Academic Journal of Research and Scientific Publishing

International, peer-reviewed scientific journal

The issue eighty-seventh

Publication date: 05 July 2026

ISSN: 2706-6495

Doi: doi.org/10.52132/Ajrsp.e.2026.87

Email: editor@ajrsp.com

Dedication

It is our pleasure and great privilege to present the issue eighty-seventh of the Academic Journal of Research and Scientific Publishing to all researchers and professor who published their research in the issue, and we thank and appreciate to all contributors and supporters of the academic journal and those involved in the production of this scientific knowledge edifice.

Academic Journal of Research and Scientific Publishing

Academic Journal of Research and Scientific Publishing | Vol 8 | Issue 87
Publication Date: 5 July 2026 ISSN: 2706-6495

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The Level of Awareness and Knowledge Sources of Safety and Security Procedures in School Laboratories among Science Teachers and Laboratory Technicians in Public Education Schools

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Received:
17 May 2026
First Decision:
24 May 2026
Revised:
10 June 2026
Accepted:
16 June 2026
Published:
5 July 2026

Abstract:

The present study aimed to investigate the level of awareness of safety and security procedures in school laboratories and their knowledge sources among science teachers and laboratory technicians, as well as to identify the significance of differences according to certain variables. To meet such an end, the study adopted the descriptive methodology. The researcher designed a scale to measure awareness of laboratory safety and security procedures, which was administered to a study sample of (348) male and female teachers and laboratory technicians. The findings revealed that the overall level of awareness regarding laboratory safety and security procedures among the study sample was lower than the acceptable standard. Furthermore, the results indicated no statistically significant differences between male and female teachers attributed to the variables of gender, experience, specialization, and academic qualification. Similarly, no statistically significant differences were found among male and female laboratory technicians attributed to the variables of gender, experience, and academic qualification. Conversely, the findings demonstrated statistically significant differences regarding the job variable in favor of the (laboratory technician) position. The results also showed that university education, external reading, the Internet, and the teacher's manual ranked as the primary knowledge sources of laboratory safety and security procedures from the perspective of the sample members. The study recommended the necessity of designing courses and training programs on laboratory safety and security for pre-service and in-service teachers, in addition to developing websites for the same purpose.

Keywords: Awareness, Safety and Security Procedures, School Laboratory, Laboratory Technician.

1. Introduction

The school science laboratory is considered one of the most important educational resources for teaching scientific subjects in the modern school. This is due to the learning experiences it provides for students, as well as the scientific and practical skills, and positive attitudes towards science and scientists, that it instills in them. It is deemed the appropriate environment where the scientific experimentation approach can be applied, utilizing the available apparatuses, tools, and materials that students use to achieve practical results that complement the theoretical aspects of the studied scientific subject (Al-Maarefa Magazine, 1433 AH). This enables them to adopt the methodology of scientists in research, experimentation, and knowledge acquisition.

From the 1950s to the present day, interest in science laboratories in middle and high schools has increasingly grown. They have been regarded as a crucial focal point for the study of science and a vital component of modern science curricula within most developmental programs and projects for science instruction (Trowbridge et al., 2004, p. 295). Consequently, the science laboratory has remained the beating heart of the science teaching process (Al-Shuaili & Al-Maamari, 2006, p. 165). It acts as the fundamental feature that distinguishes the field of science from other domains of human knowledge and contributes to its advancement over them.

Parallel to the focus on the educational role of science laboratories in the modern school, there has been an emphasis on ensuring safety and security requirements for all users of this school facility. The laboratory encompasses numerous hazards that could potentially harm both the teacher and the student if they lack awareness of safety rules and procedures, whether concerning the protocols for conducting experiments or handling the various materials and equipment housed within it.

A report issued by the Science Education Section in Hong Kong (2013) regarding science laboratory accidents in local high schools revealed that 97% of the incidents were primarily caused by a lack of knowledge regarding safety and security procedures and the negligence of laboratory users towards them. Furthermore, a report by the US Chemical Safety Board (2013, p. 8) indicated that since 2001, accidents have occurred in the laboratories of more than 120 American universities, resulting in fatalities, numerous injuries, and damages, in addition to millions of dollars in losses affecting students, teachers, researchers, and staff. This underscores the importance of fostering preventive awareness among all users of these laboratories, foremost among them being students, teachers, and laboratory technicians.

The science teacher is considered a fundamental pillar in laboratory work through their roles in supervision, guidance, monitoring, and raising awareness during the implementation of the science lesson in the laboratory with their students. Safety in this environment is the primary responsibility of the science teacher; therefore, the teacher's awareness and comprehension of safety and security standards within the laboratory are crucial elements and essential competencies that serve to protect both the teacher and the students from potential hazards. Likewise, laboratory technicians play a significant role in educating and disseminating awareness among teachers and students regarding safety and security procedures when utilizing the laboratory, operating under the assumption that they possess a solid cognitive and skill-based background, given that this lies at the core of their profession.

The findings of several studies that addressed this topic regionally and internationally, such as the study by Ali (2013) in Algeria, Al-Habeel and Ayesh (2012) in Palestine, Al-Shuaili and Al-Maamari (2006) in the Sultanate of Oman, Julius and Thomas (2014) in Nigeria, Zaveri and Karia (2012) in Pakistan, and Schroder et al. (2015) in the United States, have demonstrated a low level of awareness concerning laboratory safety and security procedures among academics, teachers, and laboratory technicians across various scientific disciplines. Similarly, the study by Iman Abdullatif (1432 AH) and the study by Al-Mudaifer (2005) in the Kingdom of Saudi Arabia also revealed a low level of awareness of these procedures among female science teachers and female laboratory technicians.

Over the past few years, science curricula in the Kingdom of Saudi Arabia have witnessed a developmental leap in their content, substance, and implementation mechanisms. This was manifested in the Mathematics and Natural Sciences Development Project, adopted by the Ministry of Education in its endeavor to develop science and mathematics education and to benefit from the experiences and expertise of successful countries in this domain.

Perhaps the most prominent distinguishing feature of the developed science curricula is their profound attention to the applied domain and their focus on conducting activities and experiments within every topic of the textbook. This is evidenced by the allocation of a supplementary manual accompanying the student's textbook to assist them in executing various experiments and activities, the majority of which are conducted in the school laboratory. As an indication of the importance of implementing these activities and experiments, these manuals included instructions and rules directed at both the teacher and the student, which must be adhered to when handling laboratory materials and equipment. This highlights the curricula's attention to safety and security standards in the laboratory and their emphasis on the necessity of disseminating awareness of these standards among all users of this vital space within the school.

1.1. Statement of the Problem:

Based on the aforementioned, and in parallel with the general trend among educational authorities in the Kingdom toward emphasizing the achievement of safety and security standards in educational institutions as a requisite for the quality of the educational process, a trend activated through a number of practical measures, including the Ministry of Education's establishment of the General Administration for School Safety and Security in 1433 AH. This step aligns with the developments witnessed in the Kingdom's school curricula, including science curricula, and the emphasis these curricula place on various safety and security standards, particularly concerning the school laboratory. The laboratory hosts diverse scientific activities requiring the use of potentially hazardous tools and materials for both the teacher and the student. Given that the teacher is the leader and guide of the instructional process within the laboratory, assisted by the laboratory technician, it is imperative that both are knowledgeable and aware of all safety and security precautions, as well as proper conduct procedures in situations that may arise in the laboratory. Therefore, the present study seeks to reveal the level of awareness among science teachers and laboratory technicians in our schools regarding safety and security procedures inside the laboratory, as well as their sources of acquiring this awareness. Consequently, the research problem is defined by the following main question:

What is the level of awareness and the sources of knowledge regarding safety and security procedures in science laboratories among science teachers and laboratory technicians in public education schools?

1.2. Research Questions:

The following sub-questions branch out from the preceding main question:

1. What is the level of awareness of safety and security procedures among science teachers and laboratory technicians?
2. Are there statistically significant differences in the level of awareness of safety and security procedures between male and female science teachers attributed to the gender variable?
3. Are there statistically significant differences in science teachers' level of awareness of safety and security procedures according to their specialization?
4. Are there statistically significant differences in science teachers' level of awareness of safety and security procedures according to their practical experience?
5. Are there statistically significant differences in science teachers' level of awareness of safety and security procedures according to their academic qualification?
6. Are there statistically significant differences in the level of awareness of safety and security procedures between male and female laboratory technicians attributed to the gender variable?
7. Are there statistically significant differences in laboratory technicians' level of awareness of safety and security procedures according to their practical experience?

8. Are there statistically significant differences in laboratory technicians' level of awareness of safety and security procedures according to their academic qualification?
9. Are there statistically significant differences in the level of awareness of safety and security procedures among the sample members attributed to the job variable?
10. What are the knowledge sources of safety and security procedures in the laboratory among science teachers and laboratory technicians?

1.3. Objectives of the Study:

The current study aimed to:

1. Determine the level of awareness of safety and security procedures in school laboratories among science teachers and laboratory technicians.
2. Identify the significance of differences among the sample members according to the study's variables.
3. Determine the knowledge sources of safety and security procedures in school laboratories among science teachers and laboratory technicians.

1.4. Significance of the Study

The significance of this study stems from the fact that it:

1. Seeks to determine the level of awareness of safety and security procedures in school laboratories among science teachers and laboratory technicians.
2. Provides stakeholders involved in developing science curricula, the Safety and Security Administration at the Ministry of Education, and other relevant government entities with a clear picture of the state of teachers' and laboratory technicians' knowledge regarding safety and security procedures in school laboratories.
3. Offers recommendations and proposals to enhance this vital pedagogical aspect.

1.5. Delimitations of the Study

- Human Delimitations: The study included a sample of male and female science teachers and laboratory technicians in the Al-Madinah Al-Munawwarah and Qassim regions.
- Objective Delimitations: The study addressed the awareness of science teachers and laboratory technicians regarding safety and security procedures in school laboratories in light of the scale developed for this purpose.

1.6. Definition of Terms:

Awareness: Linguistically, as stated in *Lisan al-Arab*, it means "to comprehend something; to grasp a speech thoroughly, to preserve, understand, and accept it, making one 'aware.' Saying someone is more aware than another means they possess greater retention and understanding. In the Hadith, the Prophet Mohammad "peace be upon him" stated, 'May Allah gladden a man who hears something from us, so he conveys it as he heard it.'" (p. 396).

Terminologically, Laila Hussam El-Din (2000) defines awareness as "an individual's perception based on sensation and knowledge, comprising both cognitive and affective dimensions" (p. 127).

Ahmed (1413 AH) defines it as "a concept founded on knowledge (the acquisition of information), understanding the meaning of knowledge, and developing a positive attitude toward knowledge. Cognitive awareness entails the availability of information regarding a specific phenomenon or subject, whereas affective awareness involves the formation of inclinations and attitudes" (p. 22).

The researcher operationally defines it as the familiarity of teachers and laboratory technicians with safety and security procedures in their utilization of the school laboratory. This is achieved through acquiring the relevant concepts, facts, and skills, and its impact on cultivating sound attitudes. It is measured here by the score the teacher or technician obtains through their performance on the scale developed for this purpose.

School Laboratory: Defined by Collins and Nancy O'Brien (2008) in the *Greenwood Dictionary of Education* as "a room or building equipped for performing scientific experiments, investigative procedures, or teaching science using specific equipment and procedures, with a designated time period allocated for laboratory work" (p. 527).

Security: Defined by Al-Malki (1435 AH) as "a human feeling of safety and tranquility, and the absence of causes of fear for one's life, the necessities of survival, and acknowledged interests, thereby encompassing the security of the individual, the community, and the nation" (p. 79).

Safety: Defined by Al-Dandani (2013, p. 11) as a set of approved procedures and methods that ensure the protection of lives and properties prior to the occurrence of an accident, and contribute to providing a safe working environment.

Safety and Security Procedures in the School Laboratory: Based on the aforementioned, the researcher defines them as the practices and rules relevant to the school laboratory aimed at preventing accidents and hazards resulting from chemical, physical, and biological factors present within it. These are associated with risk management, the safety of practices, and first aid skills, providing protection for the student, the teacher, and every user of this educational environment, which necessitates knowledge and awareness thereof.

Laboratory Technician: A specialized technician responsible for laboratory affairs in schools, entrusted with coordinating with the school's science teachers to execute the practical experiments prescribed in the academic curricula. The technician bears the bulk of the responsibilities for organizing the laboratory, ensuring its complete operational readiness, and verifying the availability of safety and security requirements within it (Al-Maarefa Magazine, 1433 AH).

2. Theoretical Framework:

2.1. The School Science Laboratory (Its Objectives, Types, and Specifications):

Experimentation is considered a fundamental component in science education, as the science laboratory plays a crucial role in testing hypotheses, verifying their validity, and translating theories and laws into tangible state. This process, namely, experimentation, is the characteristic that distinguishes natural sciences from other branches of knowledge and science, to the extent that it is often referred to as "experimental sciences," a metonymy encompassing its various branches (Physics, Biology, Chemistry, and Earth Science).

Therefore, the laboratory has acquired a central role in modern science curricula. As Doran (p. 95) elucidates, it is not merely a medium for conducting demonstrations and verification experiments, but rather the focal point of the science learning process and an effective environment for developing and enhancing students' higher-order cognitive and performance skills.

Since the 1960s, laboratory activities, as Khataybeh (2005, p. 445) notes, have become an integral part of science curricula from kindergarten through the university level. This is linked to the curriculum renewal movement and various science development programs and projects, which established laboratory work as a cornerstone in the teaching and learning of science.

Today, the school laboratory has become an essential part of the educational environment, occupying significant space within educational facilities across all levels of education. It is also considered one of the indispensable elements of modern educational technology in teaching science. These scientific laboratories have become the environment where the student develops, as they provide diverse and multiple sensory experiences that form the foundation for understanding numerous facts, information, concepts, and phenomena present in their environment (Samiha Sulaiman, 1430 AH).

The importance of laboratory work in science education is highlighted by the objectives we strive to achieve in students through its practice. This constitutes a common denominator among all science curricula worldwide. These objectives, as cited by (Al-Ayasrah, 2012, p. 168; Khataybeh, 2005, p. 440; Hala Bakhsh, n.d., p. 171; Al-Khalili et al., 1996, p. 307), consist of:

1. Understanding the nature of science.
2. Acquiring science processes.
3. Forming direct learning experiences.

4. Acquiring new scientific knowledge and information.
5. Discovering the relationship between causes and effects.
6. Training students in precise observation.
7. Assisting students in acquiring appropriate practical skills.
8. Training students in the correct use of scientific apparatus to attain accurate experiences.
9. Forming, acquiring, and developing scientific attitudes towards science.
10. Verifying the studied principles and theories.

