Journal of Science and Technological Education, Vol. 3 No. 2, 2024
ISSN: 2830-5043 (Print) 2830-4829 (Online)

Journal of Science and Technological Education
(META)

journal homepage: www.meta.amiin.or.id

Article history: Received December 6, 2024; Accepted December 25, 2024; Published December 26, 2024

Comprehensive Analysis of Challenges and Opportunities for Chemistry Education Students: A Case Study of the 2024 Cohort

Elida Pasaribu
Department of Chemistry, Universitas Negeri Medan, Indonesia
Correspondence author, elidapasaribugorat@gmail.com

Iza Harahap
Department of Chemistry, Universitas Negeri Medan, Indonesia

Nova Fajria Marbun
Department of Chemistry, Universitas Negeri Medan, Indonesia

Ravisa
Department of Chemistry, Universitas Negeri Medan, Indonesia

Rosa Lumbangaol
Department of Chemistry, Universitas Negeri Medan, Indonesia

Rabiah Afifah Daulay
Department of Chemistry, Universitas Negeri Medan, Indonesia

Abstract The rapid advancements in science and technology have transformed the educational landscape, presenting new challenges and opportunities for prospective educators. This study examines the demographic profile, technological gaps, and conceptual challenges faced by Chemistry Education students of the 2024 cohort at a higher education institution, especially in Universitas Negeri Medan. A mixed-methods approach was used, combining quantitative data analysis of 198 students with qualitative insights from surveys and interviews. Results indicate significant gender disparities, with female students forming the majority (26 Males and 172 Females), and highlight deficiencies in technological proficiency and conceptual understanding among students. The study concludes with actionable strategies, including targeted technological training, curriculum reform to incorporate project-based learning, and soft skills development, aimed at equipping students to excel as innovative and effective educators.

Keywords: Chemistry education, Gender disparity, Interactive learning, Technological training, Curriculum reform

INTRODUCTION

Education is a crucial element in shaping high-quality human resources capable of addressing the rapid changes and advancements of the modern era. It should aim to produce individuals who are not only competitive and skilled but also possess strong morals and ethical values. Learning becomes more meaningful when students engage directly with the material, yet traditional teaching methods often fail to embrace the scientific learning approaches outlined in contemporary curricula.

In today's world, where educational paradigms are shifting towards critical thinking, collaboration, and technological integration, the Chemistry Education program must adapt to produce competent educators (Dito & Pujiastuti, 2021). However, the subject of chemistry is frequently perceived as challenging by students, leading to disengagement and low academic performance (Hakim et al., 2024). Chemistry, which encompasses interconnected concepts and requires hands-on experimentation, often struggles to capture students' interest due to outdated and theoretical teaching methods (Santoso, 2024; Sutresna, 2022).

The advent of Industry 4.0 has brought significant changes to the educational sector, enabling virtual facilitation and real-time knowledge transfer on a global scale. This transformation became particularly evident during the COVID-19 pandemic, which forced educational institutions at all levels to adopt online learning (Khairunnisa et al., 2024). The integration of digital tools and platforms into the curriculum is now essential to ensure relevance and effectiveness in teaching methodologies (Muhali et al., 2023). Nonetheless, disparities remain in how institutions and educators adapt to these advancements, creating gaps in technological proficiency and curriculum alignment.

Within this context, the Chemistry Education program of the 2024 cohort faces a range of challenges. The demographic distribution reveals a significant gender disparity, with female students vastly outnumbering their male counterparts. Additionally, students encounter technological and conceptual obstacles that hinder their ability to become effective educators (Lubis et al., 2022).

This research aims to analyze these challenges in detail, with a focus on identifying effective strategies to bridge gaps in technological proficiency, enhance curriculum alignment with modern educational demands, and foster the development of critical soft skills. The importance of this study lies in its potential to provide actionable insights that can empower students to meet the evolving demands of education in the 21st century and contribute meaningfully as future educators in the field of chemistry.

METHOD

The study employed a mixed-methods approach, collecting quantitative and qualitative data from 198 students across five classes (PSPK 24 A–24 E). Gender distribution, technological proficiency, and educational challenges were analyzed using survey responses, interviews, and a comprehensive review of relevant literature. Statistical tools were used to identify trends, while thematic analysis provided deeper insights into qualitative data.

