



# Analysis of Variation in Basic Chemistry Semester Learning Plans in Indonesian Universities: Learning Achievements, Learning Methods, and Evaluation

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**Abstract:** This study investigates the variations in the preparation of Semester Learning Plans (SLP) for the Basic Chemistry 1 course across 19 chemistry education programs at 31 universities in Indonesia. The study focuses on key aspects such as material coverage, learning methods, evaluation techniques, book references, and learning media used in each SLP. Using a qualitative descriptive approach and content analysis of 19 SLP documents, the study reveals significant diversity in the covered topics, teaching methods, and evaluation techniques employed across institutions. Core topics like stoichiometry and atomic structure are taught universally, but there is notable variation in specialized content such as green chemistry, air pollution, and tropical rainforests. The learning methods are primarily interactive, with group discussions and project-based learning being the most dominant. However, no program explicitly integrates the scientific method into its curriculum. Evaluation techniques vary, with most programs combining written exams and practical projects. This research concludes that the variations in SLP reflect institutional efforts to align curricula with local needs and global trends. It recommends expanding the sample scope in future studies and including qualitative data such as interviews with lecturers and student surveys for a more comprehensive understanding of how SLP impacts learning outcomes.

**Keywords:** Basic Chemistry, Chemistry Education, Learning Methods, Semester Learning Plan

## Introduction

The Semester Learning Plan (SLP) is a crucial component in the higher education system, serving as a guide for lecturers and students to organize the learning process in a structured and systematic way (Calderón et al., 2024). As a pedagogical tool, the SLP includes essential elements such as content coverage, teaching methods, media used, and evaluation techniques to measure learning outcomes (Al-Fraihat et al., 2020). The preparation of an SLP aims to ensure that each learning process is not only well-planned but also capable of

achieving the targeted learning outcomes, especially in terms of understanding theoretical concepts and applying the acquired knowledge in practice (Martin-Visscher et al., 2020; Mutton et al., 2011).

In chemistry education, the SLP is particularly significant because the field requires mastery of complex theoretical concepts and practical skills often developed through laboratory experiments (Azizah & Yonata, 2023; Van Brederode et al., 2020). Therefore, developing a practical and relevant SLP is crucial for ensuring that students gain a comprehensive understanding and develop the necessary application skills for the

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workforce (Nurdin, 2018; Rohm et al., 2021). However, implementing SLP across universities is not always uniform, as it is influenced by each institution's educational vision, curriculum, and internal policies.

One of the primary challenges in preparing an SLP is ensuring alignment between the components of the plan and the expected learning outcomes (Fabeku & Enyeasi, 2024; McDonald et al., 2013). Several studies show that effective learning outcomes are influenced not only by the quality of the material taught but also by the teaching methods used and the evaluation techniques applied (Aldahmash & Omar, 2021; Cajamarca Carrazco et al., 2024; Dunlosky et al., 2013; Zandler, 2019). Thus, a comparative analysis is necessary to understand how SLP preparation can be optimized to meet higher education standards and better align with industry and societal needs.

This study focuses on variations in the preparation of SLP across universities, specifically in the context of Basic Chemistry 1. Basic Chemistry 1 is a fundamental course for students in science programs, especially those studying chemistry education. It covers essential topics such as stoichiometry, atomic structure, chemical bonding, chemical reactions, and other basic chemistry concepts. Therefore, it is crucial to ensure that the material is well-structured and that the teaching methods used promote deep, applicable understanding.

This study aims to fill a gap in the literature regarding the variations in the preparation of Basic Chemistry 1 SLP across universities, particularly in

Indonesia. The novelty of this research lies in its focus on how variations in content coverage, teaching methods, book references, and evaluation techniques affect student learning outcomes. The study provides recommendations for academic programs to develop SLP that are not only locally relevant but also aligned with global standards, thus supporting more effective and applicable learning for chemistry students across Indonesia.

