

THE DEVELOPMENT OF CRITICAL THINKING WORKSHEET ON THERMOCHEMISTRY TOPIC FOR STUDENT GRADE XI INTERNATIONAL STANDARD SENIOR HIGH SCHOOL

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Abstrak: Penelitian pengembangan ini bertujuan mengetahui kelayakan *worksheet* yang dikembangkan serta respon siswa setelah menggunakan *worksheet* yang dikembangkan. Kelayakan *worksheet* ditinjau dari penilaian terhadap kesesuaian isi, penyajian, dan kegrafisan oleh ahli materi serta kesesuaian kebahasaan oleh ahli bahasa. Rancangan penelitian mengacu pada model 4-D, tetapi tahap penyebaran tidak dilakukan. Instrumen yang digunakan adalah lembar telaah, lembar validasi, dan lembar angket respon siswa. Telaah dilakukan oleh dua orang dosen kimia sebagai ahli materi serta satu orang dosen kimia sebagai ahli materi dan ahli bahasa. Validasi dilakukan oleh satu orang dosen kimia dan dua orang guru kimia sebagai ahli materi serta satu orang dosen kimia sebagai ahli bahasa. Uji coba terbatas dilakukan terhadap 15 siswa kelas XI IPA 6 SMA Negeri 2 Kediri. Metode analisis data dilakukan secara deskriptif. Hasil penelitian menunjukkan bahwa *worksheet* yang dikembangkan layak digunakan karena dengan presentase kriteria kesesuaian isi 86,67 %; kriteria kesesuaian penyajian 89,1%; kriteria kesesuaian kegrafisan 95,24%; dan kriteria kesesuaian kebahasaan 75 %. Siswa memberikan respon positif terhadap *worksheet* yang dikembangkan dengan presentase penilaian siswa terhadap kriteria isi 86,67%; kriteria kebahasaan 76,67%; kriteria penyajian 80%; dan kriteria kegrafisan 90%.

Kata kunci: berpikir kritis, *worksheet*, Termokimia, kelayakan

Abstract: The aims of this research are to know the worksheet feasibility and response of students. The feasibility of worksheet are determined based on the review and validation of content suitability, presentation, and graphical by material expert and the language suitability by language expert. The research design refer to four-D models, but the disseminate steps is not done. The instruments are review sheet, validity sheet, and students' response questioner. Validity has been done by one chemistry lecturer and two chemistry teachers as a material expert and one chemistry lecturer as a language expert. The limited try out by 15 students of class XI IPA 6 SMA Negeri 2 Kediri. A method of data analysis was done descriptively. The result showed that the worksheet have been developed competent to use since has met expediency criteria for suitability of content is 86,67 %; criteria for suitability of presentation 89,1%; criteria for suitability of graphical 95,24%, and criteria for suitability of language 75 %. Students' give a positive response which the percentage of worksheet content 86,67%; worksheet language 76,67%; worksheet presentation 80%; and worksheet graphical 90%.

Key words: critical thinking, worksheet, Thermochemistry, Feasibility

INTRODUCTION

Education is a key factor in the development of the nation. Therefore,

improving the quality of education has always done. One of the government's efforts in order to improve the quality of

education is to change the curriculum several times in Indonesia. Improvements in education are also done through the development of quality schools with international standards. It is based on UU No.20 year 2003 article 50, paragraph 3[1]. Implementation of the act is the start of the International Standard School program stubs (RSBI) with adoptive and adaptive curriculum. RSBI application implemented in high schools are realized by using a bilingual language learning. Learning to use bilingual is currently only applied to subjects that hard science category, one of which is Chemistry subject.

Chemistry as part of the natural sciences is always related to how to find out about the systematic nature, so the chemistry is not only the mastery of knowledge in the form of a collection of facts, concepts, or principles, but also is a process of discovery. One of the subject matter in the chemistry is Thermochemistry. Thermochemistry of learning in the subject matter involves the calculation and concepts. These characteristics suggests that students should be given training that involves thinking skills that students are able to correlate between the concepts of the calculation. Based on the questionnaire to 30 students in senior high school, 36.67% of students stated that the matter Thermochemistry is a difficult matter. They consider the matter Thermochemistry confusing because the linkage between the sections of these materials is very high, requiring a higher level of thinking to be able to understand the concepts they learned it.

