The Interactive Students E-Worksheet Based on Discovery Learning and Representations on Hydrolyzing Salt Topic

Lisa Tania, Nina Kadaritna, Ila Rosilawati, Anisa Rosalinda, and Andrian Saputra(✉)

Chemistry Education, Lampung University, Bandar Lampung, Lampung, Indonesia
{lisa.tania,nina.kadaritna,ila.rosilawati, andriansaputra}@fkip.unila.ac.id

Abstract. This study develops interactive electronic worksheets for students based on discovery learning and chemical representations of salt hydrolysis, and the relevance of describing teacher and student answers in relation to the developed electronic worksheets. The purpose was to Research and development by Borg & Gall was used as the study design, extending to Level 5, the modified level of test results. The instruments used were expert validation, teacher and student response questionnaires. The data obtained were analyzed using descriptive statistical analysis. The results of our expert review of the content suitability and readability aspects were of a high standard, and the structural aspects were of a very high standard. Based on the results, thematic hydrolysis salt discovery learning and interactive student electronic worksheets based on chemical representations are valid. In addition, teacher responses on suitability, organization and readability, and student responses on readability and attractiveness, are each assessed to very high standards.

Keywords: discovery learning · students e-worksheet · hydrolyzing salt · chemical representation

1 Introduction

Learning is a process that can grow and encourage students to carry out the learning process by organizing the environment around them [1]. Chemistry learning is one of the lessons given to students. Chemistry studies everything about matter which includes composition, structure and properties, changes, dynamics and energetics of substances involving skill and reasoning. Therefore, chemistry learning and assessment of chemistry learning outcomes must pay attention to the characteristics of chemistry as an attitude, process and product. Chemistry learning also emphasizes providing direct learning experiences through the use and development of process skills and scientific attitudes [2].

In chemistry learning, teachers can use chemical representations to build understanding of chemical concepts [3]. Johnstone [4] divides chemical representation into three

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levels, namely the macroscopic level, the submicroscopic level and the symbolic level. These three levels are interrelated parts with each other in building an understanding of chemical concepts [5]. In fact, chemistry learning generally only uses the macroscopic level and the symbolic level, while the submicroscopic level tends to be ignored. This causes students difficulty in understanding chemical concepts which are mostly abstract [6].

In overcoming difficulties in understanding chemical concepts, in general students tend to learn by rote rather than actively seeking to build their own understanding [7]. This is relevant to the research results of Auliyani et al. [8] about the analysis of students' understanding difficulties in the colligative properties of solutions which states that one of the factors causing students to have difficulty understanding this topic is that students learn by rote. There are still many students who have difficulty understanding the concepts in acid-base titration topic [9–11]. This is caused by the way teachers teach and students forget and do not understand some of the concepts in the previously taught topic.

One learning model that can be used to train and build chemistry concepts by providing a direct and student-centered experience is the discovery learning model. The Discovery Learning learning model is a set of learning activities that maximizes every student's ability to explore and investigate systematically, critically, logically, and analytically to help students formulate their own discoveries.. By using this learning model, students are given the opportunity to think, discover, reason, and collaborate through scientific learning activities, thus training and improving their critical thinking and problem-solving skills and helping them understand important concepts. [12–15].

In the process of learning chemistry, not only learning models play an important role in helping students to understand the topic given, but also a learning media is needed. Learning media plays a very important role in the learning process, because it can help achieve learning goals better and faster [16–20]. One of the learning media that is often used to help students in the learning process is the Student Worksheet which is abbreviated as worksheet. The current Covid-19 pandemic that is hitting Indonesia, which has resulted in the government issuing policies related to learning activities in schools that were originally conducted face-to-face (offline) has now switched to online learning to avoid the spread of the Covid-19 virus. This situation encourages teachers to use worksheet whose presentation is changed to digital form. Worksheet in digital form is known as electronic worksheet (e-worksheet). E-worksheet is a student work guide in electronic form whose application uses desktop computers, notebooks, smartphones and mobile phones to make it easier for students to understand learning topics [21]. Based on the results of research by Lestari & Muchlis [22] stated that e-worksheet oriented contextual teaching and learning on thermochemical topic has medium-high criteria to train students' critical thinking skills, so it is feasible to use in learning. In another study conducted by Witri et al. [23] it was found that the development of e-worksheet based on the Toulmin argumentation pattern to improve argumentation skills on acid-base topic was declared feasible and practical.