Al-Nimrah (2004, p. 18) identifies the functions and activities conducted in school laboratories, which must be considered during their design, and they comprise:

1. Presenting and delivering lessons related to science and its fields.
2. Utilizing educational technologies, such as scientific films and various projectors, to display educational materials to students.
3. The teacher conducting experiments in front of the students.
4. Students conducting experiments themselves through working groups, which include experiments related to the fields of physics, chemistry, and biology.

The conceptualization of the school laboratory has remained largely associated with that designated room within the school building, equipped with tables, chairs, diverse materials, and physical, chemical, and biological apparatuses, predominantly focused on teaching scientific subjects. However, with the evolution in science education and the concomitant technological advancements, which have impacted the nature, role, and equipment of the school laboratory, other models have emerged. These models strive to achieve the same objectives while attempting to overcome the difficulties and problems associated with the traditional laboratory. The currently existing laboratory models can be categorized as follows:

- **The Stationary Laboratory:** This is the most common and widespread traditional model in schools and educational institutions. It is considered an essential part of any educational facility and consists of a hall or room within the building designated for this purpose, designed and equipped according to specific standards. A prerequisite for this laboratory is the provision of safety and security factors for its users. An educational facility may encompass more than one laboratory.
- **The Mobile (Micro) Laboratory:** In light of the problems accompanying the use of the stationary laboratory, such as the shortage of materials and equipment, and the high density of student numbers, the mobile (micro) laboratory emerged as a solution to overcome these issues. As Hala Bakhsh (n.d.,

p. 178) mentions, this type is a miniaturized laboratory distributed to students, consisting of a small box containing a set of small, alternative equipment made of plastic, such as tubes, burettes, and stands, along with some non-hazardous chemical materials. The primary purpose of utilizing this type is to overcome the aforementioned problems, provide safety for the learner, individualize instruction, connect the learner with science, and enhance their practical skills.

- **The Virtual Laboratory:** This model emerged as a result of the development of computer applications and their uses in the educational process. It is an interactive virtual educational environment through which various experiments are conducted in a manner simulating real laboratory experiments. The learner feels as if they are in the laboratory through their control of the apparatuses, as though they were present at the experiment site (Sharaf, 2006, p. 31). It employs computer programs and applications designed on disks, and there are also websites on the Internet that achieve the same objective. The importance of this type of laboratory lies in enabling learners to conduct laboratory experiments that cannot be performed under normal circumstances, providing them with the opportunity for self-learning. It also mitigates the risks arising from handling certain hazardous materials and equipment in a real laboratory and is economical in terms of cost and effort. Consequently, its prevalence and utilization in schools are increasing.

The design of the stationary school laboratory must observe several technical specifications, standards, and requirements that are imperative to adhere to when constructing the educational facility, with safety requirements placed at the forefront of these specifications. Al-Dandani (1434 AH, p. 28), Al-Nimrah (2014, p. 22), Iman Al-Abdullatif (1432 AH, p. 700), Al-Rifai (1426 AH, p. 6), and Al-Mudaifer (2005, p. 26) mention some of these specifications, including:

1. The laboratory should be located on the ground floor.
2. The space available and allocated for each student in the laboratory must be sufficient for their movement (2 square meters per student).
3. A working area of no less than one meter should be maintained around each apparatus or workbench.
4. Sub-aisles with a width of no less than one meter and a main aisle with a width of no less than 1.5 meters must be maintained inside the laboratory.
5. Storage cabinets should not exceed eye level, and an area for movement of no less than one meter must be left in front of them.
6. The laboratory must be equipped with two emergency exits, one of which opens onto a spacious area.

7. Emergency exit doors must open outward and be equipped with a horizontal push bar that opens the door upon pressure.
8. The fire resistance of the emergency exit doors must not be less than one hour.
9. Fire extinguishers and fire blankets should be hung near the exits at a height of one meter from the floor.
10. Laboratories must be equipped with a robust ventilation system and adequate cooling means.
11. Laboratory floors must be made of non-slip materials and be resistant to chemicals.
12. The upper half of the laboratory doors must be made of shatter-resistant glass to facilitate monitoring of activities inside the laboratory.
13. The presence of an automatic fire alarm system.
14. The presence of an automatic fire extinguishing system.
15. School laboratories should be connected to an alarm system linked directly to the relevant safety and security administration (Civil Defense).

2.2. Hazards in School Science Laboratories:

School science laboratories encompass numerous hazards arising from the neglect of adherence to safety and security procedures within the laboratory by teachers, laboratory technicians, and students. These hazards, as mentioned by Omayma Al-Mughni (2006, p. 41) and Al-Dandani (1434 AH, p. 37), can be classified into:

1. Physical Hazards: Represented by the risks of electricity, radiation, noise, and heat.
2. Chemical Hazards: Represented by poisoning, chemical burns, gases, and the inhalation of toxic gases and vapors.
3. Biological Hazards: Represented by infection with bacteria, viruses, fungi, contamination, stings, and bites.
4. Mechanical Hazards: Represented by cuts, wounds, falls, slips, and collisions.
5. Fire Hazards: Represented by thermal, chemical, and electrical fires.

2.3. Requirements for Safety and Security in the School Science Laboratory:

The school laboratory is considered one of the most dangerous places within the school building due to the materials, apparatuses, and tools it contains. Negligence in handling them could lead to a catastrophe within the school, with damage extending beyond the physical components to the human personnel interacting with them.

Laboratory workers are the individuals most vulnerable to these hazards, particularly if they are unaware of the preventive measures that must be taken during work. This is usually due to improper handling of apparatuses or chemicals inside the laboratory (Al-Shuaili & Al-Maamari, 2006, p. 166).

Therefore, it is imperative to pay close attention to the availability of safety and security means, procedures, and requirements in these laboratories, and to ensure that their users are knowledgeable about and provided with these procedures. This must be accompanied by an endeavor to raise the level of awareness by focusing on the training domain and utilizing various safety programs (Al-Habeel & Ayesh, 2012, p. 4). The responsibility for this matter lies with the authorities specialized in safety and security, in collaboration with educational institutions. The requirements for safety and security in science laboratories consist of three crucial aspects that must be present among the users of this educational environment:

First: The Preventive Aspect (Risk Management):

The fundamental element for achieving safety and security in laboratories is the awareness of the hazards present within them by the personnel working there and knowing how to prevent them. The preventive aspect pertains to the potential hazards in the laboratory and how to deal with them. This is known as "risk management," which is a crucial requirement that must be possessed by teachers, laboratory technicians, and students, as the knowledge and observance of these preventive precautions represent the first stage of safety and security requirements in laboratory work.

Risk management aims to prevent and minimize the hazards to which individuals and properties are exposed, reduce the magnitude of losses, and strive to prevent the recurrence of their causes (Abdul Moneim et al., 2008, p. 6). The most prominent hazards found in school laboratories, as explained by Allan et al. (1422 AH, p. 20), include fires, explosions, gas leaks, chemical liquid spills, electrocution, falls, collisions, and slips. These hazards may result in burns, wounds, poisoning, fractures, explosions, and diseases.

Therefore, the entity responsible for the laboratory in the school must identify activities with high-risk rates for teachers, familiarize them with apparatuses and materials that may be hazardous, and educate them about the expected injuries resulting from the misuse of these materials and apparatuses (Jo et al., 2000, p. 7).

These hazards arise due to two types of causes, as clarified by Al-Rifai (1426 AH, p. 8), which are:

1. Causes related to an unsafe working environment: This includes poor storage, lack of ventilation, improper electrical wiring, poorly manufactured apparatuses, lack of safety tools, and negligence in their maintenance.

2. Causes related to the performance of laboratory workers: This includes non-compliance with the instructions for using the facility, disregarding safety procedures and personal protective equipment, and failing to follow the correct steps during work.

The study by Iman Al-Abdullatif (1432 AH) indicated that preventive awareness of safety and security procedures among female teachers and female laboratory technicians was low, in addition to shortcomings in safety and security procedures in public school laboratories in the Kingdom. This issue is not limited to the Kingdom but extends to numerous countries, as confirmed by the study of Julius and Thomas (2014) in Nigeria, Hackling (2009) in Australia, and Mogopodi et al. (2015) in Botswana. Despite this, providing complete, hazard-free laboratories is insufficient on its own; it requires educating the workers within them about safety and security procedures and prevention methods that contribute to reducing material and human losses (Al-Habeel & Ayesh, 2012, p. 84).

Second: The Practical Aspect (Laboratory Practices):

Laboratory practices refer to all the applied activities conducted by the teacher, laboratory technician, or students inside the laboratory, which are usually linked to the science curriculum. The safety of laboratory practices is an important requirement, as the core of laboratory work lies in these practices, which necessitate the availability of a set of skills among teachers and laboratory technicians, as well as their possession of a cognitive background regarding the aspects of those practices. Most hazards that occur in laboratories result from incorrect practices and behaviors, the majority of which stem from ignorance and poor intention on the part of those performing the work, whether they are students, teachers, or laboratory technicians.

Workers in the laboratory bear the significance of adhering to safety instructions in terms of proper conduct, executing work steps accurately, following safety guidelines during implementation, and providing a safe and sound practical environment (Al-Habeel & Ayesh, 2012, p. 85).

As Al-Mudaifer (2005) mentions that the improper practice methods are considered among the most important causes of laboratory accidents. For this reason, it is necessary to build awareness of safety procedures and follow appropriate practices in the laboratory among students and teachers, so that it becomes like an ethical charter that everyone adheres to when conducting laboratory experiments (American Chemical Society, 2012, p. 6).

Third: The Remedial Aspect (First Aid):

The hazards resulting from errors in laboratory practices cause material and human losses. Proper conduct and addressing the errors caused by these practices is a matter of utmost importance, directly linked to first aid as the initial procedure to be undertaken when any injuries occur in the laboratory.

First aid is defined as the immediate preliminary care provided to the injured person before the arrival of the ambulance and medical assistance (Mansoura University, 2009, p. 2).

In the school laboratory, the probabilities of its users being exposed to various injury risks increase, occurring suddenly without prior warning. This necessitates that these users possess full knowledge and awareness of how to act and handle these emergency situations, where timely and successful intervention leads to rescuing the injured and preserving their life. Therefore, school teachers must possess a level of knowledge and skill in first aid principles that enables them to act properly in critical situations to save their students (Nairat, 2014, p. 2223).

2.4. Sources of Knowledge of Safety and Security Requirements in School Laboratories:

There are numerous and diverse knowledge sources regarding safety and security procedures and requirements in laboratories, aiming to improve awareness among the users of these laboratories in schools, including teachers, laboratory technicians, and students, so they can conduct their experiments safely (Science Education Section, 2013, p. 4). In the United States of America, educational programs on laboratory safety and security have been approved and are taught either as independent programs or within scientific subjects to assist teachers and students in elementary, middle, and high schools. This is in addition to various publications, manuals, and specialized books in this regard (American Chemical Society, 2010).

Omayma Al-Mughni (2006, p. 35) mentions sources of knowledge of safety and security requirements, including lectures, printed publications, and films, as well as training programs, which are considered an important source for hazard prevention. They acquaint laboratory users with safe working methods, rendering them more capable of predicting accidents, as they can identify danger zones and understand their consequences.

Furthermore, the internet currently serves as an important source of information on laboratory safety and security, containing many reliable websites and pages that can be depended upon to educate the users of these environments (American Chemical Society, 2010, p. 40). Social media networks, such as Facebook, have begun to be included among these sources, having proven their effectiveness in improving awareness of laboratory safety and security among university students, as demonstrated by Daclan's study (2013).

The study by Ali (2013) revealed that previous university education, teacher's manuals, publications accompanying chemicals, and the textbook are considered, in this order, the best sources of knowledge of laboratory safety procedures among teachers. The responsibility of familiarizing teachers, students, and laboratory technicians with these rules and procedures lies with the individuals and entities specialized in safety and security within the educational administration, through training courses, lectures, and publications. Additionally, the laboratory technician within the school bears the responsibility of introducing and disseminating awareness of these procedures among teachers and students, as Schroder et al. (2015) confirm the positive impact of laboratory technicians on their colleagues.

3. Literature Review:

Numerous studies have been conducted addressing the aspects of safety and security in laboratories and the extent to which their users possess awareness and understanding of these aspects. Schroder et al. (2015) conducted a survey study in the United States aiming to identify the state of practices and attitudes toward laboratory safety among workers in three types of laboratories (academic, industrial, and government). The study sample comprised (991) workers in academic laboratories, (120) workers in industrial laboratories, and (133) workers in government laboratories. The results revealed that the risk assessment rating present in laboratories was lower among academics compared to those working in industrial and government laboratories. Furthermore, the compliance rate with laboratory practice rules and safety requirements was highest among workers in industrial laboratories, followed by government laboratories, and then academic laboratories. The findings disclosed that 25% of the total sample had not received any training on laboratory safety procedures. Additionally, the results demonstrated a positive impact of laboratory technicians on their colleagues.

Mogopodi et al. (2015) conducted a study aiming to assess the level of awareness and safety and security practices in middle school laboratories in Gaborone, Republic of Botswana. The scale was administered to a sample consisting of 30 teachers in these laboratories across ten schools. Additionally, safety procedures in these laboratories were observed and monitored. The study yielded several results, most notably a lack of awareness and knowledge of safety and security procedures among teachers, as well as distinct shortcomings in the safety and security procedures within these laboratories.

The study by Can et al. (2015) in Turkey revealed that the awareness and attitudes of students and pre-service science teachers were positive toward laboratory safety procedures. The study adopted the descriptive methodology, and the sample consisted of 135 pre-service student teachers. No statistically significant differences were found among individuals in their attitudes toward school laboratory safety procedures attributed to the variables of gender, region, and academic stage.

In Nigeria, Julius and Thomas (2014) conducted a descriptive study aiming to identify hazards and safety procedures in school laboratories in Ekiti State, Nigeria. To achieve this objective, they employed the descriptive survey methodology. The researchers designed a questionnaire for hazard analysis and safety in the science laboratory, which was distributed to a random sample of teachers comprising (120) science teachers and (200) students in science classes. The study concluded that science laboratories encompass numerous hazards and that security precautions in these laboratories are minimal and non-existent in some aspects. The results indicated that the level of awareness among physics teachers was the highest compared to chemistry and biology teachers, and the same applied to the students. Hypothesis testing showed significant differences among teachers in their awareness of safety and security procedures according to specialization.

