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Analysis of Understanding Concepts and Mastery of Basic Competence of Thermochemistry Materials Post Use of Chemlovers Media

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abstract

The purpose of this study is to learn more about the level of conceptual understanding and academic competition among students studying chemistry material in thermochemistry by utilizing Chemlovers as a media and student body. Penelitian is carried out using a combined method of sequential explanation and data collection in two phases, namely quantitative and qualitative phases. Approximately 144 students from kelas XI of the MIPA SMA Negeri 10 Semarang participated in the survey. Understanding of concepts and demonstration of competency with regard to thermochemistry material was conducted using a three-tier multiple-choice test. Students' disagreement with the media's use of Chemlovers comes from their angry response. The study's findings indicate that the percentage of respondents who understood the concept well was very high, with a score of about 66,74% (top category), and a score of 7,45% (low category). The level of student mastery of thermochemistry material, 80.56% of students fulfilled the minimal completeness criteria, with the highest score of 92.50, the lowest at 58.67, and an average of 83.37. Based on the results of this study, it can be said that media like Chemlovers efficiently helps students comprehend ideas and hone analytical abilities linked to thermochemistry. Respondents' comments on the utility of this android-based media were generally favorable.

1. Introduction

Technology advancement and digitalization in twenty-first-century education have a negative impact on the educational process in Indonesia. Era that is marked by increasingly easy access to information via a variety of media provides ease for various organizations to access a variety of types of information. Numerous types of devices, applications, and platforms are used to access the information in question, with smartphones being the most prevalent. In the field of education, smartphones are frequently used as teaching aids, as a means of communication between instructors and students, or as a means of information sharing between instructors and students (Bouhnik & Deshen, 2014; Asri, 2019; Iqbal & Bhatti, 2020). According to Kitchenham (2011), a smartphone is an alternative form of a device that can be used to grow educational media, including media based on Android.

Android is a platform with an open-source information system for smartphones that is deemed to be inherently unstable (Dwi et al., 2014). This technology can be used as a tool for online learning or mobile learning, and in its current iteration, users can access learning materials and use them in rigorous learning processes (González, 2017). Android-based smartphone media have high mobility and may be accessed effectively, enabling users to utilize the content however and wherever they see fit in accordance with their needs and interests (Asri, 2019).

Study findings from observations and interviews regarding students at SMA Negeri 10 Semarang revealed that the majority of students have smartphones. This situation offers plenty of room for using android technology for learning. A study conducted by a teacher in the SMA Negeri 10 Semarang neighborhood found that the use of technology in the teaching process was used only sparingly. Media that are frequently used include of whiteboards, worksheets, textbooks and power points. This will likely give students more trouble understanding concepts and developing their analytical skills with regard to the subject matter they are learning.

Students haven't had a good knowledge of topics by using the lecture, discussion, and presentation techniques for learning up to this point (Sartika, 2018). Only the ultimate outcomes (values) that students acquire as a result of receiving assignments and practice questions throughout the learning process, as well as the outcomes of the final evaluation in the form of daily tests, are the focus of learning. According to some theories, the teacher-centered teaching approach and the emphasis on learning outcomes for students' cognitive abilities are to blame for their lack of engagement and independence in the learning process, which has an impact on their level of conceptual understanding and mastery of foundational skills (Yahya, 2014; Fatah, et al., 2016).

Thermochemistry was the subject in chemistry that students identified as having low conceptual comprehension and mastery of competency. Students find this content to be challenging and abstract (Aswita et al., 2017; Roghdah et al., 2021; Sihaloho et al., 2021). The teachers at SMA Negeri 10 Semarang agreed, saying that the abstractness and degree of difficulty experienced by the students were caused by their need for advanced literacy and mathematical computation skills in order to comprehend and solve the problems that arise in the concept of thermochemistry. Initial diagnostic test results on students who had taken thermochemistry lessons revealed that 28% of the questions could not be answered by students and that 45% of the questions were answered incorrectly or incompletely. Up to 68% of students were able to provide appropriate answers to questions, but they presented unreliable justifications and expressed uncertainty about the responses. These circumstances suggest that either students do not comprehend the idea or have misconceptions about the thermochemistry content.

