



Needs Analysis for Developing Web-Based Interactive Multimedia Integrated with Spiritual Values on Chemical Equilibrium Material for Grade XI

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Abstract: Needs Analysis for Developing Web-Based Interactive Multimedia Integrated with Spiritual Values on Chemical Equilibrium Material for Grade XI. This study aimed to analyze the needs for developing web-based interactive multimedia integrated with spiritual values on chemical equilibrium material for grade XI students. The study employed a research and development (R&D) method using the 4D development model limited to the define stage. The research was conducted at SMA Negeri 2 Percut Sei Tuan involving 36 students and one chemistry teacher. Data were collected through observations, interviews, and needs analysis questionnaires, then analyzed descriptively using qualitative and quantitative approaches through the stages of front-end analysis, student analysis, task analysis, concept analysis, and specifying instructional objectives. The findings revealed that students still experienced difficulties in understanding chemical equilibrium material, with a percentage of 62.96%. The need for web-based interactive multimedia reached 80.95% in the high category, while the integration of spiritual values obtained the highest percentage of 90.56% in the very high category. The results of task, concept, and instructional objective analyses indicated that the developed multimedia should facilitate cognitive and affective aspects in an integrated manner. Therefore, the development of web-based interactive multimedia integrated with spiritual values is considered capable of supporting chemistry learning that is more interactive, structured, and meaningful in accordance with students' learning needs and the objectives of the Merdeka Curriculum.

Keywords: needs analysis, spiritual value integration, web-based interactive multimedia, chemical equilibrium, chemistry learning.

Abstrak: Analisis Kebutuhan Pengembangan Multimedia Interaktif Berbasis Website Terintegrasi Nilai Spiritual pada Materi Keseimbangan Kimia Kelas XI. Penelitian ini bertujuan untuk menganalisis kebutuhan pengembangan multimedia interaktif terintegrasi nilai spiritual pada materi keseimbangan kimia kelas XI. Penelitian ini menggunakan metode research and development (R&D) dengan model pengembangan 4D yang dibatasi pada tahap define. Penelitian dilaksanakan di SMA Negeri 2 Percut Sei Tuan dengan subjek sebanyak 36 siswa dan satu guru kimia. Data dikumpulkan melalui observasi, wawancara, dan angket analisis kebutuhan, kemudian dianalisis secara deskriptif kualitatif dan kuantitatif melalui tahapan front-end analysis, student analysis, task analysis, concept analysis, dan specifying instructional objectives. Hasil penelitian menunjukkan bahwa siswa masih mengalami kesulitan dalam memahami materi keseimbangan kimia dengan persentase sebesar 62,96%. Kebutuhan terhadap multimedia interaktif berbasis website memperoleh persentase sebesar 80,95% dengan kategori tinggi, sedangkan integrasi spiritual values memperoleh persentase tertinggi sebesar 90,56% dengan kategori sangat tinggi. Hasil analisis tugas, konsep, dan tujuan pembelajaran menunjukkan bahwa multimedia yang dikembangkan perlu memfasilitasi aspek kognitif dan

afektif secara terintegrasi. Oleh karena itu, pengembangan multimedia interaktif terintegrasi nilai spiritual dinilai mampu mendukung pembelajaran kimia yang lebih interaktif, terstruktur, dan bermakna sesuai dengan kebutuhan belajar siswa serta tujuan Kurikulum Merdeka.

Kata kunci: analisis kebutuhan, integrasi nilai spiritual, multimedia interaktif berbasis website, kesetimbangan kimia, pembelajaran kimia

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▪ INTRODUCTION

Chemistry is one of the subjects that requires the simultaneous understanding of concepts at three levels of representation, namely macroscopic, submicroscopic, and symbolic, and is therefore often considered difficult by students (Hurrahman et al., 2022). According to Zahwa et al. (2026), one of the chemistry topics reported as a source of learning difficulties is chemical equilibrium. High school students generally experience misconceptions that are frequently found in this topic, including the assumption that at equilibrium the concentrations of reactants and products are always equal and errors in interpreting the equilibrium constant (Satriana et al., 2018), as well as difficulties in predicting the direction of equilibrium shifts based on Le Chatelier's Principle (Peris, 2022). These misconceptions not only affect students' cognitive achievement but also hinder the development of the conceptual understanding required to learn more complex advanced chemistry topics.