Ali (2013) conducted a study aiming to identify the level of understanding of laboratory safety and security rules and procedures among teachers in Algeria, as well as the sources of their knowledge of these rules. The researcher designed a scale for safety and security rules, consisting of a test administered to a sample of 170 male and female high school teachers. The results clarified that the level of understanding among teachers in Algeria regarding laboratory safety and security rules and procedures was below the required standard. They also indicated no significant differences in teachers' knowledge of these rules attributed to the variables of gender and experience, whereas the differences were significant for the specialization variable in favor of physics teachers. Furthermore, the sources of teachers' knowledge of safety and security rules and procedures were concentrated in two sources: previous university education and laboratory documents and manuals accompanying the textbooks.

In Turkey, Daclan (2013) conducted a study aiming to determine the impact of using social networks (Facebook) based on health education in disseminating awareness of laboratory safety and security procedures. The researcher employed the quasi-experimental methodology using an experimental and control group design. The sample consisted of sixteen students, distributed as ten students in the experimental group and six students in the control group. Educational material regarding laboratory safety and security was presented to them via a Facebook page (experimental group) and through traditional lectures (control group). The study instruments comprised tests to measure awareness of laboratory safety procedures. The results revealed a positive impact of the social network in improving awareness of laboratory safety and security.

The study by Al-Habeel and Ayesh (2012) aimed to evaluate the effectiveness of occupational and health safety and security procedures in scientific laboratories at Palestinian universities. The researchers relied on the descriptive-analytical methodology and designed a four-domains questionnaire, which was administered to a stratified random sample of (217) workers in these scientific laboratories. Personal interviews were also utilized to answer some of the study's questions. The study's results revealed a lack of training for workers in these laboratories regarding safety and security procedures, necessitating the establishment of safety and security units to enhance their awareness and develop their skills.

To investigate the knowledge, attitudes, and practices of laboratory technicians toward precautionary procedures during laboratory work, Zaveri and Karia (2012) conducted a study on a sample of laboratory technicians in several private hospitals in Pakistan, totaling (154) cases. The results revealed a low level of knowledge regarding these precautions among the sample members. The results also demonstrated the presence of several unsafe practices among laboratory technicians, such as smoking, eating, and using laboratory refrigerators to store water and food, among other hazardous actions. It recommended the necessity of training laboratory workers and familiarizing them with laboratory safety precautions.

The study by Shuhara et al. (2011) aimed to analyze the safety and security factors in university scientific laboratories in Japan and the sources of acquiring these factors, by identifying four main factors contributing to achieving safety: planned safety education, self-protection, practice procedures, and a sense of enjoyment. The study instrument consisted of a questionnaire following a Likert scale encompassing a number of questions, which was administered to a sample of 406 students in scientific universities and colleges. The study yielded several results, most notably that the planned safety education factor was the primary source for acquiring awareness of laboratory safety and security procedures. The study recommended the necessity of developing training programs on laboratory safety and security procedures.

In Saudi Arabia, Iman Al-Abdullatif (1432 AH) conducted a study aiming to identify the safety and security procedures in school laboratories in the Riyadh region schools affiliated with the Ministry of Education, and to determine the shortcomings, if any, and methods to address them. The researcher gathered her information through a set of forms, questionnaires, and field visits. The study reached several conclusions, including: there are distinct shortcomings in the safety and security aspects of school laboratories, and the security awareness among female teachers, female students, and female laboratory technicians regarding laboratory safety and security aspects was generally low.

A study by Nasim et al. (2010) found a distinct low level of awareness of biosafety and security procedures among laboratory technicians in Karachi hospitals, Pakistan. A survey study was administered to (253) cases of male and female laboratory technicians, and interviews were also conducted with them. The results demonstrated the presence of several erroneous practices performed during laboratory work. The study recommended the necessity of conducting intensive training courses for them.

Hackling (2009) conducted a survey study in Australia aiming to identify the state of laboratory technicians in high schools in Australia. The study sample comprised 824 laboratory technicians and 607 school principals. The instrument consisted of a multi-domains questionnaire, in addition to conducting interviews. The study reached several results, most notably that 25% of laboratory technicians in high schools require further training on laboratory safety and security precautions, and that 36% of schools require support regarding those precautions. The study recommended the necessity of providing diverse training programs and utilizing the Internet and other technologies to disseminate awareness among laboratory technicians.

The study by Al-Shuaili and Al-Maamari (2006) aimed to reveal the level of understanding of laboratory safety and security precautions among university students in Colleges of Education (Chemistry major). The sample consisted of 54 male and female fourth-year students. A test comprising 55 items, distributed across five domains and prepared by the researchers, was administered to them. The results revealed a low level of understanding among the sample members, falling below the pedagogically acceptable standard, and the absence of significant differences attributed to the gender variable or academic achievement in chemistry, except for the domain of (using chemical materials) in favor of students with a "Very Good" grade. The study recommended the necessity of including an educational unit on laboratory safety and security precautions and making this topic a part of the practical aspect examinations in chemistry courses.

The study by Al-Mudaifer (2005) aimed to identify the effectiveness of occupational and technical safety and security systems in the scientific laboratories at the Girls' Colleges in Riyadh. The researcher employed the descriptive-analytical methodology and designed two study instruments, consisting of two questionnaires: one directed at the female laboratory supervisors and the other at the female students. The study reached several results, most notably the weak level of knowledge among female students and female laboratory supervisors regarding the safety and security means and systems in these laboratories, and the lack of availability of these safety and security means and systems in the anticipated manner.

In Jordan, Al-Tarawneh (2005) conducted a study to identify the level of knowledge among students of scientific colleges regarding safety and security principles in chemistry laboratories at Mutah University. The study sample consisted of (258) male and female students, to whom a test on safety and security principles was administered. The study concluded that the students' level of knowledge of these principles was weak. It also found significant differences in favor of the female gender, and significant differences in favor of the specialization variable.

3.1. Discussion of Previous Studies:

Through reviewing the previous studies that the researcher was able to access, which were utilized in constructing the theoretical framework upon which this study is based, it became evident to the researcher that most of these studies revealed a deficiency in the level of awareness and understanding of safety and security procedures in laboratories among the study samples of teachers, students, and laboratory technicians. This is exemplified in the study by Ali (2013), Schroder et al. (2015), Mogopodi et al. (2015), Iman Al-Abdullatif (1432 AH), Zaveri and Karia (2012), Nasim et al. (2010), Al-Shuaili and Al-Maamari (2006), Al-Tarawneh (2005), and Al-Mudaifer (2005).

Furthermore, some of these studies, most notably the study by Schroder et al. (2015), Ali (2013), Daclan (2013), Shuhara et al. (2011), and Hackling (2009), revealed the existence of diverse sources of knowledge regarding safety and security procedures. Some are traditional, such as publications, manuals, education, and continuous training, while others are modern and align with the information age, such as social networks (Facebook).

Additionally, laboratory technicians have an effective role as a source for educating their colleagues. Most of these previous studies agreed on the weakness of safety and security procedures in school laboratories, as seen in the study by Julius and Thomas (2014), Iman Al-Abdullatif (1432 AH), Al-Mudaifer (2005), and Mogopodi et al. (2015).

With the exception of Daclan's study (2013), in which the researcher employed the experimental methodology, the remaining studies adopted the descriptive survey methodology by utilizing scales and questionnaires that focused in their content on laboratory safety and security procedures. This approach will be followed in the present study, which distinguishes itself from the other previous studies by identifying the main domains of awareness of safety and security in the school laboratory (risk management, laboratory practice, first aid), in light of which the scale's items were constructed.

4. Methods:

The study adopted the descriptive survey methodology, which is defined as the approach that relies on describing the studied phenomenon in terms of its nature and existence through surveying all members of the research population or a sample thereof (Al-Assaf, 1421 AH, p. 191).

4.1. Population and Sample of the Study:

The study population consisted of all male and female science teachers and laboratory technicians in public education schools in the Kingdom. The study procedures were administered to a random sample of male and female science teachers and laboratory technicians in the Al-Madinah Al-Munawwarah and Qassim regions.

The total sample of teachers amounted to (n = 215 male and female teachers) representing a percentage of (61.8%), and the total sample of laboratory technicians amounted to (n = 133 male and female technicians) representing a percentage of (38.2%). Table (1) presents a description of the study sample.

Table 1. Description of the Study Sample

Job	Gender		Total	Percentage
	Male	**Female**		
Teacher	129	86	215	61.8%
Laboratory Technician	33	100	133	38.2%
Overall Total	**162**	**186**	**348**	**100%**

4.2. Study Instrument:

The study instrument consisted of a scale for awareness of safety and security procedures, prepared by the researcher. It is a multiple-choice test distributed across three dimensions:

- Risk management inside the laboratory, comprising 15 questions.
- Safety of laboratory practices, comprising 13 questions.
- First aid, comprising 10 questions.

The researcher prepared the scale after reviewing numerous specialized manuals, books, and research papers that addressed aspects of laboratory safety and security. The instrument was refined, and its validity and reliability were verified as follows:

- Validity: The research instrument was presented to specialized experts in education, science, and laboratories to ascertain the scale's validity regarding the scientific accuracy of the items' content and the extent of the items' correlation with the main dimensions. Some modifications were made to a number of items, and several were deleted, resulting in the final version of the scale upon which it was administered, comprising (38) items. The jury members were also requested to determine the criterion score for the acceptable level of performance on the scale to be used as an indicator for judgment after administration. The acceptable level of performance on the scale was determined as a percentage of (75%), which is equivalent to a score of (28.5) out of the scale's total score of (38).

- Reliability: The scale's reliability was verified by administering it to a pilot sample comprising (30) cases. The Cronbach's Alpha coefficient for the scale as a whole amounted to (0.82), a value indicating a good, dependable reliability coefficient.

4.3. Statistical Methods:

The study utilized a number of statistical methods, including arithmetic means, standard deviations, frequencies, percentages, the *t*-test, Analysis of Variance (ANOVA), and Spearman's rank correlation coefficient. Data processing and analysis were conducted using the Statistical Package for the Social Sciences (SPSS).

5. Results:

- Results Related to the First Research Question: What is the level of awareness of safety and security procedures among science teachers and laboratory technicians?

To answer this question, the researcher calculated the mean and standard deviation for the study sample's level of awareness of laboratory safety and security procedures. A one-sample t-test was conducted to examine whether the sample mean differed significantly from the criterion score, as shown in Table 2.

Table 2. Descriptive Statistics and t-Test Results for Participants' Level of Awareness of Safety and Security Procedures

Sample	N	Mean	Standard Deviation	*t*-value	Level of Significance
Female Teachers	86	27.8	6.1	-1.06	0.293
Male Teachers	129	25.2	4.9	-7.59	0.000*
Female Lab Technicians	100	30.4	3.1	6.07	0.000*
Male Lab Technicians	33	27.8	4.3	-0.956	0.346
Total	**348**	**27.6**	**5.2**	**-3.34**	**0.001***

** A statistically significant differences at the significance level (0.05).*

The preceding table shows that the t-value for the study sample's overall level of awareness of safety and security procedures was -3.34, which was statistically significant at the 0.05 level. This indicates the presence of significant differences between the sample's performance score on the scale and the specified criterion score. Referring to the arithmetic mean of the total sample's performance on the study scale, we find it amounted to (27.6), a value lower than the criterion score set at (28.5). This signifies that the overall performance of the sample members was below the acceptable level determined in the study. Consequently, the level of awareness regarding safety and security procedures in the school laboratory among the study sample was low.

When detailing the sample according to each category, we find that the *t*-test value for the performance of female teachers and male laboratory technicians was not significant, indicating no differences between the mean performance for each category and the scale's criterion score. Conversely, the *t*-test value for the performance of male teachers and female laboratory technicians was significant; the performance of male teachers was below the acceptable level, and in a general comparison, it was the lowest among all categories, with a mean of (25.2).

Meanwhile, the performance of female laboratory technicians exceeded the acceptable level, indicating that their awareness of laboratory safety and security procedures was the highest, with a mean performance of (30.4). The researcher attributes this superiority among female laboratory technicians to their possession of prior cognitive and skill-based experiences regarding laboratories. This may have been refined and developed by the female nature, which is characterized by seriousness at work, diligence, and a desire for continuous learning and excellence compared to males.

This result aligns with the study by Mogopodi et al. (2015), Schroder et al. (2015), Iman Al-Abdullatif (1432 AH), Al-Shuaili and Al-Maamari (2006), Al-Tarawneh (2005), and Al-Mudaifer (2005), all of which concurred on the low level of awareness of safety and security procedures among users of this environment, including students, teachers, laboratory technicians, and academics.

- Results Related to the Second Research Question: Are there statistically significant differences in the level of awareness of safety and security procedures among science teachers according to gender?

To answer this question, the researcher calculated the arithmetic mean and standard deviation for the performance of the teacher sample members (male and female) on the scale. An independent samples *t*-test was utilized to determine the significance of differences, if any, as illustrated in Table (3):

Table 3. Science Teachers' Level of Awareness of Safety and Security Procedures by Gender

Gender	N	Mean	Standard Deviation	*t*-value	Level of Significance
Male	129	25.2	4.9	-3.46	0.193
Female	86	27.8	6.1		

Table (3) illustrates that the *t*-test value amounted to (-3.46), and this value is not statistically significant at the (0.05) significance level. This indicates the absence of significant differences in performance on the study scale between male and female teachers attributed to the gender variable.

The researcher attributes this result to the similarity of conditions related to the mechanisms for educating and training teachers of both genders concerning safety and security procedures in school laboratories, which remains deficient based on the sample's performance in the current study. Furthermore, there is a lack of interest among teachers of both genders in this knowledge, relying instead on their previous experiences. This occurs amidst a noticeable reluctance among teachers in the Kingdom to utilize laboratories in teaching science, relying more heavily on traditional methods, a fact confirmed by numerous studies conducted in this area, as mentioned by Al-Jabr (2009, p. 116). This contradicts the recent developments witnessed in science curricula in the Kingdom, which emphasized the aspect of practice, application, and knowledge construction by students under the supervision of teachers, where work in the school laboratory plays a crucial role in achieving these objectives.

This result agrees with the study by Can et al. (2015), Ali (2013), and Al-Shuaili and Al-Maamari (2006), where no effect of gender was observed. Conversely, it differed from the study by Al-Tarawneh (2005), in which females outperformed males in the knowledge of safety and security principles.

- Results Related to the Third Research Question: Are there statistically significant differences in science teachers' level of awareness of safety and security procedures according to their specialization?