Misconceptions about systems and environments, exothermic and endothermic reactions, types of molar enthalpy changes, and calculating the enthalpy change of chemical reactions can be found in the literature on thermochemistry (Roghdah et al., 2021; Sihaloho et al., 2021). Due to this misunderstanding, students will be unable to appropriately detect and interpret any symptoms or events that arise throughout the learning process as well as have trouble completing assignments that are linked to the topic being taught. It is necessary to make an effort to correct these flaws, particularly by using learning resources built on the Android operating system, as they will undoubtedly have an impact on diminishing student progress.

Utilizing a variety of IT learning tools and digital media, the learning process is changed from being teacher-centered to being student-centered in order to meet the demands for producing human resources that have the traits of the 4.0 industrial revolution and the 21st century. In student-centered learning, the teacher serves as a director and facility provider (directing and facilitating the learning) (Ersanggono, et al., 2011). Learners actively participate in their own learning by using both their intellect and mental processes. According to Suwarto (2010) and

Setiyono (2011), learners have the ability to construct meaning from the material they choose to study and then immediately apply it in order to complete the process of grasping concepts and acquiring fundamental skills.

One of the options for achieving a grasp of these fundamental concepts and competencies is to use Chemlovers as an Android-based learning resource. Chemlovers is supplied with a code in the form of a click-and-drag puzzle thanks to the usage of cloud-based MIT app inventor software, making it simple for pupils to utilize (Alkodri, 2019). Chemlovers is a resource that may be utilized by students as a source of knowledge and learning tools since it offers clearer, more organized information on the subject matter being studied. The usage of Chemlovers as a teaching tool is anticipated to be able to support and facilitate students' requirements during the learning process and to spark interest, motivation, activeness, and independence to help students become more independent and interested in learning. This study seeks to identify students' mastery of fundamental skills in thermochemistry material after using Chemlovers media and to describe the level of students' conceptual comprehension of thermochemistry material after using Chemlovers media.

2. Method

This study has a mixed-method, sequential explanatory design. This study's design included a method for gathering data in two stages, with the first stage involving the collection of quantitative data and the second stage involving the collection of qualitative data (Creswell, 2016). SMA Negeri 10 Semarang, which is situated in Jl. Padi Raya No. 16, Gebangsari, Genuk District, Semarang City, Central Java, was the site of the research. The study was carried out during August and September 2021. 144 class XI students in the MIPA specialization program, grouped into classes XI MIPA-1, XI MIPA-2, XI MIPA-3, and XI MIPA-4, served as the research subjects. The application of learning media, specifically Chemlovers on thermochemistry material, is the independent variable in this study. The dependent variable is the students' conceptual comprehension and command of fundamental skills.

Experts have gone through a validation procedure using the Android-based Chemlovers media, including material validation, language validation, and media validation. Table 1 displays the outcomes of the validation process.

Table 1. Outcomes of the media validation for Chemlovers for Android.

No	Validator Name	Total Score	Maximum Score	Percentage (%)	Criteria
Material validation					
1.	VAM-1	26	32	81	Very worth it
2.	VAM-2	29	32	90	Very worth it
3.	VAM-3	28	32	87	Very worth it
Language validation					
1.	VAM-1	20	24	83	Very good
2.	VAM-2	21	24	87	Very good
3.	VAM-3	21	24	87	Very good
Media validation					
1.	VAM-1	53	60	88	Very good
2.	VAM-2	53	60	88	Very good
3.	VAM-3	48	60	80	Very good

Three tier multiple choice questions were used in a written test for the quantitative data gathering. The three-tier multiple-choice questions' question items combine markers of attaining

the fundamental competency in the thermochemistry content with indicators of conceptual knowledge, as shown in Tables 2 and 3.

Table 2. Lists fundamental skills and capability indicators for competency.

Basic Competencies	Indicator
3.4 Describe the idea of enthalpy change in thermochemical equations for processes occurring at constant pressure.	3.4.1. Use a phenomenon to illustrate the idea of energy. 3.4.2. Use phenomena to distinguish between energy and environment. 3.4.3. Based on tests and phenomena, describe the features of exothermic and endothermic reactions. 3.4.4. Use energy level diagrams to analyze endothermic and exothermic reactions.
3.5 Describe Hess' law, the several types of reaction enthalpies, and the idea of bond energy.	3.5.1 Describe the various enthalpy changes that occur in reactions under a constant pressure. 3.5.2 Based on the outcomes of the experiments, determine the equation for thermochemistry . 3.5.3 Using energy level diagrams to analyze variations in reaction enthalpies. 3.5.4 Calculating the enthalpy change reaction from experimental data from calorimetry, hess energy, enthalpy of formation energy, and bond energy. 3.5.5 Use hess energy, enthalpies of formation energy, and bond energy to analyze variations in reaction enthalpy.
4.4 Give an overview of the findings from the examination of chemical experiment data under continuous pressure.	4.4.1. Recognize exothermic and endothermic events in photos and videos.
4.5 Using experimental data, comparing the enthalpy changes of various processes.	4.5.1. Using images and videos of exothermic and endothermic reactions, summarize the differences between the two.

