Jurnal Pendidikan Kimia (JPKIM)
p-ISSN: 2085-3653| e-ISSN: 2549-3116
https://jurnal.unimed.ac.id/2012/index.php/jpk/index

OPEN ACCESS
10.24114/jpkim.v16i3.65191
J. Pendidik. Kim 2024, 16(3), 285 – 292

Original Research Article

Development of innovative electronic student worksheet (E-LKPD) based on somatic auditory visual intellectual (SAVI) on salt hydrolysis topic

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Citation: Ratri, M.C., & Tina, E.P.I. (2024). Development of innovative electronic student worksheet (E-LKPD) based on somatic auditory visual intellectual (SAVI) on salt hydrolysis topic. Jurnal Pendidikan Kimia (JPKIM), 16(3), 285– 292. https://doi.org/10.24114/jpkim.v16i3.65191

ARTICLE INFO

Keywords:
E-LKPD;
Innovative;
SAVI model;
Salt hydrolysis

History:
♦Received - 30 Aug 2024
♦Revised - 27 Dec 2024
♦Accepted - 28 Dec 2024

ABSTRACT

A low understanding of salt hydrolysis and a lack of mastery of mathematics in the calculation section is a problem in learning chemistry. Therefore, this research aim is to produce a good electronic student worksheet (E-LKPD) based on SAVI learning model by determining the quality of LKPD in terms of (1) feasibility and (2) student response. This research and development (R&D) used a 4D development model that was modified to 3D. The research instruments used were interview and validation sheets, test items in the E-LKPD, and student response questionnaires. The research sample consisted of 10 students of class XI MIPA. The results showed that (1) the developed E-LKPD has good quality because it met valid criteria with a percentage of 90% in terms of material and 87% in terms of media. The average score of E-LKPD effectiveness is 78 (high criteria), and practically average score of E-LKPD based on students' response questionnaire is 94.4%; (2) students said that E-LKPD can help them learn and the material is exposed clearly (92.5%), can be used for independent study (97.5%), and the design of the E-LKPD is attractive (95%). Based on the research results, SAVI-based innovative E-LKPD can be used in chemistry learning on salt hydrolysis topics.

Introduction

Chemistry is one of the science subjects in senior high school that must be studied, and it is considered difficult by students. This is because some concepts in chemistry are abstract and complex. One of the chemistry topics that students find challenging is salt hydrolysis. Understanding salt hydrolysis requires students to comprehend it at the macroscopic, microscopic, and symbolic levels. Therefore, students often struggle with these three aspects of the material (Andina et al., 2017). This is supported by previous research conducted at senior high school (SMA) 1 Bojonegoro, which found misconceptions about salt hydrolysis, particularly at the sub-microscopic and symbolic levels. The misconception rate at the sub-microscopic level regarding partial and total hydrolysis is 44.83%, while at the symbolic level, particularly in calculating the pH of hydrolysis, which involves mathematical calculations, the average misconception rate is 65.52%. Students have a better understanding at the macroscopic level because it relates to the direct observation of phenomena. This study indicates that students have not yet mastered the concept of salt hydrolysis, especially at the sub-microscopic and symbolic levels. (Umami et al., 2020)

Interviews conducted with chemistry teachers at SMA 2 Ngaglik revealed that salt hydrolysis is a chemical topic that students find difficult to understand, as indicated by test scores that have not yet met the minimum competency criteria (KKM). This difficulty is due to a low understanding of the salt hydrolysis concept and a lack of mastery of the mathematics involved in the calculations. Therefore, teaching materials are needed to help students better understand the topic. One of the teaching tools that can be used is the LKPD, or Student Worksheet. Student worksheets can be found in paper or electronic formats. The use of E-LKPD in learning can positively impact students' learning activities, making them more active, independent, engaged, and motivated (Puspita and Dewi, 2021). The E-LKPD helps students learn progressively, providing a good flow of thinking when studying certain materials (Simanjuntak et al., 2020).