Hydrolyzing salt or better known as salt hydrolysis is one of the topics in chemistry learning that is delivered to high school students and the equivalent in class XI. Basic competence (KD) for hydrolyzing salt topic is found in KD 3.9 and KD 4.9. KD 3.9

chemistry subject in this topic in class XI is to analyze the ionic balance in a salt solution and relate its pH. KD 4.9 is a report on experiments on acids and bases of various salt solutions. To be able to achieve this KD in learning, students are expected to be able to analyze the data obtained from the experiment to find the concept of hydrolyzing salt. From the preliminary study conducted, all respondents (both teachers and students) stated the need for the development of discovery learning-based e-LKPD and chemical representation of hydrolyzing salt topic.

Based on the preliminary studies that have been carried out and the facts described above, it is necessary to develop an e-LKPD based on discovery learning and chemical representations used in the chemistry learning process, especially on hydrolyzing salt topic. Therefore, the author conducted a study entitled "Development of e-LKPD Based on Discovery Learning and Chemical Representation on Hydrolyzing Salt Topic".

Based on the background that has been described, the specific objectives of this research are:

1. Describe the validity of the discovery learning-based e-LKPD and chemical representation of the hydrolyzed salt topic developed.
2. Describe the teacher's response to the discovery learning-based e-LKPD product and chemical representation of the hydrolyzed salt topic that was developed.
3. Describe students' responses to discovery learning-based e-LKPD products and chemical representations of the hydrolyzed salt topic that was developed.

2 Methods

The study design used in this study is research and development or research and development (R&D) [25]. Up to the fifth stage, it begins with (1) research and information gathering (survey and information gathering), (2) planning (planning), (3) product design and development (development of product prototype form), and (4) initialization. Increase. Field test (preliminary field test), (5) Revision of test results (main product revision). In the fieldwork phase, data were collected from 3 chemistry teachers in class XI and 30 students in class XII MIPA from public high schools in Bandar Lampung, namely SMA Negeri 13 Bandar Lampung, SMA Negeri 14 Bandar Lampung, and SMA Negeri 15 Bandar Lampung. Was collected. During the development phase, data was obtained from three lecturers in chemical education at FKIP Lampung University. In the first field trial phase, data were collected from his three XI class chemistry teachers and 30 XI MIPA class students from his two state high schools in Bandar Lampung. The data collection method was a questionnaire. In the fieldwork phase, three chemistry teachers in class XI and 30 students in class XII MIPA from his three public high schools in Bandar Lampung filled out a questionnaire via his Google form and were randomly selected. Did. During the development stage, her three lecturers from the University of Chemistry Education FKIP Lampung, who were selected as expert validation, completed a questionnaire. In the first phase of field testing, questionnaires and e-LKPD products were distributed to chemistry teachers and students from two public high schools in Bandar Lampung.

Data analysis of the results of expert validation questionnaires, and teacher and student responses, classifies the data, aggregates the data based on the classification, scores the respondent's responses on a Likert scale, and assigns respondent response

Table 1. The interpretation of questionnaire percentage

Percentage	Criteria
80,1%-100%	Very High
60,1%-80%	High
40,1%-60%	Moderate
20,1%-40%	Low
0,0%-20%	Very Low

Table 2. Validation Criteria

Percentage	Validity
76–100	Valid
51–75	Quite Valid
26–50	Less Valid
< 26	Not Valid

points. by processing and calculating the total score. Survey responses, calculate the percentage of survey responses for each item. e. Perform interpretation based on survey percentages as follows: We use the interpretation of Arichnt [24] as Table 1. We then interpret the expert validation criteria as Table 2 using the interpretation of Arikunt [24].

3 Results and Discussion

A. Literarure Study

The literature study was conducted by analyzing Core Competencies (CC), Basic Competencies (BC), syllabus, concept analysis, and lesson plans on hydrolyzing salt topic and studying theories related to chemical representation, discovery learning learning models, e-worksheet and similar research products. in the form of research documents. At this literature study stage, the results obtained in the form of an CC-BC analysis, syllabus and concept analysis on hydrolyzing salt topic, RPP on hydrolyzing salt topic and the results of theoretical studies related to chemical representation, discovery learning learning models, e-worksheet and similar research products in the form of research articles. The results of this literature study became the basis for the preparation of discovery learning-based e-LKPD and chemical representations of the hydrolyzed salt topic that was developed.

