EXPLORING UNIVERSITY STUDENTS' AWARENESS AND UNDERSTANDING OF FORENSIC CHEMISTRY AND DNA APPLICATIONS: A QUESTIONNAIRE-BASED STUDY

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Abstract. *Forensic chemistry is a rapidly growing sub discipline of forensic science that plays an essential role in criminal investigations through the examination and analysis of physical evidence, including drugs, explosives, and toxic compounds. Despite increasing demand for forensic chemists in the job market, awareness and knowledge of forensic chemistry among university students particularly undergraduate students in chemistry and biotechnology remain insufficiently explored. This study employed a validated questionnaire to investigate the level of awareness, knowledge, attitudes, and perceptions of 20 undergraduate students at Al-Nahrain University, Iraq, regarding forensic chemistry, DNA analysis, and biotechnology. The results indicated that the majority of participants demonstrated a satisfactory level of awareness: 80% were aware of forensic science, 82% recognized the connection between DNA analysis and forensic science, 84% understood the relationship between DNA and biotechnology, and 91% appreciated the importance of DNA evidence in crime scene investigations. Additionally, 79% expressed interest in pursuing future studies in forensic science. The findings underscore significant educational implications for forensic chemistry curricula, career development pathways, and the broader enhancement of scientific literacy regarding forensic science among university students.*

Keywords: *forensic chemistry, questionnaire, awareness, undergraduate students, DNA analysis*

INTRODUCTION

Forensic science has witnessed a substantial increase in its significance within criminal investigations and legal proceedings over recent decades. A critical subdiscipline of this field is forensic chemistry, which focuses on testing and analyzing physical evidence containing various materials like toxic substances, explosives, and illicit drugs [1]. The findings from forensic chemical analyses provide a foundation for criminal inquiries and are regularly presented as valid evidence in court. Ultimately, without the application of forensic chemical methodologies and principles, a vast number of criminal cases would go unsolved, permitting guilty individuals to escape justice [1].

Forensic chemists examine physical evidence including drugs, fibers, and fingerprints alongside biological evidence such as blood, saliva, and urine. They employ advanced analytical methods, including chromatography, spectroscopy, and mass spectrometry to identify and quantify compounds present in collected evidence. Forensic chemistry thereby facilitates the resolution of diverse criminal cases, including homicides, drug trafficking, arson, and sexual assaults [4].

The work of forensic chemists involves evaluating physical evidence—such as fingerprints, fibers, and drugs—as well as biological materials like urine, saliva, and blood. To successfully detect and measure the specific compounds contained within these collected samples, they utilize sophisticated analytical techniques like mass spectrometry, spectroscopy, and chromatography. Through these methods, forensic chemistry plays an essential role in solving a wide array of criminal offenses, ranging from sexual assaults and arson to drug trafficking and homicides [4].

The employment landscape for forensic chemistry specialists is consistently expanding in response to rising demand. Forensic chemists may be employed in diverse sectors, including law enforcement organizations, governmental agencies, private laboratories, and academic institutions. The U.S. Bureau of Labor Statistics projected a 13% growth in employment for forensic science technologists from 2024 to 2032, reflecting the increasing reliance on scientific evidence in the criminal justice system [8].

Despite the growing demand for forensic chemists, there exists a notable dearth of research examining the awareness and understanding of forensic chemistry among university students [2]. Prior studies have explored aspects of forensic science education at the university level, yet few have systematically evaluated students' foundational understanding and career perceptions within undergraduate chemistry and biotechnology programs. This gap is particularly relevant in developing countries, where forensic science education may be less integrated into standard curricula [5, 7].

This study addresses this knowledge gap by presenting the results of a questionnaire-based investigation into the awareness, understanding, attitudes, and career perceptions of undergraduate chemistry and biotechnology students regarding forensic chemistry. The findings are expected to yield substantial implications for advancing forensic chemistry education and for enhancing public scientific literacy regarding forensic science.