(Source: SMAN 10 Semarang Chemistry Subject Syllabus for 2020)

Table 3. Concept Understanding Indicators.

No	Concept Understanding Indicators
1	Stating a notion.
2	The capacity to both set and not set examples.
3	Topics being presented through multiple mathematical representations.
4	The capacity to group objects into different categories depending on specific notions.
5	The capacity to use concepts for solving problems.
6	The capacity of students to create prerequisites or conditions for an idea.
7	Using, putting to use, and choosing particular processes or operations.

(Source: Yustisia, 2017)

Before being presented to students, the test instrument, which consists of three tiers of multiple choice questions, is put through a procedure of validation, reliability, differential power test, and item difficulty level test. The test instrument that was created had 25 questions, and it was evaluated in terms of three different categories: constructions, language and spelling, and content. Table 4 displays the outcomes of the test instrument validation.

Table 4. Results of test instrument validation.

No	Aspect	Indicator	Validation Score
1	Content aspect	1	3
		2	3
		3	3
2	Construction aspect	4	3
		5	3
		6	3
3	Aspects of language and spelling	7	3
		8	4
	Total score		29

The instrument validation score yielded a total score of 29 out of a possible 32 points. This result shows that the test instrument can be used. 34 class XII MIPA-3 students who had been given thermochemistry material underwent tests to measure the level of reliability, differential power, and difficulty. Following an analysis of the 25 test items, 18 were found to be valid, and the reliability of the items was 0.83 > 0.70, indicating that they can be utilized as a measuring instrument for conceptual knowledge and mastery of foundational skills in the thermochemistry subject.

The level of conceptual knowledge and mastery of students' fundamental skills are then assessed using the test results that pupils received. The minimal completion criteria, or 75, is used to determine if students have mastered basic capabilities, whereas Table 5 lists the criteria for establishing whether students have understood concepts.

Table 5. Criteria for understanding students' concepts.

Answer	Reason	Belief	Category
Right	Right	Certain	Understand Concept
Right	Wrong	Certain	Misconceptions
Wrong	Right	Certain	Misconceptions
Wrong	Wrong	Certain	Misconceptions
Right	Right	Not sure	Lucky
Right	Wrong	Not sure	Don't Understand the Concept
Wrong	Right	Not sure	Don't Understand the Concept
Wrong	Wrong	Not sure	Don't Understand the Concept

(Source: Arslan et al. (2012)

Table 6 lists the qualifications that were determined from an examination of students' conceptual comprehension based on the following formula:

$$\text{Understand Concept} = \frac{\sum \text{students understand the concept}}{\sum \text{test questions x} \sum \text{student}} x\ 100\% \quad (1)$$

Table 6. Qualification of concept understanding test results

Score Range (%)	Criteria
$66.68 \leq Z \leq 100$	High
$33{,}34 \leq Z \leq 66{,}67$	Medium
$0 \leq Z \leq 33{,}33$	Low

Student responses to the utilization of Chemlovers media in the learning process of thermochemistry material were gathered using questionnaires, which provided qualitative data. The 15 statements in this answer questionnaire are listed in Table 8 along with a Likert scale and scoring guidelines: Very suitable (SS) = 4, appropriate (S) = 3, unsuitable (TS) = 2, and

inappropriate (STS) = 1 for the positive questions and very suitable (SS), appropriate (S), unsuitable (TS), inappropriate (STS) = 4 for the negative questions.

