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Development of Evaluation Problems to Measure High Level Thinking Skills in Thermochemical Materials

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Abstract: DEVELOPMENT OF EVALUATION PROBLEMS TO MEASURE HIGH LEVEL THINKING SKILLS IN THERMOCHEMICAL MATERIALS. This research was conducted at the Laksamana Martadinata High School in Medan which aims to develop an evaluation instrument to measure students' high-level thinking skills in thermochemistry material using a 4D model of development (Research and Development, R&D) which includes, namely; Define (definition), Design (design), Develop (development), and Dissemenate (dissemination). The sample in the study was 36 students selected by purposive sampling. The instruments used are evaluation questions and validation sheets. The results of this study indicate that through the development of evaluation questions to measure higher-order thinking skills in thermochemistry material, at the higher-order thinking ability level by giving HOTS questions, the ability results are very low at 44 .5% and get very decent results on the validation sheet by expert validator namely; lecturers 91% and teachers 94%. The final product is in the form of 32 valid questions from the initial product design of 40 questions. The results of the data analysis showed that the evaluation item instrument to measure students' higher order thinking skills developed had met the feasibility of content validity with an average rating percentage of 90% and met the feasibility of construction validity so that the evaluation item instrument was considered good. This evaluation item instrument is effective and appropriate for use in the learning process which can be used as a tool to measure students' high-level thinking skills in Thermochemistry material.

Keywords: High Level Thinking, Thermochemistry Material, Development of Evaluation Questions

Abstrak: PENGEMBANGAN SOAL EVALUASI UNTUK MENGUKUR KETERAMPILAN BERPIKIR TINGKAT TINGGI PADA MATERI TERMOKIMIA. *Peneitian ini dilakukan di sekolah SMA Laksamana Martadinata Medan yang bertujuan untuk mengembangkan instrumen soal evaluasi untuk mengukur keterampilan berpikir tingkat tinggi peserta didik pada materi Termokimia dengan menggunakan model pegembangan (Research and Development, R&D) model 4D yang meliputi, yaitu;. Define (pendefinisian), Design (perancangan), Develop (pengembangan), dan Dissemenate (penyebaran). Sampel dalam penelitian yaitu 36 orang peserta didik yang dipilih dengan cara purposive sampling. Instrument yang digunakan adalah soal evaluasi dan lembar validasi. Hasil penelitian ini menunjukkan bahwa melalui pengembangan soal evaluasi untuk mengukur keterampilan berpikir tingkat tinggi pada materi termokimia, pada tingkat kemampuan berpikir tingkat tinggi dengan memebrikan soal HOTS mendapatkan hasil kemampuan yang sangat kurang sebesar 44,5% dan mendapatkan hasil yang sangat layak pada lembar validasi oleh validator ahli yaitu; dosen 91% dan guru 94%. Produk akhir yang berupa 32 soal yang valid dari rancangan awal produk 40 butir soal. Hasil analisis data menunjukkan bahwa instrumen soal evaluasi untuk mengukur keterampilan*

berpikir tingkat tinggi peserta didik yang dikembangkan telah memenuhi kelayakan validitas isi dengan rata-rata persentase penilaian 90% dan memenuhi kelayakan validitas konstruksi sehingga instrumen soal evaluasi dianggap baik. Instrumen soal evaluasi ini efektif dan layak digunakan dalam proses pembelajaran yang dapat dijadikan sebagai alat untuk mengukur kemampuan keterampian berpikir tingkat tinggi peserta didik pada materi Termokimia.

***Kata Kunci**: Berpikir tingkat tinggi, Materi termokimia, Soal Evaluasi*

▪ INTRODUCTION

Process education designed to create an environment and learning process so that students can actively develop their potential and cultivate spiritual, religious, and self-control. personality, intelligence, noble character, and the skills needed by himself and society to meet the needs of the times (Hidayat, 2013).

