Development of Website Teaching Materials Based on Systemic Approach in Thermochemistry

Marfuatun* and R F Hardiningtyas

Chemistry Education Departement, Faculty of Mathematic and Natural Sciences
Yogyakarta State University, Yogyakarta, Indonesia (55281)
*Corresponding author e-mail: afu@uny.ac.id

Abstract. The objectives of this research are to develop and to analyze the specification and the quality of teaching material of Thermochemistry. The teaching material was developed based on the systemic approach presented in a website application for a learning chemistry. The model of development was adopted from Richey and Klein model type 1. It has three phases, i.e., design & development, evaluation, and validation. The evaluation instrument was an open-ended questionnaire to obtain product recommendation data of expert judgment and a close-ended questionnaire/checklist to obtain quality from 15 reviewers and 68 students. The instrument consisted of 21 indicators. The product of this research can be accessed at www.chemistryeducation.net and it consists of handouts, quizzes, and student worksheets. The quality of instructional materials from 15 reviewers was found to have an ideality percentage of 81.90%. Meanwhile, out of 68 students had an ideality percentage of 82.69%. This indicates that the quality of website teaching materials was good.

1. Introduction

Improving the Quality of Continuing Education is the key to the success of education in carrying out its mission to educate the nation. One national education development focuses on improving the quality, relevance and competitiveness of education. This can be achieved through the provision of opportunities to educators and educational personnel to solve the problems of education and learning through innovative development, planned, and controlled, as for example through research and development [1].

Research and development to improve the quality of education can be performed through the development of teaching materials. According to Effiong, Ekpo, & Charles [2] teaching materials are printed or not printed materials that contain information for students about the learning process. The teaching materials can be textbooks, magazines, newspapers, pictures, videos, or in other forms. Teaching materials have an important role in the learning process because it can improve students' learning and learning achievement.

Currently Information and Communication Technology (ICT) is needed and perceived the importance of its use in learning. Through the utilization of ICT, the quality of education can be improved by developing a web-based learning (e-learning). Web-based learning is a learning activity that utilizes the media sites (websites) that can be accessed via the Internet network [3].

In addition to the use of ICT to improve the quality of education it is also necessary to select appropriate learning approaches. One of learning approaches that can be used to improve the quality of education is systemic learning approach. According to Nazir & Naqvi [4] systemic learning approach is a process of learning concepts through interrelated systems, so the overall relationship between
concepts becomes clear. Interrelated concepts are illustrated by systemic diagrams [5]. According to Hrin, Segedinac, Milenkovic, & Horvat [6] systemic learning approaches are different from other learning approaches, for example concept mapping should build concept hierarchy, while systemic emphasizes the relationship between concepts.

Systemic learning approaches can be used in chemistry learning. The systemic approach in chemistry learning is the study of chemical concepts through interacting systems in which all relationships between one concept and another are clearly connected using a cyclic chart [7]. According to Gabel in Hrin, Milenkovic, Kekez, & Segedinac [8] chemistry is an abstract material for students. Many students are unsuccessful in chemistry learning because it is difficult to understand chemistry lessons.

Nazir & Naqvi [4] said that students in Pakistan are lack understanding of the basic concepts of physical chemistry after an assessment. Thermochemistry is one of the physical chemistry disciplines that studies heat changes in chemical reactions [9]. Before studying thermochemical material, the students studied the matter of hydrocarbon and petroleum compounds.

Thermochemical material studies the energy used in the combustion reaction of hydrocarbon compounds so that there is a relationship between the thermochemical material with the previous material and the students usually do not understand of the previous material. Therefore, students need a complete learning. Complete learning can be achieved with a systemic learning approach. Based on research conducted by Suyanta, Marfuatun, & Widjajanti [10] the application of systemic learning approach can improve the ability to think comprehensively in students. Meanwhile, based on research by Marfuatun, Fillaeli, & Yuanita [11] the application of systemic approach based on contextual learning to the experiment of Physical Chemistry II can improve scientific process skills students and increase students' understanding of the concept of chemistry.

