schools are in need of fire extinguishers, especially those necessary for chemical fires. Some teachers said they lacked eye wash stations, showers or fume hoods in their classrooms. Other teachers complained of lacking less expensive equipment such as eye goggles. These teachers did not have enough goggles for every student in the class or lacked goggles in adequate condition.

The second most common problem was the storage of chemicals. A total of 48 teachers said their school had a problem of chemical storage. The Flinn method of storage was mentioned often in the surveys as being safe and reliable. However, many teachers reported that their schools stored their chemicals alphabetically despite how they might react with other chemicals. Acids and bases were reported as not being correctly stored and flammable chemicals were not stored in fire proof cabinets.

Disposal of chemical wastes or dissection remains was mentioned by 47 teachers. Disposal of animal remains and especially chemicals can be a very expensive procedure which many schools cannot afford. One teacher told of a chemical company which donated boxes of chemicals to the school. Among those boxes were several bottles of cyanide which the school cannot dispose of. Several authorities were contacted and no one is willing to take the extremely dangerous chemicals for disposal. Thus school sits on a potential time bomb.

Ventilation was a concern of 41 teachers. Ventilation problems can be in the form of not enough fume hoods for student use, fume hoods which do not work properly or in the form of improper circulation of air within the rooms.

Other less often mentioned problems but ones of equal importance were set up of lab classrooms (poor arrangement of lab tables or equipment), overcrowding, and asbestos ceilings. A few teachers mentioned lack of teacher knowledge as a major

problem as well as lack of concern from other science teachers in their school. Student discipline was also a concern since horseplay can lead to accidents.

Discussion

From my results, I proved my hypothesis that many teachers lack the necessary laboratory safety training. The high percentage of teachers without training implies that college curriculums need to be evaluated. Perhaps a class devoted to laboratory safety should be created in order to better prepare future teachers for the responsibilities they will face as science teachers. This course should be required or at the very least be offered as an elective. Although safety is often briefly discussed in science method classes, this does not allow enough time to cover safety practices, proper storage and maintenance of chemicals and equipment as well as first aid in case an accident was to occur.

Although it would be ideal for every science teacher, no matter what the discipline, to set aside a day or two strictly devoted to safety and then briefly review procedures before each lab, the important element is that safety must be stressed. Many of the chemicals used in biology labs are no less toxic than those used in chemistry experiments yet safety is more easily ignored or forgotten in biology. Any lab experiment involving open flames such as from Bunsen burners must be carefully supervised in order to prevent loose clothing and long hair from igniting. Physics experiments with electricity can often hold potential hazards as well. Essentially, all lab experiments hold some type of threat and must be weighed out to determine if the potential risks are worth the knowledge to be gained. The teachers which perform no laboratory exercises, although safe, deprive their students of valuable lab experiences and often neglect to introduce their students to the fascinating world of science.

When discussing non-teaching related procedures, it must be remembered that a teacher does more than just teach. In order to adequately prepare for a safe and

interesting lab experience, a great deal of time and effort must be spent preparing the lab, checking equipment and doing periodical inventories of chemicals to check expiration dates. There are a few schools who are fortunate enough to have lab preps which spend their whole day doing non-teaching related jobs in the school labs. It would be beneficial for all schools, especially the larger ones to have lab preps or assistants. In this way, a greater amount of time and effort could be devoted to lab safety. This would be an insurance benefit in the form of prevented accidents and hazards. Teachers would benefit by having more time to prepare lessons and therefore the labs could be more complex as well as safe. In the end the students would benefit as well from a greater educational experience.

Lab experiments can be very costly in the form of equipment required for the actual experiment as well as the necessary safety equipment in order to insure no harm will come to the students. This of course requires money and many schools are in dire need of funding at this time. However, the cost of labs is very often worth the experience gained by the students. Money is also needed for better storage, disposal and ventilation. All of the problems that teachers face in the classroom are frustrating for those involved because of the fact that some important labs must be done either as a demonstration by the teacher or excluded all together. In the end, the teacher must decide whether or not the laboratory experiment is too dangerous a risk for themselves and their students.

I believe that laboratory safety is a very important and integral part of science education. Most of the neglect that teachers have for lab safety is due for the most part because of lack of knowledge. Many teachers do not realize the potential danger that lurks in their classroom. Chemistry teachers are for the most part more aware of the necessary safety procedures. Biology, earth science and physics teachers often fail to see the potential hazards which lay hidden in the labs they perform. In no way am I implying that lab experiences should be lessened. Laboratory activities, if anything,

should be increased. However, these experiences should proceed with caution in order to protect both the teacher and the students.

By sending a copy of my results to those teachers who requested one and submitting my findings to HASTI (Hoosier Association of Science Teachers, Inc.) and NABT (National Association of Biology Teachers) for possible publication, I hope to heighten teacher awareness of laboratory safety and thus prevent possible accidents in the future. This survey has heightened my awareness of the problems I will face as a science educator in the near future and will help me to better teach my students. However, many Indiana science teachers will still lack necessary knowledge concerning laboratory safety while others will continue to ignore the problem.

Appendix



Ball State University

College of Sciences and Humanities
Department of Biology

Dear Science Department Chairman,

As indicated on the following page, I am an Honors senior at Ball State University and am majoring in Science Education. I am currently student teaching as well as doing my senior honors thesis which concerns laboratory safety. I would greatly appreciate your help by making copies of the survey on the next page and distributing them to all of your science teaching staff. An envelope has been provided for you to send the surveys back to my advisor here at Ball State. I would greatly appreciate your help with this project. Thank you for your time and consideration.

Sincerely,

Kelly S. Kuchenbrod

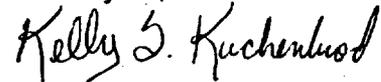
As stated on the survey, please return by March 15, 1991 so that the results may be correlated. In case the envelope should become lost, please return the surveys to my advisor at the following address:

Michael P. Mahan
North Quad 320
Ball State University
Muncie, IN 47306

Dear Science Teacher,

I am a science education major at Ball State University and am interested in laboratory safety in the secondary and middle schools. This includes all aspects of science such as chemistry, biology, earth science, physics etc. I would greatly appreciate your help in my senior thesis by answering the following questions and returning them to the head of your science department by March 15, 1991 or mail it to my advisor, Michael P. Mahan, North Quad 320, Ball State University, Muncie, IN 47304.

Thank you,



Kelly S. Kuchenbrod

1. What subjects and grade levels do you teach?

2. Have you had any formal training in laboratory safety? If so, how much and where.

3. How much time do you spend teaching lab safety in your class? Do you teach a unit or lesson on safety? If so, please describe.

4. What non-classroom related safety procedures do you do? (example: chemical inventories)

5. What laboratory safety problems do you think your school needs to address?

6. Name of school.(optional)

7. Please write any additional comments on the back.

If you have any further questions or would like more information concerning my project, please give your name and address below. (No names will be included in my thesis.)