

Overcrowding in the Instructional Space

By the NSTA Safety Advisory Board

Revised April 2020

Better professional safety practices and academic research support hands-on, process and inquiry-based laboratory and field investigations as well as hands-on activities to promote deep conceptual understanding of science by students. To ensure a safer and effective science teaching/learning environment, the following recommendations are derived from recognized reliable sources, legal safety standards, and better professional safety practices. The recommendations represent the better professional safety standards and practices on safety as it relates to overcrowding. However, it cannot be assumed that all hazards in science classrooms are ameliorated by simply reducing overcrowding. Other factors affecting safety, may include facilities design, engineering controls, appropriate personal protective equipment, standard operating procedures, and/or safety training of students and teachers. These additional factors, which can be linked with science accidents, must also be attended to as well as meeting the requirements of any legal safety code or regulation or law of any state, municipality or other jurisdiction (e.g. Federal or State OSHAs).

Overcrowding in science classrooms is the number one concern among science teachers (Horton, 1988; Rakow, 1989; West et al, 2001; Stephenson et al., 2003; West & Kennedy, 2013). However, overcrowding, as well as lack of safety training of teachers; lack of appropriate classroom management; and inadequate science equipment and facilities have all been identified as possible areas of safety concern while teaching science (Horton, 1988; Rakow, 1989; West et al., 2001; Stephenson et al., 2003; Richards-Baab, Bishoff, Carver, Fisher and Robertson-Honecker, 2010; West and Kennedy, 2014).

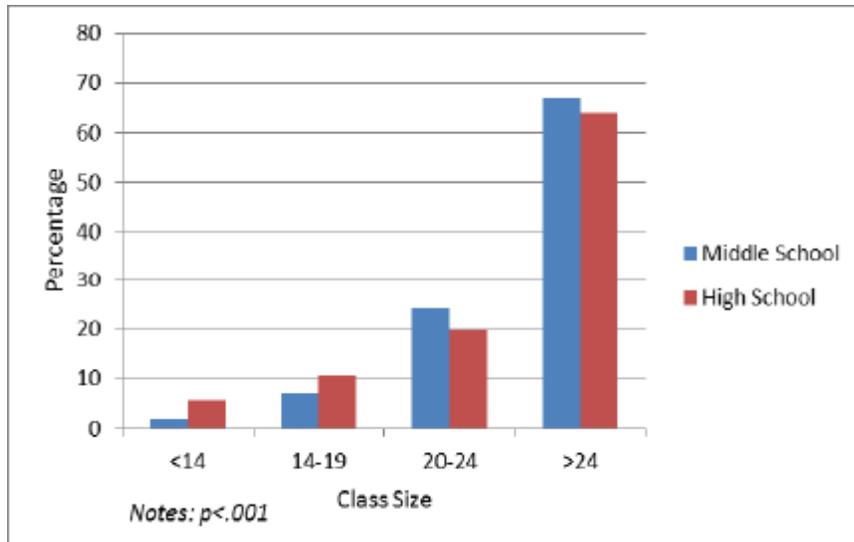
Standards of care for student safety are incorporated in building codes and guidelines established by voluntary association and by law and regulation (National Research Council, 2006). The size of the laboratory facility and the number of students using the facilities are considered when determining standards of care. Administrators should be aware of the importance of following the sets of standards for instructional space in the school laboratories.

Overcrowding is a complex issue that includes (1) class size, (2) amount of workspace per student and (3) occupancy load.

Class Size

Stephenson et al. (2003) and West and Kennedy (2014) identified that increased class enrollment significantly affected the number of accidents in the secondary science classroom (see Figure 1). Most accidents occur in classrooms with an enrollment of greater than 24 students (Stephenson et al., 2003 and West and Kennedy, 2013). Major problems with overcrowding include two issues: the teacher's ability to supervise a large number of students doing science activities and the amount of individual workspace per student. Overcrowding in regard to supervision likely affect a teacher's ability to properly manage and oversee their classroom and, therefore, may prevent the adequate supervision of students conducting science activities.

Figure 1 . Accidents Increase as Class Size Increases (p<0.001)