B. Field Study

This field survey was conducted in three public high schools in Bandar Lampung: SMA Negeri 13 Bandar Lampung, SMA Negeri 14 Bandar Lampung, and SMA Negeri 15 Bandar Lampung. In this phase, data were collected by completing a needs assessment questionnaire by her 1 chemistry teacher in class XI and her 10 students in class XII MIPA at each school.

Based on the results of the needs analysis by three chemistry teachers in class XI, information was obtained that all teachers had used the LKPD in learning the hydrolyzing salt topic, but the form was in the form of a printed LKPD. None of the printed LKPDs used by teachers were obtained from the results of making their own, but as many as 66.7% of teachers used LKPDs from publishers, while the rest took them from downloading on the internet. For the use of e-LKPD, all teachers have not used it in the learning process of hydrolyzing salt topic. Learning media based on discovery learning and three levels of chemical representation, especially the submicroscopic level, have not been involved by all teachers when teaching hydrolyzing salt topic. All teachers stated that it was necessary to develop an e-LKPD based on discovery learning and chemical representations on hydrolyzing salt topic.

Based on the results of a needs analysis of 30 Class XII MIPA students, 76.7% of the students said their teachers used a printed book as a learning medium on salt hydrolysis and the rest used printed worksheets. I was informed that it was reported that Regarding e-LKPD use, 76.7% of her students reported that the teacher did not use her e-LKPD when teaching the salt hydrolysis subject. Her 66.7% of students said they did not enjoy the learning media the teacher used in teaching the subject of salt hydrolysis. Using these learning media, 56.7% of the students said they still had difficulty understanding the subject of salt hydrolysis. Every student indicated the need to develop her e-LKPD based on discovery learning and chemical representation of the subject of salt hydrolysis.

C. Product Planning

This product component consists of three parts:

(1) an introductory section containing the title page, preface, table of contents, CC-BC sheets, competency and performance indicators, learning objectives, and general instructions for using the electronic worksheet; Contains the ID of the learning step of the e-worksheet associated with the model. Suggestion/Provocation, Problem Description/Problem Identification, Data Collection/Data Collection, Data Processing/Data Processing, Verification/Evidence, and Generalizations/Conclusion, and (3) a Conclusions section including references and back cover.

D. Initial draft of e-worksheet

The topic for hydrolyzing salt in this e-worksheet consists of: (1) understanding of hydrolysis of salt, (2) types, properties and components of the constituents of hydrolyzing salt, (3) calculation of partially hydrolyzing salt and (4) calculation of total hydrolyzing salt. The applications used in the development of this e- worksheet are Flip PDF Professional and the Liveworksheets website. The parts of the development of the initial draft of discovery learning-based e- worksheet and chemical representation on hydrolyzing salt topic consist of three parts, namely the introduction, content and closing parts. The introductory part consists of the front cover, preface, table of contents, CC-BC sheet, indicator sheet, learning objectives and general instructions for use. As for the content, it consists of identity and learning steps.

The learning steps used of course refer to the discovery learning model, including: a) stimulation. In this section, discourses related to the main sub-topics to be studied are presented. Each discourse presented is given an image that is relevant to the discussion.

b) problem statement/problem identification. In this section, the user is given orders to propose hypotheses related to the problems found in the discourse in the stimulation section. c) data collection / data collection. In this section there are instructions that direct users to be able to collect information/data needed in studying the main sub-topics. In the main sub-topic, understanding hydrolyzing salt and the types, properties and components of hydrolyzing salt, it is equipped with submicroscopic animations that make it easier for students to understand hydrolyzing salt. d) data processing / data processing. In this section there are questions/commands that help the user in processing the information/data that has been obtained in the data collection section. e) verification. In this section, the user is given an order to prove it by checking the results of data processing with a predetermined hypothesis. And f) generalization/draw conclusions. In this section, an order is displayed to write conclusions based on the knowledge that has been obtained after going through learning on the main sub-topic. The closing section consists of a bibliography and a back cover.