Teaching materials based on a systemic approach are made with the website application because students can easily access materials that are related to other concepts through the website. The use of teaching materials with website applications has a positive impact, namely increasing students' motivation and understanding of learning [12]. Teaching materials based on systemic approach with website application have not been found particularly in thermochemical material. The development of teaching materials based on systemic approach with website application can make the learning of thermochemical material more effective because it is not bound by time, distance, and place. In addition, it can also be used as an independent learning resource because students with teachers do not have to meet face to face in the classroom. Based on the above problem, the purpose of this research is to develop and arrange teaching materials based on systemic approach with website application on thermochemical material in high school and analyze its character and the quality of the teaching materials assessed based on predetermined aspects.

2. Research Methods

2.1. Development Model
The development model used in the research of development of teaching materials based on systemic approach with website application is Richey and Klein research model, that is type 1. This development model consists of 3 stages, namely design and development phase, evaluation phase, and validation phase [13].

2.2. Research Procedure
The research procedure has 3 phases, namely design and development phase, evaluation phase, and validation phase. The design and development phase produced an initial product. During the evaluation phase, the initial product was performed to produce the revised product I. The Revised Product I was reviewed to produce the final product. Phases in the study is shown in Figure 1.
2.3. Analysis of Product

2.3.1. Design Analysis of Product. Initial products were reviewed by media experts, material experts, and peer reviewers to obtain suggestions or inputs used as a reference to revise the product and produce revised product I. The revised product I was further assessed by reviewers and students. Reviewers and students provide an assessment of revised product I. Qualitative data from reviewers and students were transformed into quantitative data and analyzed to determine the product quality. Feedback was used as a reference for revision II to produce the final product. The quality of the final product was also presented in the form of ideal percentage.

2.3.2. Subject Evaluator. The subject of this research is a lecturer as a media expert, 2 lecturers as a material/content expert, 7 peer reviewers, 15 teachers as reviewers, and 68 students.
2.3.3. **Object Evaluator.** The object of assessment in this research is the quality of teaching materials.

2.3.4. **Data Types.** The type of data obtained in the study is data in the form of teaching materials products in accordance with established development procedures and product quality assessment data from 15 high school chemistry teachers as reviewer and 68 students.

2.3.5. **Data Collection Instruments.** The assessment tool of the development process consisted of an assessment questionnaire in the form of a checklist (✓) option and an input or suggestion sheet. The instrument used in this study is an adaptation of the assessment criteria in research conducted by Said Hadjerrout [14] and the Guidance and Development Guide [15] by the Ministry of National Education. Aspects assessed in the research are the aspects of the feasibility of content, language, dish, graphic, and easy to use.

2.4. **Data Analysis Technique**

In this research, data analysis technique with various phases can be seen in Figure 2.

![Data Analysis Technique Diagram](Image)

**Figure 2.** Chart of Data Analysis Technique

3. **Results and Discussion**

3.1. **Design and Development Phase**

At this stage, analysing the problems, needs, and objectives of the users with literature review were performed. Conducting studies on core competence and basic competence that used at high school. Formulating indicators and the objectives of making teaching materials were also developed. Collecting references, creates sitemap and mockup. Furthermore, assessment instruments were arranged. Domain, website addresses, CMS, website content in the form of homepages and web pages were also determined. Then, materials were uploaded, and initial product was created.

According to Jebson & Moses [16], in appropriate learning resources can lead to low student academic achievement. Therefore, researchers should develop appropriate learning resources for students to create effective and meaningful learning in the form of teaching materials. Through the analysis of
problems and needs it can be determined the principal components to be loaded in teaching materials.
The final step at this stage was to create an initial product in the form of a resource website. The next step was imputing all the material that has been prepared into the website and produce the initial product.

