Didaktika: Jurnal Kependidikan, Vol. 13, No. 2, Mei 2024

Need Analysis of Learning Resources for Teaching Gas Chromatography Materials

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Abstract

The availability of learning resources is an important component in lectures so that students can learn chemistry optimally and maximize their potential. The aim of this research is to describe the results of interviews and questionnaires analyzing learning resource needs by lecturers and students regarding learning gas chromatography in separation chemistry courses at Medan State University as a basis for developing gas chromatography learning resources according to student learning needs. This study used descriptive qualitative method. The respondents were one scholarship chemistry lecturer and 30 Chemistry Department students who had taken separation chemistry courses. This research instrument uses interview sheets and needs analysis questionnaires presented on the Google Form platform. Data analysis techniques by describing data from interviews and questionnaires regarding the need for gas chromatography learning resources are explained in detail. The results of this research are that students need learning resources in the form of open materials and virtual laboratories to support the learning process in separation chemistry subjects, especially gas chromatography. The learning resources in question are project-based learning resources that can be accessed online/digitally, containing gas chromatography teaching materials, equipped with examples of relevant contextual projects, illustrations with virtual laboratory media integration, hyperlinks to trusted websites, problem solving tests and evaluations. able to make students very enthusiastic about working on projects, completing and submitting reports correctly so that they can improve their learning outcomes and skills in gas chromatography material. It is hoped that the results of the analysis can be used as a basis for developing learning resources according to student needs.

Keywords: *needs analysis, learning resources, gas chromatography materials*

Introduction

The implementation of the National Qualifications Framework (*Kerangka Kualifikasi Nasional Indonesia*, KKNI) as the basis for standard competencies has shifted the teaching and learning paradigm to the adoption of a competency-based curriculum at Medan State University. Now the Curriculum needs to implement various learning strategies to equip students with knowledge appropriate to the subjects they study. The availability of quality learning resources is needed to help students meet their needs for competencies that are learning targets (Situmorang et al., 2018). Learning resources are very important because they can motivate students to explore the desired knowledge and skills (Situmorang et al., 2018). This is in line with research by Situmorang, Sinaga, et al., (2022) which states that the use of innovative learning resources obtained through project-based learning can develop students' critical thinking skills in analytical chemistry learning. Learning resources are very effective in facilitating students to learn actively and independently (Hutapea et al., 2023). The research results of Tampubolon et al., (2022) also show that innovative inquiry-based learning resources for teaching inorganic reactions that have

been developed and used in general chemistry classes have proven successful in encouraging students to improve their thinking skills and improve student chemistry learning outcomes.

Separation chemistry is one of the mandatory courses in the Department of Chemistry, FMIPA, Medan State University (Harahap et al., 2022). One of the important topics in separation chemistry courses is the topic of gas chromatography. Many skills are required in operating this GC instrument such as learning how to achieve better separation through manipulation of GC settings, split/splitless injection, carrier gas flow rate, and oven temperature, as well as applying GC principles to practical application (Nolvachai et al., 2023). However, taking into account that it takes lecturers about forty to fifty minutes to teach one subject at school in its entirety, this time is not enough for each student to complete laboratory work, record the results, and master the various skills required in such work (Nishonov & Qoldoshova, 2023). So, good learning resources are needed for students to use in studying gas chromatography material. However, the difficulty of selecting and determining good learning resources is a challenge for educators and students (Juliandini et al., 2020). In fact, the availability of good learning resources will help students learn chemistry optimally and maximize their potential. The material presented in learning resources will help students understand chemical concepts more easily, accurately and avoid (Sinaga et al., 2019). Based on the results of observations made by observing students' learning behavior, it is known that many students are confused about choosing the right learning resources. In fact, reference sources in the form of books and journals related to the curriculum have been informed to students since the lecture contract and written in the Semester Lecture Plan (RPS). Source books related to the curriculum are also available in the study program library, but availability is limited to gas chromatography material.