Weaknesses in concept mastery are further exacerbated by learning approaches and the use of instructional media that have not been optimized in practice. Astafani et al. (2024) stated that the factors causing difficulties in learning chemistry include ineffective teaching methods, a lack of supporting facilities, and the inability of instructional media to optimally meet students' learning needs. Thus far, the use of conventional learning media has not been fully capable of facilitating the visualization of abstract concepts at the submicroscopic level optimally (Wohlfart et al., 2023). A similar condition was found at SMA Negeri 2 Percut Sei Tuan. Based on preliminary observations, chemistry learning at the school remains teacher-centered, causing students to be passive. The available media are also limited to focusing on cognitive exercises and are not yet capable of visualizing the abstract nature of the material or providing space for students' affective value reflection.

In fact, the orientation of modern education today is no longer solely focused on cognitive achievement. In Indonesia, the implementation of the Merdeka Curriculum explicitly demands holistic character development through the dimensions of the Pancasila Student Profile, particularly the values of faith, piety, and noble character (Kemendikbudristek, 2024). This paradigm opens significant opportunities for the integration of spiritual values into science learning (Darmana et al., 2026). Manubey & Sitompul (2025) revealed that the integration of the spiritual dimension in learning is considered capable of creating more meaningful learning experiences through the interconnectedness of students' cognitive, affective, and reflective aspects. In the context of chemical equilibrium, the subtopic of equilibrium shifts (*Le Chatelier's Principle*) has the potential to foster students' spiritual values, such as a sense of awe toward the regulation of nature and gratitude. However, in reality, this affective-spiritual potential is often overlooked in the design of existing learning media (Febrian & Darmana, 2025).

To bridge cognitive problems while simultaneously addressing the gap in character education, the development of innovative technology-based learning media has become

an urgent necessity. Web-based learning media are considered effective because they can present interactive content through the integration of multimedia elements, such as text, images, videos, audio, and interactive links within a single platform (Fitrianingsih et al., 2023). In this study, spiritual values, including a sense of awe and gratitude, were explicitly integrated into the multimedia design through three components. First, brief narratives embedded in each subtopic to connect chemical equilibrium phenomena with the orderliness of nature. Second, self-assessment scales that allow students to evaluate their affective connection to the material. Third, self-reflection features at the end of each subtopic that encourage students to articulate their learning experiences both cognitively and spiritually. These three components were designed to be directly embedded within the chemistry content, ensuring that value internalization is contextual rather than merely a one-way textual narrative.

Several studies have demonstrated the effectiveness of interactive multimedia in enhancing the understanding of abstract chemistry concepts. Rahmawati et al. (2022), reported that the use of multimedia-based interactive simulations helped students visualize submicroscopic representations and improve their understanding of chemistry concepts. Similarly, Assifuah & Anim-Eduful (2025) stated that the use of multimedia instructional strategies is more effective than conventional methods in improving students' conceptual understanding. However, studies on value integration in learning remain limited to static or administrative learning resources such as teaching modules, pocketbooks, and student worksheets. These conventional resources have limitations in visualizing dynamic submicroscopic phenomena, resulting in the internalization of spiritual values often being reduced to one-way textual narratives that are less meaningful. On the other hand, existing studies on interactive multimedia have largely focused on cognitive aspects and have not explicitly accommodated affective-spiritual dimensions within their media design.

Based on the literature review conducted, no web-based interactive multimedia has yet been identified that specifically integrates spiritual values into chemical equilibrium learning. This gap highlights the urgency of developing learning media that are not only cognitively effective but also spiritually meaningful for students. In addition, developing learning media without a systematic needs analysis risks producing products that are not relevant to actual classroom problems. Therefore, this study aims to analyze the need for the development of web-based interactive multimedia integrated with spiritual values for Grade XI chemical equilibrium material through the implementation of the define stage of the 4D development model (Thiagarajan et al., 1974). The analysis includes five components: front-end analysis, student analysis, task analysis, concept analysis, and specifying instructional objectives. The findings of this study are expected to serve as a reference for designing interactive multimedia that is cognitively effective while also being spiritually meaningful for Grade XI students.

▪ **METHOD**

This study is part of a research and development (R&D) study employing the 4D model developed by Thiagarajan et al. (1974). The study was limited to the results of the first stage, namely the define stage, which aimed to determine the needs for developing web-based interactive multimedia integrated with spiritual values for Grade XI chemical equilibrium material. The study was conducted at SMA Negeri 2 Percut Sei Tuan, located on Jalan Pendidikan, Bandar Klippa, Percut Sei Tuan District, Deli Serdang Regency, North Sumatra Province, Postal Code 20373.

The research subjects consisted of two components. First, 36 Grade XI students served as respondents for the needs analysis questionnaire and were selected using purposive sampling based on the consideration that they had already studied chemical equilibrium. Second, one chemistry teacher served as the interview informant. The limitation in the number of teacher informants was due to the school condition in which only one chemistry teacher taught Grade XI during the research period; therefore, the single informant represented the most complete data source available and relevant to the focus of the study.