E. Expert Validation

After the first draft of the e-worksheet is created, the next step is expert validation to test the quality of the developed product. Expert validation was done by her three lecturers in Chemistry Education at Lampung University. The expert verification performed includes verification of aspects of content suitability, structure and readability. Expert validation is performed by providing validators with a first draft of an electronic worksheet based on discovery learning and chemical representations of salt hydrolysis, completed along with a questionnaire on three dimensions. Validators then evaluate the statements made in the questionnaire and write down their answers/suggestions for improving the electronic worksheet in designated columns of the questionnaire. The results of the three validators' average percentage ratings for the content suitability, organization aspects, and readability aspects of the developed electronic worksheets are shown in Table 3 below.

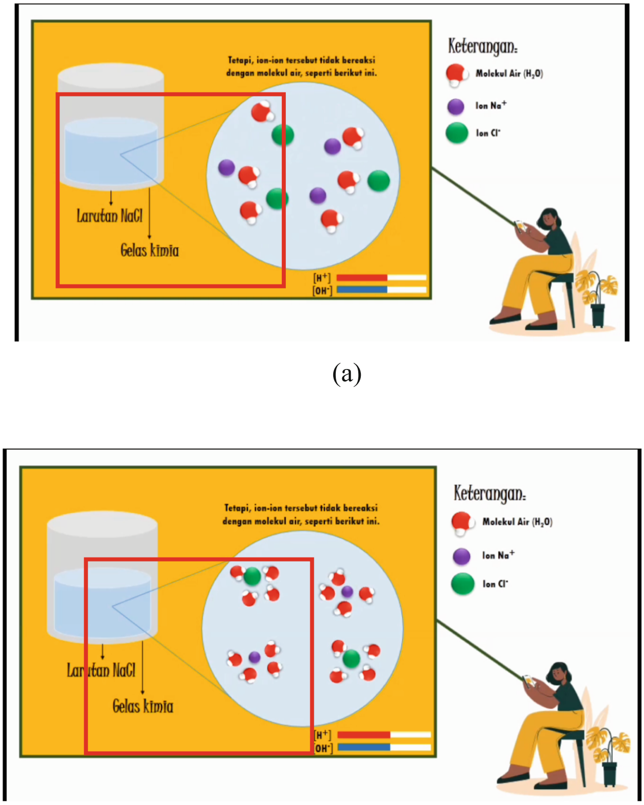
The validator gave feedback regarding the inappropriate submicroscopic animation video on e-LKPD and some animation videos did not show H^+ molecules and OH^- ions. Based on these responses, some of the contents of the animated video have been improved. One of these improvements can be seen in Fig. 1 and 2. The validator also suggest to change the sentences in data processing section, it can be seen in Fig. 3.

F. Initial Field Trial Results.

In this first phase of the field experiment, three teachers were asked to respond to aspects of suitability, organization, and readability of the content of the discovery-learning-based electronic worksheet and the chemical representation of salt hydrolysis. I was. Below

Table 3. The results of expert validation

No.	Aspect	The average of percentage	Criteria
1.	Content Suitability	77,16%	High
2.	Construction	84,94%	Very High
3.	Readabilty	78,57%	High



(a)

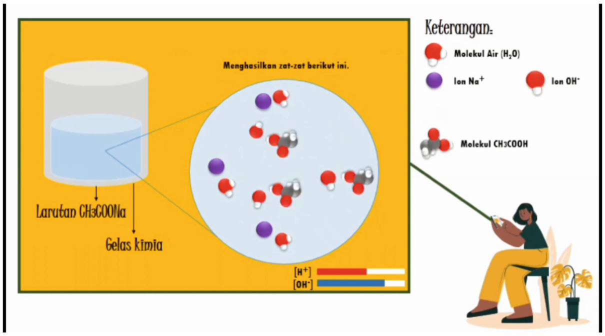
(b)

Fig. 1. Subsmicroscopic representation (a) before (b) after revision

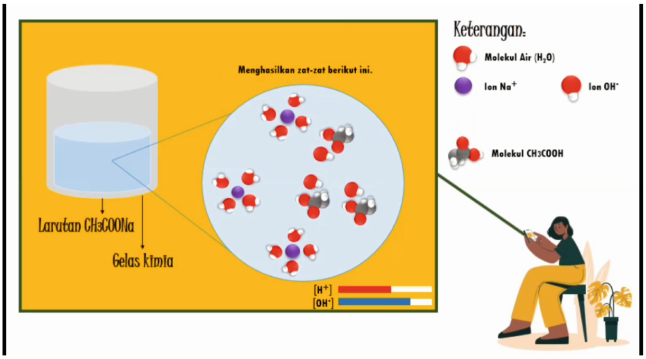
are the results of the average percentage of responses from her three teachers regarding the content adequacy, organization and readability aspects of the electronic worksheets produced, as shown in Table 4.