## Method

This study used a qualitative descriptive approach with a content analysis method. This approach was selected because it allowed researchers to understand complex phenomena through in-depth analysis of texts or documents (Creswell & Guetterman, 2019). In this context, the documents analyzed were the Semester Learning Plan (SLP) for the Basic Chemistry 1 course of 19 chemistry education study programs at 31 universities with chemistry education study programs. The qualitative descriptive approach was applied to explore comparative and interpretive information related to the scope of material, learning methods, evaluation techniques, and learning media used in each study program. Here is the figure for the research methodology steps, illustrating the stages of the qualitative descriptive approach with the content analysis method and the elements analyzed in the study.

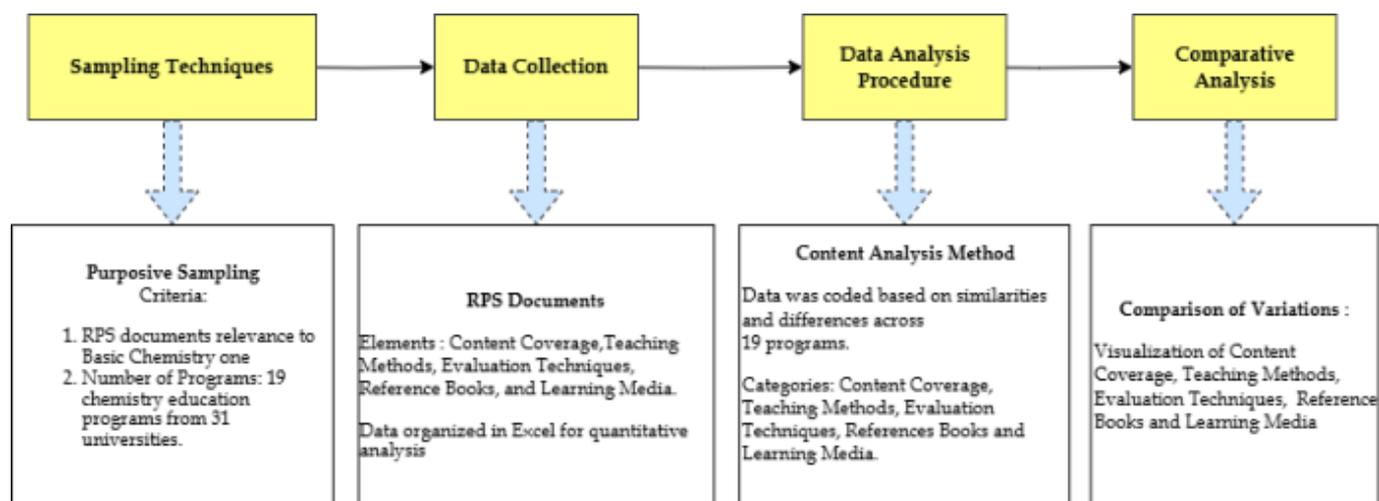


Figure 1. Research Methodology Steps

### Sampling Techniques

The sampling technique applied in this study was purposive sampling. This technique was selected because the study focused on universities that have chemistry education study programs with relevant and complete SLP documents. Of the 31 universities that

have chemistry education study programs, only 19 study programs were willing to provide their SLP for analysis. According to (Creswell & Guetterman, 2019), purposive sampling is a technique used when used in cases where researchers aim to select samples based on certain criteria that can help understand the research

problem in more depth. The criteria used in this study included the completeness of the SLP document, suitability with the Basic Chemistry 1 course, and the relevance of the SLP components to the research objectives.

#### *Data collection*

The primary data in this study were SLP documents from 19 chemistry education study programs. Each SLP contains information that includes several main elements :

1. Material Coverage: Topics taught in the Basic Chemistry 1 course.
2. Learning Methods: Strategies or approaches used for delivering lecture material.
3. Evaluation Techniques: Assessment methods used for measuring student learning outcomes.
4. Book References: References used to teach introductory chemistry
5. Learning Media: Tools or technology used to support the learning process.

