How should we harmonize the safety education with diversity in universities and research centers

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Universities are tasked with increasing environmental safety in parallel with facilitating research activities. The research field at universities has characteristics of a high level of expertise, originality, multiplicity, and interdisciplinary. The diversity of the research site is not limited to the internationalization / gender of the members, the differences in the cultural background of members, the complexity and sophistication of the research, and the interdisciplinarity of the research field, but also includes the types of equipment and chemicals used in the experiment. Though these issues likely depend on individual circumstances, they are still common issues in every country, and it is expected that the safety education methods that are effective at each site will also have high commonality. It is important to work for each country on the harmonization for sharing and cooperating on an innovative way of safety management and education methods.

Keywords: Interdisciplinary research, Program for Leading Graduate School, The first years of operation at global campus, Comprehensive structured safety training system

1. Diversity of R&D job site

The concept of diversity includes demographic factors of race, gender, and age as well as values and cultural norms. The obvious cultural differences that exist between people are language, dress and tradition. There are also significant variations in the way societies organize themselves, such as in their shared conception of morality, religious belief, and the interaction with their environment. Diversity is said to be an indispensable element for social change and development in social sciences and humanities, but the same can be said for research in natural sciences. Diversity adds the intelligence to a research group, enhances creativity and excellence of the research, and provides new idea of the research to contribute to the future of the Earth and human society.

Universities and research institutes are charged with producing results from advanced research. The constituent human resources are becoming more diverse. Elsevier, one of the world's major providers of scientific, technical, and medical information annually in 2,500 journals, reported evidence-based investigation results of the outputs, quality, and impact of research in the world using their abstract and citation database, Scopus. Elsevier compared the situation of researchers in 11 countries (Australia, Brazil, Canada, Chile, Denmark, France, Japan, Mexico, Portugal, The United Kingdom, The United States) and one region of EU28 in the two time periods 1996-2000 and 2011-2015. The number of researchers has increased from 2 to 8 times in all regions. Elsevier also measured the interdisciplinarity of published papers by using the overall citation network and showed that there is little variation in the proportion of interdisciplinary papers among all regions, ranging from about 6% to 10% in the period of 2011-2015.

A laboratory is a space where things, such as experimental instruments, machines, chemicals and high-pressure gases, are present; utilities, such as electricity, water and pressurized air, are connected to the equipment; and people operate the equipment. Each person may use several kinds of equipment, or a number of people with different skill levels may share one equipment to conduct their individual experiments, while one utility may be connected to various equipment as shown in Fig. 1. The diversity of the research site is not limited to the internationalization / gender of the members, the differences in the cultural background of members, the complexity and sophistication of the research, and the interdisciplinarity of the research field, but also includes the types of equipment and chemicals used in the experiment. Though these issues likely depend on individual circumstances, they are still common issues in every country, and it is expected that the safety education methods that are effective at each site will
also have high commonality.

In this paper, we introduce the current state of research sites where interdisciplinary research education program is conducted in Medicine and Engineering cooperation at the University of Tokyo (UTokyo), Japan, implementing safety programs where a global DNA that bridges people, ideas and traditions from around the world provides research and postgraduate programs at King Abdullah University of Science and Technology (KAUST), Saudi Arabia, and a comprehensive “Structured Safety Training System” at National University of Singapore (NUS) the harmonization of training courses to promote research collaboration in Singapore.

2. Intradisciplinary diversity in interdisciplinary excellence medical research

UTokyo aims to be a world-class platform for research and education, contributing to human knowledge in partnership with other leading global universities. It is necessary for leading global universities to foster talented people 1) who will be leaders in fields other than research, 2) who have a wide perspective and take the lead in solving societal issues, 3) who can manage projects that drive innovation, and 4) who can coordinate and unite stakeholders both domestically and internationally. For the purpose of fostering such individuals, the Program for Leading Graduate Schools was launched by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in Japan. Since 2011, a total of 62 programs have been started at a number of universities throughout Japan with support from the MEXT, and is being used to address issues related to the life science, as well as environment, materials, information, pluralistic society, and safety and security. A Graduate Program for Leaders in Life Innovation (GPLLI) was created at UTokyo in 2011 and ran for 7 years up until 2017. It aims to help students develop global leadership skills for use in diverse and complex areas that support life innovation. What makes this program unique is that it is a multidisciplinary program. About 50 students were selected from the graduate schools of medicine, the graduate schools of engineering, the graduate schools of pharmaceutical science, and the graduate schools of biological science in this program every year.

GPLLI students participate in this original curriculum in addition to the subjects required by their individual academic degrees. The curriculum includes, lectures on leadership development, multidisciplinary lecture series on life innovation, a number of different on/off campus internships, and presentation exercises. In addition, the use of a GPLLI Shared Laboratory is included in the GPLLI for two main purposes. First, the GPLLI Shared Laboratory acts as a “place for cultural exchange” to promote interactions and collaborations between students, and therefore the successive expansion of the research community. Second, the Shared Laboratory acts as a “common facility” where researchers can perform highly specialized analyses in one location. In fact, a room in the building of the graduate school of medicine is designated as Shared Laboratory, which contains a lot of cutting-edge equipments. GPLLI students and related members can reserve time on any of this equipment in advance using an online system, and are free to use the equipment. Approximately 1,200 researchers use Shared Lab for their research activities every year.