One of the important things in the development of teaching materials with the application of this website is the ability of CMS that can load a lot of data in such away, so the users can quickly move from one page to another by clicking the button on the website [17]. CMS used by researchers on the development of this resource is WordPress. According to data from W3Tech in Clobridge [18], WordPress is the most widely used CMS compared to Joomla and Drupal. WordPress has been chosen as a CMS because it has several advantages. One of them, is providing a variety of plug-ins. Plug-ins used in the development of this resource is FSIM-Pro for quizzes and AnsPress for discussion forums.

In the quiz menu the answers of the student questions are displayed on the next screen, so to find out the answers the students need to answer all the questions. According to Vaughan in Babiker [17], web-based learning in the form of multimedia will be more interactive if the answers from student questions are displayed on the next screen.

Website creation design used in website creation was responsive website design. Reasons for selecting responsive website design in addition to maintaining the look of different devices is manufacturing costs become cheaper because the creation is only on one device, but the display does not change on different devices [19]. One of the results of the design and development stage is shown in Figure 3.

![Figure 3. The "Thermochemical" Menu Display in The Handout I Section](image-url)
3.2. Evaluation Phase
In the evaluation phase in the development of this resource, a review by media experts, material experts, and peer reviewers were collected and formulated to be the revised I. Revision I was constructed by considering the suggestions and input from 1 lecturer of media expert, 2 lecturers of material experts, and 7 peer reviewers, though there are also some unused suggestions and suggestions for reasons that can be justified.

3.3. Validation Phase
The validation phase in the development of this instructional material was done by reviewers and students resulting in revision II. Revision II was formulated with attention to suggestions and input from 15 reviewers (high school chemistry teachers) and 68 students, but there were also some unused suggestions and suggestions for reasons that could be justified. Rating by reviewers and students in the form of qualitative data was then converted into quantitative data in the form of scores. Scores obtained were analyzed to obtain the average score and percentage of ideality in all aspects, every aspect, and each indicator to reflect the product quality.

The result of revision II is the final product containing teaching materials of thermochemistry for high school based on systemic approach with website application in the domain of www.chemistryeducation.net. The teaching materials produced in this development research might also be considered as enrichment materials. The quality of teaching materials development data was obtained from the assessment of 15 high school chemistry teachers and 68 students. Assessment using assessment instrument in the form of questionnaire conducted by high school chemistry teachers and students by assessing 5 aspects of assessment criteria. The quality of teaching materials based on systemic approach with website application by reviewers and students can be seen in Table 1.

| No. | Aspects of Criteria | Reviewers | Students | Reviewers | Students | Reviewers | Students |
|-----|---------------------|-----------|----------|-----------|----------|-----------|----------|
| 1   | Feasibility of content | 24.47     | 25.60    | 30        | 81.57 %  | 85.33 %   | Good     | Very     |
| 2   | Language            | 16.73     | 16.53    | 20        | 83.65 %  | 82.65 %   | Good     | Good     |
| 3   | Dish                | 19.47     | 20.49    | 25        | 77.88 %  | 81.96 %   | Good     | Good     |
| 4   | Graphic             | 16.4      | 15.91    | 20        | 82 %     | 79.55 %   | Good     | Good     |
| 5   | Easy to use         | 8.93      | 8.29     | 10        | 89.30 %  | 82.90 %   | Very     | Good     |

Total score | 86 | 86.82 | 105 | 81.90 % | 82.69 % | Good | Good |

Based on the data assessment by the reviewers it was obtained an overall average score of 86 from a maximum score of 105 while the results of the assessment by students obtained the overall average score of 86.82 from a maximum score of 105. Both average scores included in the range of scores with the percentage of idealization being equal to 81.90% for reviewers and 82.69% for students, so it is a good quality (B) and suitable to be used as teaching material for student and teacher of high school/ Islamic high school.