Curriculum is guidelines for implementing educational activities to achieve goals. Curriculum is an important tool to achieve educational goals. One of Indonesia's current efforts to improve education is to change the curriculum. In efforts to improve the quality of education, revision and refinement of the curriculum are always carried out. There have been several changes to the curriculum, the latest being the curriculum 2013 (Fadlilah, 2014)

The study of deficiencies in the previous curriculum became the basis for modifications to the 2013 curriculum. According to Nuh (2013), the results of the evaluation of the Education Unit Level Curriculum (KTSP) which had been implemented since 2006, served as the basis for compiling the 2013 curriculum. As a result of these modifications, the 2013 curriculum was different. from the previous curriculum in many ways and has an impact on its implementation, especially in schools. Teachers in charge of implementing the curriculum in schools must adapt to the needs of the new curriculum.

In the independent curriculum, independent learning is a new forum for the welfare of education in today's modern era. The previous curriculum, namely the 2013 curriculum, focused only on intra-curricular or face-to-face activities and prioritized understanding, skills, and character education, while the independent curriculum used learning guides between intra-curricular and co-curricular activities through a project to strengthen the Pancasila student profile.

Learning chemistry very need attention to product, that is chemical knowledge in the form of facts and theories, principles, process regularities, or scientific. On this basis the concept of chemistry is very broad ranging from the concrete to the abstract cannot be understood (Assriyanto, 2017). Chemistry is part of science, is an inquiry-based science; what, why, and how odd the substance-related regularities, including; structure, composition, properties, dynamics, kinetics, and energy with skill and urgency-driven reasoning (Chang and Overby, 2011; Rahmasari, et al., 2019).

According to research conducted by Utami, (2021) To fulfill their responsibilities, many teachers create learning tools based on the 2013 curriculum in preparing lesson plans. Teachers have not been able to compile; teaching materials, learning media, Student Worksheets (LKPD), and Learning Outcomes Tests (THB) which can help students develop higher-order thinking skills.

Students can determine the extent to which they have successfully participated in learning by evaluating learning outcomes. The ability of students to achieve higher levels of achievement will be influenced by the conditions under which they obtain satisfactory grades. Conversely, when the results are not good, students try to make

learning better. However, positive reinforcement from the teacher is essential to keep students from giving up. (Magdalena 2017).

Based on observations made at the Laksamana Martadinata Private High School, the results obtained were that in chemistry learning at the Laksamana Martadinata Private High School they still used LOTS (*Lower Order Thinking Skill)* which includes the level of students' ability to remember (C1), the level of student understanding (C2), the application of the material (C3), and there are only a few that sometimes allude to being able to create (C6), evaluate (C4), and analyze (C4) . This problem makes researchers interested in developing HOTS-based evaluation questions in order to find out the extent to which students' abilities to think at a higher level and the items that have been presented to students so that students are able to understand the items and have thinking skills in implementing it on new context.

It needs to be developed considering the circumstances surrounding the problem mentioned above in the HOTS assessment instrument by referring to the curriculum that is being implemented. On this occasion, the researcher developed a HOTS assessment instrument with the title: "Development of Evaluation Items for Measuring Higher-Order Thinking Skills in Thermochemical Materials".

▪ METHOD

Location and Time Study

This research was conducted at SMA Laksamana Martadinata Medan from January to March 2023 which is located at Jl. Battle No. 125, Pulo Brayan Kota, Medan district. New, Medan City, North Sumatra 20239 North Sumatra.

Population And Sample

The population is all research subjects (Arikunto, 2010). The population in this study are:

All Chemistry lecturers who are categorized as educational lecturers at Medan State University. All teachers who teach Chemistry at SMA Laksamana Martadinata Medan. All XI IPA 2 students at SMA Laksamana Martadinata Medan for the 2022/23 academic year.

The population of this study will use the sample, namely:

Two lecturers of Chemistry, Medan State University, Four Chemistry Teachers at SMA Laksamana Martadinata Medan, Class XI IPA 2 SMA Laksamana Martadinata Medan

Design Study

Where this type of research is R&D development research or often known as *Research and Development* , the development of this R&d model is quite reliable in improving practice, and usually in the development of aptitude test instruments think level tall in learning chemistry.