Based on the characteristics of the subjects of chemistry, the understanding of the concept can be done through the discovery process. This discovery process is done through the thinking process until students are able to find the right concept. On a person's thought processes are influenced by cognitive development. According to Piaget's theory of cognitive development, factors that influence a person's cognitive development is the age and active

manipulation and interaction with the child's environment [2].

At the age of senior high school, ie in the age range 15 years and above, children are at the stage of formal thinking. At this stage a person has the ability to think more of the basic-level thinking and have been trained to develop their high-level skills. The reality shows that the development of higher-order thinking skills in students less than the maximum. Based on the results of questionnaires on the 30 students of senior high school, 70% of students stated that their exercises are often done during the learning of chemistry are the problems with a given type (C1), understand (C2), and applying (C3) only, whereas the type of matter analyzes (C4), evaluating (C5), and create (C6) are rarely trained. The teachers gave the reason that they are constrained by the minimum criteria of mastery learning is quite high. On the other hand, the teachers know and understand that the higher-order thinking skills is essential for students, so that a continuous need to be trained, especially critical thinking skills.

Rate the importance of developing critical thinking skills in students is also based on the needs of thinking in science. Thinking in the learning of science in general, including higher order thinking skills ranging from planning, investigate, analyze, synthesize, and evaluate the application of theory in science. In addition, there are also based on the Peraturan Menteri Pendidikan Nasional No.23 year 2006 about graduate competency standards to senior high schools[3]. In addition to academic goals, the developing critical thinking skills in students is to keep students from making false and that haste can not be accounted for.

Another factor that affects the cognitive development of children is child manipulation and active interaction with the environment in which the development of students' cognitive structures can be done through learning by providing hands-on experience to

students through a discussion. Discussion through learning can be done using the learning tools that facilitate the learning of students in participating.

Based on observations on one international senior high school, the of chemistry in this school was performed using the device in the form of student book and worksheet, and supported by the use of presentation media. Based on the results of the questionnaire to 30 students of senior high school, 56.67% of students stated that the worksheet has not been able to assist them in understanding the material in the learning of chemistry. Based on this data, so we needful to develop of learning tools, especially the worksheet, which is tailored to the needs of students.

Development of learning tools are also based on one of the recommendations of the Pusat Kurikulum Badan Penelitian dan Pengembangan Departemen Pendidikan Nasional year 2007 on policy studies curriculum sciences[4].

Based on the learning needs and competencies tailored to the needs of students who have achieved, then the researcher to develop critical thinking skills worksheet to Thermochemistry topic grade XI for international senior high school. Issues examined in this research include feasibility worksheet and student responses. Criteria for assessing the feasibility of teaching materials used in the development of this worksheet refers to Panduan Pengembangan Bahan Ajar (Depdiknas, 2008)[5]. Such criteria include criteria

