Proceeding of the 2nd International Conference on Chemistry & Chemical Education (ICCCE)
Organized by Chemical Education Study Program of Universitas Islam Negeri Ar-Raniry Banda Aceh
Conference Date: May 21, 2024

ANALYSIS OF LEARNING DIFFICULTIES OF STUDENTS MAJORING IN CHEMISTRY ANALYTICAL CHEMISTRY COURSE

Sri Adelila Sari[1*], Ratna Sari Dewi[1], Kana Saputra[1], Agus Kembaren[1], Hanisah Hasibuan[1]

[1]Universitas Negeri Medan, Indonesia

[*]Corresponding author: sriadelilasari@unimed.ac.id

Article History: *Received: May 2, 2024* *Revised: May 29, 2024*
Accepted: May 31, 2024 *Published: June 2, 2024*

Abstract

Analytical Chemistry I, II, and III are three analytical chemistry courses that must be attended by all Chemistry Department students. Analytical chemistry is the study of separation, identification, and quantification of chemical components in both natural and artificial materials. Studying analytical chemistry can be likened to learning a foreign language due to the abstract nature of many concepts. The purpose of this study was to determine the learning difficulties faced by chemistry majors taking analytical chemistry courses. In this study, a qualitative descriptive method was used. The data collection method used was by distributing questionnaires, making observations and interviews. The data obtained were then analysed descriptively. The results showed that the availability of teaching materials (57.78% with a moderate category), the ability of students to master the material (58.31% with a moderate category), and the quality of practicum implementation (69.73% with a moderate category) were the main obstacles that caused learning difficulties for chemistry students taking analytical chemistry courses. Based on these findings, a solution is given for further research to innovate the development of teaching materials integrated with projects in analytical chemistry practicum in order to improve students' ability to master analytical chemistry material.

Keywords: Learning Difficulties, Analytical Chemistry, College Students, Chemistry Major.

1 INTRODUCTION

There are several courses in this specialised group of courses that are required for all chemistry majors. All students in the Chemistry Department were required to take analytical chemistry courses, including: Analytical Chemistry I, II, and III. The study of the separation, identification, and quantification of chemical components [1], in natural and artificial compounds is known as analytical chemistry [2]. Since many concepts in analytical chemistry are abstract, learning this course can be analogous to learning a foreign language [3]. When viewed in a larger context, chemistry is more than just the study of numbers and abstract concepts [4]. Analytical chemistry courses include deductive reasoning and hierarchically organised abstract ideas and concepts. If students do not understand the topics covered in previous chemistry lessons, it will be more difficult for them to understand the content of the lessons, and this will hinder their achievement [5].

A person with learning difficulties is someone who cannot learn as he should so that he has difficulty in completing his tasks [7], so it requires greater effort to complete it [8]. According to Silalahi (2023), learning difficulties can be understood as a condition where there were certain obstacles that must be overcome to obtain the best learning results [9]. Those who experience these obstacles may or may not realise these obstacles. These obstacles in the teaching and learning process can be physiological, psychological, or social. A person with learning difficulties is one who faces specific challenges that inhibit their ability to fulfil their learning goals [10]. Several elements, such as student ability, the quality of lecturers or teachers, the quality of the learning environment, and the quality of the learning process, affect the failure to fulfil learning objectives determined by learning success [11]. Of these four variables, student ability and the quality of the learning process were the two variables that had the greatest influence on learning achievement [12].

Proper concepts, laws, theories, and principles must be understood before one can begin to understand analytical chemistry, but analytical chemistry is a science that students find difficult to

understand [13]. Therefore, it would be better if we observe students before teaching them so that we can understand how to impart knowledge. The low learning activities during the learning process, the lack of enthusiasm for learning, and the low grades of analytical chemistry students, all indicate the low interest of students in learning analytical chemistry, based on the findings gathered by the researcher from several direct observations during classroom teaching.

The assumption that analytical chemistry is one of the most difficult subjects to understand is one of the roots of learning problems among students. Low learning outcomes are the result of this way of thinking as it lowers students' willingness to learn. Furthermore, the difficulties that students face during the learning process can be measured to determine the main cause of their learning problems. The learning process, students' contextual circumstances, and competencies that support concept mastery are the obstacles in question. Based on these problems, it was necessary to analyse the learning difficulties faced by students majoring in chemistry who took analytical chemistry courses.