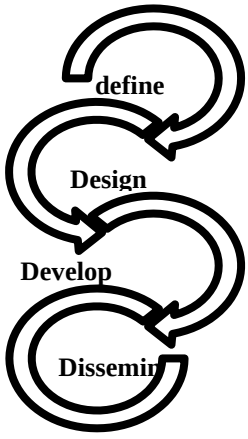

Figure: ɒevelopment Step Chart Model 4D

Skills Think Level Tall

Higher-order thinking skills include the ability to critically, creatively and creatively analyze information, as well as problem-solving skills, as well as the skills to remember, restate and refer without processing. According to Resnick (1997), characteristics Higher order thinking skills have four characteristics, namely: (1) non-algorithmic, (2) tends to be very complex, (tends to produce multiple solutions and Which to (4) involve application/implementation as well as diverse criteria, uncertainty, and self regulation.

Instrument Study

The data needed to carry out the findings of this study are in the form of evaluation questions to measure higher order thinking skills.

Procedure Study

Based on the 4D model development research, the procedure study development of evaluation questions to assess higher order thinking skills in thermochemical content. *The Research and Development (R&D)* development approach model is used in this study.

Technique Data collection

Both during the class assessment process and the process of compiling evaluation questions, data was collected, including through: Conducting observations and interviews to obtain initial data on analysis needs and analysis curriculum. Test appropriateness question evaluation made by expert validators and will indicates the content validity of the evaluation questions. Conduct trials of evaluation questions and distractor questions that were developed for participants class XI IPA 2 SENIOR HIGH SCHOOL Admiral Martadinata Medan. and evaluate scores to see if the evaluation questions developed are feasible by the teacher.

Analysis Data

Analysis data is the process of searching, finding, and systematically compiling data obtained from interviews, findings in the field, and documentation by collecting data, describing hypotheses and making conclusions (Sugiyono, 2013).

▪ RESULTS AND DISCUSSION

Results Study

, the four stages of the 4D model have been carried out, namely, *define* , *design* , *develop* , and *disseminate* . Results from the define stage is by analyzing the hots questions withlook for stimulusWhich interesting And material.

Results Stage Define (Definition)

By analyzing the following, the researcher carries out the defining stage, or discovers what is needed, the concept, evaluation, and learning specifications that will later be implemented in the module:

a. Final Initial Analysis (Front-End Analysis)

The goal is to determine the KD that can be made about hot at this stage. Because not all KD can be modeled HOTS, then KD needs to be done.

b. Student Analysis
   At this point, it was found that students answered questions in the form of moderate questions. So that at this stage the researcher has the potential to make hots questions that are in accordance with KD which are carried out at Laksamana Martadinata High School.
c. Concept Analysis
   At this point, the activity that needs to be done is to interview the teacher to find out the most important ideas being taught and to look in depth at the ideas that need to be taught.
d. Formulation of Learning Objectives
   The aim is to combine the results from the previous phase at this point, and then to identify the subject of the study. The preparation and design of the product developed is based on the research object. Based on the concept analysis, a contextual-based learning module is needed in the form of thematic teaching materials to achieve learning objectives.

Design Stage (Design)

The researcher then proceeds to the design stage, which produces the following results:

a. Analyzing KD that can be used as HOTS Problem: Because not all KD can be used as HOTS, it is necessary to do an analysis based on KD. KD can be analyzed independently by the teacher, through learning, or directly in the classroom.
b. Making question grids The purpose of the question grids is to assist students in writing HOTS questions. As a result, the grid is used to select KD which can be converted into HOTS questions by knowing their cognitive level.
c. Choose a stimulus that is interesting and relevant to the situation. Interesting stimuli are generally new or actual events, while contextual stimuli are those that correspond to the realities of everyday life. The quality indicator is the teacher's capacity to find stimuli that are contextually relevant and interesting.
d. Selecting items from the stimulus Items are arranged according to the general rules for writing items; the difference is only in the material aspects and the use of aspects of questions covering aspects; symbolic, microscopic, and macroscale.

Development Stage (Development)

The steps taken at this development stage are:

a. designing questions by first designing a question grid ;
b. validated to expert validators, namely to two lecturers and to four ppg teachers
c. Test questions for Laksamana Martadinata High School students.