To answer this question, the researcher calculated the arithmetic mean and standard deviation for the performance of the teacher sample on the scale of awareness of laboratory safety and security procedures according to specialization, as illustrated in Table (4):

Table 4. Science Teachers' Level of Awareness of Safety and Security Procedures by Specialization

Specialization	N	Mean	Standard Deviation
Physics	63	26.4	5.02
Chemistry	50	27.2	5.2
Biology	83	25.9	6.3
Science	19	24.4	4.7

It is evident from the preceding table that the mean performance of the teacher sample members on the scale whose specialization is (Chemistry) was the highest, amounting to (27.2), followed by the (Physics) specialization with a mean performance of (26.4), then the (Biology) specialization with a mean performance of (25.9), while the lowest performance means were for the (Science) specialization, amounting to (24.4). To determine the level of significance and the significance of differences among the means, an Analysis of Variance (ANOVA) test was utilized, as illustrated in Table (5):

Table 5. Analysis of Variance for Science Teachers' Performance by Specialization

Source of Variance	Sum of Squares	Degrees of Freedom	Mean Square	F	Level of Significance
Between Groups	116.527	3	38.842	1.244	0.295
Within Groups	6588.756	211	31.226		
Total	6705.284	214			

It is evident from the preceding table that the calculated (F) value equals (1.244), which is not statistically significant at the (0.05) level. This signifies the absence of statistically significant differences among teachers in the level of performance on the scale of awareness of laboratory safety and security procedures attributed to the specialization variable.

This result can be explained by looking at the convergence in performance on the scale among the sample members across all specializations. This may reflect the similarity in the conditions of preparing male and female teachers at the university level across all scientific disciplines, and the ineffectiveness of the university courses related to laboratories in their current state in familiarizing students with safety and security procedures when working in the laboratory.

This result differs from the study by Julius and Thomas (2014), Ali (2013), and Al-Tarawneh (2005), which demonstrated the presence of significant differences attributed to the specialization variable in favor of the (Physics) specialization.

- Results Related to the Fourth Research Question: Are there statistically significant differences in science teachers' level of awareness of safety and security procedures according to their practical experience?

To answer this question, the researcher calculated the arithmetic mean and standard deviation for the performance of the teacher sample members on the scale of awareness of laboratory safety and security procedures according to experience, as illustrated in Table (6):

Table 6. Science Teachers' Level of Awareness of Safety and Security Procedures by Experience

Experience	N	Mean	Standard Deviation
Less than 5 years	26	26.6	5.2
5 to 10 years	65	26.5	5.8
More than 10 years	124	25.9	5.6

It is evident from the preceding table that the mean performance of the teacher sample members on the scale according to their experience was largely converging. The mean performance for those possessing experience of (less than 5 years) was the highest, amounting to (26.6), followed by individuals possessing experience of (5 to 10 years) with a mean performance of (26.5), and finally the mean performance for teachers possessing experience of (more than 10 years) which amounted to (25.9).

To determine the level of significance and the significance of differences among the means, an Analysis of Variance (ANOVA) test was utilized, as illustrated in Table (7):

Table 7. Analysis of Variance for Science Teachers' Performance by Experience

Source of Variance	Sum of Squares	Degrees of Freedom	Mean Square	F	Level of Significance
Between Groups	15.892	2	7.946	0.252	0.778
Within Groups	6689.392	212	31.554		
Total	6705.284	214			

It is evident from the preceding table that the calculated (F) value equals (0.252), which is not statistically significant at the (0.05) level. This signifies the absence of statistically significant differences among teachers in the level of performance on the scale of awareness of laboratory safety and security procedures attributed to the experience variable. The interpretation of this result is linked to what was previously discussed regarding the variables of gender and specialization, specifically, the weak relationship of teachers in general with the laboratory as an educational environment. This is a consequence of factors, some of which are attributed to the teacher, and others to the role of the authorities supervising school laboratories within the Ministry of Education. It is also noteworthy here that the newly experienced teachers performed better on the scale than those with extensive experience. This can be associated with their recent graduation and potentially their benefit from university studies, which the results indicated is considered the primary source of knowledge regarding laboratory safety and security procedures among the sample members. This result aligns with the study by Ali (2013), where experience had no effect on performance.

- Results Related to the Fifth Research Question: Are there statistically significant differences in science teachers' level of awareness of safety and security procedures according to their academic qualification?

To answer this question, the researcher calculated the arithmetic mean and standard deviation for the performance of the teacher sample members on the scale of awareness of laboratory safety and security procedures according to the qualification variable, as illustrated in Table (8):

Table 8. Science Teachers' Level of Awareness of Safety and Security Procedures by Qualification

Qualification	N	Mean	Standard Deviation
Diploma	4	22	3.3
Bachelor's	200	26.4	5.4
Master's	11	25.5	8.2

The preceding table presents the mean scores for science teachers' level of awareness of laboratory safety and security procedures according to academic qualification. Teachers with a bachelor's degree had the highest mean score (M = 26.4), followed by those with a master's degree (M = 25.5), and then those with a diploma (M = 22.0). To determine whether these differences were statistically significant, a one-way analysis of variance (ANOVA) was conducted, as shown in Table 9.

Table 9. Analysis of Variance for Science Teachers' Performance by Qualification

Source of Variance	Sum of Squares	Degrees of Freedom	Mean Square	F	Level of Significance
Between Groups	81.056	2	40.528		
Within Groups	6624.227	212	31.246	1.297	0.275
Total	6705.284	214			

It is evident from the preceding table that the calculated (F) value equals (1.297), which is not statistically significant at the (0.05) level. This signifies the absence of statistically significant differences among teachers in the level of performance on the scale of awareness of laboratory safety and security procedures attributed to the qualification variable. It is noteworthy here that the mean performance of teachers possessing a (Bachelor's) qualification was the best compared to those with (Master's) and (Diploma) qualifications. This may be due to the fact that most teachers holding a Bachelor's qualification are still practicing the teaching profession and maintain a connection with utilizing and interacting with the laboratory. This is in contrast to holders of other qualifications, some of whom work as supervisors (Master's) or in the lower grades of elementary school (Diploma), where their utilization of the laboratory is minimal.

- Results Related to the Sixth Research Question: Are there statistically significant differences in the level of awareness of safety and security procedures between male and female laboratory technicians attributed to the gender variable?

To answer this question, the researcher calculated the arithmetic mean and standard deviation for the performance of the laboratory technician sample members (male and female) on the scale. An independent samples *t*-test was utilized to determine the significance of differences, if any, as illustrated in Table (10):

Table 10. Laboratory Technicians' Level of Awareness of Safety and Security Procedures by Gender

Gender	N	Mean	Standard Deviation	*t*-value	Level of Significance
Male	33	27.8	4.3	3.77	0.068
Female	100	30.4	3.1		

Table (10) illustrates that the *t*-test value amounted to (3.77), and this value is not statistically significant at the (0.05) significance level. This indicates the absence of significant differences in performance on the study scale between male and female laboratory technicians attributed to the gender variable.

The researcher attributes this result to the similarity of conditions related to the mechanisms of preparing and training laboratory technicians of both genders. This occurs in light of the competent administration for school laboratories within the Ministry of Education focusing on the material aspects related to these laboratories, while neglecting the technical and awareness aspects pertaining to the users of this environment, including technicians and others. Foremost among these neglected aspects is the provision of effective training programs related to safety and security. Furthermore, there is a reluctance among male and female laboratory technicians to attend such training programs, which necessitates resorting to alternative methods to achieve this objective. The most important of these methods is utilizing modern technologies and communication channels, which have proven their effectiveness, as confirmed by Daclan's study (2013).

- Results Related to the Seventh Research Question: Are there statistically significant differences in laboratory technicians' level of awareness of safety and security procedures according to their practical experience?

To answer this question, the researcher calculated the arithmetic mean and standard deviation for the performance of the laboratory technician sample members on the scale of awareness of laboratory safety and security procedures according to experience, as illustrated in Table (11):

Table 11. Laboratory Technicians' Level of Awareness of Safety and Security Procedures by Experience

Experience	N	Mean	Standard Deviation
Less than 5 years	55	30	3.2
5 to 10 years	22	29.9	3.6
More than 10 years	56	29.4	3.9

It is evident from the preceding table that the mean performance of the laboratory technician sample members on the scale according to their experience was converging. The mean performance for those possessing experience of (less than 5 years) was the highest, amounting to (30), followed by individuals possessing experience of (5 to 10 years) with a mean performance of (29.9), and finally the mean performance for technicians possessing experience of (more than 10 years) which amounted to (29.4).

To determine the level of significance and the significance of differences among the means, an Analysis of Variance (ANOVA) test was utilized, as illustrated in Table (12):

Table 12. Analysis of Variance for Laboratory Technicians' Performance by Experience

Source of Variance	Sum of Squares	Degrees of Freedom	Mean Square	F	Level of Significance
Between Groups	10.418	2	5.209		
Within Groups	1689.372	130	12.995	0.401	0.671
Total	1699.789	132			

It is evident from the preceding table that the calculated (F) value equals (0.401), which is not statistically significant at the (0.05) level. This signifies the absence of statistically significant differences among laboratory technicians in the level of performance on the scale of awareness of laboratory safety and security procedures attributed to the experience variable. Referring to the mean performance, this result corroborates what was previously mentioned regarding teachers: newly minted professionals, those closest to their university studies, possess cognitive and skill-based experiences regarding laboratory safety and security procedures. This may be a residual effect of those studies, influencing their performance on the scale, despite the lack of significant variance among the sample members of technicians. This finding underscores the necessity for the competent administration for school laboratories within the Ministry of Education to develop continuous training mechanisms for in-service personnel, ensuring that laboratory technicians maintain full awareness and understanding of their job requirements.

- Results Related to the Eighth Research Question: Are there statistically significant differences in laboratory technicians' level of awareness of safety and security procedures according to their academic qualification?

To answer this question, the researcher calculated the arithmetic mean and standard deviation for the performance of the laboratory technician sample members on the scale of awareness of laboratory safety and security procedures according to qualification, as illustrated in Table (13):

Table 13. Laboratory Technicians' Level of Awareness of Safety and Security Procedures by Qualification

Qualification	N	Mean	Standard Deviation
Diploma	122	29.9	3.2
Bachelor's	11	28	6.5

The preceding table presents the mean scores for laboratory technicians' level of awareness of laboratory safety and security procedures according to academic qualification. Laboratory technicians with a diploma had the highest mean score (M = 29.9), followed by those with a bachelor's degree (M

= 28.0). To determine whether the differences between the means were statistically significant, a one-way analysis of variance (ANOVA) was conducted, as shown in Table 14.

Table 14. Analysis of Variance for Laboratory Technicians' Performance by Qualification

Source of Variance	Sum of Squares	Degrees of Freedom	Mean Square	F	Level of Significance
Between Groups	36.175	1	36.175	2.849	0.094
Within Groups	1663.615	131	12.699		
Total	1699.789	132			

It is evident from the preceding table that the calculated (F) value equals (2.849), which is not statistically significant at the (0.05) level. This signifies the absence of statistically significant differences among laboratory technicians in the level of performance on the scale of awareness of laboratory safety and security procedures attributed to the qualification variable. It is observed from the preceding result that obtaining a higher qualification (Bachelor's) for laboratory technicians did not positively impact the sample members' level of performance on the scale. This may be attributed to the fact that the courses studied during the Bachelor's degree did not have a strong correlation with laboratory safety and security procedures. This underscores the necessity of reconsidering and developing the current academic programs and courses in universities related to the preparation of laboratory technicians, in parallel with the development of science curricula in the Kingdom.

- Results Related to the Ninth Research Question: Are there statistically significant differences in the level of awareness of safety and security procedures among the sample members attributed to the job variable?

To answer this question, the researcher calculated the arithmetic mean and standard deviation for the performance of the sample members on the scale. An independent samples *t*-test was utilized to determine the significance of differences, if any, as illustrated in Table (15):

Table 15. Differences in Participants' Level of Awareness of Safety and Security Procedures by Job

Job	Number	Mean	Standard Deviation	*t*-value	Level of Significance
Teacher	215	26.2	5.6	6.46	0.000*
Laboratory Technician	133	29.7	3.6		

**Indicates the presence of statistically significant differences at the significance level (0.05).*

It is evident from Table (15) that there are statistically significant differences at the significance level of (0.05) attributed to the job variable in favor of the (laboratory technician) position. The mean performance for individuals whose job is (laboratory technician) amounted to (29.7) compared to the study's criterion score of (28.5), whereas the mean performance for individuals whose job is (teacher) amounted to (26.2).

This result may be attributed to the fact that the sample members (laboratory technicians), by virtue of their current profession and previous studies that are directly related to the school laboratory, possess knowledge and skills pertaining to safety and security to a degree surpassing that of teachers. The latter's knowledge of these procedures perhaps relied on personal endeavors, coupled with limited experiences from university studies.

- Results Related to the Tenth Research Question: What are the knowledge sources of safety and security procedures in the laboratory among science teachers and laboratory technicians?

Frequencies and percentages were calculated for the sample members' responses regarding their knowledge sources of safety and security procedures in the laboratory. Furthermore, these options were ranked for each category, and the correlation (Spearman's coefficient) between the ranking of choices by teachers (male/female) and laboratory technicians (male/female) for these sources was studied separately, as illustrated in Table (16).

Table 16. Ranking of Participants' Sources of Knowledge about Safety and Security Procedures

Sources	Female Teachers			Male Teachers			Female Lab Techs			Male Lab Techs			Total		Overall Rank
	F	%	R	F	%	R	F	%	R	F	%	R	F	%	
Teacher's Manual	34	14.1	3	49	14.2	3	11	4.7	9	3	6	6	97	11.1	4
Laboratory Technician	18	7.4	7	28	8.1	6	24	10.2	4	5	10	4	75	8.6	6
Colleagues	29	12	5	26	7.5	7	22	9.3	5	2	4	8	79	9	5
Educational Supervisor	9	4	9	10	2.9	10	13	5.5	7	5	10	5	37	4.2	9
Training Programs	10	4.1	8	12	3.5	9	22	9.3	6	2	4	9	46	5.3	8
Publications & Booklets	6	2.4	10	7	2	11	9	3.8	10	3	6	7	25	2.9	11
External Reading	36	15	2	51	14.7	2	44	18.6	2	8	16	3	139	15.9	2
University Education	43	18	1	74	21.4	1	25	10.6	3	12	24	1	154	17.6	1
Media	22	9	6	33	9.5	5	13	5.5	8	1	2	10	69	7.9	7

Social Networks	5	2	11	14	4	8	8	3.4	11	0	0	11	27	3.1	10
Internet Websites	30	12	4	42	12.1	4	45	19.1	1	9	18	2	126	14.4	3
Total	**242**	**100**		**346**	**100**		**236**	**100**		**50**	**100**		**874**	**100**	
Spearman (r)	$r_s = 0.92$						$r_{s=}0.77$								

F = frequency; R = rank

The value of Spearman's correlation coefficient between the choices of female and male teachers amounted to (r = 0.92). This value indicates a high consensus in ranking the knowledge sources of safety and security procedures between male and female teachers. The correlation value for female and male laboratory technicians amounted to (r = 0.77), which is also a significant value indicating convergence in ranking the knowledge sources of those procedures. Referring to the preceding table, it is evident that the ranking of the top four options for the (male and female teachers) category was identical, as the sources (university education, external reading, teacher's manual, Internet websites) appeared in this order at the top ranks as their knowledge sources of laboratory safety and security procedures.