The data collection process involved documenting each element listed in the SLP. All documents were reviewed and verified for completeness before inclusion in the analysis. An Excel spreadsheet was used to organize data, such as the number of topics and learning methods used in each university, in order to obtain additional quantitative data.

#### *Data Analysis Procedure*

Data analysis was performed using the content analysis method. Content analysis identifies patterns or themes from text data (Creswell & Guetterman, 2019). Each element in the SLP, such as material coverage, learning methods, and evaluation techniques, was coded based on the similarities and differences found among the 19 study programs analyzed. This coding process helped categorize these elements so that certain patterns relevant to the research objectives could be identified.

After coding, the data was categorized to allow for comparative analysis across universities. For example, the material taught at each university was analyzed to uncover variations in the number and scope of topics. Additionally, learning methods used in each study program were classified into several types, such as group discussions, project-based learning, or laboratory simulations. Evaluation techniques were similarly categorized into written exams, projects, laboratory reports, and class participation.

#### *Suitability of Learning Achievements*

To evaluate the suitability between the targeted learning outcomes and other elements in the SLP, such as learning methods and evaluation techniques, a

suitability matrix was prepared. This matrix helps in visualizing how each element in the SLP is related to the other and whether these elements supported the learning outcomes that have been set. (Creswell & Guetterman, 2019) Emphasizes that using matrices in qualitative analysis can help researchers identify significant relationships between variables or elements being analyzed.

#### *Comparative Analysis*

A comparative analysis was performed to determine significant variations among chemistry education study programs at 19 universities. The results of this analysis were aimed at showing patterns of differences or similarities in the preparation of SLP, particularly in terms of the materials taught, the methods used, and the evaluation techniques. Using quantitative data obtained from Excel spreadsheets, these variations were examined to find trends or key differences that could impact the quality of learning outcomes at each university.

For example, a university that emphasizes a green chemistry approach in its content coverage might have used different learning methods compared to a university that focuses more on basic chemistry theory. Differences in evaluation methods were also examined to understand how universities evaluate students' practical and theoretical skills.

## **Result and Discussion**

This study aimed to analyze variations in the preparation of Semester Learning Plans (SLP) in Basic Chemistry 1 courses at various universities in Indonesia, focusing on the scope of materials, learning methods, evaluation techniques, and learning media used. This analysis was based on data from 19 chemistry education study programs at 31 universities that offer the study program. The data analyzed was derived from the SLP document and was supported through additional analysis presented in Excel format.

#### *Coverage of Material in Basic Chemistry SLP 1*

A study of the Basic Chemistry 1 course in 19 study programs shows significant diversity in the breadth and depth of topics covered. Some universities, such as Code A, cover a wide range of topics with a total of 23 main subjects, while other universities, such as Code C, are more focused on 11 main subjects. This variability reflects the priorities of each institution in balancing essential foundational knowledge with specialized content tailored to the educational vision, available resources, and regional needs of each university. Core material, including stoichiometry, atomic structure,

chemical reactions, and bonding principles, is taught in almost all institutions, ensuring a common foundational understanding necessary for students to advance to more complex chemistry topics at later stages. These topics serve as an important theoretical foundation to support an advanced understanding of chemistry.