After that, validation was carried out by expert validators, namely two professors of chemistry at Medan State University and four PPG teachers where in the validation aspects seen were; material, construction, language, and some additional elements.

Lecturer Validation

Two validators are coded V1 (Validator 1) and V2 for this expert validation. The sum of the proportions of answers to all statements on one aspect of the assessment ($\sum$

% Xin) divided by the number of statements on one aspect of the assessment (n) multiplied by 100% yields the proportion (%) of the validation assessment per aspect in this question. Table 4.2 and Figure 4.1 display the results of the validated assessment.

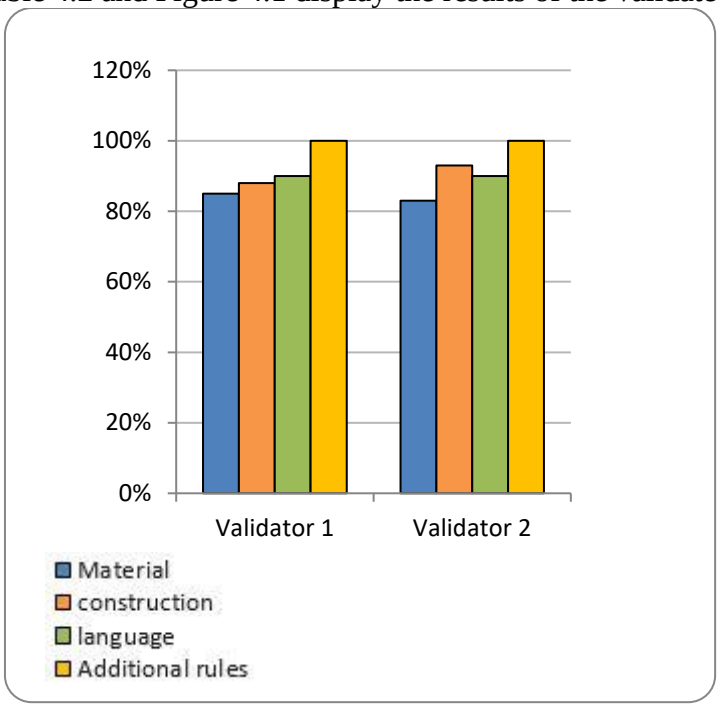

Figure 1. Lecturer Validation Results Diagram

Based on Picture 1. results validation of material, construction, language, and additional rules by expert validators, namely two lecturers, therefore it can be seen very well that the result of the typical extent obtained is validator 1 of 91% and validator 2 of 92%. This shows the difficulty of assessing higher order thinking skills. on "proper" thermochemical materials based on criteria validation carried out on expert validators. Referring to the data presented above, it is known that the experts agreed on an evaluation instrument for higher order thinking skills in thermochemical material to be tested at the feasibility test stage with revisions. The evaluation instruments provided by experts are detailed in table 1.2.

Table 1. Revised evaluation from experts

Aspect	Aspects studied	Question number that needs to be corrected	Expert advice
Material	The items are in accordance with the learning objectives	1,5,9,11,17,20,21, 22,23,24,38,40	the operational verb learning objectives are less relevant.
	Items using an interesting stimulus (new, encouraging students to read)	1,7,9,36	In the following questions, more facts are emphasized in everyday life to make it more interesting.
Contextual	The answer choices in the form of numbers/time are arranged based on the order of the size of the chronology		Compilation of answers, pay attention if you want the largest, then for all

Aspect	Aspects studied	Question number that needs to be corrected	Expert advice
			questions that use numbers, do the same as the previous question and vice versa, if you want the smallest, then be consistent in the next question.

With codes V1 (Validator 1), V2 (Validator 2), V3 (Validator 3) and V4 (Validator 4), this expert validation is given to four validators. All aspects of the assessment, including material aspects, construction, language, and a number of additional rules, are requested by the validator. The sum of the proportions of answers to all statements on one aspect of the assessment ($\sum$ % Xin) divided by the number of statements on one aspect of the assessment (n) multiplied by 100% yields the proportion (%) of the validation assessment per aspect in this medium. The predefined validation was obtained after the result collection. Figure 1.2 illustrates the validation of the assessment results obtained.