The table also reveals that the sources (university education, Internet websites, external reading, laboratory technician) were the primary sources in ranking for the (female and male laboratory technicians) category. It is observed that there is a consensus among everyone that (university education, Internet websites, external reading) were the primary sources in their knowledge of laboratory safety and security procedures.

The table further shows that the primary knowledge source of safety and security procedures among (male and female teachers) and (male laboratory technicians) was (university education), which obtained the highest percentage of selection among these categories and achieved the first rank in the overall ranking with a frequency of (154) and a total percentage of (17.6%). Meanwhile, the primary knowledge source of these procedures among (female laboratory technicians) was (Internet websites), which came third in the overall ranking with a frequency of (126) and a percentage of (14.4%).

The table also demonstrates that the sources (publications and booklets) and (social networks) came in the lowest ranks in the overall ranking as knowledge sources of the procedures among the sample members.

This result highlights the importance of university education as a specialized stage that contributed to imparting a portion of the sample members' knowledge regarding laboratory safety and security procedures. This aligns with the study by Ali (2013), which reached the same conclusion. Furthermore, the result demonstrates the importance of Internet websites as a significant knowledge source for laboratory safety procedures in this era, wherein this global network and its contained potential have become an essential cognitive source for acculturation, teaching, and learning through its diverse mediums, such as forums and social networks. This was demonstrated by Daclan's study (2013) regarding the positive impact of the (Facebook) network in developing awareness of laboratory safety and security procedures, which contradicted the result of the current study, wherein the sample members considered such networks not to be among the fundamental sources of their knowledge of these procedures.

6. Recommendations and Proposals:

In light of the preceding findings, the current study recommends the following:

1. Activating safety and security procedures within the content of science curricula by urging and monitoring the implementation of these procedures by science teachers and laboratory technicians during the instructional delivery of science lessons in the laboratory.
2. Conducting specialized training courses for science teachers and laboratory technicians regarding laboratory safety and security procedures on a continuous and periodic basis.
3. Intensifying and activating awareness-raising efforts concerning safety and security procedures in school laboratories through the issuance of specialized manuals and publications, alongside monitoring their implementation by the competent authorities within the Ministry of Education and educational directorates.
4. Establishing an interactive website dedicated to school laboratory safety and security under the supervision of the competent authority within the Ministry of Education.
5. Incorporating specialized courses on school laboratory safety and security into university academic programs at the Colleges of Science and Education for science teachers and laboratory technicians.
6. Engaging specialized scientific colleges in universities and Civil Defense administrations in organizing training programs and workshops focused on laboratory operations and safe practice methods, as well as conducting field visits for science teachers and laboratory technicians to acquire practical expertise.
7. Conducting further educational research on the current state of school laboratories in the Kingdom, the attitudes of science teachers and laboratory technicians toward laboratory work, and the extent of their adherence to and implementation of safety and security procedures while working therein.

7. Declarations:

This research is a translated version from Arabic of a research paper published in the Journal of Security Research, King Fahd Security College, Issue 64, May 2016. The necessary approval was

obtained to publish the translated version in English. The author declares that no funding was received for this research. The author also declares that there is no conflict of interest regarding the publication of this article. The author confirms sole responsibility for the conception and design of the study, data collection, analysis and interpretation of results, and preparation of the manuscript. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Doi: https://doi.org/10.52132/Ajrsp.e.2026.87.1

Generative AI Governance in Higher Education (Systematic Literature Review)

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Received:
6 May 2026
First Decision:
15 May 2026
Revised:
28 May 2026
Revised:
9 June 2026
Accepted:
21 June 2026
Published:
5 July 2026

Abstract:

This study aimed to provide a comprehensive review of generative AI governance in higher education during the period 2022–2026, in light of the rapid expansion of the use of big language models and content generation applications within universities. The study adopted a comprehensive scope review methodology, guided by the SALSA framework for the research, evaluation, synthesis, and analysis phases, and by PRISMA-ScR guidelines for documenting the review procedures. The study analyzed peer-reviewed scientific literature, sectoral, institutional, and regulatory frameworks, and selected university policies, with particular attention to the Arab context and research and regulatory gaps. The results showed that generative AI governance is not limited to addressing issues of cheating and plagiarism, but encompasses interconnected dimensions, most notably: academic integrity, privacy, transparency, disclosure, fairness, capacity building, human oversight, risk management, and assessment redesign. The study also indicated that the global trend is moving toward responsible and conditional use rather than outright prohibition or unregulated adoption. The study concluded that effective governance requires combining research evidence, sectoral frameworks, and institutional policies, while translating general principles into clear procedures at the university and course levels. It also revealed the need for more specialized policies that address privacy, linguistic equity, data protection, and the transparency. The study recommends developing flexible university guidelines, disclosure models, data use controls, ongoing training programs, and periodic review mechanisms that ensure a balance between innovation, quality of learning, and academic integrity.

Keywords: AI governance, generative AI, higher education, academic integrity, university policies, risk management, comprehensive review.

1. Introduction:

1.1. Background of the Study:

Since the end of 2022, higher education has witnessed a qualitative shift in its relationship with artificial intelligence (AI) technologies, particularly following the widespread adoption of generative AI applications based on large linguistic models, such as ChatGPT. These applications are now capable of producing academic texts, summarizing sources, generating research ideas, formulating questions, providing feedback, and assisting in programming, translation, and linguistic analysis. These capabilities have transformed generative AI from a mere educational support tool into a new actor influencing teaching, learning, assessment, scientific research, and knowledge management systems within higher education institutions (Kasneci et al., 2023; Lo, 2023).

Recent literature indicates that the use of artificial intelligence (AI) in higher education was already on the rise before the advent of generative AI tools. However, the subsequent rise of ChatGPT has reshaped the educational, ethical, and institutional debate with greater urgency. A review by Crompton and Burke (2023) showed that AI applications in higher education expanded into assessment, prediction, intelligent assistance, intelligent learning systems, and student learning management. However, generative AI added a new dimension beyond data analysis or decision support to content creation itself, presenting universities with complex challenges related to the quality of learning, the authenticity of academic achievement, the reliability of outputs, data protection, and equitable access to digital tools.

Therefore, the debate is no longer limited to the question: How can generative artificial intelligence be employed in education? The more important question has become: How can it be governed within higher education institutions in a way that balances innovation and responsibility? The literature indicates that these technologies offer promising educational opportunities, such as supporting personalized learning, facilitating access to knowledge, assisting faculty in preparing educational materials, and expanding research and academic writing capabilities. Conversely, they raise serious challenges related to information hallucinations, bias, privacy violations, reduced transparency, diminished critical thinking, and the potential for misuse in cheating, plagiarism, or the production of inauthentic academic work (Cotton et al., 2024; Kasneci et al., 2023; Lo, 2023).

This has led universities to move from a phase of rapid or partial response to one of needing to build more mature governance frameworks. Some institutions initially resorted to prohibition or restriction, while others adopted more open policies based on responsible and conditional use. Studies analyzing university policies reveal that the majority of universities that have issued guidelines on generative AI tend to adopt an "open and cautious" stance; they allow its use in specific educational contexts but link it to controls related to academic integrity, privacy, the accuracy of outputs, disclosure of use, and the development of assessment methods (Wang et al., 2024). Furthermore, a study by Jin et al. (2025), which analyzed the policies of higher education institutions in six global regions, shows that university policies are increasingly focusing on academic integrity, improving teaching and learning practices, equitable access, and building AI competencies among students and faculty.

In the same vein, governance is no longer solely an internal institutional matter but has become linked to broader international and regulatory frameworks. UNESCO, in its guidelines on generative artificial intelligence in education and research, emphasized the need to adopt a humanistic perspective centered on learner protection, data privacy, human oversight, capacity building, and the development of coherent policies to regulate the use of these technologies in education and research (Miao & Holmes, 2023). UNESCO's Recommendation on the Ethics of Artificial Intelligence also provides a global normative foundation based on human rights, human dignity, transparency, equity, and human oversight (UNESCO, 2022). In the regulatory context, the European AI Act represents a prominent model of risk-based regulation, classifying certain uses of AI in education and training as high-sensitivity areas when they relate to admission, assessment, or the determination of educational pathways (European Parliament and Council of the European Union, 2024). NIST's framework for managing generative AI risks also provides a practical perspective for higher education institutions by focusing on governance, risk mapping, measurement, and management across the lifecycle of AI systems (NIST, 2024).

Consequently, the governance of generative AI in higher education emerges as an emerging research field where educational, ethical, legal, technical, and institutional dimensions intersect. Governance here is not limited to establishing a general usage policy, but encompasses building an integrated system that defines responsibilities, oversight mechanisms, disclosure standards, acceptable usage limits, data protection procedures, evaluation controls, stakeholder training requirements, and mechanisms for periodic policy review. This is confirmed by the study by Crompton et al. (2026), which, based on a global Delphi study, developed a framework for the governance of generative AI in higher education comprising eight key areas: academic integrity, ethical and responsible use, privacy and protection, equitable access, generative AI literacy, integration strategy, human oversight and accountability, and institutional support and infrastructure.

1.2. Problem Statement:

Despite the increasing number of studies addressing the use of generative artificial intelligence (GI) in higher education, the governance aspect still suffers from conceptual and methodological fragmentation. Much of the literature has focused on educational opportunities or the challenges of academic integrity, while a comprehensive governance approach remains less developed, particularly regarding linking university policies to international frameworks, analyzing stakeholder roles, identifying accountability mechanisms, and building models applicable to different university environments. This gap is even more pronounced in non-Western contexts, including the Arab context, where the Arabic literature on generative AI governance in higher education remains limited compared to the rapid pace of technological and institutional transformation.

The main challenge is that generative artificial intelligence has entered the university environment at a pace that has outpaced many institutions' ability to develop clear and up-to-date policies. This situation has created a gap between the actual use of these tools by students, researchers, and faculty members, and the universities' capacity to regulate this use according to principles of academic integrity, data protection, fairness, transparency, and accountability. Furthermore, simply resorting to bans or relying on automated text detection tools is not a sufficient governance solution, as the problem runs deeper than just plagiarism control. It involves redefining learning, assessment, academic writing, the boundaries of acceptable assistance, and the institution's responsibility to guide responsible use.

Accordingly, this study stems from the need for a comprehensive and systematic review of the scientific literature, regulatory frameworks, and institutional policies related to the governance of generative artificial intelligence in higher education during the period from 2022 to 2026, with the aim of building an integrated analytical understanding of the governance dimensions, revealing research and regulatory gaps, and proposing a conceptual framework that can contribute to guiding higher education institutions, especially in Arab environments, towards adopting more consistent and responsible policies.

1.3. Research Questions:

This study seeks to answer the following main question:

What are the dimensions of generative AI governance in higher education as reflected in peer-reviewed scientific literature, regulatory frameworks, and institutional policies published during the period 2022–2026?

The following sub-questions stem from this main question:

1. What theoretical approaches have addressed generative AI governance in higher education?
2. Which governance dimensions are most prominent in previous studies, such as academic integrity, privacy, transparency, accountability, equity, and capacity building?
3. How have sectoral, institutional, and regulatory frameworks addressed generative AI issues related to education and research?

4. How have universities globally responded to the use of generative AI through institutional policies and guidelines?
5. What is the position of Arabic literature and contexts within the global debate on generative AI governance in higher education?
6. What research and regulatory gaps does this comprehensive review reveal?

1.4. Study Objectives:

This study aims to provide a comprehensive review of generative AI governance in higher education by analyzing relevant peer-reviewed literature, regulatory frameworks, and institutional policies during the period 2022–2026. The following sub-objectives stem from this overarching goal:

1. Identifying the main theories related to generative AI governance in higher education.
2. Classifying recurring governance dimensions in the literature, including academic integrity, data governance, privacy, transparency, accountability, fairness, and human oversight.
3. Analysis of the sectoral, institutional and regulatory frameworks related to the governance of generative artificial intelligence in higher education.
4. Examining university response patterns through institutional policies and guidelines related to generative AI.
5. Highlighting research and regulatory gaps, particularly in the Arab context.

1.5. Significance of the Study

The theoretical significance of this study stems from the novelty and multifaceted nature of its subject matter. It contributes to developing a structured academic understanding of the governance of generative artificial intelligence (AI) in higher education, a field still in its formative stages.

The study also bridges the gap between the literature on AI in education, digital governance, AI ethics, and higher education policies. This allows for a move beyond a piecemeal approach that focuses solely on cheating or plagiarism, towards a more comprehensive perspective that considers the university as an integrated governance system.

The practical significance lies in the study's potential to provide a knowledge base for university decision-makers, higher education regulatory bodies, quality assurance and accreditation centers, and academic leaders. This will enable them to develop clear policies for the use of generative AI.

Furthermore, it can help faculty members understand the boundaries of responsible use, support the design of more authentic assessments, and guide students towards more conscious and ethical practices. This study is of increasing importance in the Arab context in light of the need for governance frameworks that take into account linguistic, cultural and organizational specificities, while benefiting from global experiences and international standards.

1.6. Study Limitations

This study adheres to specific thematic, temporal, linguistic, and methodological boundaries.

- Thematically, it focuses on the governance of generative artificial intelligence (GI) in higher education, addressing AI in general only insofar as it contributes to the conceptual framework. It does not concentrate on purely technical aspects related to model building or algorithms, but rather on the dimensions of governance, policies, risks, and institutional use.

- Temporally, the study covers literature published between 2022 and 2026, a period that witnessed the most significant shift in the use of generative AI tools in higher education. Some references prior to 2022 may be used within the theoretical framework only if they establish the concept of governance or AI ethics, without being included in the main analytical sample.

- Linguistically, the study relies on literature published in both Arabic and English. In terms of methodological boundaries, the study adopts a comprehensive zoning review methodology, guided by the SALSA framework in the search, evaluation, synthesis, and analysis phases, and by PRISMA-ScR guidelines in documenting search, screening, inclusion, and exclusion procedures.

1.7. Study Terminology

In this study, generative artificial intelligence (GAI) refers to a class of AI systems capable of generating new content in response to inputs or commands. This includes text, images, code, summaries, questions, feedback, and other outputs relevant to education and research.

Generative AI governance refers to the system of principles, policies, procedures, and institutional mechanisms that regulate the use of GAI tools within higher education institutions. This ensures responsible use and protects academic integrity, privacy, fairness, transparency, accountability, human oversight, and the quality of education and assessment.