To understand the concept of salt hydrolysis thoroughly, a learning model that engages all the senses is necessary. This can be achieved through the somatic, auditory, visual, and intellectual (SAVI) learning model. The SAVI approach involves all senses, from body movement to hearing, vision, and cognitive skills. SAVI learning model offers innovative learning techniques that involve direct practice, listening, seeing, and understanding the content of the subject matter (Dapa and Kiriweno, 2019). By engaging all senses in learning, students can better comprehend the material. A thorough understanding can enhance students' intellectual capacity, helping them achieve the desired core competencies. The SAVI learning model aims to increase students' engagement, independence, and skills in the teaching and learning process, leading to better learning outcomes (Novita and Madjdi, 2024)

This study developed an E-LKPD based on the SAVI learning model for salt hydrolysis to help students understand hydrolysis concepts by involving all senses, including body movement, hearing, vision, and cognitive ability. The research found that the developed E-LKPD was of good quality, meeting valid criteria with a 90% rating for content and 87% for media. The average effectiveness score of the E-LKPD was 78, while the average practical score based on students' response questionnaires was 94.4%. Students reported that the E-LKPD helped them learn, with 92.5% stating that the material was clearly presented, 97.5% noting that it could be used for independent study, and 95% finding the E-LKPD design attractive. Based on this research results, the innovative SAVI-based E-LKPD can be effectively used in teaching chemistry, particularly in salt hydrolysis. Moreover, based on the research data, it can be concluded that the aim of this research was achieved, as the development of the E-LKPD demonstrates good feasibility and received positive student response.

Methods

This research and development used a 4D design that was modified into a 3D design. The 3D model has three stages: define, design, and develop. This model was chosen because the dissemination step could not be conducted due to time and resource constraints.

Define

This stage involved the analysis of the need for the E-LKPD and the development of the E-LKPD concept. In this initial stage, information regarding the problems related to salt hydrolysis and the material to be used in the E-LKPD was determined.

Design

In the second stage, we designed the E-LKPD using Canva and Articulate Storyline 3, following the SAVI approach.

Develop

The final stage (develop) involved the validation of the product (E-LKPD) and research instruments, followed by a trial of the product. The research instruments included the E-LKPD, interview sheets, validation sheets, test items in the E-LKPD, and student response questionnaires. Data obtained from the validators' assessments were processed and calculated using formulas 1, 2, and 3, according to (Akbar, 2013), and the validity criteria are shown in Table 1.

$$Va_1 = \frac{TSe}{TSh} \times 100\% \quad (1)$$

$$Va_2 = \frac{TSe}{TSh} \times 100\% \quad (2)$$

$$V = \frac{Va1+Va2}{2} = \ldots \% \quad (3)$$

V = Combined validation
Va1 = Validator 1 validation result
Va2 = Validator 2 validation result
TSh = Maximum expected total score
Tse = Total empirical score (validation results from validators)

Table 1. Criteria for validity level (Akbar, 2013)

No	Validity score	Category
1	85.01 % - 100%	High Validity
2	70.01 % - 85.00%	Moderate validity
3	50.01 % - 70.00%	Low Validity
4	01.00 % - 50.00%	Invalid

$$Percentage\ (\%) = \frac{total\ score}{maximum\ score} x\ 100\% \quad (4)$$

Table 2. Criteria for validity level (Sugiyono, 2012)

No	Validity score (%)	Criteria
1	82 - 100	High Validity
2	63 - 81	Moderate validity
3	44 - 70	Low Validity
4	0 - 43	Invalid

$$Content\ validity = \frac{D}{(A+B+C+D)} \quad (5)$$

Table 3. The group for the gregory's formula calculation (Gregory, 2004)

		Weak relevance (item rated 1 or 2)	Strong relevance (item rated 3 or 4)
Expert Judge 2	Weak relevance (item rated 1 or 2)	A	B
	Strong relevance (item rated 3 or 4)	C	D

Table 4. Criteria for validity level (Retnawati, 2016)