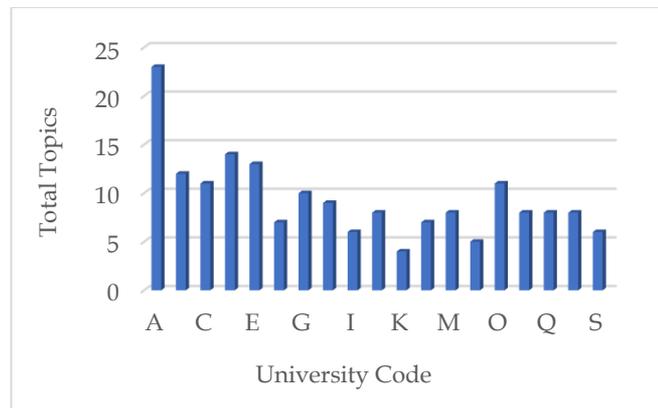


Figure 2. Number of Basic Chemistry Topics 1

However, some universities add special materials that reflect specific academic interests or address local and global challenges, such as Code A adds material on "Air Pollution and Greenhouse Effects," which equips students with insights into global environmental issues in the context of environmental chemistry (Jairi et al., 2024, 2024). Code B emphasizes "Green Chemistry," which promotes sustainable practices in chemical processes, which is in line with the global trend towards environmentally friendly scientific practices (Lambin & Corpart, 2018). Code P focuses on "Tropical Rainforests," a unique topic that introduces students to biodiversity and conservation efforts relevant to tropical ecosystems (Hasbi et al., 2023). Code S includes "Biomolecules," broadening students' horizons into the increasingly important realm of biochemistry in fields such as pharmacology and bioengineering (Ripoll et al., 2023).

The adoption of this additional content demonstrates how institutions integrate both global and regional perspectives into their chemistry curriculum, enhancing the relevance of academic content with real scientific issues (Xia et al., 2025). The diversity of topics provides flexibility for universities to design education according to student interests and equip them with knowledge relevant to the industry and regional ecosystem (Furukado et al., 2024). For example, students in Code P can understand the tropical rainforest ecosystem, which is suitable for careers in environmental science, forestry, or conservation. Similarly, students in Code B benefit from learning green chemistry, which prepares them to work in industries focused on reducing environmental impact.

Table 1. Special Topics

University (Code)	Special Materials Studied
A	Air pollution and the greenhouse effect
B	Green Chemistry
P	Wet Tropical Forest
S	Biomolecules

Examples of the specific materials presented emphasize trends in chemistry education that lead to specific and contextual learning, equipping students to handle complex real-world issues (Collie & Martin, 2024). Such specialization enables institutions to respond to current scientific challenges, meet educational standards, and address societal needs. In general, the graphs and tables show that each university has a focus and uniqueness in the material taught, according to their respective curricula and educational approaches. The material taught exclusively at one university reflects a specialization or special attention to a particular field, which can be driven by the expertise of the lecturer, local and global needs, or the objectives of the study program. Universities tend to emphasize materials that are in line with their academic focus. For example, university A emphasizes environmental issues such as air pollution, while university B focuses on the application of environmentally friendly Green Chemistry. University P focuses on the local potential of the area, namely tropical rainforests. This shows a variation in teaching approaches to address real problems (Ju et al., 2023). Overall, the variety in the material taught reflects the university's efforts to offer study programs that not only meet national education standards but also differentiate themselves based on regional or industry specialization and needs. This provides students with the opportunity to gain knowledge that is varied and relevant to their interests or career aspirations.

*Learning Outcomes: Consistency and Variation*

Learning outcomes across universities show fairly uniform standards, particularly in terms of mastery of basic chemistry concepts, application of scientific methods, and problem-solving skills. Despite consistency in learning outcome objectives, some universities add specific practical or application skills such as laboratory skills or mastery of chemical analysis software. This is in line with literature that emphasizes the importance of matching learning outcomes to the needs of the workplace and global standards (Chang & Liu, 2024).

The variation in learning outcomes across study programs reflects differences in the university's vision and mission, as well as available resources. Some study programs are more oriented towards practical