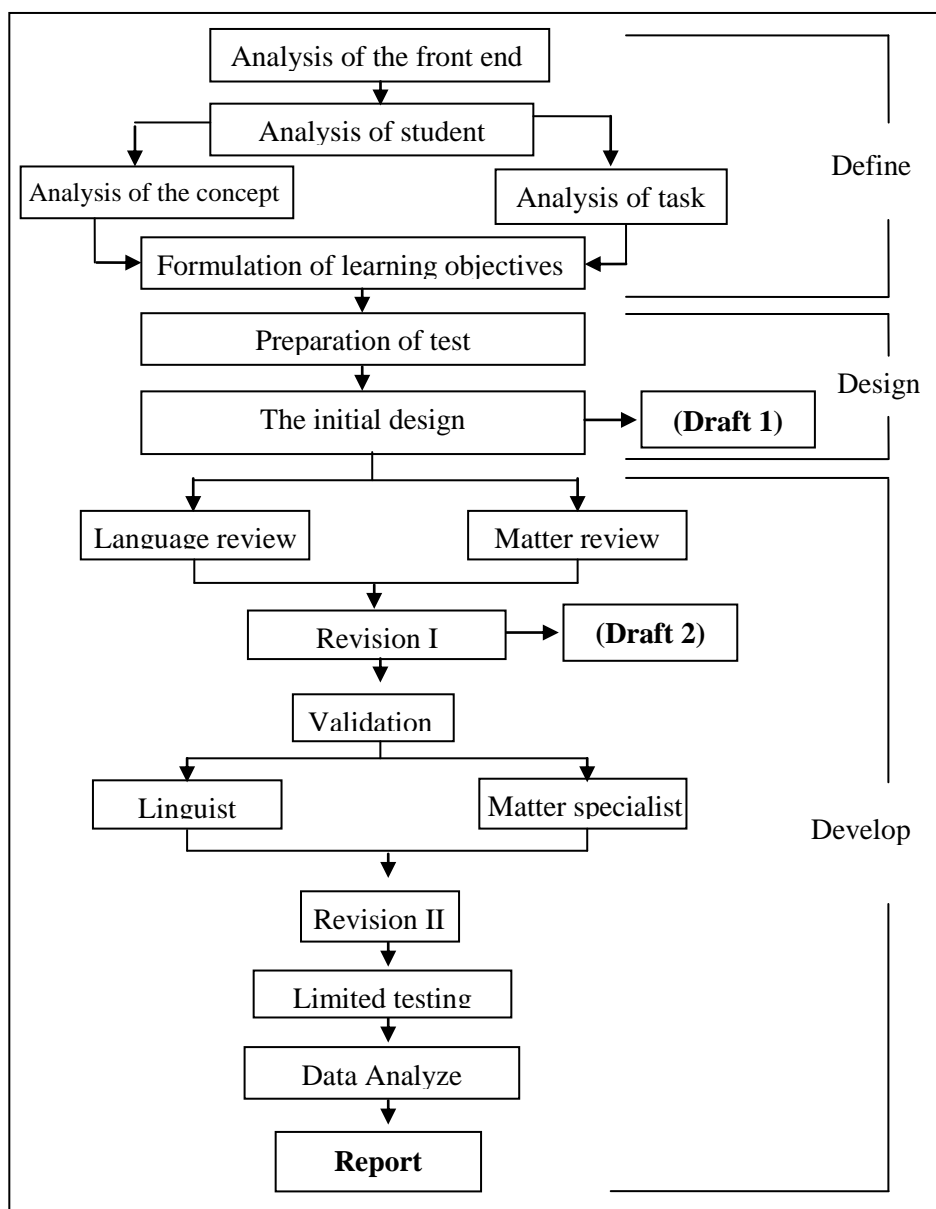
of content, presentation, language, and graphical.

According to Depdiknas (2009:9) [6], think is reasonable to cultivate knowledge of the activities that we receive through the senses, and is intended to reach the truth. While critical thinking is one of the higher-order thinking processes that can be used in the formation of students' conceptual system. According Filsame (2008) [7], the construction of most of the critical thinking perspective is based on three ideas, namely the philosophical, psychological, and educational. Theory which is a representation of an educational perspective in the theory of critical thinking is Bloom's Taxonomy.

The theory of critical thinking that are relevant to the stages of thinking in Bloom's Taxonomy is the critical thinking theory of Angelo. Angelo (in Ahmad, 2007)[8], identified five systematic behavior in critical thinking, including the skills to analyze, synthesize skills, skills to formulate and solve the problem, concluded skills, and evaluate skills.

METHOD

This research uses a model of the development of four-D model is suggested by Thiagarajan, Semmel, and Semmel (1974) in Ibrahim[9]. In this research disseminate phase is not made because the development is done in this research only to determine the feasibility of the worksheet. The development design is presented in Figure 1.



Picture 1 The Design of Worksheet Development (Adaptation from Thiagarajan, Semmel, dan Semmel (1974))[9]

The data was collected by filling the assessment form (sheet review and validation sheet) by matter experts and linguists, as well as the limited testing conducted on 15 students of SMA Negeri 2 Kediri. Limited testing conducted to determine the student response after using the worksheet.

The review results were analyzed by qualitative descriptive study to

provide an overview of the advice given by material experts and linguists.

The validation results were analyzed by quantitatively analyzed descriptively. A feasibility criteria were evaluated according to Table 1.

Table 1 Score of Likert Scale	
Assessment	Scale value
Very poor	0
Poor	1

Quite	2
Good	3
Very good	4

(Adaptation from Riduwan, 2010)[10]

Calculating the percentage of feasibility criteria on each using the following formula:

$$K = \frac{F}{N \times I \times R} \times 100\%$$

Description:

K = the percentage of assessments

F = number of respondents' answers

N = the highest score in the questionnaire

I = the number of questions in the questionnaire

R = number of respondents

(Riduwan, 2010) [10]

Based on that percentage has been calculated, and then the feasibility criteria can be determined based on Table 2.