2 METHODOLOGY

This study was aimed to analyse the learning difficulties faced by chemistry majors who take analytical chemistry courses. Descriptive qualitative methodology was used in this study.

2.1 Research Subject

All respondents in the study were students majoring in chemistry at Medan State University. Purposive sampling was used to collect research samples. A total of 500 students from the Chemistry Department of Medan State University who took or had completed analytical chemistry courses became research samples for the 2020-2022 academic year.

2.2 Data Collection

The data collection techniques used were questionnaires, interviews, and observations; the results were analysed descriptively.

2.1.1 Questionnaire

The questionnaire was used to collect information about the learning difficulties faced by students majoring in chemistry who took analytical chemistry. A four-point Likert scale; strongly disagree (1), disagree (2), agree (3), and strongly agree (4) was used for measurement. There were forty different questions in the questionnaire for data collection. Indicators include students' ability to understand analytical chemistry course materials, the quality of material delivery by lecturers, and practicum implementation.

2.1.2 Interview

Students majoring in analytical chemistry provided information regarding their learning difficulties through an interview sheet. Seven different questions related to analytical chemistry lecture activities were asked during the interview.

2.1.3 Observation

Data collection regarding barriers to learning difficulties in analytical chemistry by using an observation sheet was completed by five lecturers teaching analytical chemistry courses at Medan State University. An observation sheet with five closed questions and Yes/No answer options was used for this observation approach.

2.3 Data Analysis Technique

The data obtained were then analysed according to the categories in Table 1.

Table 1. *Quality categories of observed indicators*

Score (%)	Category	Description
0 – 20	Very low	Learning difficulties
21 – 40	Low	Learning difficulties
41 - 60	Medium	Learning difficulties
61 – 80	High	No learning difficulties

81 - 100	Very high	No learning difficulties

3 RESULTS

The following was the result of the research that had been conducted.

3.1 Description of Percentage of Student Capacity on Material Mastery

The results obtained from this measurement determine the level of concept mastery for each student, and this measurement was used to measure student capacity. Descriptive percentages was used to present the results of the study. The results of the research data analysis were in the form of a description of the level of difficulty faced by chemistry major students in analytical chemistry courses related to basic chemistry skills, basic mathematics skills, understanding of material concepts, and ability to analyse concept relationships.

Table 2 *Provides an overview of the learning difficulties faced by students*

Indicators	Percentage (%)
Basic math skills	56.04
Basic chemistry skills	54.61
Ability to understand material concepts	54.34
Ability to analyze interconceptual relationships	68.28
Average	58.31

The average percentage of students' ability to master the material in the four categories of analytical chemistry courses, as shown in Table 2, is 58.31%, included in the medium ability category. In conclusion, the material mastery factor was an obstacle for students in understanding analytical chemistry courses, causing learning difficulties.

3.2 Description of the Percentage of Quality of Analytical Chemistry Lecturers in Lectures

The quality of lecturers with predetermined indicators, attendance during lectures, discipline, availability of teaching materials, and application of teaching methods to interaction in learning, were factors that had an impact on the learning process. Table 3 displays the results of the evaluation of the quality of lecturers teaching analytical chemistry courses.

Table 3. *percentage level of analytical chemistry lecturer quality*

Indicators	Percentage (%)
Lecture Attendance	86.10
Discipline	87.00
Availability of teaching materials	57.78
Learning Methods	83.63
Interaction in Learning	84.72
Average	79.97

Based on the data in Table 3, the average medium category for lecturer quality indicators was 79.97%. Therefore, it can be concluded that the lecturers have done their job well during the lecture process. However, there were several things that need to be analysed further because they become obstacles for students in learning in analytical chemistry courses. One of them was the availability of teaching materials which received a medium category score of 57.78%.

3.3 Description of the Percentage of Practicum Implementation Quality

The quality of practicum implementation with predetermined indicators, infrastructure, condition of tools and materials, practicum manuals, and laboratory staff were factors that had an impact on practicum implementation. Table 3 displays the percentage of the quality of practicum implementation.