Furthermore, the define stage was carried out through five sequential procedures adapted from Thiagarajan et al. (1974), namely: (1) front-end analysis, conducted through direct classroom observations in Grade XI over two meetings to identify learning conditions, teaching methods, and the media used; (2) student analysis, conducted through the distribution of questionnaires to 36 students to identify learning difficulties, media preferences, and the need for spiritual value integration; (3) task analysis, conducted by mapping the cognitive steps that students must master based on ATP 11.5 of the Merdeka Curriculum while simultaneously identifying points of spiritual value integration in each subtopic; (4) concept analysis, conducted by constructing a hierarchical concept map of chemical equilibrium covering prerequisite and core materials; and (5) specifying instructional objectives, conducted by formulating cognitive and affective learning objectives referring to ATP 11.5 of the Merdeka Curriculum.

Data were collected using three instruments. First, a structured observation sheet with several observation aspects, including learning methods, types of media used, student participation, digital literacy skills, and students' initial responses to the orderliness of nature as an affective-spiritual indicator, recorded using Yes/No options accompanied by descriptive notes. Second, a semi-structured interview guide covering three dimensions: identification of learning problems, media and facility needs, and perceptions of the integration of spiritual values in chemistry. Third, a student needs analysis questionnaire consisting of 15 dichotomous-scale statements (Agree/Disagree), covering three dimensions: cognitive learning difficulties, media preferences and needs, and the need for spiritual value integration. The spiritual values indicators analyzed included a sense of awe toward the orderliness of nature and gratitude, operationalized through statements such as "I feel a sense of awe when I learn that chemical equilibrium systems in nature operate in an orderly manner" and "I feel grateful to be able to learn about natural phenomena through chemistry."

Content validation of the instruments was conducted through expert review by the research supervisor and contextual suitability confirmation by the chemistry teacher as a practitioner at the research site. Formal statistical reliability testing was not conducted because the dichotomous-scale questionnaire in this study was not intended as a psychometric measurement instrument but rather as a screening instrument for needs assessment in front-end needs analysis aimed at identifying the prevalence of needs (Thiagarajan et al., 1974). The overall trustworthiness of the data was ensured through triangulation with observation and interview data.

Observation and interview data were analyzed descriptively using the qualitative analysis model of Miles, Huberman, and Saldana through the stages of data condensation, data display, and conclusion drawing/verification (Wiradimadja et al., 2021). Questionnaire data were analyzed quantitatively using the following percentage formula:

$$P = \frac{\sum \text{The 'Yes' Answer}}{\sum \text{Maximum Score}} \times 100\%$$

The intervals and assessment categories referred to the criteria proposed by Kurniawan & Anggraini (2017), as presented in Table 1. Data triangulation was conducted by comparing findings from the three data sources to ensure the validity of the results.

Table 1. Intervals and Value Categories for Needs Analysis

Intervals (%)	Category
81 – 100	Sangat Tinggi
61 – 80	Tinggi
41 – 60	Cukup
21 – 40	Rendah
0 - 20	Sangat Rendah

▪ RESULT AND DISCUSSION

This study reports the results of the implementation of the define stage in the 4D development model, which encompasses five analytical components, namely *front-end analysis*, *student analysis*, *task analysis*, *concept analysis*, and *specifying instructional objectives*. The results and discussion of each component are presented sequentially below.

1. *Front-end Analysis*

The results of classroom observations in Grade XI at SMA Negeri 2 Percut Sei Tuan indicated that chemistry learning remains teacher-centered, dominated by lecture-based instruction supported by PowerPoint presentations, YouTube videos, and Student Worksheets. Students tended to be passive, were less actively engaged, and two-way interaction between teachers and students was very limited throughout the learning process. Interviews with the chemistry teacher also revealed that the main challenge encountered was students' misconceptions regarding chemical equilibrium, particularly the tendency to perceive equilibrium as a static condition, causing difficulties in predicting equilibrium shifts based on Le Chatelier's Principle. The media currently used were considered predominantly one-way and incapable of visualizing the abstract concepts of chemical equilibrium, while also failing to provide opportunities for spiritual value reflection within the context of chemistry learning. Nevertheless, supporting infrastructure, including the school's Wi-Fi network and the availability of students' personal devices, was found to be adequate, providing a strong foundation for the selection of website-based learning media.