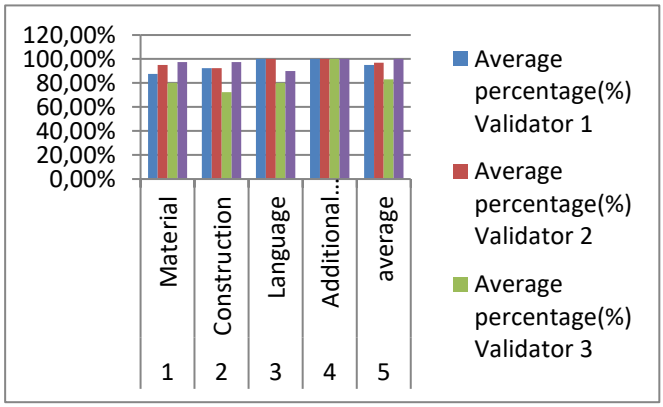

Figure 2. Diagram of PPG Teacher Validation Results

Based on Picture 1.2 results validation of material, construction, language, and additional rules by expert validators, namely four PPG teachers, it is proven that the average proportion obtained is in validator 1 is 95%, validator 2 is 97%, validator 3 is 83% and validator 4 is 100%. This shows the difficulty of assessing higher order thinking skills in "proper" thermochemical materials based on criteria validation carried out on expert validators.

Referring to the data presented above, it is known that the experts agreed on an evaluation instrument for higher order thinking skills in thermochemical material to be tested at the feasibility test stage with revisions. The evaluation instruments provided by experts are more detailed in table 1.4.

Table 2. Revised evaluation from experts

Aspect	Aspects studied	Question number that needs to be corrected	Expert advice
Material	Items in accordance with the learning objectives.	3	In this question, it enters the cognitive level of C3

Aspect	Aspects studied	Question number that needs to be corrected	Expert advice
Textual	Items in accordance with the learning objectives. Figures, graphs, tables, diagrams or the like are clear and functional.	5, 10, 27	• In question no 5 under the diagram, make more detailed questions so that the diagram can be answered. • In question number 10 the yellow mark on the question should be removed. • In question 27, you should use a white background image. • In question 28, use an image with a white background to make the question more interesting. If taken from an internet source, try to have a white background image.

- PPG Teacher Validation

With codes V1 (Validator 1), V2 (Validator 2), V3 (Validator 3) and V4 (Validator 4), this expert validation is given to four validators. All aspects of the assessment, including material aspects, construction, language, and a number of additional rules, are requested by the validator. The sum of the proportions of answers to all statements on one aspect of the assessment ($\sum$ % Xin) divided by the number of statements on one aspect of the assessment (n) multiplied by 100% yields the proportion (%) of the validation assessment per aspect in this medium. Figure 1.2 illustrates the validation of the assessment results obtained.

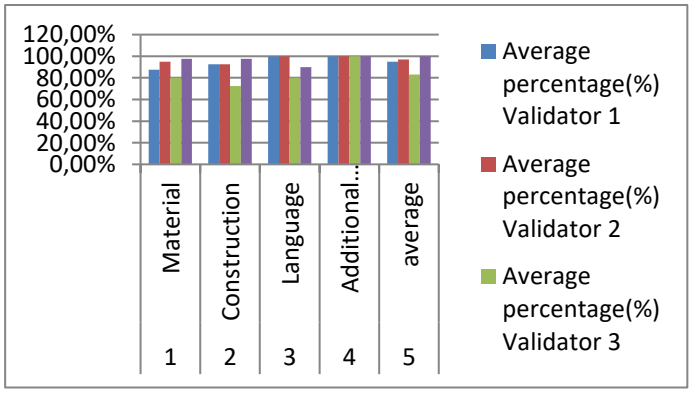

Figure 3. PP Teacher Validation Result Diagram

Based on Picture 4.2 results validation of material, construction, language, and additional rules by expert validators, namely four PPG teachers, After that, the average proportion is also known as validator 1 of 95%, validator 2 of 97%, validator 3 of 83% and validator 4 of 100%. This shows the difficulty of assessing higher order thinking

skills. on "proper" thermochemical materials based on criteria validation carried out on expert validators.