Table 4. *Percentage level of practicum implementation quality*

Indicators	Percentage (%)
Infrastructure Facilities	78.89
Condition of Tools and Materials	54.50
Availability of teaching materials	58.22

Practicum Manual	58.22
Laboratory Staffing	66.30
Average	69.73

Based on the data in Table 4, the average percentage of the quality of practicum implementation was 69.73% (high category). Thus, the quality of practicum implementation was not a barrier for chemistry students taking analytical chemistry courses. On the other hand, the percentage of practicum manuals and indicators that show the condition of practicum tools and materials was in the medium category.

The average ability of students in mastering analytical chemistry courses based on data from Table 2, for the four categories studied was 58.31% (moderate category). Thus, students had difficulty in mastering chemical concepts. In addition, Table 3 showed that the average percentage of lecturer quality in the lecture process was 79.97% (medium category). Thus, it can be concluded that students experience difficulties during lectures. Table 4 showed that the average proportion of obstacles in the quality of practicum implementation was 69.73% (moderate category). Thus, it can be concluded that students experience considerable difficulties in analytical chemistry lectures. For more details, the percentage comparison of the three components together can be viewed from the following graph, which represents the three factors that were thought to be the root of students' difficulties in learning analytical chemistry:

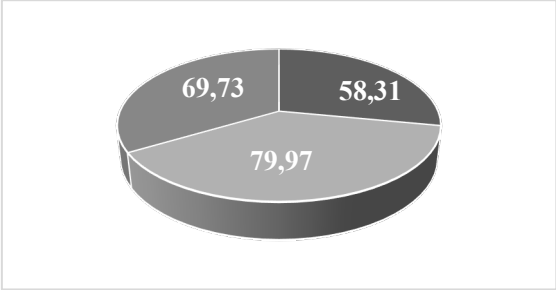

Figure 1. *Percentage of factors inhibiting learning difficulties in analytical chemistry*

These three factors have previously been researched and believed to be inhibiting factors and causes of student learning difficulties. With a percentage of 58.31%, the percentage of student capacity had the lowest number. This figure showed that one of the factors causing student learning difficulties in analytical chemistry courses was students' capacity to understand the course. Based on interviews with respondents, reading material that was difficult to understand was the main cause of difficulties in mastering the course. As most of the analytical information was abstract, students felt that certain topics were difficult to understand. The students also indicated in their responses that the terms used in the analytical chemistry textbook were unfamiliar to them. Furthermore, information obtained through interviews with 5 analytical chemistry lecturers at Medan State University, three of the five lecturers said that students still often cheat on assignments. Students argue that the material mastery factor is quite an obstacle as a cause of learning difficulties in analytical chemistry when viewed from four aspects, namely the ability to understand material concepts, the ability to analyse relationships between concepts, the ability to perform basic chemical and mathematical skills. In the aspect of basic mathematical ability, the number of students who had this ability was still relatively low. Based on data from questionnaire analysis, 56.04% of students reported having learning difficulties. These difficulties include: (1) unable to solve problems involving numbers; (2) difficulty translating graphs verbally into one or a few words; (3) unable to accurately listen to problems related to mathematics; and (4) lack of logical reasoning ability.

Basic maths skills can have a great impact on chemistry learning outcomes [14]. Although it was not required to study maths before chemistry, it may be helpful to understand the concepts and formulas covered in chemistry to have a strong foundation in this subject [15]. Many quantitative reasoning problems in chemistry require a solid understanding of algebraic, geometric, and calculus ideas. To calculate the mass, volume, and concentration of chemical compounds as well as interpret and evaluate experimental data, students need to use mathematical formulas. Therefore, having a strong foundation in arithmetic is highly recommended if you want to pursue chemistry or other science-related fields. It will provide a solid foundation for studying other sciences and provide a better understanding of the concepts and calculations involved in chemistry. Scientific concepts, principles, and procedures must be understood using mathematical reasoning. Problem-solving ability in

chemistry can be enhanced by mathematical ability. Students with stronger maths skills were better prepared to learn chemistry than students with weaker maths skills. A number of studies were conducted to examine the impact of maths ability on chemistry learning achievement. Chemistry learning achievement was affected by maths ability, and students with different levels of maths ability performed very differently when learning chemistry. Lack of maths ability would hinder students from mastering chemistry materials. A study conducted in 2019 by Cholifah et al. even showed a positive relationship between chemistry learning achievement and maths ability. Chemistry learning achievement increases along with maths ability [16].