In GPLLI Shared Laboratory, there are microscopes, equipment for genetic engineering studies, a next generation sequencer, centrifuges, and cell culture systems. This equipment makes it possible for many types of medical and life science research to be performed in a single GPLLI Shared Laboratory. However, each piece of equipment has particular requirements related to safety management. For example, several contain special lasers and use high-pressure gas. Device management is critical for the safe use of centrifuges, while bio-safety is more important when using genetic engineering equipment. Students must be educated on these topics before they use the equipment. Although GPLLI does in fact provide several technical courses, these courses focus only on how to manipulate and
3. Implementing safety programs at KAUST

KAUST aspires to be a destination for scientific and technological education and research. By inspiring discoveries to address global challenges, and strives to serve as a beacon of knowledge that bridges people and cultures for the betterment of humanity.

The KAUST Research Safety Team makes every effort to keep our scientists, students, and faculty members safe on campus and in the laboratories. We develop policies, procedures, bulletins, and guidelines to prevent risks and accidents from occurring. Training programs are held on several laboratory safety topics throughout the year. It is our priority to investigate incidents that occur in the labs to prevent future safety hazards. Our lab safety team monitors compliance through inspections and keeps our university leadership informed of all non-compliance issues. The following is the main safety programs and good safety practices earned from the first years of operation at KAUST.

1. Safety inspections using corrective action tracking system

Safety inspections are conducted twice a year using a corrective action tracking system to engage; students, researchers and Principal Investigators turning them into advocates for Laboratory Safety Programs (Fig. 2). We use an internal procedure to apply re-inspections according to clear criteria and also to suspend laboratory operations if necessary.

2. Lab Safety Representatives (LSR)

The primary goals of LSR program are to increase awareness, communication, and collaboration between the research community and the Research Safety Team, and to ultimately promote a culture of safety and trust at KAUST. LSR help to increase awareness, communication, and collaboration between the research community and the Research Safety Team. Each laboratory is required to appoint a LSR with responsibilities that goes from promotion of RST programs, conduct self inspections, provide assistance during emergencies and building evacuations and participation during the Lab Safety Forum among others.

3. Lab Safety Training Courses

The research safety team currently offers 45 different laboratory safety courses, 3 of them are hands-on, 3 courses are required to work in any laboratory space plus there are some specific courses depending on the hazards and activities in each laboratory.

Lab Safety training courses are offered as a classroom courses advertised in a monthly calendar; online courses available all the time using Blackboard and some courses are more involved and interactive that require hands-on such as Fire Extinguisher, First Aid, Chemical Spill and Chemical Segregation Training. Some other examples of offered training courses are Laser Safety Training, Biosafety Training, Liquid Nitrogen Training, Field Research Safety Training, Compressed Gas Safety Training, Hydrofluoric Acid Training, Fume Hood Safety Training, Flammable Liquid Safety Training, Electrical Safety Training, Working With Reactive Chemicals Training, and Among others hazard specific.

4. Research Certificate Program

The main objective of the Research Safety Certificate Program is to encourage KAUST lab members to broaden
their safety knowledge by taking diverse courses related to laboratory safety and to recognize their efforts and reward their commitment to safety by granting a Research Safety Certificate. Six training courses are required plus eight training courses are optional for a total of 14 courses to complete the program.

5. Lab Safety Recognition Program

The objective of the Laboratory Safety Recognition Award is to foster a culture that values research safety, promotes safe behaviors, and creates a safe research workplace. There are two categories in KAUST for the Laboratory Safety Recognition Award: the Team Award and the Individual Award.

6. Building Zone Matrix

An internal program divides the campus into zones using the building numbers. One person from the Research Safety Team is responsible for specific buildings. The concept is to work more closely on a building level versus campus level and to foster better relationships, provide better communication and excellent customer service to lab users.

7. Laboratory Departure Clearance

The laboratories have a high turnover rate given the natural conditions of research, studies and global collaborations. This process is to inspect and complete checklist of research staff leaving the university and make sure of appropriate disposal of hazardous waste, samples or chemicals, ensures proper handover of chemicals and site preparation for the next person to use the lab in good conditions. Lab users who depart without completing departure process will be charged for the full cost of clearing their work area.

4. A multi-pronged approach to safety & health training and education in tertiary institutions

The Office of Safety, Health and Environment (OSHE) is a university level department that oversees safety and health policies, standards and programs in NUS. In 2012, NUS introduced the requirement for staff and students to complete university level safety and health training courses. In particular, laboratory officers, technicians, veterinary, research staff and students who are exposed to chemical, radiation and biological hazards would need to complete certain safety and health training prior to commencing their research or teaching activities. These requirements are detailed in a training framework entitled the “NUS Structured Safety Training System (SSTS)”.