Tabel 2 Interpretation Score Criteria

Percentage	Criteria
0% - 20%	Very poor
21% - 40%	Poor
41% - 60%	Quite
61% - 80%	Good/appropriate
81% - 100%	Very good/very appropriate

(Adapted from Riduwan, 2010:15) [10]

Worksheet developed critical thinking skills are said to be feasible if the percentage of each criterion achieved $\geq 61\%$ [9].

The results of student responses obtained by filling a questionnaire. Students provide an assessment on each criterion based on the scores in Table 3.

Tabel 3 Guttman Scale

Answer	Value/score
Yes	1
No	0

(Riduwan, 2010) [10]

Calculating the percentage of each criterion using the following formula:

$$K = \frac{\Sigma \text{skor jawaban YA}}{\Sigma \text{pertanyaan}} \times 100\%.$$

Description:

K = The percentage of viability
(Riduwan, 2010) [10]

Based on that percentage has been calculated, then the eligibility criteria can be determined based on Table 2.

RESULTS AND DISCUSSION

Define phase

Analysis of the front end

Some things to consider in the analysis of the front end is as follows: (1)The curriculum used in SMA Negeri 2 Kediri is the adoptive and adaptive curriculum. (2)The theory of learning that are relevant in this worksheet development is cognitive development theory by Piaget and social learning theory by Vigotsky. (3)Demand is the future of students as young people are required to have a high human resource and by a workshet that was developed, it is expected that students can learn the material independently.

Analysis of student

Students who become research subjects are students in grade XI IPA 6 SMA Negeri 2 Kediri.Characteristics of the students are (1) Students have obtained the material on affirmative reactions as a basis for studying of Thermochemistry topic. (2) Students grade XI IPA 6 SMA Negeri 2 Kediri median age of 16-18 years. According to Piaget's developmental theory 15 years and above age range, one is at the stage of formal thinking which allows one to be able to think abstractly and symbolically. (3) Students grade XI IPA 6 SMA Negeri 2 Kediri at the time of the study had received Thermochemistry topic, but do not use critical thinking skills worksheet.

Analysis of task

Analysis of tasks performed by detailing the course content taught in outline form. This analysis includes: (1)Analysis of the structure that covers the content of the subject analysis, competency standards, basic competencies, and indicators of learning outcomes. (2)Analysis of procedural where the analysis produces the procedural stages of completion of tasks

in accordance with the Thermochemistry study materials. (3) Analysis of Information Processing in which this analysis will result in the grouping of tasks undertaken by students in every meeting.

Analysis of the concept

Concept analysis is done by identifying how the concepts of Thermochemistry topic and arranged systematically. The results of our analysis is the concept map of Thermochemistry topic.

Formulation of learning objectives

The aim of learning objectives formulation is to convert the results of the analysis task and analysis concepts into specific learning objectives. The results of this activity is the learning objectives at every meeting.

Design Phase

Preparation of test

Preparation of the test is a step that connects the define phase with the design phase.

The initial design

This stage aims to design the learning of critical thinking skills worksheet. The main activity at this stage is the writing of the worksheet and consultation in stages to the lecturers. On the activity of writing, script writing researchers collected material relating to the subject matter Thermochemistry. Component of critical thinking skills worksheet that was developed consisting of the title: the title page; preface; how use of the book; table of contents; map concepts; the home page of each worksheet; content worksheet, which consists of a summary of the material, case studies, and the stage of completion; and references, where

everything is arranged in two languages, namely English and Indonesian. The results of this activity is the initial design of critical thinking skills worksheet to Thermochemistry topic with the above components.