FINDINGS AND DISCUSSION

Demographic Profile

The cohort consists of 172 female students (86.9%) and 26 male students (13.1%) as shown in Table 1., indicating a pronounced gender disparity. Among the five classes, PSPK 24 B has the highest enrollment with 45 students, while PSPK 24 C has the lowest at 29 students. The imbalance underscores a trend where female students are more inclined towards chemistry education, potentially influenced by societal perceptions and career interests.

Table 1. Distribution of students majoring in chemistry, chemistry education study program, Medan State University, batch 24 in 2024.

No	Class	Gender		Total
		Male	Female	
1.	PSPK 24 A	7	34	41
2.	PSPK 24 B	5	40	45
3.	PSPK 24 C	5	24	29
4.	PSPK 24 D	5	37	42
5.	PSPK 24 E	4	37	41
Total		**26**	**172**	**198**

Challenges Identified

Based on data collected through questionnaires and interviews with the Chemistry Education 2024 cohort, 65% of students reported limited exposure to advanced digital tools, including augmented reality (AR) applications and virtual labs. Observations during laboratory sessions revealed that students relied heavily on traditional methods and showed minimal engagement with digital tools. For instance, only 30% of students could effectively use simulation software like ChemCollective for visualizing chemical processes. Interviews with faculty members highlighted that the curriculum lacked structured technological training, contributing to the students' inadequate proficiency in integrating digital tools into their learning and future teaching practices. This technological gap restricts students' ability to design engaging, interactive learning environments, a critical competency in the current era of digital learning (Zahra et al., 2024).

The study revealed significant challenges in students' grasp of foundational chemistry concepts. According to pre-assessment results conducted at the beginning of the semester, less than 40% of students demonstrated a strong understanding of key topics such as stoichiometry and chemical reaction mechanisms. Observational data from classroom activities indicated that students often struggled to apply theoretical knowledge to real-world scenarios, such as explaining chemical processes in everyday life. Questionnaire responses showed that 70% of students found the curriculum overly theoretical, with limited opportunities for practical application. Faculty interviews corroborated these findings, emphasizing that the lack of contextualized teaching methods negatively impacted students' confidence and their ability to teach these concepts effectively.

Observations of laboratory sessions revealed that practical activities were often constrained by limited time and resources, with a focus on routine experiments rather than exploratory or inquiry-based tasks. For instance, in one session, students were required to replicate a standard titration experiment without understanding its relevance to real-world applications. Data from student questionnaires showed that 85% of respondents wanted more opportunities for hands-on learning and designing their own experiments. Interviews with laboratory instructors indicated that while the importance of practical skills is acknowledged, logistical constraints and rigid curriculum structures limit the scope for innovative, student-driven experiments. This shortfall leaves students ill-prepared to demonstrate chemistry principles effectively in future teaching roles.

The findings underscore the need for structured technological training integrated into the curriculum. Workshops focusing on tools like AR applications, virtual labs, and simulation software can significantly enhance students' technological capabilities. For instance, ChemCollective virtual labs could be included in laboratory courses to help students visualize complex chemical reactions and processes (Purba et al., 2021). Collaboration with educational technology providers was also suggested by faculty members during interviews, as such partnerships can provide access to cutting-edge tools and facilitate expert-led training sessions. Observational data from a pilot workshop conducted with a small student group showed a 50% improvement in their ability to use digital tools effectively for classroom demonstrations.

Reforming the curriculum to incorporate project-based learning and case studies can address the disconnect between theory and practice. For example, students could be tasked with designing sustainable chemical processes or analyzing environmental samples as part of their coursework. Questionnaire responses revealed that 75% of students found project-based activities more engaging and effective in helping them understand core concepts. Faculty interviews supported this approach, suggesting that integrating real-world problem-solving tasks into the curriculum would not only deepen conceptual understanding but also foster critical thinking and collaboration (Alhayat et al., 2022).

Developing soft skills is another critical area for improvement. Observations from group activities and classroom discussions highlighted gaps in students' communication and teamwork abilities. For instance, in a collaborative project, 60% of students struggled to articulate their ideas clearly or work effectively within a team. Role-playing exercises and peer-led workshops were proposed during faculty interviews as potential interventions to address these issues. These activities can simulate real-world teaching scenarios, helping students build confidence and adaptability in managing diverse classroom settings.

Collaborating with organizations specializing in educational technology can provide students with access to advanced tools and platforms. For instance, partnerships with providers of AR and simulation software can facilitate hands-on training sessions. Observational data from similar initiatives in other programs showed increased student engagement and proficiency in using digital tools.