New innovations in developing learning resources are needed to improve students' skills in learning separation chemistry, especially gas chromatography material (Situmorang, Gultom, et al., 2022). Learning resources aim to make learning easier for readers because learning resources are more easily accessible anytime and anywhere, encourage students to participate actively and make the learning experience stronger in their memories thereby improving their learning outcomes (Sary et al., 2018). Innovative learning resources become effective learning strategies with learning systems that are optimized to meet student (Situmorang et al., 2020). Based on the background above, it can be used as a reference in developing good learning resources. For this reason, it is necessary to carry out an initial needs analysis to determine the learning resource needs that students need. Needs analysis is the process of searching or exploring information related to expected needs, as a basis for developing a product (Sunardi et al., 2023). The results of this needs analysis will help direct the preparation of learning resources to suit student needs. It is hoped that the development of innovative learning resources will be able to improve student skills and student understanding regarding the topic of gas chromatography. This research focuses on the need for innovative learning resources to improve students' skills in learning chemistry, especially gas chromatography material. The goal is to understand and overcome the challenges students face in accessing and using appropriate learning resources for the topic of gas chromatography.

Method

This type of research uses a qualitative descriptive approach using observation methodology in the form of interviews and distributing questionnaires and is reported in accordance with consolidated criteria for reporting qualitative research (Pollock et al., 2024). A qualitative descriptive approach is considered the most appropriate because the aim is to provide data descriptions to investigate opinions, thoughts, attitudes and experiences regarding learning gas

chromatography using university learning resources, in addition to realizing that the interviews with students were short (20-25 minutes) and informative. what is collected is descriptive and superficial, so a deeper interpretation cannot be achieved. Therefore, the use of methods that focus on 'how', 'what' and 'why' was deemed appropriate for this research.

The research was carried out on October 2023. The research procedure was carried out starting from the needs analysis stage by making observations at the Chemistry Education Study Program, Medan State University. This stage is divided into 2 stages consisting of: (1) Learning and context analysis; and (2) Needs analysis. The subjects in this research were students majoring in chemistry, Faculty of Mathematics and Natural Sciences (FMIPA) Medan State University (Unimed) with a total of 30 students (4 male and 26 female) semester 7 who had taken the course Separation Chemistry in the previous semester with an average age of 21 years when the research data was collected and one lecturer teaching the separation chemistry course had a Doctorate in analytical chemistry who was 61 years old when the research data was collected. The learning and context instruments in this research used a list of interview questions for lecturers and students as well as a needs analysis questionnaire which had previously been validated by an instrument expert, namely an experienced lecturer at FMIPA Unimed. The scale used in preparing a needs analysis questionnaire for students is a Likert Scale using a scale of 1-4 (Purba et al., 2019). Table 1 below displays the grid for a needs analysis questionnaire for students regarding the needs and learning of gas chromatography.

Table 1. Needs Analysis Questionnaire Instrument Grid for Students

No	Assessment Indicators (Extensions)	Item Number	Amount
1	Challenge (*Tantangan*)	1, 3, 5, 8	4
2	Curiosity (*Keingintahuan*)	2, 7	3
3	Participation (*Keikutsertaan*)	4, 6	3
4	Confidence (*Keyakinan*)	16, 18, 19	3
5	Attention (*Perhatian*)	12, 13, 15, 17	4
6	Relevance (*Keterkaitan*)	10, 11, 20	3
7	Satisfaction (*Kepuasan*)	9, 14	2
Amount			**20**

Data collection techniques by distributing validated needs analysis questionnaires to students using the Google Form platform to make it easier to distribute questionnaires. Then conducted interviews with one lecturer and five students. Data from questionnaires and interviews were then used as material for further analysis. Data analysis technique by describing the data from the needs analysis questionnaire and the results of the interviews conducted. Data in the form of percentages and opinion descriptions are described in depth to obtain results in the form of conclusions about the need for learning resources that students need in learning. The final results of the questionnaire assessment in the form of percentages are obtained using the formula below:

$$P = \frac{F}{N} x100\%$$

Information:

P = Percentage sought

F = Number of values obtained

N = Total number of values

After the percentage data from the needs analysis questionnaire for students is obtained, the categories are determined based on Table 2.