METHOD

Research Design and Instrumentation

A cross-sectional questionnaire-based study design was employed to evaluate undergraduate students' awareness, knowledge, attitudes, and perceptions regarding forensic chemistry. The questionnaire comprised structured items designed to assess: (1) prior awareness of forensic science; (2) understanding of the relationship between DNA analysis and forensic science; (3) knowledge of DNA applications in biotechnology; (4) appreciation of DNA evidence in crime scene investigations; and (5) interest in pursuing further studies or careers in forensic science. Survey data were collected during a single academic semester at Al-Nahrain University, Baghdad, Iraq.

Sampling Strategy and Response Rate

Participants were recruited from the undergraduate programs in Chemistry and Biotechnology at Al-Nahrain University, a prominent public research institution in Iraq. A convenience sampling approach was employed, targeting students enrolled in relevant science courses. A total of 32 questionnaires were distributed; 20 were completed and returned, yielding a response rate of 62.5%. The study sample consisted of 20 undergraduate students (50% male, 50% female), representing an equal gender distribution.

Data Analysis and Interpretation

Completed questionnaires were analyzed using descriptive statistics, including frequencies and percentages, to characterize participants' awareness, knowledge, attitudes, and perceptions. Inferential statistics were employed using Microsoft Excel (Version 2019) to examine variations in awareness levels across different academic disciplines and educational levels. Results are presented as percentage values and illustrated with bar charts (Figures 1–5).

RESULT AND DISCUSSION

Awareness of Forensic Science

The questionnaire was administered to a sample of 20 undergraduate students enrolled in chemistry and biotechnology programs. As illustrated in Figure 1, approximately 80% of participants indicated prior awareness of

forensic science, while 20% reported no previous knowledge of the field. These findings suggest that forensic science has gained meaningful recognition among university students, likely attributable to its increasing presence in academic curricula, digital media, and popularized criminal investigation programming. However, the presence of a non-negligible proportion of students with limited awareness indicates the continued need for targeted educational initiatives and introductory academic courses dedicated to forensic chemistry and its applications in criminal investigations and legal procedures.

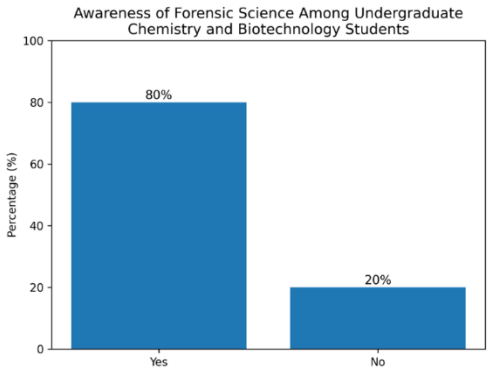


Figure 1 Awareness of Forensic Science Among Undergraduate Chemistry and Biotechnology Students

Understanding of the Relationship between DNA Analysis and Forensic Science

Results pertaining to students' understanding of the connection between DNA analysis and forensic science are presented in Figure 2. Approximately 82% of participants recognized the importance of DNA analysis in forensic investigations, while 18% demonstrated limited or no awareness of this connection. These findings indicate that the majority of students possess a functional understanding of DNA's role in the identification of individuals and the support of criminal investigations [7]. Nonetheless, the persistence of a subset of students with insufficient awareness underscores the importance of enhancing educational programs and practical activities related to forensic genetics and forensic chemistry.