Table 7. Student response questionnaire statement items with regard to the usefulness of the media for Chemlovers

No.	Statement
1	I'm able to comprehend the subject on thermochemistry more easily thanks to the Chemlovers study resources.
2	I can better comprehend Thermochemical materials by seeing movies and photos.
3	The practice problems and commentary provided in the media Chemlovers are understandable.
4	Some of the menu options offered by the Chemlovers media have my curiosity.
5	By using the Chemlovers media, I'm inspired to look into studying subjects on my own.
6	I enjoy using the Chemlovers learning resources to learn.
7	Boredom can be avoided throughout the teaching and learning process by using the educational tool Chemlovers
8	Clear visuals can be seen in the educational software Chemlovers.
9	It is new to me to use Chemlovers material in the educational process.
10	The appropriateness of the symbols and emblems in the media Chemlovers
11	I get more engaged in my studying when I use the learning tool Chemlovers to study chemistry.
12	Chemlovers is a media platform that is simple to use and run.
13	I think Chemlovers can help students better understand the idea through educational media.
14	The educational website Chemlovers can be used to learn about Thermochemical substances.
15	I'm eager to study more about thermochemistry after using the Chemlovers media.

This survey tries to determine whether the media being used meets the needs of the students. The received qualitative data is then transformed into percentages based on the standards listed in Table 8's criterion.

Table 8. Criteria for student questionnaire responses.

Intervals (%)	Criteria
85 – 100	Very high
70 – 84	High
55 – 69	Currently
40 – 54	Low
25 - 39	Very low

3. Result and Discussion

The learning method for the thermochemistry curriculum with Chemlovers media is conducted over the course of five meetings, with each meeting lasting one hour (1 x 60 minutes). Students use Chemlovers media as a medium and source of independent study, which includes descriptions of the content reinforced by images, videos, and quizzes (practice questions). At the conclusion of the learning process, students were given evaluation and response surveys to help determine their conceptual comprehension of the topic, their mastery of the fundamental skills related to thermochemistry, and their opinions of the usage of Android-based Chemlovers media.

In the thermochemistry material, the percentage of students who understand the concepts and have mastered the fundamental skills is shown in Figure 1, and the degree to which students have mastered the fundamental skills is determined by the attainment of classical completeness with a minimal completeness criteria value of 75, which is shown in Table 9.

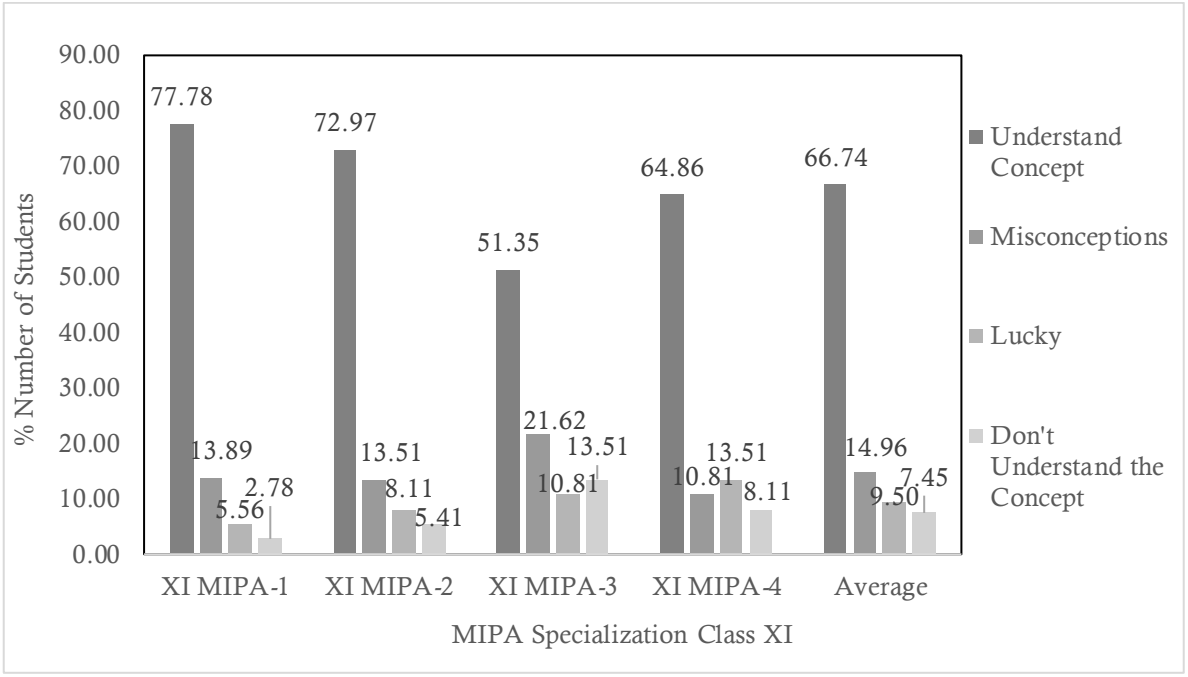

Figure 1. The degree of conceptual understanding among students

Table 9. Analysis of students' proficiency with fundamental skills.