According to research by Hafiz et al., (2023) which explained the effect of mathematics ability on students' chemistry learning achievement, students with high mathematics ability had greater chemistry learning achievement compared to students who had low mathematics ability [17]. The same findings were also shown by Nursa'dah and Nurrahmah (2019), who found that the variables of self-efficacy and basic mathematical ability had a major effect on understanding chemical concepts [18]. Analytical and mathematical abilities had a strong positive correlation with cognitive learning outcomes of buffer solution material [19]. Because they would be able to examine events, problems, topics, or decisions in depth, analytical skills are very important for university students [20]. [20]. An analytical person can analyse claims using impartial criteria and identify the source of the problem [20]. An analytical person can analyse claims using impartial criteria and identify the source of the problem [21]. At least, chemistry majors should master five basic chemistry skills: (1) understanding basic chemical ideas and concepts; (2) understanding the relationships between chemical ideas; and (3) generating and assessing scientific representations, such as chemical equations, graphs, and diagrams; (4) assessing and solving chemical problems methodically; and (5) describing chemical knowledge effectively.

Data collected for this study, only 54.61% of chemistry majors had basic chemistry proficiency. In other words, it could be said that students still found it difficult to applied the principles of basic chemistry because they were not proficient in this area. Before talking about courses, lecturers of courses that strongly refer to basic chemistry, such as analytical chemistry courses, must re-explain the basics of basic chemistry. In the basic chemistry course of the Chemistry Department of Medan State University in the same semester, the theory and practicum parts of the course were taught independently. The problem that arises is the difficulty of making comparisons between the material learned by students in theory and practicum lectures. Often students had not learnt the material that would be practised in the laboratory during practicum activities. Practicum supervisors were required to give a brief explanation of the theory before the practicum began. Basic chemistry courses include discussions and problem-solving exercises in addition to theoretical instructions delivered in a more general format such as lectures. Lecturers currently more often state chemical formulas technically (using differentials and integrals) rather than explaining their meaning and application, so basic chemistry lectures become more complex and difficult for students to follow. Verification, or testing of chemical concepts or laws, is the main goal of basic chemistry laboratory practicum. The process of acquiring knowledge was not emphasised when using the inquiry approach.

Students need to learn not only basic ideas and principles, but also scientific thinking styles, which included how to organise scientific knowledge effectively, explain scientific concepts and principles, and interpret scientific concepts and principles. Many of the ideas and principles that make up chemical knowledge used to be abstract [22]. Understanding various chemical ideas and principles correctly was a challenge for most students. To solve basic chemistry problems involved these principles, students must first be able to recognised and understand chemical concepts [23]. Data showed that analytical chemistry was a course that was considered difficult by most students because it required a fairly high intellectual capacity. Many students repeat this course because they were unable to complete it. Ineffective teaching strategies for analytical chemistry may be the cause.

Based on the research findings, the percentage of lecturer quality of 79.97% falls into the moderately good category. Further analysis reveals that the reason why the percentage of lecturer quality was considered moderate was because it received a relatively low score of 57.78% on the indicator of providing reference books. This can certainly be a useful tool for analytical chemistry teachers in developing teaching materials that were interesting, innovative, and made it easier for students to understand.

