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Development of blended learning-based e-learning to improve students' concept understanding in the COVID-19 pandemic era

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Abstract: Information technology plays a crucial role in online learning, and schools must adapt to the pandemic by utilizing e-learning as a learning medium. This research aims to produce e-learning based on a blended model that is feasible, practical, and effective for increasing students' understanding of concepts. This research uses the ADDIE development model. The product developed consists of a learning implementation plan, e-learning media, and concept understanding test instruments validated by three expert. Data instruments consist of questionnaires assessing feasibility, practicality of learning, and concept understanding test instruments. The validation results show that the average percentage of the feasibility of lesson plans is 88.6% (very feasible), the e-learning media is 85.1% (very feasible), and the concept understanding instruments is 84.6% (very feasible). The practicality test results showed that the student response was 79.3% with practical criteria, the teacher response was 83% with very practical criteria and the implementation of learning was 78.7% with practical criteria. E-learning media is effective in increasing students' conceptual understanding with an average N-gain score of 67 with medium criteria. Based on this description, it can be concluded that e-learning media based on the blended model is very feasible, practical, and effective for increasing students' understanding of concepts in chemistry learning.

Keywords: e-learning, blended learning, COVID-19, understanding of concepts

Abstrak: Teknologi informasi berperan penting dalam pembelajaran daring, dan sekolah harus beradaptasi dengan pandemi ini dengan memanfaatkan e-learning sebagai media pembelajaran. Pembelajaran dengan memanfaatkan media komputer sangat dibutuhkan di era pandemi ini. Penelitian bertujuan menghasilkan e-learning berbasis model blended yang layak, praktis dan efektif untuk meningkatkan pemahaman konsep siswa. Penelitian menggunakan model pengembangan ADDIE. Produk yang dikembangkan terdiri dari rencana pelaksanaan pembelajaran, media e-learning, instrumen tes pemahaman konsep yang divalidasi oleh tiga ahli. Instrumen data terdiri dari angket penilaian kelayakan, kepraktisan pembelajaran, instrumen tes pemahaman konsep. Hasil validasi menunjukkan bahwa persentase rata-rata kelayakan RPP adalah 88,6% (sangat layak), e-learning adalah 85,1% (sangat layak), dan instrumen pemahaman konsep adalah 84,6% (sangat layak). Hasil uji kepraktisan menunjukkan respon siswa sebesar 79,3% dengan kriteria praktis, respon guru sebesar 83% dengan kriteria sangat praktis dan keterlaksanaan pembelajaran sebesar 78.7% dengan kriteria praktis. E-learning efektif dalam meningkatkan pemahaman konsep siswa dengan rata rata N-gain sebesar 67 dengan kriteria sedang. Berdasarkan uraian tersebut disimpulkan bahwa media e-learning berbasis model blended sangat layak, praktis dan efektif untuk memperbaiki pemahaman konsep siswa pada pembelajaran kimia.

Kata kunci: e-learning, blended learning, COVID-19, pemahaman konsep

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INTRODUCTION

The WHO declared COVID-19 a public health emergency that is causing concern worldwide (Zhou et al., 2020). This novel disease has never been previously identified in humans. The pandemic of Covid-19 is a multifaceted issue that has affected the global

community. It has also impacted the education sector, resulting in a decline in the quality of student performance (Iftiah et al., 2023). In order to keep the learning process going throughout this pandemic emergency, the traditional learning system has to be replaced by online learning (Camargo et al., 2020; Wege et al., 2022). This alters the learning pattern, necessitating that educators and educational developers use remote digital tools to educate students and provide learning materials (Usak et al., 2020).