No	Validity score	Criteria
1	0.8-1	High
2	0.4 – 0.79	Medium
4	0 – 0.39	Low

Table 5. Criteria for E-LKPD's test item (Pranowo, 2021)

No	Validity score (%)	Criteria
1	80 - 100	High
2	60-80	Medium
3	50-59	Low
4	0 - 49	Very low

Table 6. Effectiveness criteria (Artini et al., 2023)

No	Validity score (%)	Criteria
1	76 - 100	High
2	56 - 75	Medium
3	40 - 55	Less
4	0 - 39	Ineffective

Table 7. The student's response criteria (Pranowo, 2021)

No	Validity score (%)	Criteria
1	75 - 100	Very good
2	50 - 74	Good
3	25 - 49	Fair
4	0 - 24	Bad

Table 8. The E-LKPD practically result criteria (Sugiyono, 2012)

No	Validity score (%)	Criteria
1	75 - 100	Very good
2	50 - 74	Good
3	25 - 49	Fair
4	0 - 24	Bad

The validation result of E-LKPD and student response questionnaire were then analyzed using formula (4) (Purwanto, 2010), and the validity criteria are shown in Table 2. The content validity of the test items was analyzed using Formula (5), with group descriptions shown in Table 3 (Gregory, 2004), and the criteria are shown in Table 4. The E-LKPD's test result was analyzed using formula (4), and the criteria are listed in Table 5. The E-LKPD's effectiveness was analyzed using formula (4) and the criteria are listed in Table 6. The student's response was analyzed using formula (4), and the criteria are listed in Table 7. The E-LKPD practically result was analyzed using formula (4), and the criteria are listed in the Table 8.

Results and Discussion

The aim of developing innovative E-LKPD products based on the SAVI learning model for salt hydrolysis using the 3D development method is to assess the quality of E-LKPD products in terms of feasibility. The learning process can be effective if the learning tools developed meet the quality criteria of validity, effectiveness, and practicality. Therefore, to produce a high-quality E-LKPD product in terms of feasibility, it must meet these criteria: valid, effective, and practical. For the validity criteria, E-LKPD products need to be validated by experts to ensure they meet the required standards of product validity.

Stage I: Define

Analysis of the need for the use of E-LKPD

The needs analysis identifies a problem and determines an appropriate action or solution (Herwina, 2020). The needs analysis was conducted through interviews with chemistry teachers at SMA 2 Ngaglik to gather the necessary information and identify problems in learning chemistry, particularly in the topic of salt hydrolysis. Based on the interviews, several issues were identified, including the primary sources used for learning, which were books and the internet. Additionally, conventional LKPDs created by chemistry teachers in the association (MGMP) were used as learning resources. However, teachers had never developed E-LKPDs due to a lack of proficiency with new software. Furthermore, students struggled with learning chemistry, especially salt hydrolysis. They found it difficult to understand and remember compounds that act as strong acids, strong bases, weak acids, and weak bases. They also lacked mastery in the mathematics required to calculate pH using logarithms. This was reflected in the average test results of some students, which still did not meet the minimum completeness criteria (KKM). Therefore, an LKPD as supplementary material for teachers is needed.