Books in printed form were provided as learning resources for students majoring in chemistry at Medan State University. Medan State University students who take analytical chemistry courses most often use Analytical Chemistry I (Basic Analytical Chemistry) textbooks. Although this book was quite complete, it had several shortcomings, including no colour, no practice questions and summary

material at the end of each chapter, and not integrated with the delivery of lecture material. Thus, learning resources were needed to support independent learning and broaden the understanding of the topics covered in the practicum and teaching materials of the analytical chemistry course. Learning was an active process that occurred in the mind of the learner, and in which information from sources in the environment (not limited to teachers, textbooks, and peers) was reinterpreted within the framework of existing knowledge and understanding [24] Teaching materials can be used to provide fundamental knowledge to lecturers and students [25] Some of them used teaching books as learning resources in analytical chemistry courses. Because teaching materials were part of educational facilities and infrastructure, teaching materials played an important role in helping the lecture process. Improving the quality of students' knowledge of analytical chemistry can help them to perform better in lectures.

As a learning resource for all courses that play an important role and become a mandatory reference in the learning process, teaching materials were one of the learning media used. Books are an educational tool that can be used in lectures to help students learn the information, knowledge, experience, and skills they need. According to Andriani's research (2019), students' concept understanding on acid-base material developed through the used of teaching materials in the form of contextual-based chemistry modules. In line with Sunaryo (2024), teaching materials can improve student understanding (27). According to Magdalena et al. (2020), varied learning resources had an impact on students' ability to understand topics and gain better knowledge from various points of view [28]. Various materials that can assist in learning were combined to create varied learning materials [29]. To make it easier to understand, learning materials combine theory, practice, case studies, teaching strategies, demonstrations, and media [30]. Diverse teaching materials can enhance students' conceptual understanding, foster rich learning opportunities, and increase enthusiasm and drive for learning [31]. Integrating lectures with practicum can help improve students' understanding of analytical chemistry courses [32]. Ideally, the implementation of practicum and analytical chemistry lecture processes were carried out simultaneously. The most significant factor affecting the course of practicum was the absence of materials and equipment in the laboratory.

The research findings showed that, on average, 69.73 percent of the quality of practicum implementation was achieved. This indicated that learning challenges related to practicum implementation still exist in the chemistry department of Medan State University. Based on the results of data analysis, the practicum guide (58.22%) and the condition of the equipment (54.50%) had the lowest percentage among the four indicators of the quality of practicum implementation. Respondents considered that the practicum facilities were inadequate and the use of the laboratory was less than optimal, and the practicum guide presented was considered to contain pictures/illustrations that made it easier for students to do the practicum. The availability of the necessary tools and materials was a major factor in the implementation of practicum in the laboratory [33]. The right tools and materials will result in better implementation [34]. Students were expected to participate in a pre-lab activity, often known as a response, before doing the lab [35]. Students will be given several questions related to the relationship between the course topic and the practicum they will do during the response process. The response was done to further explore the cognitive abilities of each person, with the hope that it can help in understanding the relevance of the material. Students were expected to integrate the content, activities, and observations into their report during the report writing process.

The quality of the lab manual also needs to be considered [36]. The lab manual has significant value as a resource for students who wish to complete the lab, as it can enhance their basic knowledge. In order to make this book more useful for students doing practical learning [37], it was strongly recommended that the publishing team and authors evaluate the breadth of content and visuals that support analytical chemistry learning from the lab manual [38]. Murti's research, (2022) supported this; pictures or graphs at the beginning of the lesson can encourage students to learn the material, and clear instructions on how to use the rules make it easier for students to complete all given tasks [39]. As pointed out by Alexander et al. (2018), audio-visual versions of lab guides can be used as a means to present lab guides. Since the information is not only written down, but also includes audio and visuals to enhance the learning experience, this approach allows students to learn on their own [40]. The used of learning models, concept maps, teaching aids, interactive multimedia, innovative and interactive teaching materials were some of the strategies that have been implemented to support and improve the competence of chemistry majors to become knowledgeable and creative educators in the field of chemistry. Created the latest learning resources supported by technological advances is a strategy in developing and improving students' higher order thinking skills.

4 CONCLUSIONS

The results showed that the learning difficulties of chemistry majors were in the ability of students to master the material 58.31% (moderate category), the availability of teaching materials 57.78% (moderate category), and the quality of practicum implementation 69.73% (moderate category). Based on these results, strategies for further research are given to produce innovative teaching materials integrated with projects in analytical chemistry practicum, with the aim of improving students' ability to learn the course.