Technology utilization in education has arisen as a significant topic and is regularly addressed in several situations (Adiyono et al., 2024; Dainamang et al., 2024; Faudi et al., 2023). This is because educational technology has become more critical. The term "technology for education" refers to a tool that may offer educational programs in both unidirectional and interactive forms (Husaini, 2014). Denker (2013) states that learning activities are no longer limited to specific classrooms. Furthermore, the emergence of distance learning has been facilitated by technology, which has also facilitated the development of more innovative teaching both within and outside the classroom (Almeida et al., 2019; Chandio 2021). Educational innovation that incorporates information technology into the learning process is known as online learning.

Students are capable of learning at any time and location through online learning (Fitriyani et al., 2020; Raiman et al., 2021). Furthermore, students have the opportunity to engage with their instructors through a variety of applications, including e-classroom, telephone, Zoom, live chat, and WhatsApp groups (Dhull et al., 2017). This educational innovation is designed to address the challenge of the limited availability of diverse learning resources. The learning innovation of the impact of COVID-19 has introduced a new paradigm for educational institutions, which no longer characterizes the learning process as face-to-face in the classroom. Distance technology information systems online play a critical role in education and must be adequately prepared to facilitate the learning-from-home approach.

One of the alternatives to learning from home by utilizing computers as learning media is developing e-learning based on blended learning. According to Gunawan (2015), internet and multimedia technology enhance the quality of learning achieved by facilitating access to resources and services that guide information exchange and cooperation, such as e-learning. It is a distance learning that utilizes web or internet-based technology that has the advantages of (a) having a discussion room, where participants and instructors can conduct dialog or interaction and collaborative discussions; (b) having an electronic voice box, where participants can ask questions to instructors or other participants; (c) having the ability to store references and data (d) learning materials can combine audio, video, and graphics (Maatuk et al., 2022). With e-learning, learning is no longer limited to the teacher-centered classroom, but the learning process develops anywhere and anytime by utilizing internet access so that learning will be centered on students. Hermawannto et al. (2013) explained that learner-centered learning will make students' mastery of concepts better so student-centered learning will make students' mastery of concepts better.

The e-learning developed in this study is designed by integrating a blended learning model that aims to improve students' concept understanding. In line with the research of Sudiarta et al. (2016) on the effect of the blended learning model assisted by animated video on students' concept understanding, it shows that the blended learning has a positive impact on students' problem-solving and concept understanding. According to Prihadi

(2003), the blended learning model is a combination of in-person teaching in the classroom and online learning via e-learning websites, journals, and social networks. The blended learning used in this research is the Rotation Model. Muller et al. (2021) explained that the rotation model presents subject matter by rotating on a predetermined schedule or educator policy between learning modalities, with one of them learning online.

The update in this research is an e-learning developed to be able to train students' concept understanding, computer media operation and e-learning media can record traces of students who are active in learning. In this media, students can also access interactive materials presented in the form of videos, and animations that are relevant to the content of chemistry materials that are accessed for free. Based on the explanation, it is necessary to research the development of blended learning-based e-learning to improve students' concept understanding. This research aims to create e-learning media based on blended models in the pandemic era that are feasible, practical, and effective to improve students' understanding of concepts.

METHOD

The ADDIE model, which encompasses the stages of Analysis, Design, Development, Implement, and Evaluation, was employed in this development research. The analysis is associated with the examination of the work situation and the environment to determine which products require development. Product design activities are conducted in accordance with the requirements. Development is the process of creating and evaluating products. Implementation is the process of evaluating products on a limited and large scale. The evaluation phase is an activity that evaluates the compliance of each activity step and the final product with the specifications. Figure 1 illustrates the five stages of ADDIE development.