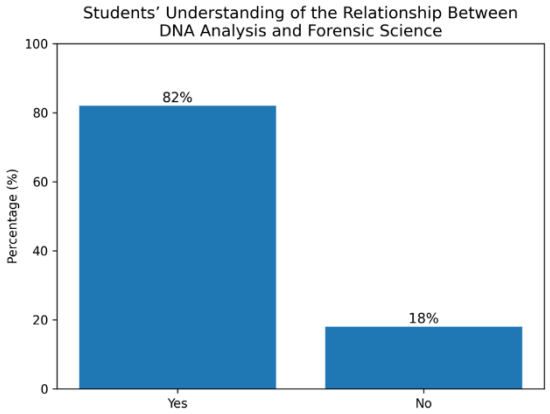


Figure 2 Students' Understanding of the Relationship between DNA Analysis and Forensic Science

Awareness of the Relationship Between DNA and Biotechnology

As shown in Figure 3, approximately 84% of participants recognized that DNA plays a fundamental role in biotechnology applications, including genetic engineering, medical diagnostics, and molecular research. This relatively high level of awareness may be attributed to students' academic backgrounds and their prior exposure to biological and chemical sciences throughout their undergraduate coursework. In contrast, 16% of students demonstrated limited understanding of this relationship, suggesting that some individuals may require additional educational support and laboratory-based activities to consolidate their knowledge of modern DNA-based biotechnological applications.

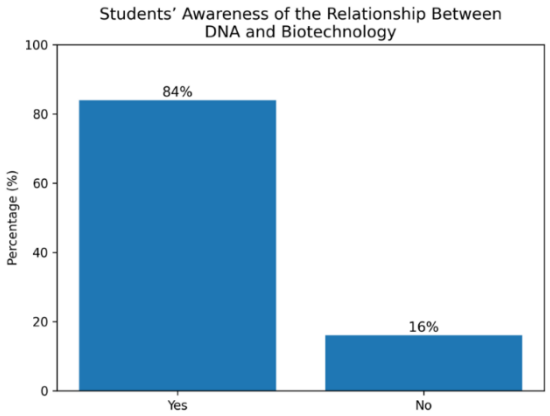


Figure 3 Students' Awareness of the Relationship between DNA and Biotechnology

Awareness of DNA Evidence in Crime Scene Investigation

Figure 4 presents students' awareness of the significance of DNA evidence in crime scene investigations. A high proportion of participants (91%) recognized the importance of DNA evidence in forensic contexts, while only 9% demonstrated limited awareness. This strong awareness likely reflects both academic instruction and widespread media exposure to DNA-based forensic applications [3]. The increasing use of DNA analysis in modern forensic practice may have contributed to students' familiarity with this topic, irrespective of formal coursework.

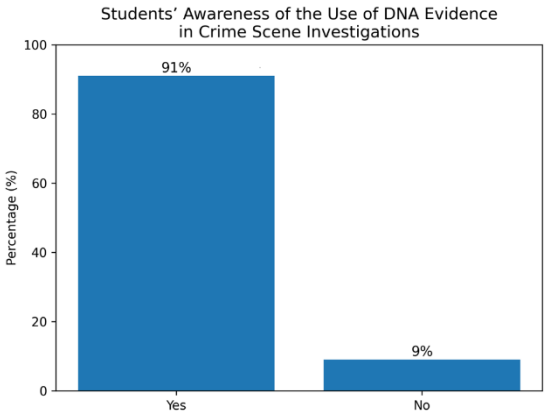


Figure 4 Students' Awareness of the Use of DNA Evidence in Crime Scene Investigations

Interest in Pursuing Future Studies in Forensic Science

Results regarding students' interest in continuing their studies in forensic science are presented in Figure 5. A majority of participants (79%) expressed interest in pursuing further education or career opportunities in forensic science, while 21% reported limited interest. The high level of expressed interest may reflect the increasing societal importance of forensic science and its natural connections to chemistry and biotechnology curricula [5]. The smaller proportion of disinterested students may reflect individual academic preferences or limited knowledge of available career pathways in the field.