ACKNOWLEDGEMENTS

This research can be carried out well thanks to the assistance of various parties, the UNIMED Institute for Research and Community Service (LPPM), the Head of the UNIMED Chemistry Department, and other parties involved and have provided good cooperation in this research.

REFERENCES

[1] Z. Zulfahmi and F. Handayani, “Analisis Kesulitan Belajar Mahasiswa Dalam Perkuliahan dan Praktikum Kimia Dasar Jurusan Farmasi Universitas Ubudiah Indonesia,” *Journal of Education Science,* vol. 6, no. 1, pp. 86-95, 2020.

[2] K. Yenni, “Analisis Kesulitan Penguasaan Konsep Teoritis dan Praktikum Kimia Mahasiswa Calon Guru Kimia,” *Jurnal Konfigurasi,* vol. 1, no. 2, pp. 146-153, 2017.

[3] E. Widiyastuti and A. Jazuli, “Deskripsi Kemampuan Berpikir Analitik Matematis Mahasiswa Pendidikan Matematika,” *The 8thUniversity Research Colloquium 2018Universitas Muhammadiyah Purwokerto,* pp. 401-409, 2018.

[4] A. P. D. S. Wibowo, M. Sri and Ashadi, “Hubungan Antara Kemampuan Analisis dan Kemampuan Matematik dengan Hasil Belajar Kimia Siswa (Pokok Bahasan Larutan Penyangga Kelas XI Semester Genap SMA Negeri 2 Wonogiri Tahun Ajaran 2017/2018),” *Jurnal Pendidikan Kimia,* vol. 8, no. 1, pp. 78-84, 2019.

[5] L. Tambunan and J. Tambunan, “Pengembangan Bahan Ajar E-Modul Matematika Berbantuan Aplikasi Canva pada Materi Grafik Fungsi Eksponen dan Logaritma,” *Jurnal Cendekia: Jurnal Pendidikan Matematika,* vol. 7, no. 2, pp. 1029-1038, 2023.

[6] K. S. Taber, “Building the Structural Concepts of Chemistry: Some Considerations from Educational Research,” *Chemistry Education Research and Practice,* vol. 2, no. 2, pp. 123-158, 2001.

[7] Y. N. Syabana and J. Susilowibowo, “Pengembangan Bahan Ajar Modul Berbasis Flipbook Pada Mata Peajaran Komputer Akuntansi Transaksi Perusahaan Dagang Guna Mendukung Proses Pembelajaran Peserta Didik XII AKL 1 di SMKN 1 Jombang,” *Jurnal Riset Pendidikan Ekonomi,* vol. 7, no. 1, pp. 17-27, 2022.

[8] V. Suslistya and G. Mahadewi, “Manajemen Laboratorium Sebagai Langkah Peningkatan Mutu Pelaksanaan Praktikum Ilmu Pengetahuan Alam,” *SEARCH: Science Education Research Journal,* vol. 1, no. 2, pp. 1-13, 2023.

[9] S. Sunaryo, “Analisis Manfaat Buku Ajar dalam Meningkatkan Pemahaman Mahasiswa pada Mata Kuliah Pendidikan Pancasila di Universitas Mega Buana Palopo,” *Indonesian Character Journal,* vol. 1, no. 1, pp. 19-23, 2024.

[10] S. A. Silalahi, “Studi Kasus Pada Peserta Didik Dalam Kesulitan Belajar,” *Jurnal Pendidikan Sosial dan Humaniora,* vol. 2, no. 1, pp. 146-152, 2023.

[11] L. P. Sari and D. A. Siregar, “Analisis Pelaksanaan Praktikum Fisika Di Laboratorium Pada Mahasiswa Program Studi Pendidikan Fisika Institut Pendidikan Tapanuli Selatan,” *Jurnal Education and Development,* vol. 10, no. 2, pp. 616-618, 2022.

[12] N. Sappaile, “Hubungan Pemahaman Konsep Perbandingan dengan Hasil Belajar Kimia Materi Stoikiometri,” *JIP STKIP Kusuma Negara Jakart,* vol. 10, no. 2, pp. 58-71, 2019.