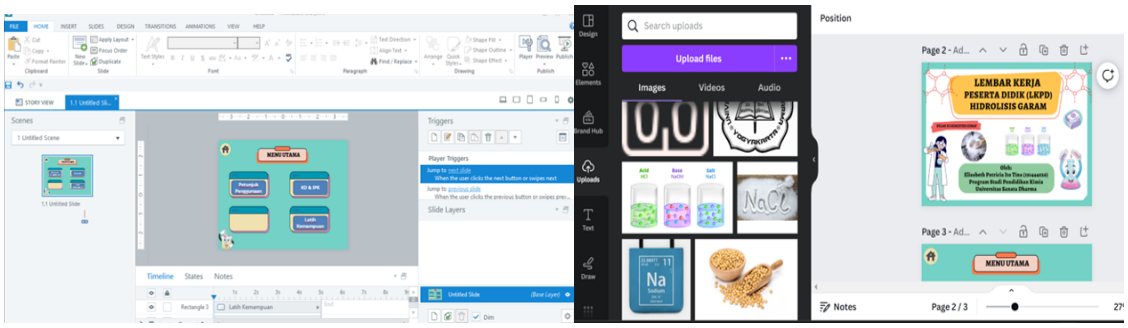
Concept analysis

Concept analysis for the E-LKPD is a crucial step in ensuring the adequacy of concepts built from the materials used to achieve basic competencies and competency standards (Setiawati et al., 2023). Concept analysis is conducted to identify, describe, and organize the key aspects of salt hydrolysis material that students need to learn. The process involved several steps, including analyzing the syllabus and lesson plans from the 2013 curriculum to identify basic competencies (KD), indicators of competency achievement (IPK), and learning objectives for salt hydrolysis. Based on the syllabus analysis from the 2013 curriculum, salt hydrolysis is included in KD 3.11 for knowledge and KD 4.11 for skills. KD 3.11 involves analyzing ion equilibrium in salt solutions in relation to pH, while KD 4.11 focuses on experiments involving the acid-base properties of various salt solutions. Considering the KD for salt hydrolysis, a further breakdown of IPK, learning objectives, and sub-materials was conducted. KD 3.11 was translated into three IPK, and KD 4.11 into one IPK.

Stage II: Design

The E-LKPD is designed by following a modified E-LKPD format and is aligned with the stages of the SAVI learning model. The materials and components of salt hydrolysis are incorporated into the E-LKPD design according to the selected format. This E-LKPD design utilizes Canva and Articulate Storyline 3, both of which offer various features that facilitate the E-LKPD design process. The E-LKPD is created with a combination of colors, backgrounds, animations, and interactive elements, such

as buttons, to make the learning experience more engaging and enjoyable for students studying salt hydrolysis. Additionally, the E-LKPD includes pictures, videos, virtual laboratories, and tests that are varied in format to complement the SAVI learning model. The design process in Canva and Articulate Storyline 3 is illustrated in Fig-1a and Fig-1b, respectively.



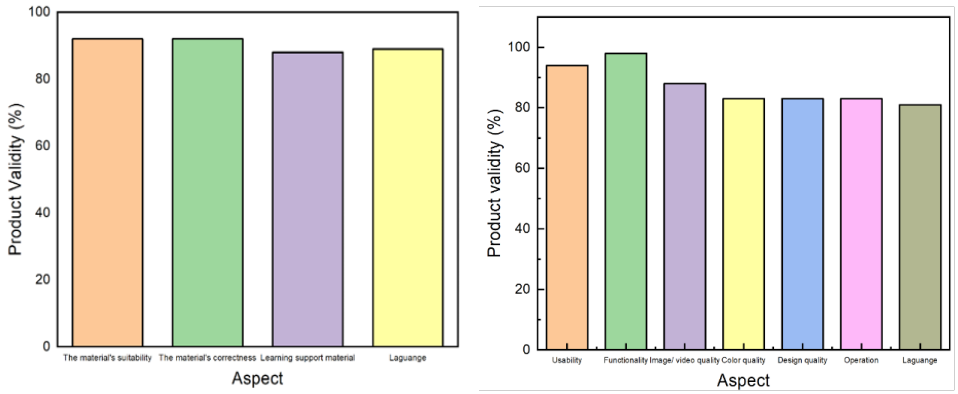
(a) (b)

Fig-1. E-LKPD design (a) E-LKPD cover design in canva, (b)Design of E-LKPD using Articulate Storyline 3

Stage III: Development

Product and research instrument validation

Product validation. The validation process for SAVI-based innovative E-LKPD products on salt hydrolysis material is divided into two parts: material validation and media validation. The material validation of the SAVI-based innovative E-LKPD for salt hydrolysis includes four aspects: the alignment of the material with the KD, the accuracy of the content, the inclusion of supportive learning materials, and the clarity of language. The results of the product validation, in terms of material, by experts are shown in Fig-2a. Based on the average percentage per aspect, the overall average is 90%. An average value within the range of 85.01-100.00% falls under the criteria for high validity (Akbar, 2013). This indicates that the E-LKPD developed, in terms of material, is suitable for use in learning.