Component	Results
Number of students	144
The number of students who meet the minimal completeness criteria	116
The highest score	92,50
Lowest value	58,67
Average value	83,37
% classical completeness	80,56

The ability of students to comprehend the concept of the thermochemistry material varied, as shown in Figure 1 and Table 9. The requirements for comprehending the concept were met by the largest percentage of pupils in each class, and these criteria were then sequentially followed by the criteria for misconception, luck, and not understanding the subject. With an average mastery score of 83.37 and 80.56% of participants meeting the minimal completeness requirement, it can be seen that 50% of students have fulfilled the criteria for understanding the idea in each class. The remaining 10% of students do not meet the criteria for comprehending the concept.

Based on these findings, it can be concluded that using Chemlovers media to teach thermochemistry facilitates and aids students in comprehending the notion of the subject matter so that students can grasp these fundamental competencies. By acquiring classical mastery > 75% minimal completeness criteria in academic subjects, Chemlovers media can be deemed to be helpful in aiding learning. This study supports that of Wahyudin and Isa (2010), who found that using multimedia in the classroom can improve students' interest and comprehension as well as their cognitive outcomes.

Android applications can be employed and are thought to be excellent learning media, according to Laila and Irsandi's (2016) research. The use of smartphones as learning tools gives students more opportunities for in-depth learning, fosters learning through information retrieval, develops practicum skills, builds student competencies in a dynamic way, and enables students to measure each simulation-based learning concept independently (Rogozin, 2012).

Students are encouraged to be more engaged and critical when learning through smartphone-based media. Students' interactions in the Android-based learning process, including using Chemlovers media, encourage individual learning, enhance critical thinking skills, and give participants rich learning opportunities (Mardiana & Kuswanto, 2017; Simanjuntak & Budi, 2018). This procedure significantly enhances students' capacity for learning (Widyastuti & Wuryanto, 2020).

These students' individual learning activities are consistent with constructivism learning philosophy. This idea states that in order for students to develop their own knowledge, they must find concepts or information, compare it to already known concepts, and then update it if necessary. According to constructivism theory, students' responses to learning events through their five senses will result in the construction of a mental schema or cognitive framework (Padmaningrum et al., 2010). Given that students are taught to think creatively when addressing issues, this learning process will assist them in developing ideas, comprehending concepts, and giving meaning to the information and events they encounter (Wasonowati et al., 2014).

Student response surveys distributed at the conclusion of the learning process were used to gather feedback from students on the process of learning thermochemistry subject using Chemlovers media. The applicability of this chemovers media to the demands of students during the learning process is assessed using the answered questionnaire. Figure 2 displays the results of the students' responses to each statement item on the student response survey regarding the usage of Chemlovers media.