[13] E. Romyati and A. Tjahjono, "Pemanfaatan Buku Teks dalam Menunjang Pembelajaran Matematika di Sekolah Menengah Kejuruan Negeri I Kebumen Tahun 2019," *Jurnal Riset Akuntansi dan Bisnis Indonesia STIE Widya Wiwaha,* vol. 1, no. 1, pp. 217-227, 2021.

[14] D. A. Rokhim, "Pengembangan Virtual Laboratory pada Praktikum Pemisahan Kimia Terintegrasi Telefon Pintar," *Jurnal Kajian Teknologi Pendidikan,* vol. 3, no. 2, pp. 216-226, 2020.

[15] S. Rajagukguk, "Analisis Kesulitan Belajar Kimia Organik Mahasiswa Fakultas Keguruan dan Ilmu Pendidikan Universitas Simalungun," *EKSAKTA: Jurnal Penelitian dan Pembelajaran MIPA,* vol. 7, no. 2, pp. 1-189, 2022.

[16] S. A. Rahman, "Hubungan Antara Kemampuan Spasial Terhadap Hasil Belajar Kimia," *Chemistry Education Practice,* vol. 5, no. 2, pp. 163-176, 2022.

[17] A. Rahayu, "Analisis Keterampilan Proses Sains Mahasiswa pada Praktikum Dasar-Dasar Kimia Analitik," *Dalton: Jurnal Pendidikan Kimia Dan Ilmu Kimia,* vol. 3, no. 1, 2020.

[18] A. Priliyanti, I. W. Muderawan and S. Maryam, "Analisis Kesulitan Belajar Siswa dalam Mempelajari Kimia Kelas XI," *Jurnal Pendidikan Kimia Undiksha,* vol. 5, no. 1, pp. 11-18, 2023.

[19] F. P. Nursa'adah and A. Nurrahmah, "Pengaruh Kemampuan Dasar Matematika dan Efikasi Diri Terhadap Pemahaman Konsep Kimia," *Simposium Nasional Ilmiah dengan tema: (Peningkatan Kualitas Publikasi Ilmiah melalui Hasil Riset dan Pengabdiankepada Masyarakat),* vol. 1, no. 1, pp. 214-220, 2019.

[20] W. Murti, "Pengaruh Penggunaan Buku Pedoman Praktikum Ekologi Tumbuhan Terhadap Hasil Belajar Mahasiswa," *Jurnal Binomial,* vol. 5, no. 1, pp. 13-24, 2022.

[21] P. Medina, "Analisis Miskonsepsi Siswa Kelas X pada Materi Larutan Elektrolit dan Non Elektrolit serta Reaksi Oksidasi dan Reduksi dalam Pembelajaran Kimia di SMAN 8 Kota Padang," *Eduscience Development Journal,* vol. 4, no. 2, pp. 81-90, 2022.

[22] I. Magdalena, R. O. Prabandani and E. S. Rini, "Analisis Pengembangan Bahan Ajar," *Nusantara: Jurnal Pendidikan dan Ilmu Sosial,* vol. 2, no. 2, pp. 170-187, 2020.

[23] H. Luo, G. Li, Q. Feng, Y. Yang and M. Zuo, "Virtual Reality in K-12 and Higher Education: A Systematic Review of The Literature from 2000 to 2019," *Journal of Computer Assisted Learning,* vol. 37, no. 3, pp. 887-901, 2021.

[24] P. Laksono, "Pengembangan Three Tier Multiple Choice Test pada Materi Kesetimbangan Kimia Mata Kuliah Kimia Dasar Lanjut," *Orbital: Jurnal Pendidikan Kimia,* vol. 4, no. 1, pp. 44-63, 2020.

[25] N. Kusumawati and E. S. Maruti, Strategi Belajar Mengajar di Sekolah Dasar, Jawa Timur: CV. AE Media Grafika, 2019.

[26] Y. Kurniawati, "Analisis Kesulitan Penguasaan Konsep Teoritis dan Praktikum Kimia Mahasiswa," *Jurnal Konfigurasi,* vol. 1, no. 2, pp. 146-153, 2017.