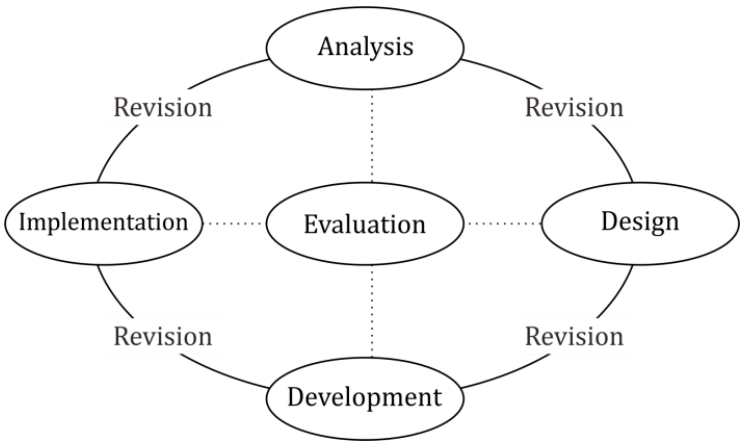


Fig. 1. Steps of ADDIE development model

The limited and large trial subjects were conducted on X MIA class students in one of the high schools in Mataram city as many as 88 students (44 students limited scale and 44 student in large scale, consisting of two classes, namely X MIA^{1} and X MIA^{2} classes in large scale. The concept understanding test instrument used is a multiple-choice test that refers to the indicators developed by Anderson and Bloom (2001), namely: interpret, exemplify, classify, conclude, compare, and explain. Feasibility data collection in the form of lesson plan validation sheets, e-learning, and concept understanding instruments using multiple-choice

tests. Feasibility data in the form of learning application sheets, and teacher and student questionnaires related to learning using e-learning media. Effectiveness data in the form of concept understanding test results tested on students.

1. Feasibility data analysis technique

Data analysis to ascertain the feasibility of the product that was developed, namely using the feasibility percentage formula (Ernawati, 2017).

$$\% \text{ Feasibility} = \frac{\text{Score Obtained}}{\text{Maximum Score}} \text{ x } 100\% \quad (1)$$

The results of the feasibility percentage calculation are then categorized as presented in Table 1.

Table 1. Feasibility dan practicality criteria

Percentage of Assessment Results	Feasibility Level	Practicality Level
30 - 39	Not Feasible	Not Practical
40 – 55	Less Feasible	Less Practical
56 – 65	Simply Feasible	Practical enough
66 – 79	Feasible	Practical
80 – 100	Very Feasible	Very Practical

2. Practicality Data Analysis Technique

Data on the practicality of teacher and student responses to the device and the use of e-learning media were analyzed using the formula (Daryanto, 2016).

$$P = \frac{\sum x}{\sum xi} x\ 100\% \quad (2)$$

Note:

P : Percentage of scoring results

$\sum x$: Total number of scores obtained

$\sum xi$: Total maximum score

The level of practicality is described by confirming the percentage of scoring results achieved with the practicality criteria as presented in Table 1.

3. Effectiveness data analysis techniques

To determine the effectiveness of using e-learning media using the N-gain test which aims to determine the improve in concept understanding after being taught using e-learning is analyzed using the formula (Hake, 1999). The N-gain calculation results are then categorized as presented in Table 2.

$$Indeks\ gain\ (g) = \frac{posttest - pretest}{Maximum\ Score - pretest} \quad (3)$$

Table 2. N-gain index criteria

Score	Conversion in Percent	Category
g ≥ 0.7	g ≥ 70	High
0.7 ≤ g ≥ 0.3	70 > g ≥ 30	Medium
g ≤ 0.3	g > 30	Low

RESULTS AND DISCUSSION

Analysis stage

The analysis stage is the first step in the development of e-learning that incorporates blended learning. Several activities are conducted during this stage, including analyzing student requirements and issues, as well as the analysis of fundamental skills. Problem analysis is conducted to uncover fundamental issues that arise in the process of learning chemistry and to discover alternate solutions to these learning challenges. The focus of the problem analysis is on the learning media used by teachers in delivering chemistry learning materials.

The needs analysis results are that in general students need interactive online learning media to explain the content of abstract and microscopic chemical material, especially during the Covid-19 pandemic, as a researcher offers to develop blended learning-based e-learning where in this learning platform the content of abstract and microscopic chemical material is explained interactively through visualization of images, animations, audio and video relevant to the material as contained in Figure 2 which can be accessed anywhere and anytime online.