Development Phase

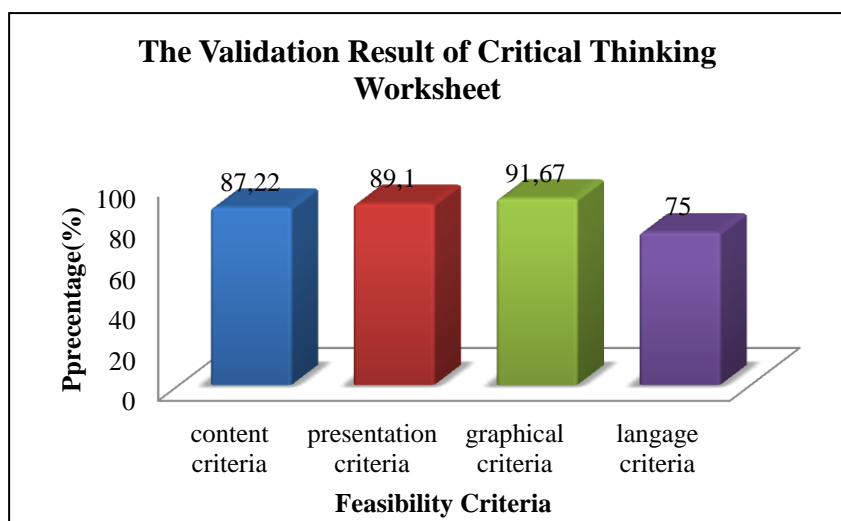
The purpose of the development phase is to refine critical thinking skills worksheet to Thermochemistry topic that has been made for the better through revision based on the advice of experts.

Review and revision I

Critical thinking skills worksheet study conducted by two experts of matter (Unesa chemistry lecturer) as well as one matter experts and linguists (Unesa chemistry lecturer). Their activities included suggestions based on criteria of content, presentation, and graphical to matter experts as well as the criteria of language to linguist to draft I. The results of this activity is draft 2 of worksheet critical thinking skills.

Validation and revision II

Validation is performed by one person Unesa chemistry lecturer and two chemistry teachers as a matter experts of and one person of Unesa chemistry lecturer as a linguist. The validation results are reported in this study is the result of data validation I, the validation is performed before the second revision. Revision II carried out to completion worksheet based on the suggestions obtained at validation. But after the second revision of the validation is not done anymore, because on the second revision procedure is only carried out repairs to just write and not related to substance improvement worksheet. Validation results are presented in Picture 2.



Picture 2 The Validation Result of Critical Thinking Worksheet

Based on Picture 2, the results percentage of a feasibility assessment of worksheet contents is 86.67% with a very appropriate category.

These results showed that the worksheet has been developed to meet the feasibility contents criteria based on Panduan Pengembangan Bahan Ajar (Depdiknas, 2008)[5]. Such criteria include: Compliance with curriculum curriculum materials and Cambridge; compliance with the Standards of Competence material and the Basic Competence to be achieved; material relevant to the indicators of learning outcomes; summary of the material composing the key concepts, the evaluation questions in the worksheet easy understandable and in accordance with learning outcomes indicators; activity experiments or experiments in the worksheet according to the materials and basic competencies is developed; presentation of the book according to the level of thinking and reading skills of students; facts, concepts, and illustrations are presented accurately; learning support materials presented (features and examples) in accordance with the development of science and technology; presentation of material in a logical and systematic worksheet based on the order of knowledge that will be given, as well as compliance with the

criteria of critical thinking skills, the skills to analyze, synthesize skills, skills to recognize and solve problems, skills concluded, and the skills to evaluate or judge.

Based on Picture 2, the results percentage of a feasibility assessment of worksheet presentation is 89.1% with a very appropriate category.

These results showed that the worksheet has been developed to meet the presentation feasibility criteria based on Panduan Pengembangan Bahan Ajar (Depdiknas, 2008) [5]. Such criteria include: cover the content of the manuscript presented worksheet; clear indicators of learning outcomes; presentation worksheet intriguing; concept presented coherent and balanced among sub chapter from beginning to end; suitability of illustrations with the subject matter; illustrations or pictures to help understanding concept; presentation accompanied by a reference image; presentation of student-centered materials; writing a bibliography in accordance with applicable rules; presentation of the worksheet is interesting or exciting; information presented is complete; and completeness of the presentation.

Based on Picture 2, the results percentage of a feasibility assessment of

worksheet graphical is 95.24% with a very appropriate category.

These results showed that the worksheet has been developed to meet the graphical feasibility criteria based Panduan Pengembangan Bahan Ajar (Depdiknas, 2008)[5]. Such criteria include: the use of the font (type and size); display design; layout of text, images, tables, and graphs are presented in a harmonious; illustrations, graphics, images used; print quality: quality of paper used; as well as terms, formulas, and the symbol that is clearly stated in italics / bold / underlined.