Table 2. Learning and Context Assessment Criteria

Valuation Percentage	Category
81 – 100 %	Very Good
61 – 80 %	Good
41 – 60 %	Currently
21 – 40 %	Not Enough
0 – 20 %	Very Less

(Source: Yeung et al., 2023).

The needs analysis data collection instrument used to assess existing gas chromatography learning resources at universities is a teaching material assessment instrument by the National Education Standards Agency (*Badan Standar Nasional Pendidikan* / BSNP) which has been modified and validated by instrument expert lecturers (Purba et al., 2020). The modified BSNP instrument grid is presented in Table 3.

Table 3. Standardization Instrument Grid for Feasibility of Gas Chromatography Learning Resources at Universities

No	Aspect	Indicator	Item Number
1	Content Eligibility	Conformity of Material with Indicators in the Semester Learning Program and Activity Plan (RPKPS)	1, 2
		Accuracy	3,4,5,6
		Update of Material	7, 8, 9
2	Language	Straightforward	10, 11
		Communicative	12, 13
		Dialogic and interactive	14, 15
		Suitability to the student's level of development	16, 17
		Use of the terms symbols and emblems	18, 19
3	Depth of material	Contents of learning resources (teaching materials)	20, 21
		Presentation supporting relationships	22, 23, 24
		Accuracy and presentation of the content of learning resources	25, 26, 27, 28
4	Presentation and Graphics	Font usage (type and size)	29, 30, 31
		Presentation Techniques	32, 33, 34, 35
		Layout	36, 37
		Amount	**37**

Source: Aspects of BSNP Teaching Material Assessment with Modifications

The quality of university learning resources is obtained from the results of the questionnaire instrument which has been filled in on a Likert scale (1 – 4) (Lukman & Ishartiwi, 2014). Overall product quality can be determined by determining the average score of all aspects assessed by researchers. The product quality percentage can be calculated using the formula below:

$$\text{Percentage of quality for each aspect } (\%) = \frac{\sum \text{average score obtained}}{\sum \text{average ideal score}} \text{x} 100\%$$

After the data is calculated, it is then analyzed using quantitative descriptive analysis which is presented in the form of score distributions and percentages for categories based on Table 4 below:

Table 4. Classification of Product Quality Assessment

Valuation Percentage	Category
76 – 100 %	very worthy
50 – 75 %	Worthy
26 – 50 %	Decent Enough
< 26 %	Not feasible

(Source: Arikunto, 2013).

Results

Results of Interview Analysis with Lecturers

Results of interviews conducted by researchers with Lecturer Dr. Marudut Sinaga, M, Si. which will be held on October 8 2023 in Building 19, 3rd floor of the Chemistry Laboratory. The results of the learning and context analysis carried out on lecturers during interviews are summarized in table 5 below.

Table 5. Interview Results Analysis of Needs for Learning Gas Chromatography for Lecturers

No	Analysis of Interview Questions and Answers of Respondents (Lecturers)
1	Have you ever taught a separation chemistry course, especially on the topic of gas chromatography? **Answer:** Yes, I have. Currently I am also teaching a course in Separation Chemistry.
2	What learning resources are commonly used when studying separation chemistry courses, especially on the topic of gas chromatography? **Answer:** First, it starts with an in-depth study of the material by delivering teaching materials in the form of Power Point Slides where it is hoped that there will be interaction between students and lecturers. However, in practice GC instrumentation is not yet available. So as a substitute, students see YouTube as their virtual lab. There were 5 meetings for Gas Chromatography. The material is: Basic Principles, Differentiating stationary phase and mobile phase, qualitative analysis (retention time), and quantitative analysis (chromatogram peaks).
3	Are there any obstacles to learning when using these learning resources? **Answer:** There is no direct practice in using the GC method. So it seems like something is incomplete. Only explore theory but no direct practice for sample execution.
4	How effective is the use of these learning resources in learning gas chromatography? **Answer:** It would be better if learning was not only done with theory but also with direct practice, both in real labs and virtual labs.
5	How do students respond to the use of learning resources commonly used in learning gas chromatography? **Answer:** Students watch YouTube to see live experiments in the form of analysis videos using gas chromatography.
6	What media are used to deliver gas chromatography learning material? **Answer:** The media is in the form of Power Point Slides.
7	Is gas chromatography instrumentation available in the laboratory? **Answer:** There used to be, but now it is damaged and cannot be used. The one in the laboratory is HPLC but there is only one type of column. At least there must be a virtual lab to bridge the availability of gas chromatography instrumentation.
8	Have you ever carried out gas chromatography practical activities in the laboratory for students? **Answer:** Never because the instrumentation cannot be used. Due to lack of maintenance.