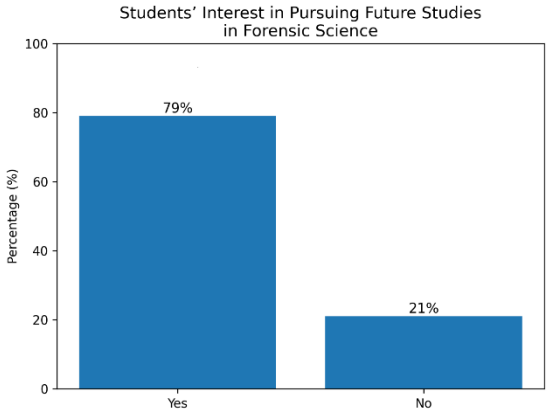


Figure 5 Students' Interest in Pursuing Future Studies in Forensic Science

Figure 5. Students' interest in pursuing future studies in forensic science. Results showed that 79% of undergraduate chemistry and biotechnology students expressed interest in continuing studies related to forensic science, while 21% reported no such interest.

Demographic Characteristics of Participants

The study sample comprised 20 undergraduate students from Chemistry and Biotechnology programs at Al-Nahrain University. The participants included both male and female students, with an equal gender distribution of 50% males and 50% females. Demographic characteristics were considered during data analysis and interpretation to ensure balanced representation.

Overall Awareness of Forensic Chemistry among University Students

Taken together, the results indicate that undergraduate chemistry and biotechnology students at Al-Nahrain University demonstrated a generally satisfactory level of awareness of forensic chemistry, DNA analysis, and biotechnology applications. Most participants showed positive attitudes toward forensic chemistry education and career opportunities, with the majority expressing interest in studying forensic science courses and pursuing related careers. These findings align with prior research emphasizing the positive impact of forensic science education on student engagement and career interest [7]. Notably, awareness levels appeared to be influenced by multiple factors, including

students' field of study, educational level, and exposure to forensic science through media and personal experiences.

LIMITATIONS AND FUTURE RESEARCH

Several limitations of this study must be acknowledged. First, the relatively small sample size (n = 20) limits the generalizability of the findings to the broader student population. Second, data collection was confined to a single university in Iraq, which may not be representative of undergraduate student populations at other institutions or in different national or cultural contexts. Third, the questionnaire instrument, while structured and systematic, may not capture the full depth of students' conceptual understanding of forensic chemistry, and social desirability bias cannot be entirely excluded.

Future research should address these limitations by employing larger, multi institutional samples drawn from diverse universities and geographic regions. The use of mixed methods approaches combining validated surveys with semi structured interviews, focus groups, or concept mapping exercises would allow for a more nuanced and comprehensive assessment of students' knowledge, attitudes, and misconceptions regarding forensic chemistry. Longitudinal study designs examining changes in awareness following dedicated forensic chemistry instruction would also be valuable.

CONCLUSIONS

This study evaluated the awareness, knowledge, and career perceptions of undergraduate chemistry and biotechnology students regarding forensic chemistry. The results indicate that most participants demonstrated a foundational understanding of forensic science, DNA analysis, and biotechnology, and the majority expressed interest in pursuing further studies in this field. However, a subset of students exhibited limited awareness, indicating the need for enhanced educational programming in forensic chemistry.

To improve student awareness and engagement with forensic chemistry, universities are encouraged to consider the integration of dedicated forensic chemistry modules, workshops, seminars, and laboratory-based activities related to forensic investigations and DNA analysis into undergraduate science curricula. Supplementary educational resources, including guest lectures by practicing forensic chemists, laboratory demonstrations, and the use of case-based learning approaches, may further strengthen students' appreciation of forensic chemistry and its associated career opportunities.

Overall, this study highlights the importance of promoting forensic chemistry education within university science programs as a means of developing students' scientific knowledge, professional identity, and readiness for careers in forensic and criminal investigation fields.

AUTHOR CONTRIBUTIONS

R.M. contributed to data collection, analysis, and manuscript preparation. K.Z. contributed to study conceptualization and manuscript review. W.A.A. contributed to questionnaire design and data interpretation. E.Y. conceived the study, supervised the research, and revised the manuscript. All authors have read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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