In this study, higher education refers to universities, colleges, and post-secondary education institutions that offer academic, professional, or research programs. This includes teaching, learning, assessment, supervision, scientific research, and related academic and administrative services. A comprehensive scope review means a review methodology that aims to map the literature, frameworks and policies related to an emerging or multidimensional topic, classify its axes and identify research and organizational gaps, without being limited to measuring the impact of a specific intervention or testing a narrow hypothesis.

2. Conceptual and Theoretical Framework:

2.1. Introduction:

The conceptual and theoretical framework of this study serves as the basis for situating generative AI governance within higher education as a complex issue that extends beyond the technical use of tools to encompass the organization of the relationship between humans, institutions, algorithms, and academic knowledge. Higher education does not treat generative AI as a neutral digital application, but rather as a socio-cognitive technology that influences the production, evaluation, dissemination, and attribution of knowledge, as well as the roles of students, faculty, and university administrations. Therefore, understanding this phenomenon requires constructing a framework that integrates the concepts of generative AI, AI governance, educational ethics, and academic quality and integrity policies.

2.2. Theoretical Foundations Explaining the Governance of Generative Artificial Intelligence in Higher Education

The theoretical framework of this study is constructed by integrating five theoretical lenses that help explain and analyze the phenomenon.

1- Socio-technical systems theory provides an important entry point for understanding generative artificial intelligence in universities. Technology does not operate in a vacuum, but rather within social, organizational, and cultural contexts that determine how it is used and its effects. From this perspective, the issue is not simply the existence of a tool like ChatGPT, but rather the way in which roles are redistributed among students, professors, the curriculum, and the technological system. Bearman et al. (2023) demonstrated that the discourse on artificial intelligence in higher education is linked to a socio-technical transformation and a reshaping of power and agency in academic work, where humans are no longer the sole actors in the production and organization of knowledge.

2- The responsible innovation approach provides a basis for analyzing the balance between leveraging the potential of generative AI and mitigating its negative impacts. This approach does not reject innovation, but rather stipulates that it must be values-driven, reflective, participatory, responsive, and proactive. In higher education, this means that universities should not adopt generative AI tools simply because they are available or popular, but because they serve clear educational objectives, are subject to ethical and institutional evaluation, and consider their implications for learning, equity, and privacy.

3- Risk-based governance provides a suitable framework for classifying generative AI uses according to their sensitivity. Not all uses are created equal; using a tool to generate initial examples differs from using it to assess students, make admission decisions, or analyze personal data. Therefore, a university can permit some low-risk uses, impose conditions on medium-risk uses, and prohibit or restrict high-risk uses. This logic is consistent with the NIST AI RMF and the European Artificial Intelligence Act, which link controls to the degree of risk and the nature of the impact (European Parliament and Council of the European Union, 2024; NIST, 2023).

4- Stakeholder theory is useful in analyzing the distribution of responsibilities within the university. The governance of generative AI is not solely the responsibility of senior management; it also involves students, faculty members, researchers, IT units, teaching and learning centers, ethics committees, quality assurance centers, libraries, legal advisors, and technology providers. Each stakeholder has a different interest and responsibility. Students are responsible for disclosure and ethical use, faculty members for designing clear tasks and assessments, the institution for policy, training, and safeguards, and the technology provider for transparency, security, and data protection.

5- The diffusion theory of innovations provides a framework for understanding the varying responses of universities to generative AI. Some universities may adopt the technology rapidly, while others hesitate or impose strict limitations. Jin et al. (2025) used this theory to analyze generative AI adoption policies in global universities, focusing on innovation characteristics such as relevance, testability, and observability, as well as communication channels and institutional roles. This is relevant to the current study because it demonstrates that governance is not merely a regulatory document, but rather an institutional adoption process influenced by the university's culture, capabilities, resources, and discourse surrounding the technology.

2.3. Governance Dimensions of Generative AI in Higher Education

Based on international literature and frameworks, eight key governance dimensions have been identified as forming the conceptual framework for this study.

The first dimension is academic integrity. This includes issues of cheating, plagiarism, originality, disclosure of the use of AI tools, and the limits of acceptable assistance in assignments and research. Cotton et al. (2024) noted that tools such as ChatGPT pose direct challenges to academic integrity because they enable students to produce work that appears original without necessarily reflecting their actual learning. However, governance measures should not be limited to detecting cheating; they should also include redesigning the grading system, clarifying expectations, and training students in ethical use.

The second-dimension concerns data governance and privacy. Many generative AI tools operate through external platforms, and users may inadvertently enter personal, research, or institutional data into these tools without understanding its implications. Therefore, governance should include clear rules regarding permissible and prohibited data, consent mechanisms, student data protection, and compliance with relevant national and international laws.

The third dimension is transparency and disclosure. This means that students and faculty members should know when and how the tool may be used, that its use in academic work should be disclosed when appropriate, and that policies should be clear and unambiguous. Transparency also requires clarifying the limits of automated transcription tools and ensuring they are not used punitively without fair verification, given the potential for error and bias.

The fourth dimension is accountability and human oversight. Reliance on generative artificial intelligence does not eliminate human responsibility for academic or research decisions. Therefore, decisions regarding evaluation, admission, formal feedback, research supervision, and scientific publication should remain subject to responsible human oversight. International frameworks emphasize that human oversight is a fundamental principle for ensuring the safe and equitable use of artificial intelligence (UNESCO, 2022).

The fifth dimension is equity and inclusion. This includes ensuring that generative AI does not widen the gap between students who have access to advanced, paid tools and those who do not, or between speakers of languages strongly supported in models and speakers of underrepresented languages. In the Arab context, this dimension is particularly important due to language issues, the quality of Arabic content, differences in digital infrastructure, and varying policies among universities.

The sixth dimension is capacity building and AI literacy. Governance is not successful simply by issuing policies; it requires empowering users to understand the potential, limitations, and risks of AI. UNESCO's AI competency frameworks for teachers and students emphasize the importance of building knowledge, skills, and values that enable the safe, ethical, and responsible use of AI (Miao & Cukurova, 2024; UNESCO, 2024).

The seventh dimension is assessment governance and the quality of learning. Generative AI requires a re-evaluation of tasks that measure rote memorization or superficial text production, and a shift towards more authentic, contextual, cumulative, oral, reflective, and process-based assessments. The question is no longer simply: Did the student use the tool? But rather: Did the student achieve the learning outcomes? And was the use of the tool a legitimate part of the learning process or a replacement for it?

The eighth dimension is institutional support and infrastructure. This includes governance committees, support units, guidance manuals, ongoing training, consultation channels, disclosure models, updated policies, and mechanisms for periodic evaluation.

Crompton et al. (2026) developed a framework encompassing eight key areas for generative AI governance in higher education, including academic integrity, ethical and responsible use, privacy, equitable access, generative AI literacy, integration strategy, human oversight and accountability, and institutional support and infrastructure.

Based on the foregoing, the study's subsequent analysis relies on governance dimensions as a general conceptual framework to facilitate the interpretation of previous studies and sectoral, institutional, and organizational frameworks. These dimensions are not used to rigidly categorize all sources, but rather to guide comparative analysis and identify areas of agreement, disagreement, and research and organizational gaps in the governance of generative artificial intelligence in higher education.

3. Methodology:

3.1. Study Design:

This study adopted the Scoping Comprehensive Review methodology as the most suitable design for studying the governance of generative artificial intelligence in higher education. This is due to the novelty of the topic, its multifaceted educational, ethical, organizational, and technical dimensions, and the diverse sources of knowledge related to it, including peer-reviewed academic studies, international frameworks, university policies, and institutional guidelines. Scoping is particularly appropriate for emerging topics that require mapping knowledge, identifying key concepts, classifying trends, and uncovering research and organizational gaps, rather than measuring the impact of a specific intervention as in traditional systematic reviews or meta-analyses (Arksey & O'Malley, 2005; Peters et al., 2020; Tricco et al., 2018).

The study was guided by the SALSA framework, which includes four interrelated phases: Search, Appraisal, Synthesis, and Analysis, to organize the review procedures and ensure their methodological consistency (Grant & Booth, 2009). It was also guided by the PRISMA-ScR guidelines for reporting on scope reviews, which enhances the transparency of the presentation of search, screening, inclusion, and exclusion procedures (Tricco et al., 2018).

3.2. Scope of the Review:

The review covered the period from 2022 to 2026, a period that witnessed the wider adoption of generative AI tools in higher education, particularly following the emergence of ChatGPT and the shift in academic discourse from experimental use to policy and governance issues.

The review included published sources in both Arabic and English, focusing on higher education, universities, scientific research, assessment, and institutional policies. The search, screening, and analysis procedures were structured around the study's problem, objectives, and questions as presented in the introduction, without extending the review to general education or the purely technical aspects of model building.

3.3. Data Sources and Research Strategy:

The study relied on two types of sources: peer-reviewed academic sources and reliable organizational or institutional sources. Academic sources included global databases such as Scopus, Web of Science, ERIC, ScienceDirect, SpringerLink, Taylor & Francis Online, and Wiley Online Library, in addition to Google Scholar as an auxiliary source for citation tracking. Arabic sources included databases such as Dar Al-Manzoma, Al-Manhal, Shamaa, peer-reviewed Arabic educational journals, and repositories of Arab universities.

The review also included documents issued by reliable international, organizational, and institutional bodies, such as UNESCO, the OECD, the European Commission, and NIST, in addition to publicly published university policies and some relevant Arab and regional frameworks or initiatives. These documents were included because they represent an essential part of the governance topic, as governance is not only reflected in peer-reviewed articles but is also embodied in policies, guidelines, organizational frameworks, and institutional usage protocols.

The study employed a bilingual search strategy, utilizing English keywords such as: Generative AI governance, GenAI in higher education, ChatGPT policy, AI governance in universities, responsible AI, AI ethics in higher education, academic integrity and generative AI, generative AI guidelines, and AI risk management in education. Arabic keywords were also used.

The AND and OR operators were employed according to the requirements of each database, in addition to backward and forward tracing of pivotal sources to ensure that influential studies were not overlooked.

3.4. Inclusion and Exclusion Criteria

References that met the following criteria were included:

- They were published between 2022 and 2026 and addressed generative AI, ChatGPT, or large language models.
- They were related to higher education, universities, or scientific research and addressed at least one dimension of governance, such as academic integrity, privacy, transparency, accountability, fairness, institutional policies, risk management, or capacity building.
- They were published in a peer-reviewed scientific journal or by an international organization, regulatory body, university, or reputable government entity.

References that addressed AI in general without a clear focus on generative AI or higher education, purely technical studies that did not include an educational or governance dimension, unreviewed journalistic articles or personal opinions, duplicate studies, and sources whose full text was unavailable or that did not provide data that could be analyzed within the review objectives were excluded.

3.5. Screening and Source Selection Procedures:

The source selection process was conducted in three stages:

1- Records were collected from databases and institutional sources, and duplicates were removed.

2- Titles and abstracts were examined to determine their initial relevance to the study topic.

3- The full texts of the shortlisted sources were read, and the final inclusion and exclusion criteria were applied.

The search and screening process will be presented in the final version of the study using a flowchart according to PRISMA-ScR guidelines. This flowchart will show the number of records identified, the number of records after duplicate removal, the number of sources excluded after title and abstract examination, the number of full texts assessed for eligibility, and the number of sources included in the final analysis. Final figures are not included in this stage until after the actual database search has been conducted to avoid using unreliable numbers. The final number of sources suitable for analysis ranged from 49, including 20 peer-reviewed studies and reviews, and 19 sectoral, institutional, regulatory frameworks, and selected university policies.

3.6. Data Extraction and Analysis

A form was designed to extract data from the sources included in the review, aiming to standardize the reading and analysis of the scientific and regulatory material. The form included bibliographic, methodological, and analytical fields appropriate to the nature of the study sources, whether they were peer-reviewed scientific studies, sectoral, institutional, and regulatory frameworks, or university policies and institutional guidelines.

For peer-reviewed studies, the form extracted the study title, author's name, publication year, country or geographic area, study objectives, methodology, and key findings and recommendations. For sectoral, institutional, and regulatory frameworks, the form extracted the document or framework name, issuing body, scope, regulatory or advisory nature, and the governance principles or requirements it provides for higher education. For university policies and guidelines, the form extracted the university name, the policy or guide title, the document nature, scope of application, and the rules or guidelines related to the use of generative artificial intelligence in teaching, assessment, and research.

The extracted data was used to classify and thematically analyze sources according to key review axes, include academic integrity, privacy and data governance, transparency and disclosure, equity and accessibility, assessment and quality of learning, capacity building, and institutional responsibility and risk management. The results were then analyzed using a thematic synthetic analysis, comparing studies, frameworks, and policies to identify areas of agreement, disagreement, and research and organizational gaps. These findings were then linked to the study's objectives and questions, as well as to the governance dimensions outlined in the theoretical framework.

3.7. Review Reliability and Limitations

To enhance the review's reliability, the study utilized multiple databases, employed diverse keywords in both Arabic and English, distinguished between peer-reviewed studies and institutional documents during analysis, and applied predefined inclusion and exclusion criteria. Furthermore, it utilized citation tracking for pivotal sources. The study also adhered to APA7 academic citation standards and distinguished between research evidence and regulatory or normative sources.

However, the review has several limitations. The field's novelty and rapid evolution may lead to the emergence of new studies or policies after the research is completed. Additionally, some university policies may not be publicly available, potentially limiting the global representation of institutional responses. Moreover, the Arabic literature on generative AI governance in higher education may be relatively limited, making the analysis of the Arab context more likely to identify research gaps and opportunities than to offer broad, definitive generalizations.

4. Analysis of previous studies and international frameworks related to the governance of generative artificial intelligence in higher education

4.1. Previous studies

4.1.1. Introduction:

Previous studies on generative AI in higher education reveal a clear expansion in research approaches since 2022. The literature has shifted from an initial focus on the potential and immediate risks of tools like ChatGPT to a more nuanced treatment of issues such as academic integrity, institutional policies, assessment, privacy, equity, capacity building, and accountability. It is noteworthy that peer-reviewed studies have not always addressed governance as an explicit concept, but rather have explored its core elements by analyzing uses, risks, policies, student and faculty perceptions, and ethical and regulatory challenges.

Accordingly, Table (1) presents an analytical matrix of twenty peer-reviewed studies directly or closely related to the governance of generative artificial intelligence in higher education. These studies are categorized according to thematic axes reflecting key literature trends: educational opportunities and the research landscape; academic integrity, ethics, and bias; institutional policies and university governance; assessment, originality, and teaching; and adoption, capacity building, and the Arab context. This categorization helps move beyond the traditional descriptive presentation of previous studies toward an analytical reading that reveals the contribution each study makes to understanding the governance of generative artificial intelligence in higher education.