(a) (b)

Fig-2. Product Validation Results based on (a) material aspect and (b) media aspect

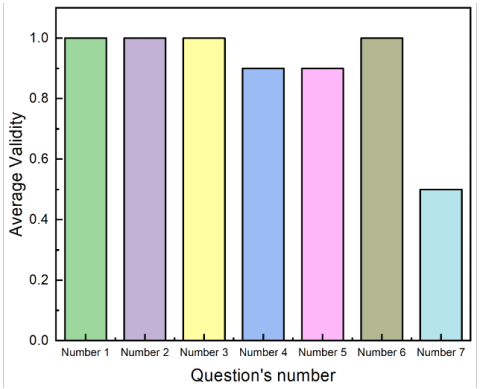


Fig-3. Results of item validation of excercises questions

Fig-2b shows the results of the product validation by media experts. The average percentage across all aspects of the product, in terms of media, is 87%. An average value within the range of 85.01-100.00% is classified as having high validity (Akbar, 2013). This overall percentage indicates that the E-LKPD developed is deemed highly suitable for use in the learning process.

Test item validation. The item validation consists of 3 parts: the exercise questions, assignments, and final tests. This item validation includes three aspects, namely material, construction, and language. Fig-3 shows the validation results of the exercise question items that obtained validity results for each item. Questions 1 to 6 are included in the high validity criteria. Question number 7 has a validity result of 0.5, which means it has medium validity criteria. Validity results with a range of > 0.8 are high validity, and a range of 0.4 - 0.8 is included in the medium validity criteria (Retnawati, 2016). Based on the average validation results of the exercise question, it is found that the items section has a high level of validity, so the items are good to use.

The results of the validation of the assignment question can be shown in Table 9. Table 9 shows the results of validating the assignment items on each item. Questions 1, 2, and 3 have the same validity result, 1.0, including in the high validity criteria (Retnawati, 2016). Based on the results of the validation of the Assignment items, a high level of validity is obtained so that it can be interpreted that the items have good quality to be used to measure students' abilities.

Table 9. Assignment item validation results

Question Item	Average Validity Results	Validity Criteria
Number 1	1,0	High Validity
Number 2	1,0	High Validity
Number 3	1,0	High Validity

Table 10. Result of item validation of final test

Question Item	Average Validity Results	Validity Criteria
Number 1	1.0	High Validity
Number 2	1.0	High Validity
Number 3	1.0	High Validity
Number 4	1.0	High Validity
Number 5	1.0	High Validity
Number 6	1.0	High Validity
Number 7	1.0	High Validity
Number 8	1.0	High Validity
Number 9	1.0	High Validity
Number 10	1.0	High Validity

Table 10 shows the validation results of the final test items obtained the validity results on each item. Questions 1 to 10 have the same validity result value of 1.0 with high validity criteria (Retnawati, 2016). They are included in the high validity criteria so that the question is of good quality and can be used.

Validation of questionnaire

The student response questionnaire sheet must be validated first by the validator before being given to students. Validation of the student response questionnaire includes 3 aspects, namely aspects of instructions for use, language, and response coverage. The results of the student response questionnaire validation were high validity, moderate validity and high validity for three aspects, respectively (Fig-4).