As no feedback/suggestions were provided by all respondents regarding these three aspects, discovery learning and chemical representation-based e-worksheets on hydrolysis of salts were developed based on BC, themes, discovery learning, and chemical representation. Can be said to be consistent with.

In this first phase of the field experiment, 30 students were asked to provide discovery-learning-based electronic worksheets and responses on readability and attractiveness aspects of chemical representations of salt hydrolysis. The results of the average percentage of responses from her 30 students on the readability and attractiveness aspects of the electronic worksheets she produced are shown in Table 5.



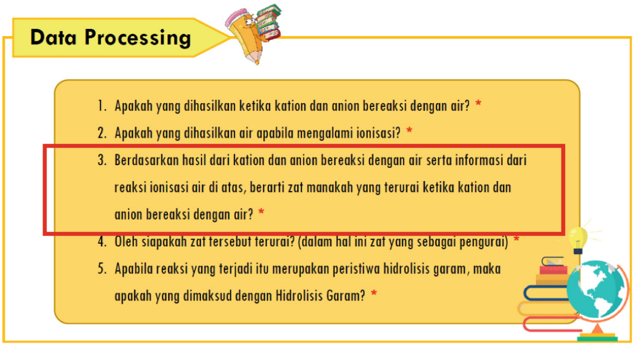
(a)



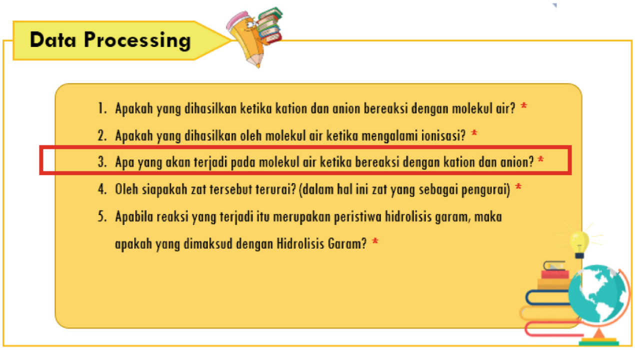
(b)

Fig. 2. Subsmicroscopic representation of solvation (a) before (b) after revision

The final phase of this research is to revise the test results and improve the electronic worksheet based on discovery learning and chemical representation of the subject of salt hydrolysis. Product revisions are made based on teacher and student responses/suggestions to this generated electronic worksheet. Based on the teacher and student response results, there were no comments/suggestions from teachers and students for the developed product, so no corrections and improvements were required.



(a)



(b)

Fig. 3. Questions in data processing of e-worksheet (a) before (b) after revision

Table 4. The average percentage of teacher responses

No.	Aspect	Percentage	Kriteria
1.	Content suitability	87,94%	Very High
2.	Construction	88,64%	Very High
3.	Readibility	89,99%	Very High

Table 5. The average of students respons percentage

No.	Aspects	Percentage	Criteria
1.	Readibility	88,42%	Very High
2.	Attractiveness	89,64%	Very High

4 Conclusion

Research conclusions are based on expert validation. This includes content adequacy and readability aspects with high standards, and design aspects with very high standards, and electronic worksheets based on discovery learning and chemical representations of hydrolyzed salt materials are,valid. We have very high standards for teacher responses, including content suitability, organizational aspects, and readability aspects. We have very high standards for student responses, including aspects of readability and attractiveness.