Teaching materials developed in the research are considered feasible because through teaching materials with this website application students can solve problems in learning, improve critical thinking skills, learning to be active, interactive, creative, collaborative, and accumulative, and improve students' ability to operate computer or other tool electronics that can be used to access the
website [20]. The assessment of product quality of teaching materials development is not only done on the whole aspect, but also in every aspect. Explanation of product quality of teaching materials development in every aspect is as follows:

1. Aspect of Feasibility of Content. In the content feasibility aspect, the average score of products (\(X\)) from reviewers’ rating is 24.47, which means that the product quality category on the content feasibility aspects is Good (G). Assessment from the students get the average score of products (\(X\)) of 25.60 which means that the product quality category on the content feasibility aspects is Very Good (VG). The percentage of ideality on the content feasibility aspect by reviewers is 81.57% while by students it is 85.33%. The results of the research indicates that the assessment of teaching materials in terms of content feasibility aspects is not ambiguous and has good content [21]. The teaching materials developed are not ambiguous because the teaching materials focus on a concept and have specific goals. This is in accordance with the opinion of Liu & La Mont Johnson in Hadjerrouit [22], ie web-based learning is a learning that focuses on a concept, has specific learning goals, student-centered learning, self-learning, and can be used repeatedly.

2. Aspect of Language. In this aspect, the average score of products (\(X\)) from reviewers’ rating is 16.4 which means that product quality category in language aspects is Good (G). Assessment from the students get the average score of products (\(X\)) of 16.53 which means that the product quality category in the language aspects is Good (G). The percentage of ideality in the language aspect by the reviewers is 82% while by the students it is 82.65%. Based on the results shown on each indicator it shows that the content of the website is presented with the language and reading level appropriate to the students and teachers of high school / Islamic high school so that students and teachers can understand the content of the website [23].

3. Aspect of Dish. It obtained the average score of products (\(X\)) from reviewers’ rating of 19.47 which means that the product quality category on the aspect of dish is Very Good (VG). Assessment from the students get the average score of the product (\(X\)) of 20.49 which means that the product quality category on the aspect of dish, is Very Good (VG). The percentage of idealization in the aspect of dish by reviewers is 77.88% while by student it is 81.96%. The percentage of ideality in the first indicator is 80% to indicate that the purpose of the website is clear, and it is in accordance with the opinion of Libbrecht [24], ie learning resources needed and can be used students outside the school should be easily understood, sought, and have a clear purpose.

4. Aspect of Graphic. The aspect of graphics obtained the average score of products (\(X\)) from reviewers’ rating of 16.4 which means that the category of product quality on the aspect of graphic is Good (G). Assessment from students got average score of products (\(X\)) of 15.91 which mean that product quality category at aspect of graphic is Good (G). Percentage of ideality on the aspect of graphic by reviewers is 82% while by the students it is 79.55%. The results shown on each indicator shows that in terms of website display graphics it is good. The view of website in the form of multimedia with good results can improve the quality of learning, namely understanding and the level of thinking students. Basically, with the use of multimedia, the human brain will process and rearrange the information obtained from some media [25].

5. Aspect Easy to Use. It obtained the average score of products (\(X\)) from reviewers’ rating of 8.93 which means that the category of product quality on the aspect of easy to use is Very Good (VG). Assessment from the students get the average score of products (\(X\)) of 8.29 which means that the category of product quality on the aspect of easy to use is Good (G). The percentage of ideality in the easy to use by reviewers is 92% while the by students it is 82.9%. Based on the results shown on each indicator it shows that website navigation is easy to use so that students will not be confused in using the website on learning [23].

4. Conclusion
Based on the research it can be concluded that teaching materials based on systemic approach with website application on thermochemical material for chemical in high school / Islamic high school have been produced. The resulting product characters contain thermochemical handouts featuring
 thermochemical material and their relation to other chemical material concepts and include cyclical diagrams of the interrelationships between the concepts, quizzes, and worksheets. The quality of teaching materials based on systemic approach with website application on thermochemical material for chemical in high school / Islamic high school based on assessment of 15 reviewers obtained an idealization percentage of 81.90% and based on 68 students obtained an idealization percentage of 82.69% so that the quality of this teaching material is included in Good category (G).

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