Referring to the data presented above, it is known that the experts agreed on an evaluation instrument for higher order thinking skills in thermochemical material to be tested at the feasibility test stage with revisions. The evaluation instruments provided by experts are detailed in table 1.4.

Table 3. Revised evaluation from experts

Aspect	Aspects studied	Question number that needs to be corrected	Expert advice
Material	Items in accordance with the learning objectives.	3	In this question entered into the C3 cognitive level
Textual	Items in accordance with the learning objectives. Figures, graphs, tables, diagrams or the like are clear and functional.	5, 10, 27	• In question no 5 under the diagram, make more detailed questions so that the diagram can be answered. • In question number 10 the yellow mark on the question should be removed. • In question 27, you should use a white background image. • In question 28, use an image with a white background to make the question more interesting. If taken from an internet source, try to have a white background image.

- Field Trials

Students are given forty hot questions in the pilot phase, and they are given 45 minutes to answer them. Regarding the proportion (%) of student responses, the first proportion (%) of responses per aspect is calculated by dividing the total proportion of answers to all statements on one aspect of the assessment ($\sum \% X$) by the number of statements on that aspect (n) and multiplied by 100%. Figure 1.3 illustrates the results of tests used to assess students' higher order thinking skills.

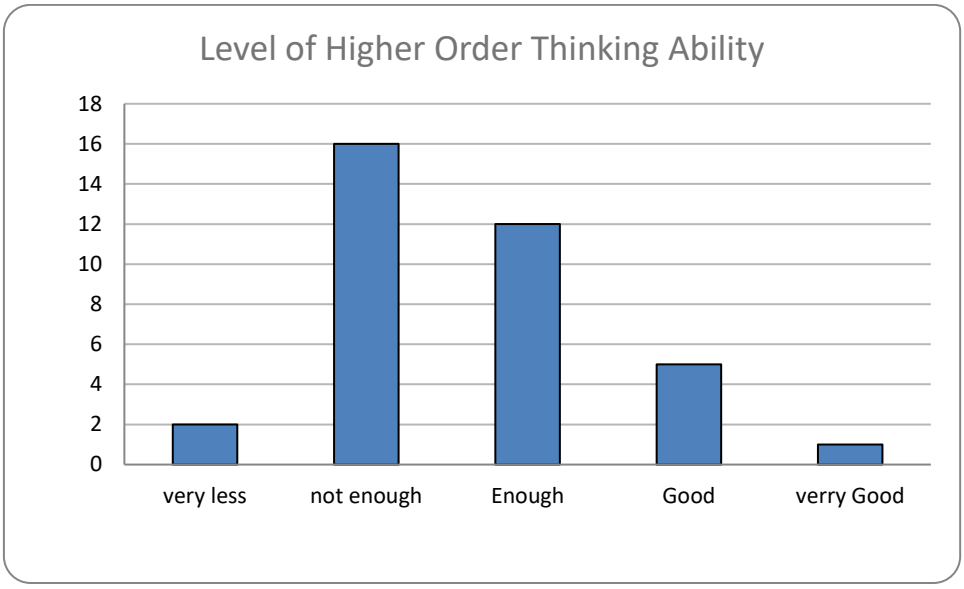

Figure 4. Test Results for Hots Questions

Based on Picture 1.3 the results of field trials on hots questions , namely at the level of student ability it is very lacking by 2 students, 16 students are lacking, 12 students are sufficient, 5 students are good, and 1 student is good. This shows the difficulty of assessing higher order thinking skills. on thermochemistry material must be revised based on the criteria of trials conducted on students to get the final product, namely a proper hots evaluation question.

Discussion

Process study development Which carried out using R&D development or often known as research and development by using model 4d developed by Thiagarajan, where the four stages of the four-dimensional model are as follows: develop, define, design, and disperse. This development begins at the define stage, namely when questions of evaluating high-level skills with KD analysis are analyzed early and ended independently by the teacher, in the lesson , or through directly to the school field .