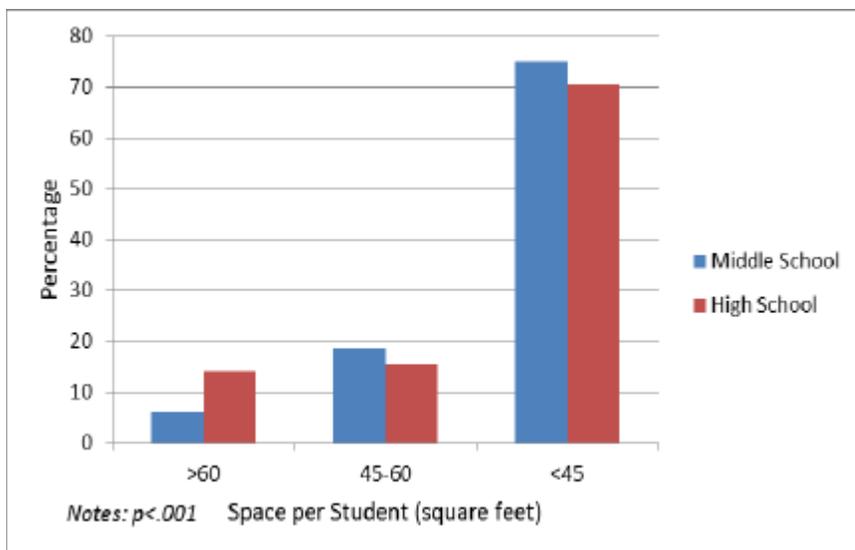


Workspace per student

Stephenson et al. (2003) and West and Kennedy (2014) also identified a statistically significant correlation between space per student and the frequency of incidents and accidents in the science classroom (See Figure 2). Students conducting science activities often work with equipment and chemicals/biologicals/physicals that pose safety risks, especially if not handled properly. Handling science equipment and chemicals safely requires sufficient individual work space. Space per student is not simply an issue of room size, but rather, the number of students within the space. A smaller classroom may have sufficient space per student if the class enrollment is small; likewise, a large classroom may not have sufficient space per student if the class enrollment is too large.

If there are inclusion students with collaborative teachers in the science classroom, the amount of individual workspace per student is reduced. It is recommended that the number of occupants in the classroom is decreased when there are additional instructional support personnel present.

Figure 2: Accidents Increase as Space/Student Decreases (Elbow Space) ($p < 0.001$)



Occupancy Load

Occupant load (NFPA 101 -2012: section 3.3.162.2) is “the number of people that might occupy a building or portion there at any one time” (e.g. educational science laboratory). In addition, the International Building Code (IBC)1004.1 “Design occupant load is used to determine the “means of egress requirements, the number of occupants for whom means of egress facilities shall be provided shall be determined in accordance with this section.” For educational science laboratories, the requirement is 50 square feet net per person or 4.6 square meters net per person (NFPA 101-2018 Occupant Load Factor table 7.3.1.2 – Shops, laboratories, vocational rooms, pg. 101-81). Both fire and building legal standards like occupancy load codes are designed to establish and maintain safer laboratories. (Roy, K, 2013).

Gross square footage is the total floor area within the inside perimeter of the room walls whereas net square footage is the total floor area within the inside perimeter of the room walls with deductions made for cabinets, furnishings, equipment. Factors such as the laboratory footprint, placement of furniture and equipment, number of exits, level of hazards (e.g. flammables, gas, etc.), additional people such as administrators or specialty teachers such as special education teachers and more also have impact on the specific occupancy load designation for a laboratory. The authority of jurisdiction or local fire marshal determines the occupancy loads in laboratories in most school districts. School employers should check with their local fire marshal to determine which occupancy code is applicable to their academic facility (e.g. NFPA 101, IBC 1004, etc.).

Professional Standards/Better Safety Practices

Science education organizations at the national and state levels have long advocated for limiting science class size to 24 students (if the minimum square footage per occupant is in concert with the established occupancy load) and adequate work surface space is provided (National Science Teachers Association, 2007; National Science Education Leadership Association; American Chemical Society, 2012; Motz, Biehle, and West. 2007). Note that whether is it a legal safety standards (NFPA, IBC, etc.) or better professional practice (NSTA, etc.), occupancy loads for labs are not recommendations or voluntary. They

are a legal expectation which must be followed and carry liability should there be a safety incident in the lab.

Summary

NSTA continues to recommend that:

- science class sizes in every class (not average over all classes) be limited to:
 - 24 (high school/middle school) students if there is at least 60 square feet/student net in a combination of classroom/laboratory room or 50 square feet/student net in a pure laboratory room.
 - 24 elementary students if there is at least 45 square feet/student net in either a pure laboratory or combination classroom/laboratory.
 - 24 students for field trips (This will depend on the number of chaperones (students/teacher/adult ratio), safety hazards of the location, number of special needs students (number of necessary paraprofessionals), etc.)
- adequate workspace area is provided for each student of at least:
 - At the secondary level, 60 square feet/student net in a combination of classroom/laboratory room or 50 square feet/student net in a pure laboratory room
 - At the elementary level, 45 square feet/student net in either a pure laboratory or combination classroom/laboratory
- ICC (International Code Council) and/or NFPA as applicable jurisdiction-wise requirements regarding occupancy loads are met.
- best professional practices of the professional organizations are followed.

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