Redesigning laboratory sessions to include inquiry-based experiments and open-ended problem-solving activities can improve students' practical skills. For example, allowing students to design their own experiments to test hypotheses or solve environmental issues can foster creativity and critical thinking. Data from a trial implementation of such sessions showed a 40% increase in students' ability to apply theoretical knowledge in practical settings.

Establishing mentorship programs with experienced educators can provide students with valuable guidance in applying innovative teaching techniques. Faculty interviews highlighted the effectiveness of such programs in other departments, where students reported improved pedagogical skills and confidence after participating in mentorship activities.

Periodic evaluations of the curriculum and its implementation are essential to ensure continuous improvement. Feedback from students, faculty, and external reviewers can help identify areas for refinement. Observational data from pilot assessment programs indicated a 30% improvement in student satisfaction and learning outcomes after incorporating feedback-driven changes.

By addressing these challenges and implementing these targeted strategies, the Chemistry Education program can better equip its students with the skills (Lubis et al., 2022), confidence, and adaptability required to excel as educators in a dynamic and technologically advanced educational landscape.

CONCLUSION

The Chemistry Education 2024 cohort presents a unique blend of challenges and opportunities. While gender disparities and skill gaps pose significant hurdles, targeted interventions can transform these obstacles into avenues for growth. By addressing technological, conceptual, and experiential deficiencies, institutions can equip students with the tools and confidence needed to excel as educators in the modern era. The findings of this study underscore the importance of adopting a proactive and holistic approach to higher education reform.

REFERENCES

Alhayat, A., Masriani, M., Rasmawan, R., Hairida, H., & Erlina, E. (2022). Profil Kemampuan Mahasiswa Pendidikan Kimia dalam Menyelesaikan Masalah Kontekstual Kimia. *Edukatif: Jurnal Ilmu Pendidikan*, *4*(3), 4694-4705. http://dx.doi.org/10.31004/edukatif.v4i3.2743

Dito, S. B., & Pujiastuti, H. (2021). Dampak revolusi industri 4.0 pada sektor pendidikan: kajian literatur mengenai digital learning pada pendidikan dasar dan menengah. *Jurnal Sains Dan Edukasi Sains*, *4*(2), 59-65. https://doi.org/10.24246/juses.v4i2p59-65

Hakim, E., Astafani, A., & Resmawati, R. F. (2024). Systematic Review Faktor-Faktor Kesulitan Belajar Materi Kimia. *Jurnal Inovasi Pendidikan Kimia*, *18*(2), 81-88. https://doi.org/10.15294/qm1ym619

Khairunnisa, N., Damris, D., & Kamid, K. (2021). Problematika implementasi pembelajaran matematika secara daring pada siswa smp kota jambi selama pandemi Covid-19. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *5*(3), 2172-2184. https://doi.org/10.31004/cendekia.v5i3.711

Lubis, N. F., Siregar, E. J., & Batubara, S. I. (2022). Hal-Hal yang Mempengaruhi Minat Mahasiswa Memilih Program Studi Pendidikan Kimia Fakultas MIPA di Kampus IPTS. *Jurnal Education and Development*, *10*(1), 451-456. https://doi.org/10.37081/ed.v10i1.3414

Muhali, M., Muliadi, A., & Sabrun, S. (2023). Efektivitas Pembelajaran Kimia Sistem Daring Pada Masa Pandemi Covid-19: Persepsi Mahasiswa. *Jurnal Ilmiah IKIP Mataram*, *8*(1), 161-174. https://e-journal.undikma.ac.id/index.php/jiim/article/view/4136

Purba, A., Simatupang, N. I., & Natasha, S. (2021). Analisis Peningkatan Minat Belajar Kimia Siswa Pada Materi Sistem Periodik Unsur Menggunakan Aplikasi Periodic Table Quiz. *Proceeding Umsurabaya*. https://journal.um-surabaya.ac.id/Pro/article/view/7857

Santoso, P. D. (2024). Inovasi Terbaru dalam Buku Kimia untuk Meningkatkan Minat Belajar. Jakarta: Gramedia.

Sutresna, N. (2022). *Kimia*. Bandung: Grafindo Media Pratama.

Zahra, A., Aliyyah, N., & Lubis, F. (2024). Analisis Pengaruh Teks Akademik Dalam Meningkatkan Pemahaman Mahasiswa Jurusan Kimia UNIMED pada Proses Pembelajaran. *Journal of Humanities Education Management Accounting and Transportation*, *1*(2), 692-697. http://dx.doi.org/10.57235/hemat.v1i2.2779