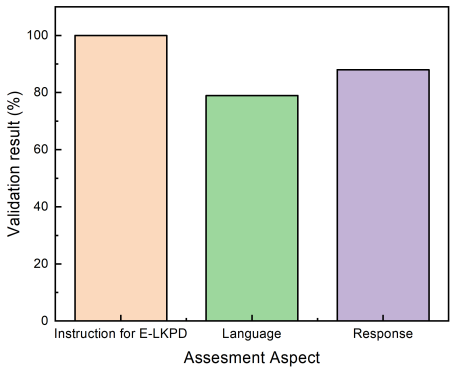


Fig-4. Results of validation of student response questionnaire

Based on the average value per aspect, the overall average is 89%. The average value in the 85.01-100.00% range is included in the high validity criteria so that students can use the response questionnaire to assess the developed E-LKPD (Akbar, 2013).

Product trial

Product trials were carried out after the E-LKPD went through validation and revisions provided by validators. This product trial was carried out on a limited basis to test the practicality and effectiveness of the products developed. Practicality can be obtained through a student response questionnaire, and effectiveness is seen from working on the questions in the E-LKPD.

The exercise question. The results of the exercise question in the E-LKPD were then analyzed, and the following is a summary of the results of the analysis of the answers to the exercise question items in Table 11. Based on the score of each student, the average score of the overall exercises question is 83. Scores ranging from 70 to 84 are included in the high

criteria (Payadnya et al., 2022). Based on the results of the exercise question answers, it can show that students can understand salt hydrolysis material well.

Table 11. Results of Analysis of Answers to Exercise Questions

Student code	Student score	Criteria
S1	100	Very High
S2	100	Very High
S3	71	High
S4	86	Very High
S5	86	Very High
S6	100	Very High
S7	57	Medium
S8	71	High
S9	57	Medium
S10	100	Very High
Average	83	High

Table 12. Results of analysis of final test answers

Student Code	Student Score	Criteria
S1	100	Very High
S2	100	Very High
S3	100	Very High
S4	100	Very High
S5	90	Very High
S6	90	Very High
S7	90	Very High
S8	80	Very High
S9	80	Very High
S10	70	High
Average	90	Very High

The assignment item. In the assignment item section, three assignment questions are asked about each IPK of salt hydrolysis material. The assignment questions are done by students in groups and independently. The results of working on the assignment items in the E-LKPD are then analyzed, and the following is a summary of the answers to the assignment items in Fig-5. Fig-5 shows the results of students' answers to the assignment items. The criteria for moderate results include a value with a range of 50 – 69 (Payadnya et al., 2022). Based on the results of students' answers to the assignment questions, students can understand the concept of salt hydrolysis well.

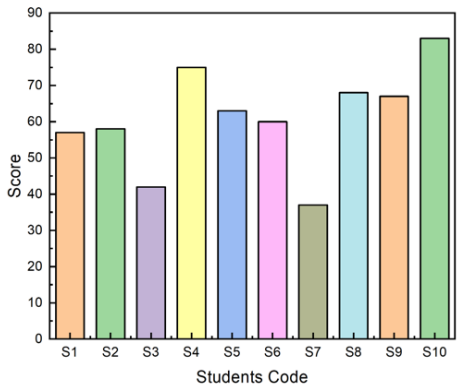


Fig-5. Results of analysis of assignment question answers

The final test. In the final test question, there are 10 items in the form of multiple-choice, an evaluation question that students do. The results of working on the final test items in the E-LKPD are then analyzed, and the following shows a summary of the results of the analysis of the answers to the final test items in Table 12. Based on the results of students' answers to the final test items, the overall score average is 90. Scores ranging from 85 to 100 are very high criteria (Payadnya et al., 2022). Students did the final test questions to find out the learning process and assess their ability after studying the salt hydrolysis E-LKPD.

The student response questionnaire

The student response questionnaire is given at the end of the meeting after students use the developed E-LKPD. The following, Fig-6 shows the results of the analysis of the student response questionnaire. Based on the data, the average percentage value of the assessment in each aspect of the assessment can be shown. In the student response questionnaire, there are 3 aspects of assessment, namely aspects of content quality and learning objectives, techniques, and learning quality. In terms of the quality of content and learning objectives, the average percentage is 95.8%, the technical aspect is 92.5%, and the learning quality aspect is 95%. Based on the average of each aspect, the overall average percentage is 94.4%; The percentage range of 76- 100 is included in the very good criteria (Sari et al., 2016). Therefore, the student's response to the

E-LKPD is very good, and the SAVI-based innovative E-LKPD product on salt hydrolysis material can be declared very practical for learning.