Under this framework determining the applicable health and safety training requirements is to be done in a phased approach as follows:

1. As a new staff or student, the first phase of training is to undergo training that provides an overview of the requirements for working safely in NUS. The two mandatory staff induction training courses are (1) “Fire Safety Training Course” (2) “NUS Requirements on Safety, Health and Emergency Management”. The respective departments conduct induction training for students.

2. The next phase of training is hazard specific training. The type of training the staff is required to attend is dependent on the nature of the research work or teaching experiments that the staff or student would be doing. Hazard specific training consists of core discipline-specific modules and additional supplementary (‘Add-on’) modules. For example, individuals performing activities involving the use of hydrofluoric acid will need to attend the core discipline specific module of Chemical Safety and the add-on module of Safe Use & Handling of Hydrofluoric Acid. Hazard specific training is also done via integration of safety training into undergraduate or postgraduate student modules. For example, safety lessons are included the module entitled “Advance Experiments in Organic & Inorganic Chemistry” in the Department of Chemistry. This is a compulsory module for chemistry students and involves practical sessions. In recent years NUS has embarked on harmonizing its safety and health training courses with other institutes, hence reducing the time spent on training for researchers who are doing cross or multi-institutional research and teaching programs.

3. In the final phase, there is appointment-based training. This training depends on the roles and responsibilities assigned to the staff or student. For example, appointed Fire Wardens or Coordinators, would need to undergo the “Fire Warden Training Course” and the “Fire Safety Coordinator Course” respectively.

4. In addition to the corporate level training, staff and students would need to undergo relevant training by their departments and/or supervisors. The purpose of such training is to ensure the staff and student operate the equipment or perform the activity in a safe manner. Examples of such training include induction to the department or laboratory they are working in, risk management training, equipment specific training, etc.

OSHE implemented an online training management system to help supervisors manage the training records of their staff. This online system named “EHS360” is home to a number of applications to manage safety and health related applications such as license management, accident and incident management, etc. Within the “Training Module”, supervisors first identify and assign relevant safety and health training courses for each staff or student under his/her supervision. Trainees will then receive email notifications and reminders to attend these assigned trainings. Supervisors can also use the system to verify that his/her staffs have completed the training, as it is able to generate training reports for supervisors to review.

NUS has developed a comprehensive system to ensure that all staff and students undergo the relevant safety and health training required for their activities during the course of their research and education in NUS. This is done through a framework that requires a phased approach to building the competency of staff and students starting from induction to...
hazard-specific and finally appointment-based training.

5. Challenge for harmonization on safety management and human resource development

The current and emerging global trends of unpredictable climate change, concentration of populations in cities and lack of natural sustainable resources has fueled significant increases in research funding in Universities as governments look to academics to help provide solutions to address the challenges arising from these trends.

Researchers would require to work across academic disciplines, i.e. interdisciplinary research or utilizing multiple disciplines, i.e. multidisciplinary research to find solutions to address these challenges. We have noted that many universities are now embracing such interdisciplinary and multidisciplinary research, for example UTokyo has implemented GPLLI. Diversity is therefore the key to ensure a holistic and comprehensive understanding of the problem and coming up with practical solutions. At times such challenges would require researchers to look beyond their institution and work with collaborators across multiple institutions. In the course of their research, there will be generation of new materials, technologies or equipment. To prevent injury and ill-health of the researchers generating these new materials, technologies or equipment, adequate safety and health standards must be established. This is even more challenging given that the demographics of researchers in laboratories is also changing with researchers from different nationalities, age and cultures working together as noted in the Safety offices of these Universities are expanding and/or tailoring their safety and health programs to ensure they address the diversity arising from interdisciplinary/multidisciplinary research. For example KAUST has implemented comprehensive safety and health programmes to ensure interdisciplinary research is done safely in the University. They require compulsory induction laboratory safety training and also discipline specific training, therefore ensuring the competency of the researcher before he or she starts work and in the course of time, if the researcher starts working on a new subject area, he or she would to attend the relevant discipline specific training. In Singapore they have a system to ensure the training courses of different universities are recognized by each other by following a uniform syllabus. This will ensure researchers who work across universities are not required to re-do the training once they work in a different university and it also facilitates standardization of practices.

In conclusion, universities and research centers are becoming increasing diverse in their demographics and activities as a result of their focus on interdisciplinary/multidisciplinary research. To ensure that all researchers are competent in performing these activities, it is important that they are adequately educated and trained on existing and new hazards that they may be exposed it. It is therefore important that universities and research centers have

(1) Comprehensive training system that will ensure all researchers go through the necessary induction, disciplinary specific training and lab specific training.

(2) Comprehensive collection of relevant laboratory, workshop, and field related safety training courses that will help them keep pace with new and emerging research areas.

(3) Integrating safety into every stage of the academic and career journey, for example integrating safety into the undergraduate and postgraduate academic courses.

References