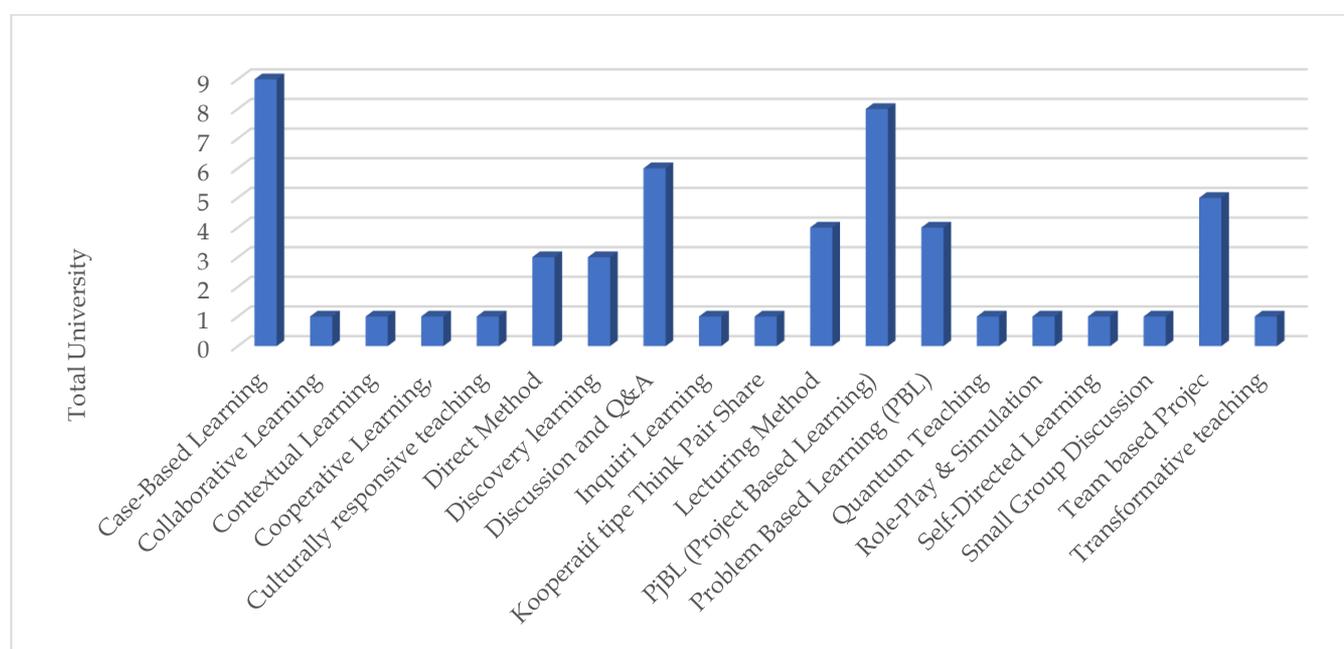
applications, indicating a more contextual and skills-based approach to learning.

#### *Learning Methods: Interaction and Adaptation*

The learning methods applied by various universities mostly combine interactive methods such as group discussions, project-based learning, and collaborative learning. However, some universities show further innovation by utilizing laboratory simulations as a medium or complement to physical laboratory activities. This finding shows the importance of innovation in learning, especially in universities with limited infrastructure. The practical implications of using virtual laboratory simulations are increasing the accessibility and flexibility of student learning, which

can indirectly improve their experimental skills (Aliev et al., 2023).

The use of interactive and technology-based learning methods, such as simulations, reflects a global trend in science education, where active and collaborative learning is recognized as a more effective strategy for increasing student understanding and engagement (Antonio & Castro, 2023). Laboratory simulations, in particular, provide students with the opportunity to conduct chemistry experiments digitally, which not only saves costs but also allows for easier access and more flexible experiment repetition (Alkan & Koçak, 2015). The following graph illustrates the methods used



**Figure 3.** Learning Methods

The chart illustrates a variety of learning methods applied across the universities studied, with prominent methods including project-based learning, case-based, and discussion methods. Notably, none of the universities incorporated the scientific method explicitly in their curriculum. The absence of this approach suggests a gap in focusing on science process skills essential for chemistry students. Introducing the scientific method as a core learning model is advised. This method could systematically enhance students' skills in scientific inquiry, hypothesis testing, and data interpretation—skills fundamental to both academic and practical chemistry applications. Incorporating this method aligns well with the aim of fostering hands-on learning experiences that are critical in chemistry education (Woodcock, 2014).

#### *Type of Assessment: Diversity in Evaluation*

Student evaluation is generally conducted through a combination of written exams, projects, lab reports, and class participation. However, there are differences in the proportion of assessment given to each component. Some universities give greater weight to project-based assessments, while others place more emphasis on written exams. This variety of assessment methods reflects a comprehensive approach to evaluating student learning outcomes. By using a variety of assessment methods, universities can assess different aspects of learning, from mastery of theory to practical skills.