The teacher-centered learning condition identified in the field is consistent with Rahmawati et al. (2022), who reported that misconceptions related to dynamic equilibrium concepts and Le Chatelier's Principle are difficult to address through conventional learning approaches alone because static media are unable to visually represent the dynamic nature of equilibrium. This finding reinforces the urgency of transitioning to more interactive media, as emphasized by Ahyan et al. (2022), who stated that web-based chemistry learning media can create more interactive and flexible learning environments compared to teacher-centered instruction, which tends to reduce student

engagement. Furthermore, the availability of Wi-Fi infrastructure and students' personal devices at the school fulfills important prerequisites, as Haleem *et al.* (2022) emphasized that internet connectivity and access to technological devices are key factors determining the success of digital learning implementation.

Based on the findings of the front-end analysis, web-based interactive multimedia is considered an appropriate solution because it can simultaneously address three essential needs: (1) visualizing abstract and dynamic chemical equilibrium concepts at the submicroscopic level that cannot be represented through static media; (2) providing two-way interactivity that conventional media such as PowerPoint presentations and worksheets do not offer; and (3) integrating opportunities for spiritual value reflection, which have thus far been absent from existing media designs. These three needs can only be accommodated simultaneously through a web-based digital platform that supports the integration of multimedia, simulations, and reflective features within a single unified interface.

2. Student Analysis

The needs analysis questionnaire was distributed to 36 Grade XII Science students at SMA Negeri 2 Percut Sei Tuan. A summary of the students' needs analysis results is presented in Table 2.

Table 2. Recapitulation of Student Needs Analysis Data

No	Aspect	Total Score	Maximum Total Score	% Agree	Category
1	Difficulty in Understanding Chemical Equilibrium Material	68	108	62.96%	High
2	Need for Interactive Media	204	252	80.95%	High
3	Integration of Spiritual & Character Values	163	180	90.56%	Very High
Total		435	540	80.6%	High

The analysis results showed an average percentage of 80.6% for "Agree" responses, which falls into the high category. The spiritual values and character integration aspect obtained the highest percentage at 90.56% (very high category), followed by the need for interactive media at 80.95% (high category), and the difficulty in understanding chemical equilibrium material at 62.96% (high category).

The high percentage of learning difficulties (62.96%) indicates that chemical equilibrium remains challenging for students to understand due to its abstract and dynamic nature. This finding is consistent with the study by which showed that students continue to experience various misconceptions regarding chemical equilibrium, particularly related to the concepts of dynamic equilibrium, Le Chatelier's Principle, and the factors affecting equilibrium shifts.

The high demand for interactive media (80.95%) indicates that students prefer learning media that are more engaging, interactive, and easier to understand than the conventional media currently used. This finding is in line with the study by Mutiarasani *et al.* (2025) which stated that interactive multimedia based on multiple representations can help students understand abstract chemistry concepts through the integration of

macroscopic, microscopic, and symbolic representations. Furthermore, the use of interactive multimedia can enhance student engagement and help reduce difficulties in understanding abstract chemistry concepts.

The highest percentage in the spiritual values integration aspect (90.56%) indicates that students have a strong interest in chemistry learning that is connected to spiritual values and character development. Relating chemical equilibrium concepts to spiritual values such as awe and gratitude serves as a bridge between abstract scientific concepts and students' everyday experiences, making learning more contextual and meaningful. This finding is consistent with Manubey & Sitompul (2025), who stated that the integration of spiritual values into learning can increase student engagement and create a more meaningful learning process.

3. Task Analysis

Based on the task analysis referring to ATP 11.5 of the Merdeka Curriculum, two main components were identified as the foundation for the development of the interactive multimedia. The first component consists of a mapping of the cognitive competencies that students must gradually master, beginning with understanding the concept of dynamic equilibrium, calculating equilibrium constants (K_c and K_p), and progressing to analyzing the factors that influence equilibrium shifts based on Le Chatelier's Principle. The second component involves the integration of spiritual values into the learning material. The spiritual values integrated include a sense of awe toward equilibrium phenomena in nature and gratitude for the orderliness of natural laws that can be understood through the concept of chemical equilibrium.

The gradual progression from the concept of dynamic equilibrium to Le Chatelier's Principle reflects the scaffolding principle within Vygotsky's Zone of Proximal Development (ZPD) theory, in which interactive multimedia functions as digital scaffolding that assists students in moving from their actual level of competence to their potential level of competence through structured visualizations and simulation (Rahman, 2024). Without a gradual cognitive mapping process, multimedia may present concepts in a disorganized manner, thereby increasing students' cognitive load. Meanwhile, the integration of spiritual values within each subtopic was designed contextually to ensure that the values remain closely connected to the scientific concepts being studied. As a result, value internalization becomes reflective and meaningful rather than merely instructional for students (Manubey & Sitompul, 2025).