Table 1. Analysis of previous studies according to the dimensions of generative AI governance in higher education

No	Title and author/s name	Country/ Region	Objectives and Methodology	Key findings and recommendations
First axis: Educational opportunities and research field map				
1	Kasneci et al. (2023). *ChatGPT for Good? On Opportunities and Challenges of Large Language Models for Education.*	International	It aimed to analyze the opportunities and challenges of large-scale language models in education, and used a multidisciplinary analytical study.	The study demonstrated that LLMs offer opportunities for personalized learning, feedback, writing, and cognitive support, but also raise challenges related to bias, hallucinations, over-reliance, and the need for critical thinking skills. The study supports the necessity of guiding their use with clear educational and ethical policies.
2	Lo (2023). *What Is the Impact of ChatGPT on Education? A Rapid Review of the Literature*	International	To provide a quick review of the impact of ChatGPT in education, a quick literature review was used.	The study showed that ChatGPT has educational potential in supporting learning and writing, but it poses risks related to accuracy, integrity, and over-reliance. It recommended caution in its integration and the development of clear guidelines for educational use.

3	Crompton & Burke (2023). *Artificial Intelligence in Higher Education: The State of the Field.*	International	The study aimed to analyze the state of artificial intelligence in higher education and trends in its use, and employed a literature review.	The study showed that AI applications in higher education have expanded into assessment, prediction, intelligent assistance, and adaptive learning. Its findings support the need for institutional policies that consider the transition from analytical to generative AI.
4	Dai et al. (2026). *Generative AI in Higher Education: A Bibliometric Review of Emerging Trends, Power Dynamics, and Global Research Landscapes*.	International	The study aimed to create a bibliometric map of GenAI literature in higher education during 2022–2025, and the study used a bibliometric analysis of thousands of articles from Web of Science.	The study revealed a rapid growth in research output, the dominance of certain countries and institutions in published knowledge, and the emergence of topics related to integrity, ethics, politics, and justice. It underscores the need for broader geographical and contextual representation in governance research.
The second axis: academic integrity, ethics, and bias				
5	Cotton et al. (2024). *Chatting and Cheating: Ensuring Academic Integrity in the Era of ChatGPT.*	UK/Higher Education	The study aimed to analyze the impact of ChatGPT on academic integrity, and used a critical analytical study.	The study confirmed that ChatGPT poses direct challenges to academic integrity due to its ability to produce seemingly authentic texts. It recommended not only relying on detection tools but also redesigning the academic calendar, clarifying usage limits, and fostering a culture of integrity.

6	Bittle & El-Gayar (2025). *Generative AI and Academic Integrity in Higher Education: A Systematic Review and Research Agenda*.	International	The study aimed to review the impact of GenAI on academic integrity in higher education, and the study used a systematic review.	The study concluded that GenAI offers educational opportunities but increases the risk of academic dishonesty. It recommended clear policies, student education, the adoption of authentic assessment methods, and avoiding complete reliance on automated transcription tools.
7	Li et al. (2024). *Ethical Implications of ChatGPT in Higher Education: A Scoping Review*.	International/ Multilingual	The study aimed to explore the ethical challenges of using ChatGPT in higher education, and employed a scoping review.	The study found that the most prominent ethical issues are academic integrity, assessment, and data protection. It recommended further empirical research and the development of clear ethical policies for the use of ChatGPT in universities.
8	Li et al. (2025). *Potential Societal Biases of ChatGPT in Higher Education: A Scoping Review.*	International/ Multilingual	The study aimed to analyze potential societal biases associated with the use of ChatGPT in higher education, and the study used a scoping review.	The study highlighted the limited in-depth treatment of biases in higher education literature, the dominance of English-speaking contexts, and the weakness of studies in the humanities and social sciences. It supports the need for governance that considers linguistic and cultural equity.
Third axis: Institutional policies and university governance				
9	Wang et al. (2024). *Generative AI in Higher*	US	The study aimed to analyze the policies and guidelines of the	The study showed that most universities adopt an open yet cautious stance toward GenAI,

	Education: Seeing ChatGPT Through Universities' Policies, Resources, and Guidelines.		top 100 American universities regarding GenAI. The study used university policy and document analysis.	focusing on ethics, privacy, and the accuracy of the results. It recommended specialized policies, the management of sensitive information, and the development of assessment methods.
10	Jin et al. (2025). *Generative AI in Higher Education: A Global Perspective of Institutional Adoption Policies and Guidelines.*	International	The study aimed to analyze GenAI adoption policies in global universities from the perspective of innovation diffusion, and the study used institutional policy analysis using innovation diffusion theory.	The study showed that policies focus on academic integrity, teaching and learning, equity, and building AI competencies. It also highlighted the need for more comprehensive frameworks to address privacy, equitable access, and the roles of stakeholders.
11	Crompton et al. (2026). *Governing Generative AI in Higher Education: A Global Delphi Study on Policy and Practice.*	International	The study aimed to develop a global framework for GenAI governance in higher education, and the study used a global Delphi study with the participation of experts from 22 countries/regions and six continents.	The study concluded with a framework of eight areas: academic integrity, ethical and responsible use, privacy, equitable access, GenAI literacy, integration strategy, human oversight and accountability, and institutional support and infrastructure.
12	Dotan et al. (2024).	US	The study aimed to develop a responsible	The study emphasized that GenAI governance at the

	Responsible Adoption of Generative AI in Higher Education: Developing a "Points to Consider" Approach Based on Faculty Perspectives.		approach to adopting GenAI in higher education based on faculty perceptions, and the study used a participatory qualitative/process study and focus groups.	university should prioritize shared academic governance, academic freedom, and teaching and research objectives, rather than imposing a rigid, centralized model. It also provided benchmarks to help universities adopt this approach responsibly.
		The fourth axis: Evaluation, authenticity, and teaching		
13	Luo (2024). *A Critical Review of GenAI Policies in Higher Education Assessment: A Call to Reconsider the "Originality" of Students' Work.*	International universities	The study aimed to critically analyze GenAI policies related to university calendar and authenticity, and the study used a policy analysis of 20 universities using the WPR framework.	The study revealed that many policies portray GenAI as a threat to authenticity and called for a rethinking of the concept of authenticity in the digital environment. It recommended more authentic assessments and a clearer definition of acceptable assistance.
14	Lee et al. (2024). *The Impact of Generative AI on Higher Education Learning and Teaching: A Study of Educators' Perspectives.*	Australia	The study aimed to explore faculty members' perceptions of the impact of GenAI on teaching and learning, and it used a mixed methodology: surveys and interviews.	The study revealed academics' concerns about GenAI's impact on integrity and assessment, despite their awareness of its educational potential. It recommended providing institutional support and training for academics on responsible pedagogical integration.

15	Belkina et al. (2025). *Implementing Generative AI (GenAI) in Higher Education: A Systematic Review of Case Studies.*	International	The study aimed to review experimental case studies that incorporated GenAI into university teaching and learning, and the study used a systematic review of experimental case studies.	The study showed that integrating GenAI can support learning, feedback, and educational efficiency, but it needs conscious educational design, clear guidelines, and a balance between innovation and integrity.
Fifth axis: Adoption, capacity building, and the Arab context				
16	Chan & Hu (2023). *Students' Voices on Generative AI: Perceptions, Benefits, and Challenges in Higher Education.*	Hong Kong	The study aimed to explore university students' perceptions of GenAI, its benefits and challenges, and the study used a survey of university students.	The study revealed positive trends toward GenAI in learning, while also highlighting concerns regarding accuracy, privacy, ethics, and its impact on personal and professional growth. Its findings support student involvement in policymaking.
17	Baek et al. (2024). *ChatGPT Seems Too Good to Be True": College Students' Use and Perceptions of Generative AI.*	US	The study aimed to examine university students' use of and perceptions of ChatGPT, and the study used a quantitative survey on 1001 university students.	The results showed that ChatGPT usage is influenced by age, specialization, type of institution, and institutional policies. The study recommended providing guidance to students and developing policies that take into account the different usage patterns among different groups.

18	Barus et al. (2025) *Shaping Generative AI Governance in Higher Education: Insights from Student Perception.*	Indonesia	The study aimed to explore students' perceptions of GenAI governance in higher education, and the study used a mixed approach with a sequential interpretive design.	The study showed that students support the integration of GenAI, but they demand clear guidelines, ethical training, and mechanisms to prevent misuse. It recommended involving students in developing governance policies.
19	Al-Mamary et al. (2025). *Empowering ChatGPT Adoption in Higher Education.*	Saudi Arabia	The study aimed to analyze university students' intention to adopt ChatGPT, and the study used a quantitative approach based on the theories of self-determination and the technology-to-performance chain.	The study showed that ChatGPT adoption is influenced by psychological and technical factors such as autonomy, competence, and the suitability of the technology for performance. Its findings support the importance of building student competencies and providing clear institutional guidance.
20	Assad & Alomari (2026). *A Systematic Literature Review of ChatGPT Adoption in Arab Higher Education.*	Arab context	The study aimed to review the adoption of ChatGPT in Arab higher education, and the study used a systematic review of 40 articles published between 2023 and 2025.	The study revealed that Arabic literature focuses on personal learning, skills development, enhancing learning experiences, writing, and translation, but suffers from limited theoretical frameworks and geographical representation. This underscores the need for more Arabic studies focused on governance.

4.1.2 Analytical Review of Previous Studies

Table (1) shows that previous studies on generative artificial intelligence in higher education are distributed among foundational studies, methodological reviews, policy studies, and field studies. These studies reveal that GenAI governance cannot be limited to the issue of academic integrity alone, although integrity was the most prominent approach in the early literature. Studies such as Cotton et al. (2024) and Bittle and El-Gayar (2025) showed that text generation tools pose direct challenges to the originality of academic work, but at the same time, they emphasized that detection tools alone are insufficient, and that a governance solution requires redesigning assessment, clarifying the limits of use, and building a responsible academic culture.

Studies also show that institutional policies have become a prominent focus in GenAI literature. Wang et al. (2024) and Jin et al. (2025) revealed that universities are gradually adopting an open yet cautious approach, permitting conditional use and linking it to disclosure, privacy, output accuracy, fairness, and capacity building. This means that university governance is no longer based on a simplistic "prohibit" or "allow" dichotomy, but rather on flexible and gradual regulation that considers the diversity of disciplines, courses, and risks.

Assessment studies, particularly Luo (2024), confirm that generative AI necessitates a re-evaluation of the concept of academic authenticity. Authenticity no longer means the complete absence of digital tools, but rather the student's ability to employ these tools openly, critically, and responsibly, demonstrating understanding, verification, and self-contribution. Thus, assessment governance serves as a link between academic integrity and the quality of learning.

Studies on adoption and student and faculty perceptions reveal that successful governance depends not only on written policies but also on users' awareness, trust, and understanding of the ethical and educational boundaries of the tool. This underscores the importance of involving students and faculty in policy development, providing institutional training, and developing AI competencies. This point is particularly relevant in the Arab context, as Assad and Alomari's (2026) review indicates that the Arabic literature still requires further research that moves beyond analyzing usage and perceptions to developing institutional governance models that consider linguistic, cultural, and organizational specificities.

Accordingly, previous studies reveal two key gaps: first, the need for an integrated governance model that links integrity, privacy, fairness, evaluation, capacity building, and accountability within a single framework; and second, the need to adapt this model to Arab contexts, ensuring it is not directly transferred from Western universities or international frameworks but rather reconstructed to reflect the Arabic language, university organizational structures, national legislation, and levels of digital readiness.

4.2. Sectoral, Institutional, and Regulatory Frameworks for Governing Generative Artificial Intelligence in Higher Education

4.2.1 Introduction

In addition to peer-reviewed studies, sectoral, institutional, and regulatory frameworks are a crucial resource for understanding generative AI governance in higher education. These frameworks encompass not only binding laws but also policy frameworks, quality assurance guidelines, responsible use principles, assessment and academic integrity guidelines, and institutional university policies. This broad definition of "regulatory frameworks" is appropriate for higher education, as many influential directives for universities are issued as sectoral or institutional guidelines, not solely as binding legislation.

These frameworks were analyzed according to the fields defined in the data extraction methodology: document or framework name, issuing authority, scope, regulatory or advisory nature, and the governance principles or requirements they provide for higher education. Table (2) presents a selected sample of frameworks that are specialized or closely related to higher education, while general frameworks are kept in a decentralized, supporting location.

Table (2) Analysis of Institutional and Regulatory Frameworks Relevant to the Governance of Generative Artificial Intelligence in Higher Education

No	Frame/Document Name	Entity/Scope	organizational nature	Implications of higher education
1	*Guidance for Generative AI in Education and Research*	UNESCO/ International	An international guiding framework specializing in education and research	It directs educational and research institutions to adopt a responsible use of generative artificial intelligence, with a focus on protecting learners and researchers, human oversight, capacity building, and institutional policies.
2	Maintaining Quality and	QAA – Quality Assurance	Sectoral guidelines for quality	It provides guidance to universities and colleges on managing the use of GenAI while maintaining quality

	Standards in the ChatGPT Era	Agency for Higher Education. UK	assurance and academic standards	and academic standards, and links governance to issues of assessment, integrity, and standards.
3	*Reconsidering Assessment for the ChatGPT Era*	QAA – Quality Assurance Agency for Higher Education. UK	Sectoral guidelines for calendar reform	Directing higher education institutions to review their assessment practices in light of GenAI tools, and to move towards more authentic and sustainable assessments.
4	Assessment Reform for the Age of Artificial Intelligence	TEQSA – Tertiary Education Quality and Standards Agency. Australia	Framework/Guidelines from the Higher Education Quality Regulatory Authority	It provides guidance to the higher education sector on how to leverage the opportunities of generative artificial intelligence and manage its risks in assessment, thereby supporting learning assurance and academic integrity.
5	Generative AI in Higher Education Teaching & Learning: Policy Framework	Higher Education Authority. Ireland	National Policy Framework for Higher Education	It provides a common reference for higher education institutions in dealing with GenAI opportunities and challenges in teaching, learning and assessment, while respecting institutional autonomy and academic freedom.
6	Generative Artificial Intelligence: Guidelines for Educators	QQI / National Academic Integrity Network. Ireland	Educational guidelines and academic integrity	It helps teachers in higher education understand acceptable and unacceptable uses of GenAI, and links the use of the tool to academic integrity and assessment.