The use of various evaluation techniques reflects the university's efforts to comprehensively assess student learning outcomes, both in terms of theoretical mastery and practical skills (Boström & Palm, 2020).

Project-based assessments, for example, allow students to apply theoretical knowledge in a more real-world context, while written exams place more emphasis on

students' ability to understand and remember key concepts (Almulla, 2020). The following is a graph of the evaluation methods used.

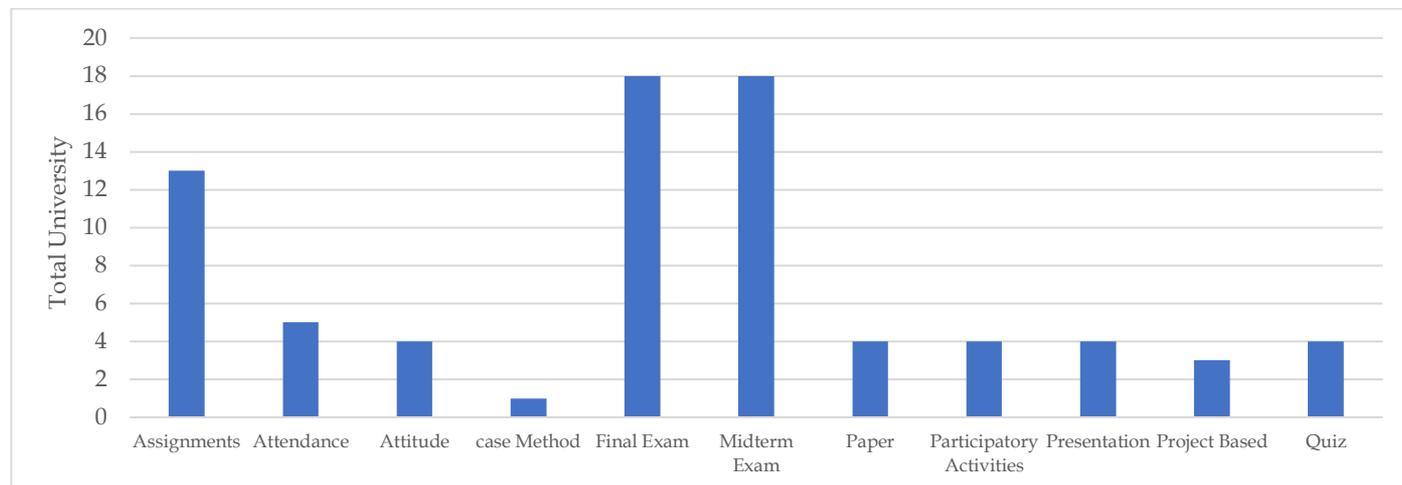


Figure 4. Types of Evaluation

This chart shows diversity in evaluation techniques among the programs, including written exams, project assignments, laboratory reports, and participation in group discussions. The variation suggests an attempt to assess both theoretical understanding and practical skills, but the proportions of each type differ significantly between institutions. The diversity in assessment methods points to flexibility in evaluation approaches, which could support varied competencies like critical thinking and application of knowledge (Altun & Yildirim, 2023).

*Reference Books: Standards and Adaptations*

Textbooks used across universities show some agreement on the importance of specific literature, such

as Chang's "General Chemistry" and Brown's "Chemistry: The Central Science." The use of the same reference books across universities reflects an effort to meet specific academic standards in chemistry education. However, some campuses add local references or more contextual resources to complement the core teaching materials.

The adjustment of the use of reference books shows flexibility in curriculum development, where universities can add teaching materials that are relevant to the local context or current trends in chemistry. Richer literacy, through the use of diverse references, can improve the quality of student learning (Gurses et al., 2015). The following is a graph of the use of reference books.