References

1. Pane A, Dasopang MD. Belajar dan pembelajaran. Fitrah: Jurnal Kajian Ilmu-Ilmu Keislaman. 2017 Dec 30;3(2):333–52.
2. Sukmawati T. Upaya Meningkatkan Aktivitas Dan Hasil Belajar Kimia Pada Ma-teri Kesetimbangan Kimia Melalui Penerapan Model Pembelajaran Inquiry Based Learning (IBL) siswa kelas XI-IA 5 SMA Negeri 4 Banda Aceh. Jurnal Pendidikan dan Pengabdian Vokasi (JP2V). 2020 Oct 6;1(3):307–15.
3. Hilton A, Nichols K. Representational classroom practices that contribute to students' conceptual and representational understanding of chemical bonding. International journal of science education. 2011 Nov 1;33(16):2215-46.
4. Johnstone AH. Macro and microchemistry. Chemistry in Britain. 1982 Jan 1;18(6):409-10.
5. Treagust D, Chittleborough G, Mamiala T. The role of submicroscopic and symbolic representations in chemical explanations. International journal of science education. 2003 Nov 1;25(11):1353-68.
6. Özmen H. Some student misconceptions in chemistry: A literature review of chemical bonding. Journal of Science Education and Technology. 2004 Jun;13(2):147-59.
7. Suyanti, RD. Strategi Pembelajaran Kimia. Yogyakarta: Graha Ilmu: 2010.
8. Auliyani A, Hanum L, Khaldun I. Analisis Kesulitan Pemahaman Siswa pada Materi Sifat Koligatif Larutan dengan Menggunakan Three-Tier Multiple Choice Diagnostic test di Kelas XII IPA 2 SMA Negeri 5 Banda Aceh. Jurnal Ilmiah Mahasiswa Pendidikan Kimia. 2017 Feb 20;2(1).
9. Supatmi S, Setiawan A, Rahmawati Y. Students' misconceptions of acid-base titration assessments using a two-tier multiple-choice diagnostic test. African Journal of Chemical Education. 2019 Feb 5;9(1).
10. Damanhuri MI, Treagust DF, Won M, Chandrasegaran AL. High School Students' Understanding of Acid-Base Concepts: An Ongoing Challenge for Teachers. International Journal of Environmental and Science Education. 2016;11(1):9-27.
11. Nyachwaya JM. General chemistry students' conceptual understanding and language fluency: acid–base neutralization and conductometry. Chemistry Education Research and Practice. 2016;17(3):509-22.
12. Fahmi F, Setiadi I, Elmawati D, Sunardi S. Discovery learning method for training critical thinking skills of students. European Journal of Education Studies. 2019 Jul 22.
13. Khabibah EN, Masykuri M, Maridi M. The effectiveness of module based on discovery learning to increase generic science skills. Journal of Education and Learning (EduLearn). 2017 May 1;11(2):146-53.
14. Haryadi R, Pujiastuti H. Discovery Learning based on Natural Phenomena to Improve Students' Science Process Skills. Jurnal Penelitian & Pengembangan Pendidikan Fisika. 2019 Dec 28;5(2):183-92.

15. Nugrahaeni A, Redhana IW, Kartawan IM. Penerapan model pembelajaran discovery learning untuk meningkatkan kemampuan berpikir kritis dan hasil belajar kimia. Jurnal Pendidikan Kimia Indonesia. 2017 Dec 12;1(1):23-9.
16. Westera W. Reframing the role of educational media technologies. Quarterly Review of Distance Education. 2015;16(2):19-32.
17. Fuady R, Mutalib AA. Audio-visual media in learning. Journal of K6 Education and Management. 2018;1(2):1–6.
18. Puspitarini YD, Hanif M. Using Learning Media to Increase Learning Motivation in Elementary School. Anatolian Journal of Education. 2019 Oct;4(2):53-60.
19. Orey M, Jones SA, Branch RM. Educational media and technology yearbook. Springer; 2012.
20. Cahyadi A. Pengembangan Media dan Sumber Belajar Teori dan Prosedur. Serang: Laksita Indonesia: 2019.
21. Puspita V, Dewi IP. Efektifitas E-LKPD berbasis Pendekatan Investigasi terhadap Kemampuan Berfikir Kritis Siswa Sekolah Dasar. Jurnal Cendekia: Jurnal Pendidikan Matematika. 2021 Feb 8;5(1):86-96.
22. Lestari DD, Muchlis M. E-LKPD Berorientasi Contextual Teaching And Learning Untuk Melatihkan Keterampilan Berpikir Kritis Siswa Pada Materi Termokimia. Jurnal Pendidikan Kimia Indonesia. 2021 Apr 30;5(1):25-33.
23. Witri E, Hasibuan M. Development of electronic student worksheets based on toulmin argumentation patterns to improve argumentation skills in basic acid materials. Jurnal Pendidikan Kimia. 2020 Dec 1;12(3):116-23.
24. Arikunto S. Prosedur Penelitian Suatu Pendekatan Taktik Edisi Revisi. Jakarta: Rineka Cipta: 2010.
25. Borg WR, Gall MD, Gall JP. Educational Research an Introduction Seventh Edition. New York: Pearson Education Inc: 2003.