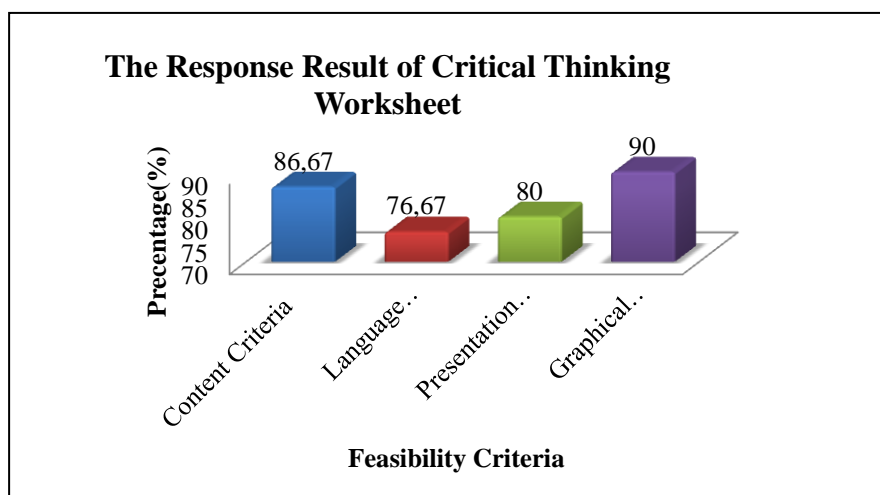
Based on Picture 2, presenting the results of a feasibility assessment of critical thinking skills worksheet language is 75% with appropriate category.

These results showed that the worksheet has been developed to meet language feasibility criteria based on Panduan Pengembangan Bahan Ajar (Depdiknas, 2008) [5]. Such criteria

include: writing worksheet using the appropriate language to the level of student progress; writing worksheet uses good English and correct; keruntutan ketertautan language or inter-chapters, sub-chapters, paragraphs, and sentences; writing worksheet using terms that are easily understood ; and writing worksheet using the term or symbol or emblem steadily.

Limited testing

Limited testing conducted to determine the student response after using the worksheet developed critical thinking skills. A limited testing was made to 15 of students of class XI IPA 6 SMA Negeri 2 Kediri. Students provide an assessment of critical thinking skills worksheet to Thermochemistry topic provided by filling the questionnaire responses of students. The results of student responses to critical thinking skills worksheet is presented in Picture 3.



Picture 3 The Response Result of Critical Thinking Worksheet

Based on Picture 3 the contents criteria of critical thinking skills worksheet to Thermochemistry topic get a response from the students at 86.67% with very good category.

These results showed that the worksheet that was developed to help students with an excellent understanding

of Thermochemistry topic. This is because they think that these questions and a description or explanation of the worksheet easier to understand critical thinking skills that can assist students in learning of Thermochemistry topic.

Based on Picture 3 the language criteria of critical thinking skills

worksheet to Thermochemistry topic get a response from the students at 86.67% with good category.

These results showed that the English language and terms used in the worksheet chemistry developed easily understood by students.

Based on Picture 3 the presentation criteria of critical thinking skills worksheet to Thermochemistry topic get a response from the students at 80% with good category.

These results showed that the worksheet that was developed to help students with an excellent understanding of the subject matter in Thermochemistry. This is because they argue that the worksheet can raise their motivation to learn and ask, either the teacher or friend. In addition, students also argued that critical thinking skills worksheet interesting and entertaining as well as illustrations or pictures presented can assist them in understanding the concepts that make them more active in teaching and learning activities, both individually and as they work in groups.

Based on Picture 3 is the graphical criteria of critical thinking skills worksheet to Thermochemistry topic get a response from the students at 90% with very good category.

These results showed that the color of text in a worksheet Thermochemistry topic of critical thinking can support a good illustration or image. Students also argued that the font and size of paper used to make them comfortable when reading the subject matter of critical thinking worksheet to Thermochemistry topic.

CONCLUSION

Based on result of this research and discussion can be concluded that the critical thinking skills worksheet developed on Thermochemistry topic appropriate to use with the feasibility criteria for the percentages of content is 86.67%; the feasibility of presentation is 89.1%, the feasibility of graphical is 95.24%, and the feasibility of language

is 75%. Student responses to critical thinking skills worksheet Thermochemistry topic is viewed through the questionnaire responses of students indicate that students responded positively to the worksheet that was developed. The percentages of response criteria are for content is 86.67%, for language is 76.67%; for presentation is 80%, and for graphical is 90%.

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