7	Principles on the Use of Generative AI Tools in Education	Russell Group. UK	Sectoral principles issued by the Association of Universities	Developed by Russell Group universities and artificial intelligence experts, it emphasizes AI literacy, equipping staff to support students, adapting teaching and assessment, and maintaining academic integrity.
8	Guidelines for the Responsible Use of AI in External Quality Assurance	ENQA – European Association for Quality Assurance in Higher Education. European	Guidelines for external quality assurance agencies.	It focuses on the responsible use of artificial intelligence in quality assurance, with principles of transparency, data protection, fairness, human oversight, training, and continuous review.
9	Australian Framework for Artificial Intelligence in Higher Education	Australian Centre for Student Equity and Success. Australia	Sectoral framework for higher education	The use of artificial intelligence in higher education is linked to issues of equity, ethical innovation, integrity, quality of learning, and student experience.
10	Policy Framework and Guidelines on GenAI in Education.	University of Amsterdam. Netherlands	Institutional University Policy Framework	It describes the university's policy on GenAI in education, providing a central framework and guidelines for responsible and transparent use, with an emphasis on scientific integrity and periodic policy updates.
11	Policy Framework Generative Artificial Intelligence	Maastricht University. Netherlands	Institutional University Policy Framework	It explains the university's position and vision regarding the use of GenAI in education, research and institutional operations, and provides guidelines for responsible use.

12	Framework for Generative AI in Education	Vrije Universiteit Amsterdam. Netherlands	Institutional University Policy Framework	It guides colleges in developing their own policies for the use of GenAI in education, and links institutional use to accountability and consistency across academic units.
13	*Policy on the Use of Artificial Intelligence (AI) in Student Assessment*	Swansea University. UK	Official university policy for evaluation	Principles for the responsible use of artificial intelligence applications, including GenAI, are defined in student assessment, with an emphasis on ethics, transparency, fairness, and maintaining academic standards.
14	Regulation (EU) 2024/1689: Artificial Intelligence Act	European Parliament and Council of the European Union. EU	Binding general legal framework	It is not specific to higher education, but it is important because it classifies some uses of artificial intelligence in education and training as high-risk when they affect admission, assessment, or educational pathways.
15	Artificial Intelligence Risk Management Framework: Generative Artificial Intelligence Profile	NIST US	Supportive general risk management framework	It is not intended for higher education, but it offers practical tools for identifying, measuring, and managing GenAI risks, and can be employed in universities when evaluating tools, protecting data, and managing sensitive uses.
16	National Framework for Artificial Intelligence in Digital Learning (AIDL) in the	National eLearning Center – NeLC. KSA	A national framework for digital education, including higher education	It offers a national framework for adopting AI in digital learning, encompassing nine dimensions: leadership, curriculum and content design, teaching and learning, assessment and performance

	Kingdom of Saudi Arabia			monitoring, ethics and responsible use, technology standards, data security and privacy, student support, professional development, and continuous evaluation and improvement. This framework assists universities in developing institutional AI policies aligned with digital education, data protection, and responsible use.
17	Policies for the Use of Artificial Intelligence in Education and Scientific Research	Imam Abdulrahman Bin Faisal University. KSA	Institutional university policy for education and scientific research	The policy provides an institutional framework for the use of AI in education and research, guiding faculty, students, and researchers toward responsible use. It establishes governance requirements related to academic integrity, ethical use, safeguarding the quality of learning, and adherence to institutional controls when employing AI tools in educational and research activities.
18	Generative AI Use Policy	Princess Nourah bint Abdulrahman University. KSA	institutional university policy	The policy guides faculty, researchers, students, and administrative staff toward the responsible and informed use of generative artificial intelligence. Governance requirements include: ethical use, protection of academic integrity, support for teaching, learning, and research, risk mitigation, and alignment with SDAIA and NeLC guidelines.

19	Generative AI Usage by the Students Policy	United Arab Emirates University. UAE	University policy for students	The policy provides guidelines for the use of GenAI in academic work, focusing on academic integrity, ethical considerations, data privacy, information security, and compliance with laws and regulations. It also emphasizes that the use of GenAI should support learning and the achievement of course and program outcomes, not replace student effort or critical thinking.

4.2.2. Analytical of Institutional and Regulatory Frameworks

Table 2. illustrates that the regulatory frameworks for generative AI in higher education extend beyond general legal frameworks to encompass a wide range of sectoral and institutional frameworks. The importance of sectoral frameworks, such as QAA, TEQSA, HEA, and ENQA, lies in their direct link between GenAI governance and quality assurance, academic standards, assessment, and integrity issues central to university operations. Furthermore, the Russell Group Principles and QQI/NAIN guidelines reveal that governance in higher education is moving toward regulating responsible use, rather than outright prohibition.

Institutional frameworks, such as those of the University of Amsterdam, Maastricht University, and Swansea University, demonstrate how general principles are translated into practical policies within the university. They define rules of use, scope of application, the roles of students and faculty, and the limits of GenAI use in teaching, assessment, and research. These frameworks represent a crucial level of governance because they demonstrate how institutions move from general discourse on AI to actionable regulatory procedures. Conversely, general frameworks such as the EU AI Act and NIST remain valuable, not because they are specific to higher education, but because they provide a regulatory and operational language for managing risk, human oversight, privacy, and accountability. Therefore, the governance of generative AI in universities should be based on an integration of higher education-specific frameworks and general frameworks for risk management and legal regulation, with priority given to the analysis of sectoral and institutional frameworks directly related to universities.

Gulf and Arab frameworks and policies are of particular importance because they shift the discussion on the governance of generative artificial intelligence (AI) from the level of general global frameworks to the level of institutional application within Arab universities. In Saudi Arabia, the National Center for E-Learning's AI in Digital Learning framework provides a national reference point that helps educational institutions regulate the use of AI within dimensions that include leadership, teaching and learning, assessment, ethics, data security and privacy, professional development, and continuous improvement. The policies of Princess Nourah bint Abdulrahman University and Imam Abdulrahman bin Faisal University also exemplify the Saudi universities' move towards issuing institutional policies that guide the use of generative AI, or AI in general, in education and scientific research, emphasizing responsible use, academic integrity, quality of learning, and risk mitigation. In the UAE context, the United Arab Emirates University's policy provides an example of guiding students' use of generative AI in academic work, linking governance to academic integrity, privacy, information security, and the achievement of learning outcomes. These models indicate that the Gulf context is beginning to move from adopting general principles of AI ethics to developing university and sectoral policies more closely connected to higher education.

Despite the trend among Arab and Gulf universities to keep pace with regulations for the use of artificial intelligence in higher education, a gap remains in the scarcity of published studies analyzing Arab universities' policies related to generative AI. While global studies have analyzed the policies of American and other international universities, the analysis of Arab policies remains limited, both in terms of the number of universities studied and the depth of governance analysis. The second gap concerns data governance and privacy. Arab universities need clear policies regarding the input of student data, unpublished research materials, and institutional documents into generative AI tools, especially given the varying national data protection laws. The third gap relates to linguistic and cognitive equity. Generative tools do not necessarily perform the same in Arabic and English, and the quality of Arabic content, linguistic and cultural biases, and the representation of Arabic knowledge in large-scale models are all issues that require in-depth governance analysis.

5. Discussion and Recommendations:

The review showed that academic integrity was the most prominent approach in the early literature on generative AI in higher education. Studies such as Cotton et al. (2024) and Bittle and El-Gayar (2025) focused on the risks of cheating, plagiarism, and the production of academic work using text-generating tools. However, the analysis reveals that this approach is insufficient, as generative AI not only threatens integrity but also reshapes the relationship between the student, the learning task, and the knowledge produced. Therefore, the solution lies not only in detection tools but also in redesigning assessment methods, clarifying usage rules, and building a culture of disclosure and accountability.

The study also indicated that global university policies are moving towards a "conditional responsible use" model. Studies by Wang et al. (2024) and Jin et al. (2025) showed that many universities are not inclined towards outright prohibition but rather seek to develop guidelines that combine openness to the potential of the technology with caution regarding its risks. This trend indicates a gradual maturation in institutional discourse, as universities come to realize that completely banning GenAI tools may be unrealistic, while unregulated permission may threaten integrity, privacy, and fairness.

The review also reveals that Institutional and Regulatory frameworks add a crucial dimension not provided by academic studies alone. UNESCO guidelines offer a humanistic and educational perspective on responsible use in education and research, while NIST provides an operational framework for risk management, and the European Artificial Intelligence Law offers a risk-level-based regulatory model. Thus, it is clear that the governance of generative AI in universities must integrate three levels: the ethical, the institutional, and the operational.

5.1. Theoretical Implications

This study presents three main theoretical implications. First, it emphasizes that the governance of generative AI in higher education should be understood as an interdisciplinary field encompassing pedagogy, technology ethics, data governance, risk management, and higher education policy. This means that approaching it solely from an pedagogical or purely technical perspective is insufficient to grasp its complexities.

Second, the study contributes to broadening the concept of academic integrity in the age of generative AI. Integrity no longer simply means preventing plagiarism or detecting cheating; it now includes disclosure, transparency, acceptable limits of assistance, and the design of assessment tasks that measure actual learning. Thus, integrity shifts from being a matter of individual conduct to a shared institutional responsibility.

Third, the study suggests that governance in this field should be adaptive, not rigid. The rapid evolution of GenAI tools renders fixed policies obsolete, and therefore, universities need adaptable models, mechanisms for periodic review, risk registers, and continuous channels for feedback from students and faculty.

5.2. Applied Implications for Higher Education Institutions

The study's findings indicate that universities need to move from broad public policies to practical operational frameworks. An institutional statement on generative AI is insufficient without clear guidelines for its use in courses, disclosure models, data protection controls, training programs, and fair accountability mechanisms.

The findings also demonstrate that faculty members play a crucial role in governance implementation, as they are responsible for translating public policy into course practices. Therefore, training faculty members in designing authentic assessments, explaining the limitations of GenAI use, and guiding students toward critical and responsible use is essential for the success of any institutional policy.

Furthermore, the importance of student participation in governance is highlighted. Students are not merely recipients of instructions; they are the most frequent users of these tools. Consequently, policies developed without understanding student usage patterns, motivations, and concerns may be less effective. Universities should incorporate consultation channels, periodic surveys, and feedback mechanisms to understand the impact of policies on learning and equity.

5.3. Recommendations for Universities

The study also recommends the formation of a permanent committee for generative AI governance. This committee should include representatives from academic administration, information technology, quality assurance, legal affairs, research, faculty, and students. Its responsibilities would include reviewing tools, updating policies, classifying risks, monitoring compliance, and providing support to colleges and programs.

The study recommends developing standardized and flexible disclosure forms for the use of GenAI in assignments, research, and projects. These forms should require students or researchers to clearly state the name of the tool used, its purpose, the nature of the assistance, and how the outputs will be verified. Disclosure should be viewed as an educational and ethical practice, not a punitive measure.

Finally, the study recommends that universities redesign their academic calendars to be more authentic, progressive, and diverse. This includes relying on oral presentations, applied projects, progress calendars, reflective journals, step-by-step discussions, and linking tasks to real-world or local contexts. This approach helps reduce reliance on tasks that can be fully generated by AI.

The study also recommends implementing strict data protection controls, including preventing the entry of sensitive personal, research, or organizational data into uncertified GenAI tools, reviewing the terms of use of these tools, and prioritizing secure enterprise solutions whenever possible.

5.4. Recommendations for Policymakers and Regulatory Bodies:

The study recommends that higher education regulatory bodies to:

- Develop national or regional guidelines for the governance of generative AI in universities, ensuring that each institution does not operate in isolation. These guidelines could include general principles, policy models, minimum data protection standards, disclosure mechanisms, and guidance for assessment and academic integrity.

- Integrating generative AI governance into quality and accreditation standards. Just as universities are assessed on institutional governance, quality, research, and digital transformation, they should also be evaluated on their ability to responsibly manage generative AI tools.
- Supporting the development of open Arabic resources on the responsible use of generative AI in higher education, including student guides, faculty guides, policy models, and examples of authentic assessments. This would help reduce reliance on foreign resources that may not take into account the linguistic and cultural specificities of Arab universities.

5.5. Recommendations for Researchers:

- Conducting more focused Arab research analyzing published university policies on GenAI, rather than solely focusing on trends and acceptance. Comparative studies between Arab and international universities are also needed on issues of disclosure, data protection, assessment redesign, and building AI competencies.
- Conducting field studies on the impact of using generative AI on the quality of learning, not just on students' attitudes toward it. The important question is not simply whether students use the tool, but how its use affects critical thinking, academic writing, achievement, and cognitive independence.

The study further recommends research on linguistic equity and bias in GenAI outputs in Arabic, including information accuracy, phrasing quality, representation of Arabic knowledge, and cultural biases. This issue is of particular priority for Arab universities seeking to use these tools without compromising the language, identity, and local knowledge.

6. Conclusion:

This study aimed to provide a comprehensive review of generative AI governance in higher education during the period 2022–2026, in light of the rapid transformations universities worldwide have undergone following the widespread adoption of large language models and content generation applications. The study was based on the premise that generative AI is not merely an educational tool or assistive technology, but rather an institutional and epistemological shift affecting the nature of learning, assessment, research, academic integrity, data protection, and the distribution of responsibilities within the university.

Through an analysis of peer-reviewed studies, institutional and regulatory frameworks, and selected university policies, the study revealed that generative AI governance in higher education requires a multidimensional approach. While the literature showed that academic integrity was the most prominent focus in the early stages of the discussion, a more mature governance approach extends beyond the issue of cheating and plagiarism to broader dimensions, including privacy, transparency, disclosure, equitable access, human oversight, capacity building, risk management, and assessment redesign. The study also showed that international frameworks, such as UNESCO guidelines, the NIST framework, the European Artificial Intelligence Law, provide important references for universities, but they are insufficient on their own unless translated into clear institutional policies, implementation procedures, disclosure models, training programs, and monitoring mechanisms. The selected university policies demonstrate that the global trend is leaning towards "conditional responsible use," meaning recognizing the potential of generative AI while regulating its use through rules of integrity, privacy, disclosure, and evaluation.

The study further highlighted that the Arab context still requires more research and regulatory efforts in this field. Despite the growing Arab interest in using generative AI in higher education, studies and policies addressing integrated institutional governance remain limited. This underscores the need for Arab models that consider language, academic culture, national legislation, digital sovereignty, and equitable access to AI tools.

In light of this, the study emphasizes that the success of higher education institutions in dealing with generative AI will not be achieved through blanket prohibition or unconditional adoption, but rather through intelligent and evolving governance that balances innovation with responsibility, and leveraging technological potential while protecting human beings, knowledge, and academic integrity. Therefore, generative AI governance should become an integral part of higher education governance in the coming phase, not a temporary response to a transient technological tool.

7. Declarations:

The author declares that no funding was received for this research. The author also declares that there is no conflict of interest regarding the publication of this article. The author confirms sole responsibility for the conception and design of the study, data collection, analysis and interpretation of results, and preparation of the manuscript. Ethical approval and informed consent were not applicable to this study.

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