No	Analysis of Interview Questions and Answers of Respondents (Lecturers)
9	How are gas chromatography practical activities carried out in the separation chemistry course? If you have never had a practical practicum, have you ever carried out a virtual practicum or replaced it with a project assignment? **Answer:** Replace with project activities using journals and YouTube videos. However, the purpose of carrying out the practicum is not yet available because the sample tested in the video will definitely be different from the one we want to analyze.
10	How effective are gas chromatography practical activities in separation chemistry courses? **Answer:** It is not yet effective because there is no instrumentation, but an alternative can be provided where students watch videos on YouTube.

Results of Interview Analysis with Students

Interviews were conducted with five students majoring in chemistry who had taken the separation chemistry course. The results of the learning and context analysis carried out on students on behalf of Fayzura Rifda Siahaan of the Chemistry study program class PSKM 21 B at the time of the interview are summarized in table 6 below.

Table 6. *Interview Results Analysis of Needs for Gas Chromatography Learning for One of the Students*

No	Analysis of Interview Questions and Respondents' Answers (Students)
1	Have you ever studied separation chemistry courses, especially on the topic of gas chromatography? **Answer:** I have
2	What learning resources are commonly used when studying separation chemistry courses, especially on the topic of gas chromatography? **Answer:** In zoom meetings and in person. Usually the references are also from journals.
3	Are there any obstacles to learning when using these learning resources? **Answer:** The theory studied cannot be put into practice
4	How do you respond to the use of learning resources commonly used in learning gas chromatography? **Answer:** That's good enough
5	What media are used to deliver gas chromatography learning material? **Answer:** Power Point and YouTube media
6	Is gas chromatography instrumentation available in the laboratory? **Answer:** No, because the Gas Chromatography instrumentation is damaged.
7	Have you ever carried out gas chromatography practicum in the laboratory? **Answer:** Never.
8	How are gas chromatography practical activities carried out in the separation chemistry course? If you have never had a practical practicum, have you ever carried out a virtual practicum or replaced it with a project assignment and what form did the project take? **Answer:** The gas chromatography practicum itself has never been carried out directly, we only looked at YouTube to understand for ourselves how the gas chromatography practicum tools are.

Results of Analysis of Gas Chromatography Learning Questionnaires for Students

Based on the results of a pre-research questionnaire distributed to 30 students majoring in chemistry at FMIPA Unimed who had taken separation chemistry courses, detailed results were obtained which are shown in table 7.

Table 7. *Percentage of Results of Needs Analysis Questionnaire Distribution to Students*

No	Assessment Indicators (Extensions)	Percentage	Category
1	Challenge (*Tantangan*)	65	Good
2	Curiosity (*Keingintahuan*)	67.08333333	Good
3	Participation (*Keikutsertaan*)	58.75	Moderate
4	Confidence (*Keyakinan*)	58.75	Good
5	Attention (*Perhatian*)	64.79166667	Good
6	Relevance (*Keterkaitan*)	56.38888889	Moderate
7	Satisfaction (*Kepuasan*)	56.38888889	Good
Average		**61.0218254**	**Good**

Based on table 7 above, a graph can be obtained depicting the percentage of each indicator assessed in the gas chromatography learning assessment in the chemistry department, FMIPA Unimed in Figure 1 below.