[27] D. Henrliniar, "Upaya Meningkatkan Kemampuan Analisis Siswa SMA Negeri 1 Lebakwangi Kabupaten Kuningan pada Mata Pelajaran Biologi Melalui Model Pembelajaran Berbasis Masalah," *JURNAL LOCUS: Penelitian dan Pengabdian,* vol. 2, no. 3, pp. 200-217, 2023.

[28] H. Harmen, M. Muslima and Y. Salama, "Memahami Konsep Dasar Diagnostik Kesulitan Belajar," *Jurnal Pendidikan dan Konseling (JPDK),* vol. 5, no. 2, pp. 5859-5866, 2023.

[29] D. Harefa, "Student Difficulties In Learning Mathematics," *Afore: Jurnal Pendidikan Matematika,* vol. 1, no. 2, pp. 1-10, 2022.

[30] M. Hafiz, D. Desniarti and Y. Annisa, "Hubungan Antara Kemampuan Matematika dengan Kemampuan Kimia Siswa di Tingkat SMA," *Jurnal Penelitian Tindakan Kelas dan Pengembangan Pembelajaran,* vol. 6, no. 3, pp. 630-634, 2023.

[31] B. A. Habsy, A. T. F. Senja, N. Mahmudah and D. D. Kartikasari, "Penanganan Masalah Kesulitan

Belajar Akademik," *TSAQOFAH,* vol. 4, no. 1, pp. 263-277, 2024.

[32] E. Eliyarti, C. Rahayu and Z. Zakirman, "Deskripsi Pengetahuan Awal Alat Praktikum Materi Koloid dalam Perkuliahan Kimia Dasar Mahasiswa Teknik," *Jurnal Pendidikan Kimia dan Ilmu Kimia,* vol. 3, no. 1, 2020.

[33] Eliyarti and C. Rahayu, "Deskripsi Efektivitas Kegiatan Praktikum dalam Perkuliahan Kimia Dasar Mahasiswa Teknik," *EduSains: Jurnal Pendidikan Sains dan Matematika,* vol. 7, no. 2, pp. 51-60, 2019.

[34] E. N. U. Cholifah, S. Yamtinah and E. S. VH, "Hubungan Kemampuan Analisis dan Matematika dengan Prestasi Belajar Siswa Pada Materi Larutan Penyangga Kelas XI SMA Negeri 4 Surakarta," *Jurnal Pendidikan Kimia,* vol. 8, no. 2, pp. 179-184, 2019.

[35] K. Badhe and Y. S. Y. Sani, "Analysis of Science Laboratory Readiness for Science Learning at SMP Muhammadiyah Waipare," *Holistic Science,* vol. 3, no. 1, pp. 15-19, 2023.

[36] A. Aryanto, F. Fadliati and R. Jasmarika, "Analisis Kesulitan Belajar Matematika pada Siswa Kelas III Sekolah Dasar Negeri 015 Langkan," *Jurnal Pendidikan Tambusai,* vol. 8, no. 1, pp. 9473-9480, 2024.

[37] D. P. Anjani, "Penggunaan Bahasa Baku Pada Penulisan Laporan Praktikum Prodi Studi Teknik Kimia Upn "Veteran" Jawa Timur," *Sabda: Jurnal Sastra dan Bahasa,* vol. 2, no. 1, pp. 31-41, 2023.

[38] R. Andriani, "Analisis Kesulitan Belajar Mahasiswa Program Studi Biologi Pada Matakuliah Kimia," *Jurnal Jendela Pendidikan,* vol. 3, no. 1, pp. 74-82, 2023.

[39] M. Andriani, Muhali and C. A. Dewi, "Pengembangan Modul Kimia Berbasis Kontekstual Untuk Membangun Pemahaman Konsep Siswa Pada Materi Asam Basa," *Hydrogen: Jurnal Kependidikan Kimia,* vol. 7, no. 1, pp. 25-34, 2019.

[40] A. Alexander, H. M. Rahayu and A. D. Kurniawan, "Pengembangan Penuntun Praktikum Fotosintesis Berbasis Audio Visual Menggunakan Program Camtacia Studio di SMAN 1 Hulu Gurung," *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education),* vol. 6, no. 2, pp. 75-82, 2018.