Students response to innovative E-LKPD based on SAVI learning model on salt hydrolysis material

Students' responses to SAVI-based innovative E-LKPD on salt hydrolysis material can be shown through the students' response questionnaire and comments and suggestions given by students. Several statements in the response questionnaire support the idea that students responded well to the E-LKPD developed. In statement 2, the discussion of salt hydrolysis material in E-LKPD exposed a percentage of 92.5%. This shows that students understand the discussion of salt hydrolysis material in E-LKPD well and clearly. In addition, students also feel that E-LKPD can help them learn, which is indicated by a percentage of 92.5%. Students can also learn independently using E-LKPD, as seen from the percentage of 97.5%. Students also like the E-LKPD design because it looks attractive, with 95% percentage (Fig-7). Based on the student's response questionnaire results, the average percentage of students' responses to the product was 94.4%, with very good criteria. The range from 76 - 100 is included in the excellent criteria (Sari et al., 2016).

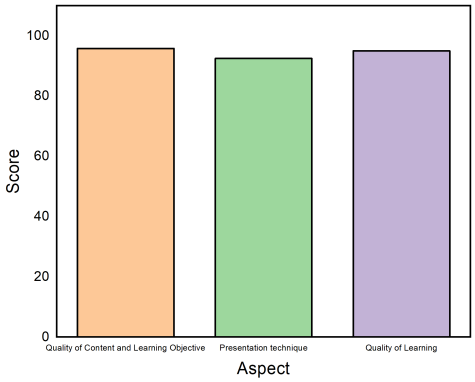


Fig-6. Results of the student response questionnaire

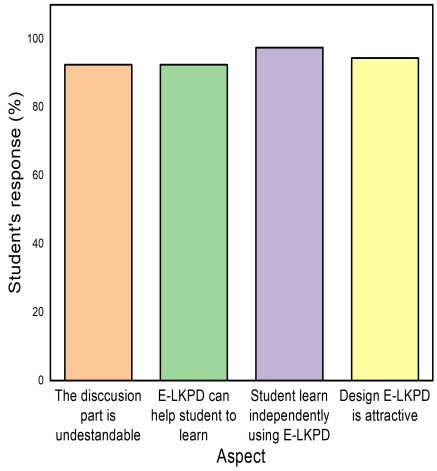


Fig-7. Students' response to SAVI-based innovative E-LKPD on salt hydrolysis material

Students also responded well to E-LKPD products through comments and suggestions after using SAVI-based innovative E-LKPD on salt hydrolysis material. Therefore, students showed a very good and positive response to the SAVI-based innovative E-LKPD on salt hydrolysis material. Students also said that the E-LKPD material is quite clear and easy to understand, has an attractive appearance and features to increase the enthusiasm for learning, and that E-LKPD should be further developed to assist better learning in the classroom. Here is the link to innovative E-LKPD based on the SAVI learning model: https://bit.ly/E-LKPD_Inovatif_Hidrolisis_Garam, and it is free access.

Conclusion

The innovative SAVI-based E-LKPD on salt hydrolysis produced high-quality results, meeting validity, effectiveness, and practicality criteria. It was rated high validity criteria, with a 90% material assessment and 87% media assessment. The average student score was 78, indicating the E-LKPD effectively enhances understanding of salt hydrolysis. A student response questionnaire averaged 94.4%, demonstrating its practicality for high school chemistry. Students provided positive feedback, rating the clarity and helpfulness of the discussion on salt hydrolysis at 92.5%. They also found the E-LKPD supportive of independent learning (97.5%) and appreciated its attractive design (95%), suggesting further development could enhance its classroom effectiveness.

Conflict of Interests

The author declares that there is no conflict of interest in this research and manuscript.

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