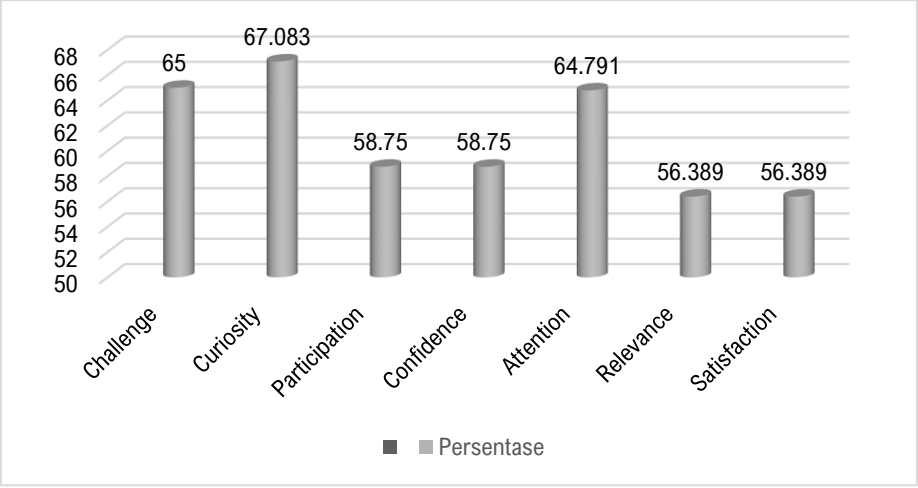

Figure 1. Percentage of Learning and Context Assessment Indicators Based on the Results of the Needs Analysis Questionnaire Analysis for Students

Results of assessment analysis of existing gas chromatography learning resources at universities

The results of the analysis of learning resources commonly used by students in learning separation chemistry, where the learning resources commonly used are PowerPoint slides made by the lecturer. Next, an analysis of the learning resources was carried out using a modified National Education Standards Board (BSNP) instrument, in order to obtain analysis results that could be used as a reference in developing learning resources according to students' needs. The results of the analysis of gas chromatography learning resources in the form of power point slides are presented in Table 8 below.

Table 8. Tabulation of Assessment of Gas Chromatography Learning Resources at Universities

No	Aspect	Average Value	Percentage	Category
1	Content Eligibility	2.67	66.75	Worthy
2	Language	3.00	75	Worthy
3	Depth of material	2.33	58.25	Worthy
4	Presentation and Graphics	3.00	75	Worthy
	Average	**2.75**	**68.75**	**Worthy**

Discussion

Based on the interview results in Table 5 above, it was found that the gas chromatography learning sources used at the University were PowerPoint slides and YouTube. This learning has a weakness in that students cannot carry out gas chromatography practicum because the GC instrumentation in the campus laboratory is damaged. In fact, students are expected to be able to understand, operate independently, and learn how to achieve better separation through manipulation of GC settings, such as split/splitless injection, carrier gas flow rate, and oven temperature, as well as apply GC principles to practical applications (Nolvachai et al., 2023). So, learning resources are needed that can learn the basic principles of GC more quickly than if they were in the laboratory using interactive gas chromatography and computer-based simulations, namely virtual laboratories (Pardo et al., 2018). Thus, learning resources integrated with the gas chromatography virtual laboratory can complement the current shortcomings of physical laboratory facilities, and can meet students' needs for carrying out practical sessions (Ulum, 2022). Based on the results of interviews conducted with students in Table 6 above, information was obtained that students who had taken separation chemistry courses on the topic of gas chromatography had never proven GC theory through practice. Usually the learning resources used during learning are PowerPoint and YouTube. This is an obstacle, gas chromatography material should be presented in project-based learning resources that are equipped with relevant contextual project examples, virtual laboratory media integration, hyperlinks to reliable websites, problem solving tests, and evaluations (Purba et al., 2019). Which can provide a longer learning experience in students' memories regarding the topic of gas chromatography (Sutiani et al., 2021).

Based on Table 7 and the graph in Figure 1 above, it was obtained from the results of distributing questionnaires to students that from the seven indicators it was assessed that there were five indicators in the good category, namely the aspects of challenge, curiosity, confidence, attention and satisfaction. Meanwhile, there are 2 indicators in the medium category, namely participation and linkage. Learning resources are needed on the topic of gas chromatography that can increase student participation in active learning and improve their performance in class (Purba et al., 2019). What can be done is to develop innovative learning resources that are applied to project-based learning. The project-based learning model allows students to carry out scientific discoveries systematically through laboratory experiments, field studies and project assignments so as to increase students' active participation during learning (Situmorang, Sinaga, et al., 2022). In research by Mursid et al., (2022) Project Based Learning (PjBL) was proven to be able to improve problem-solving abilities, creativity, independence, academic achievement and a better perspective, especially in learning science, namely chemistry. The learning resources on gas chromatography topics that will be developed in accordance with the results of the needs analysis carried out are learning resources that are applied to project-based learning.