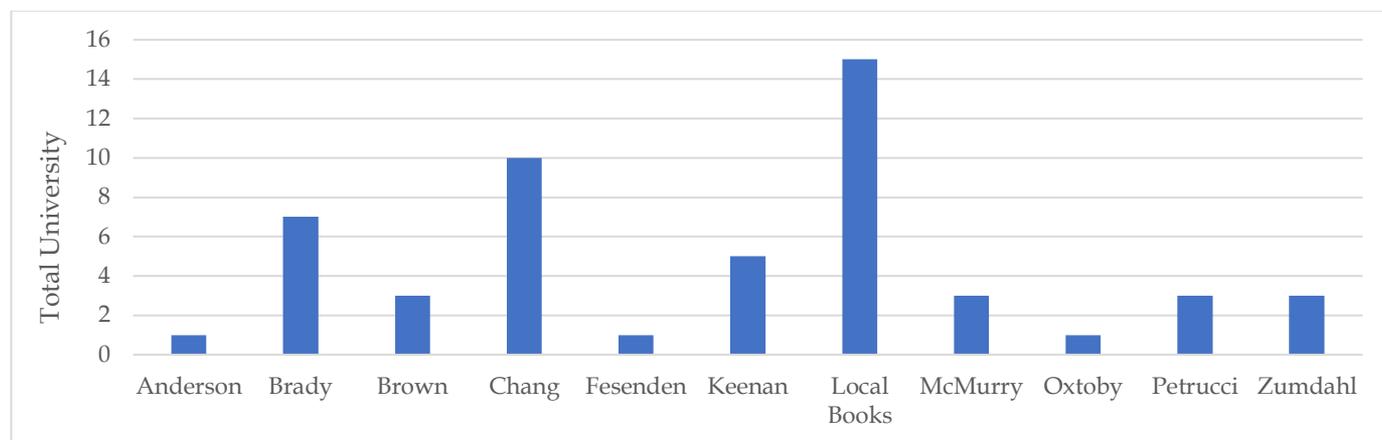


Figure 5. Reference Books

The reference books used across the institutions reveal both consistency in foundational texts, such as

Chang's General Chemistry and Brown's Chemistry: The Central Science, and some variation in additional

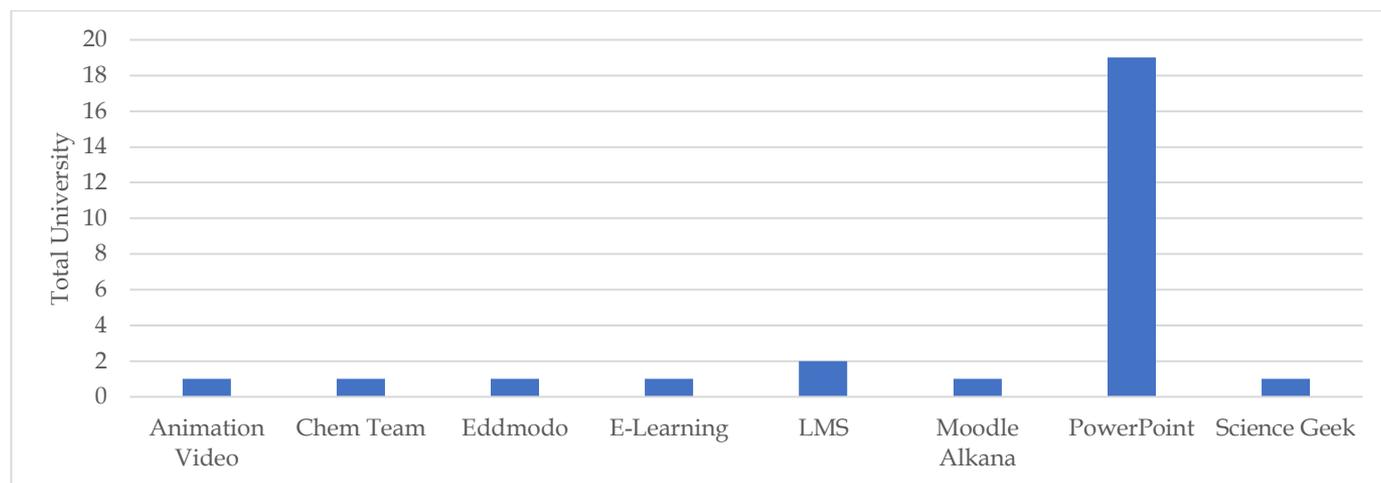
resources tailored to specific university focuses. This indicates a general alignment with academic standards while also allowing room for contextual and specialized resources.