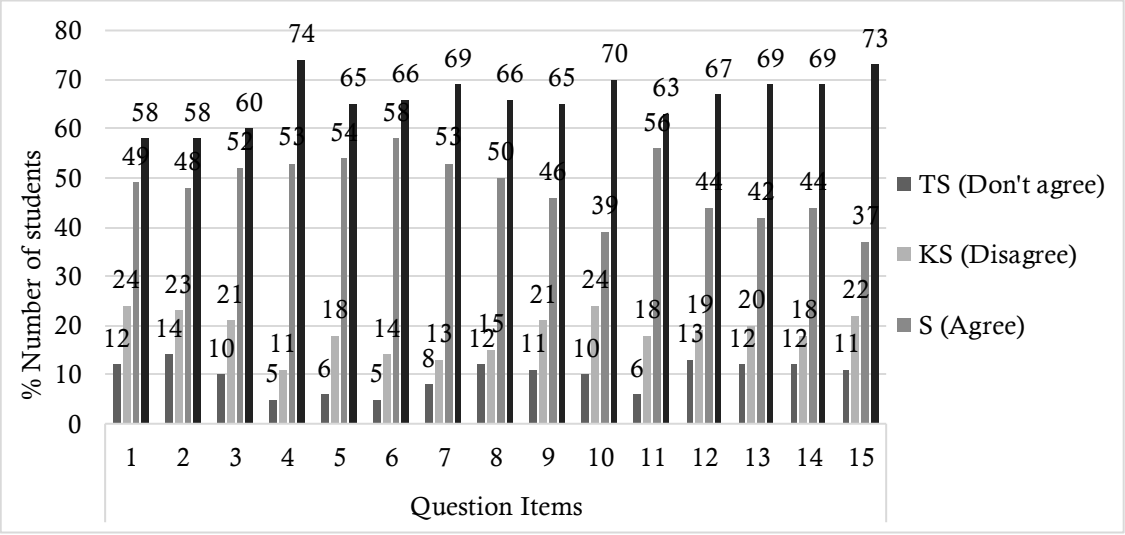

Figure 2. Responses from students to using Chemlovers media

When employing Chemlovers media as a method and source of learning for the entire set of thermochemistry information shown in Figure 3 as a whole, the students' replies were then examined to see how they felt about the chemistry learning process.

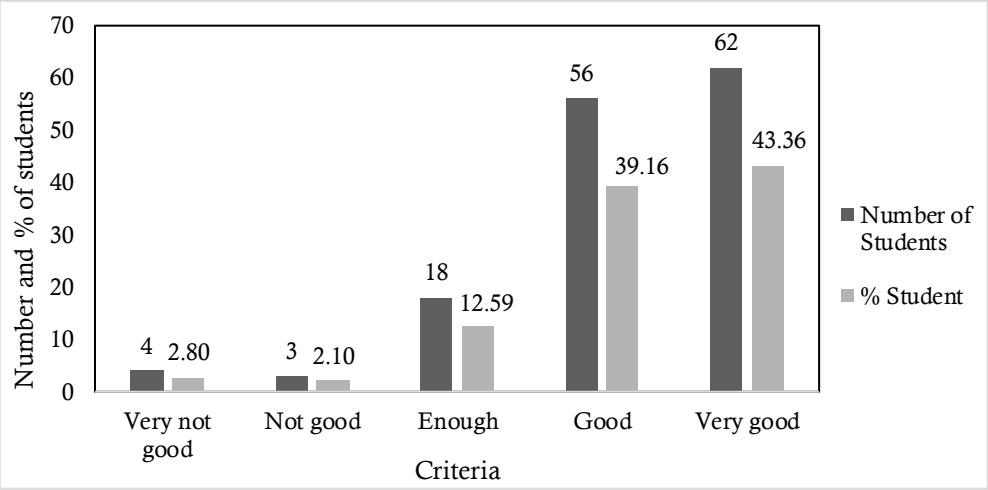

Figure 3. Student reactions to Chemlovers' media use

Figures 2 and 3 show that student reactions to using Chemlovers media to learn thermochemistry subject were extremely high. Each statement item received excellent student replies, with the majority of the student responses being in strong agreement. With percentages of 39.16% and 43.36%, the participants' replies fell primarily into the good and very good categories. These findings suggest that students respond favorably to using Chemlovers media when learning about thermochemistry.

Cell phone or smartphone use during the learning process has a good influence, supports interactions and learning processes, strengthens learning environments, and motivates students to be more independent and engaged (Sutomo & Yahya, 2017; Nafidi et al., 2018). In order to make learning material more meaningful and to increase students' comfort level, motivation, and interest in the subject matter, multimedia-assisted learning helps students and teachers understand concepts from several points of view (Jeffrey et al., 2014; Astatin & Nurcahyo, 2016). Students become more engaged, more able to comprehend the subject matter and work through the issues presented, motivated, and show a greater interest in understanding chemistry. Students become more inventive in coming up with ideas and answers to issues thanks to Chemlovers media, and they have a greater understanding of the connection between the content being studied and its application in daily life.

4. Conclusion

Chemlovers as a learning tool with a percentage of comprehending concepts of 66.74% (high category), 14.96% misconceptions (low category), lucky 9.50% (poor category), and no understanding of the concept of 7.45%, thermochemistry aids in students' conceptual knowledge (low category). Having met the medium criteria for the overall conceptual understanding test with a score of 33.37%. 80.56% of students met the required level of completion (minimal completeness criteria 75), demonstrating the efficacy of the usage of Chemlovers media. The average score for students' basic competency in thermochemistry material was 83.37, with the best score being 92.50 and the lowest being 58.67. It is possible to create and use learning tools for the learning process based on Android, such as Chemlovers. Chemlovers, an Android-based media platform, can be utilized as a tool to assist students in grasping concepts and mastering the abilities of the subject matter being studied because of its easily accessible menus and features.

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