4. Concept Analysis

Based on the concept analysis referring to the Merdeka Curriculum, the Grade XI chemical equilibrium material was organized hierarchically into two main groups, as presented in Table 3.

Table 3. The Concept of Chemical Equilibrium Material for Grade XI

Material Group	Sub-material
Prerequisite Material	Concepts of chemical reactions, reaction equations, basic stoichiometry
Core Material	1) Concept of dynamic equilibrium 2) Equilibrium constants based on concentration (K_c), partial pressure (K_p), and the relationship between K_c and K_p

Material Group	Sub-material
	3) Calculation of K _c and K _p values 4) Le Chatelier's Principle (the effects of concentration, temperature, pressure, and volume)

Mastery of prerequisite material is essential before students study the core concepts of chemical equilibrium, as it enables them to construct new conceptual understanding more effectively. Furthermore, the hierarchical organization of concepts from prerequisite material to core content reflects the principle of the advance organizer, in which prior knowledge serves as a cognitive bridge connecting concepts already known by students to new and more complex concepts (Elfeky *et al.*, 2024). In the context of chemical equilibrium, mastery of stoichiometry and chemical equations as prerequisite knowledge provides the foundation that enables students to develop a meaningful understanding of K_c, K_p, and Le Chatelier's Principle. This is supported by Mutiarasani *et al.* (2025) who stated that the structured presentation of concepts in multimedia helps students connect chemical representations at the macroscopic, microscopic, and symbolic levels in an integrated manner.

5. Specifying Instructional Objectives

The learning objectives were formulated based on ATP 11.5 of the Merdeka Curriculum, referring to the revised Bloom's Taxonomy to align the learning outcomes with both cognitive and affective domains. The formulation of the learning objectives is presented in Table 4.

Tabel 4. Formulation of Learning Objectives for Grade XI
Chemical Equilibrium Material

No	Dimension	Instructional Objectives
1	Cognitive	Students are able to explain the basic concept of dynamic equilibrium
2	Cognitive	Students are able to analyze the relationship between K _c and K _p
3	Cognitive	Students are able to calculate K _c and K _p values based on substance concentration or partial pressure data
4	Cognitive	Students are able to explain the factors that affect equilibrium shifts
5	Affective	Students are able to demonstrate gratitude and awe toward the orderliness of equilibrium phenomena and apply them in daily life

The establishment of learning objectives encompassing both cognitive and affective dimensions was intended to ensure that learning focuses not only on concept mastery but also on students' character development. This is in line with the Merdeka Curriculum, which places character strengthening as an essential component of the learning process through the Pancasila Student Profile (Kemendikbudristek, 2024). Theoretically, the simultaneous formulation of cognitive and affective objectives is consistent with Bloom's Taxonomy, which positions the cognitive and affective domains as two complementary dimensions in the development of students' holistic competencies. Consequently, the

design of learning objectives and instructional activities becomes more structured and aligned with students' levels of cognitive development (Adijaya et al., 2023).

The implication of these findings is that the interactive multimedia to be developed should be capable of supporting the achievement of both cognitive and affective objectives simultaneously through the integrated presentation of content, visualizations, and learning activities. This is consistent with the study by Mutiarasani et al. (2025), which stated that interactive multimedia based on multiple representations can assist students in understanding abstract chemistry concepts through integrated visualizations at the macroscopic, microscopic, and symbolic levels, thereby making learning more meaningful and easier to understand.

▪ CONCLUSION

The results of the implementation of the define stage in this study indicate that the development of Web-Based Interactive Multimedia Integrated with Spiritual Values for Grade XI Chemical Equilibrium Material is highly necessary and urgently needed. The results of the student needs analysis revealed a high level of learning difficulty (62.96%) due to the abstract and dynamic nature of chemical equilibrium concepts. In contrast, students' demand for interactive learning media was categorized as high (80.95%), while interest in the integration of spiritual and character values was classified as very high (90.56%).

Through systematic front-end analysis, student analysis, task analysis, concept analysis, and the formulation of learning objectives, this study successfully established a foundational framework for media development. The integration of spiritual values, such as fostering a sense of awe and gratitude for the orderliness of natural laws, can be contextually embedded within chemical equilibrium content without diminishing its scientific substance. Ultimately, the findings of this define stage provide a structured foundation for the development of interactive multimedia that is not only cognitively effective but also spiritually meaningful for students.

Future studies are recommended to proceed to the design and development stages in order to create, validate, and evaluate the practicality and empirical effectiveness of the proposed multimedia platform in chemistry classrooms.

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