### **Instructional Media**

The most frequently used learning media in various universities are PowerPoint presentations, learning videos, and virtual laboratories. The use of these media helps students access materials more interactively and flexibly, especially in today's digital era. However, the use of this technology also faces

several challenges, especially in terms of limited access to technological infrastructure in some universities, which can affect the effectiveness of the use of technology-based learning media.

The use of technology-based learning media is essential to support the learning process, especially in situations where distance learning or blended learning is applied (B\* & Suchithra, 2019). Learning videos and virtual simulations allow students to access materials at any time, so they have more time to understand and repeat difficult concepts (Brown et al., 2021). The following is a graph of the learning media used.



**Figure 6.** Learning Media

This chart shows that the most commonly used digital learning medium is PowerPoint presentations. Additional tools such as animated videos and e-learning are used in fewer than five study programs. This indicates potential for broader development of virtual-based media to support more interactive and flexible learning. Chemistry concepts that require visual representation and repeated simulations can be more easily understood with the aid of these tools (Enero Upahi & Ramnarain, 2019). It is therefore recommended to consider implementing virtual-based media in the learning process.

### *Research Strengths and Implications*

This study provides a comprehensive view of the variation and consistency in the preparation of the Basic Chemistry 1 SLP across universities. The strength of this finding is its ability to identify general trends in chemistry education while still considering variations in local approaches and adaptations. Thus, this study can be a basis for developing flexible curriculum standards that still meet the desired quality of education. These findings enrich the scientific discussion on how higher education curricula should be designed to balance academic standards and students' specific needs.

Recommendations generated from this study can be used to develop better guidelines in the preparation of SLP, which will ultimately improve the quality of learning in higher education.

### *Research Limitations and Recommendations for Further Research*

The main limitation of this study is the number of documents analyzed, which is only 19 SLP of chemistry education study programs from 31 universities in Indonesia, which does not fully represent the variation of the curriculum across universities in Indonesia. The analysis is only based on written documents without evaluating student learning outcomes directly, so factors such as lecturer skills and university infrastructure are not fully considered. For further research, it is recommended to expand the scope of the sample and include other qualitative data, such as interviews with lecturers or surveys to students, in order to get a more complete picture of how SLP affects learning outcomes. Further research can also explore the influence of educational policies or other factors that may influence curriculum variation across universities.

## Conclusion

This study reveals significant variations in the preparation of Semester Learning Plans (SLP) for Basic Chemistry 1 courses in 19 chemistry education study programs at various universities in Indonesia. These variations are seen in terms of material coverage, learning methods, evaluation techniques, reference books, and learning media used. Although some basic topics, such as stoichiometry and atomic structure, are taught in almost all universities, there is a different emphasis on specific topics such as green chemistry, environmental issues, and tropical rainforests. The varied learning methods, from group discussions to virtual laboratory simulations, indicate institutional adaptation to resource constraints and local needs but also lead to differences in the practical skills developed by students. The evaluation techniques used also show differences in the proportion between written exams and practical projects, which potentially affect the focus of the competencies measured. In addition, technology-based learning media such as learning videos and virtual laboratory simulations are part of supporting student flexibility and engagement. This study allows institutions to maintain local relevance while ensuring equal learning outcomes across universities. These findings are important as a basis for developing educational policies that can improve the quality and equity of chemistry education in higher education in Indonesia.

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### Author Contributions

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### Conflicts of Interest

The authors declare no conflict of interest

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