Based on the results of the assessment of gas chromatography learning resources that already exist at universities in Table 8 above in the form of PowerPoint slides, information on four aspects was obtained, namely appropriateness of content, language, depth of material, presentation and graphics, so the existing learning resources are in the appropriate category with an average 68.75%. It is hoped that after innovation is carried out by developing project-based learning resources integrated with virtual laboratories on the topic of gas chromatography in accordance with student learning needs, the results of the assessment of the learning resources developed will increase to the very feasible category. This is in line with research conducted by Rizki et al., (2019) which stated that innovation in chemistry learning is very helpful

by bringing students closer to learning sources so that knowledge in the field of chemistry will be easily mastered by students and can improve their learning outcomes and competencies. Other research conducted by Juliandini et al., (2020) stated that ideal innovative learning resources are integrated with the latest technology which can facilitate students to learn optimally according to their needs, and learning activities can be carried out at any time without being limited by time and place.

As an implementation of this research, based on the results of the needs analysis carried out, it can be concluded that a learning resource is needed that can learn the basic principles of GC more quickly than if they were in a laboratory using interactive gas chromatography and computer-based simulations, namely a virtual laboratory. Thus, learning resources that are integrated with a virtual gas chromatography laboratory can complement the current lack of physical laboratory facilities, and can meet students' needs to carry out practical sessions more optimally. So the results of this research can be used as a reference for educators in developing learning resources on the topic of gas chromatography that are good and suitable for use based on the suitability of the instrument by the National Education Standards Agency (BSNP). The research limitations is that it analyzes gas chromatography learning resources at only one university. As a recommendation for future research, an analysis of learning needs can be carried out in divergence chemistry courses in general and gas chromatography topics in particular by involving more than one university as research subjects.

Conclusion

Based on the results of interviews with lecturers, it was concluded that the learning resources that lecturers usually use in teaching gas chromatography (GC) are PowerPoint slides and YouTube, there are weaknesses in learning where students cannot do GC practicum because the existing GC instrumentation has been damaged and cannot be used. Based on the results of interviews with students, the same conclusion was obtained as the statement expressed by the lecturer, where gas chromatography learning was carried out using PowerPoint slides and YouTube, students had never carried out GC practicum due to the unavailability of instrumentation on campus so they only read research journals about GC and watch YouTube analysis of component separation using the GC method. The results of the gas chromatography learning analysis questionnaire showed that the aspects of challenge, curiosity, confidence, attention and satisfaction were in the good category; aspects of participation and linkage are in the medium category so it is necessary to improve learning by involving students more in learning and linking the GC method with various other supporting fields of science.

The results of the analysis of learning resources commonly used by students in learning separation chemistry, namely PowerPoint slides made by the lecturer. Analyzed using the modified National Education Standards Agency (BSNP) instrument in the worthy category for each aspect assessed, namely appropriateness of content, language, depth of material, presentation and graphics. However, there needs to be a lot of development of GC learning resources to suit students' learning needs, namely project-based learning resources that can be accessed online/digitally, containing gas chromatography teaching materials, equipped with relevant contextual project examples, illustrations with virtual laboratory media integration, hyperlinks to trusted websites, problem solving tests and evaluations that can make students very enthusiastic about working on projects, completing and submitting reports correctly so that they can improve their learning outcomes and skills in gas chromatography material. It is hoped that the results of the analysis can be used as a basis for developing learning resources according to student needs.

Acknowledgment

Thanks are expressed to the lecturers who have validated the instruments used in this research. Thank you to the lecturer in the separation chemistry course who was willing to be a research subject to collect information through interviews and all respondents, namely students majoring in chemistry, Faculty of Mathematics and Natural Sciences, Medan State University who volunteered to participate and help collect research data.

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