Furthermore, the researcher conducted a concept analysis with interviews with educators conducted as part of the activity to learn more about the important concepts being taught and to identify related topics. After collecting all the analysis data that has been carried out so that researchers can formulate learning objectives that will be designed in developing hots-based evaluation questions. Evaluation questions prepared by covering aspects; macroscopic, microscopic, and symbolic. Namely on the macroscopic aspect in the form of formulas and numbers, while the presentation diagrams and chemical reaction processes represent the microscopic and symbolic levels.

The steps taken at this development stage are: (1) designing questions by first designing a question grid ; (2) validating expert validators, namely two lecturers and four PPG teachers; (3) Try out questions for students of SMA Laksamana Martadinata. In the initial design the researcher made real observations in the field of SMA Laksamana Martadinata. data that obtained is used as preliminary data to formulate development question After HOTS was formulated, the observed data obtained 40 thermochemical items that were in accordance with the basic competencies in the syllabus and lesson plans. After that, expert validators, two chemistry professors at Medan State University and four PPG teachers, carried out the validation. Specifically, by dose validation proportion: Validators 1 and 2 were 91% and 92%, respectively. This shows the difficulty of assessing higher order thinking skills in "proper" thermochemical materials based on criteria validation carried out on expert validators. And with the validation of four PPG teachers namely; validator 1 is 95%, validator 2 is 97%, validator 3 is

83% and validator 4 is 100%. This shows the difficulty of assessing higher order thinking skills. on "proper" thermochemical materials based on criteria validation carried out on expert validators.

So it can be concluded that at the stage of developing evaluation questions based on hots with the appropriate criteria for use covering aspects ; macroscopic, microscopic, and symbolic. That is, on the macroscopic aspect in the form of formulas and numbers, while the microscopic and symbolic level, such as the presentation of diagrams and chemical reaction processes, with that the hots-based evaluation questions are ready for testing which will be carried out on students of SMA Laksamana Martdinata in class XI IPA 2.

The results of the field trials showed that the level of student ability was very low by 2 students, 16 students less, 12 students sufficient, 5 students good, and 1 student good. This shows the difficulty of assessing higher order thinking skills. on thermochemistry material must be revised based on the criteria of trials conducted on students to get the final product, namely a proper hots evaluation question. And by revising it, we get the results, namely 32 items that are in the proper category by conducting validation, reliability, differentiability, distortion, and reliability tests which get results greater than the rtable, namely; obtained $r_{count} > r_{table}$ (0.8485>0.329).

- **CONCLUSIONS**

The following are the findings of this study, which are based on the formulation of the problem, research objectives, and previous discussion: Obtained evaluation questions whose preparation includes aspects; macroscopic, microscopic, and symbolic. Namely on the macroscopic aspect in the form of formulas and numbers, while the microscopic and symbolic level such as the presentation of diagrams and chemical reaction processes. Questions for evaluating higher-order thinking skills or Host-based questions have been integrated with Non-exclusive Scientific Ability (KGS) is found in every problem where the inquiry development strategy is carried out according to signs of conventional scientific ability, especially (1) direct perception, (2) distorted perception, (3) understanding of the scale, (4) representative conversation , (5) coherent system, (6) reasonable consistency, (7) causal regulation, (8) demonstrating, (9) consistent conjecture, and (10) constructing ideas. Level validity grain question that evaluation developed which in the initial questions there were 32 valid questions and 8 invalid questions out of 40 validated questions. And the validation results by expert validators, namely 2 lecturers and 4 ppg teachers, obtained satisfactory percentages and obtained feasible criteria, and on the test of discrimination, level of difficulty, distructuring, and reliability in the 32 final questions met the requirements.

The following recommendations are made in light of the findings presented: Development of evaluation questions based on *Hots with scientific* engineering skills on the subject thermochemistry can be made on other materials and better aspects of generic science skills so as to increase students' conceptual understanding of thermochemistry subject matter and improve students' generic science skills. Future researchers should take a closer look at the general skills of science students, not just indicators; constructing concepts, logical consistency, logical inference, logical framework, symbolic discussion, causation, and logical consistency.

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