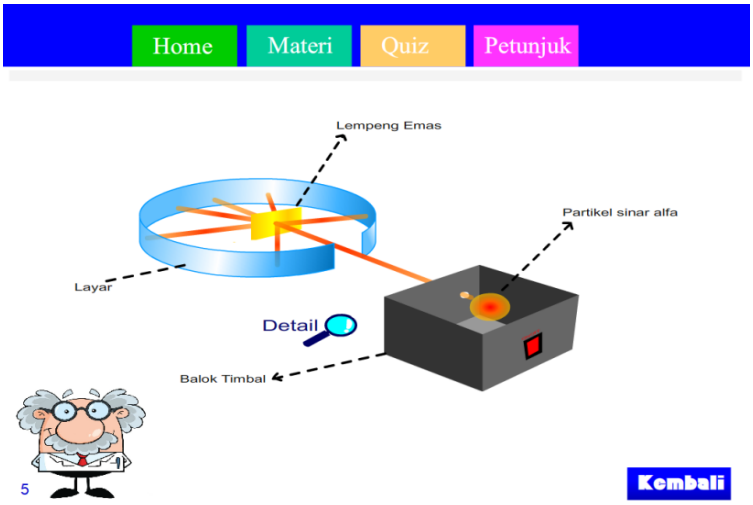


Fig. 2. Example of chemical material display that is visualized interactively on e-learning media.

The analysis of basic competencies determined that the material developed focuses on basic competencies (3.2. Understanding the atomic models of Dalton, Thomson, Rutherford, Bohr, and wave mechanics).

Design stage

This stage is a systematic process that begins with compiling flowcharts and storyboards as the basis and description of the form, content, and appearance in developing

blended learning-based e-learning. This stage is carried out by collecting relevant material content, animations, photos, audio, and video support in the e-learning development.

Development stage

This stage is the stage of making blended learning-based e-learning modules, lesson plans, and concept understanding instruments through two steps, (expert and developmental testing). The expert appraisal is an expert lecturer assessment followed by revision while developmental testing is a trial of development results. The developmental testing of results of developmental testing were carried out by limited group trials and large group trials as well as testing the effectiveness of e-learning product on improving concept understanding and students.

The results of e-learning media development as a learning media source that can be accessed and used simultaneously by teachers and their students in learning. The e-learning media products developed results are then packaged in a website that can be accessed through the site http://e-learningnw.id. The components of the development results' main features consist of eight content options: the home menu, learning materials, schedules, assignments, groups, libraries, quizzes, and messages. The supporting features menu has four groups of content, namely videos, the latest assignments, the latest materials, and announcements.

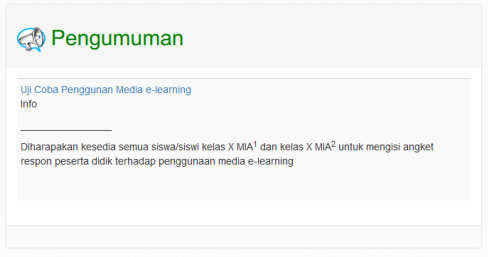
These e-learning media feature components are developed with specifications by combining content elements in the form of video, text, graphics, images, audio, photos, and learning animations by utilizing internet access. These elements are integrated into computer technology equipped with a controller so that it can be operated by the user. The e-learning media produced is packaged to present parts of microscopic and abstract chemical concepts that cannot be explained in more detail by other learning resources, presenting videos and learning animations with a more attractive and informative display. It aims to facilitate and enhance students' interest in learning.

E-learning media becomes a very crucial component in assisting the teaching process, as an effort to reduce the role of teachers in learning, to optimize the student understanding level of the material taught. The development of this media is tailored to the objectives, materials, as well as the ability, and characteristics of the learners to greatly support the effectiveness and efficiency of the learning process and results.

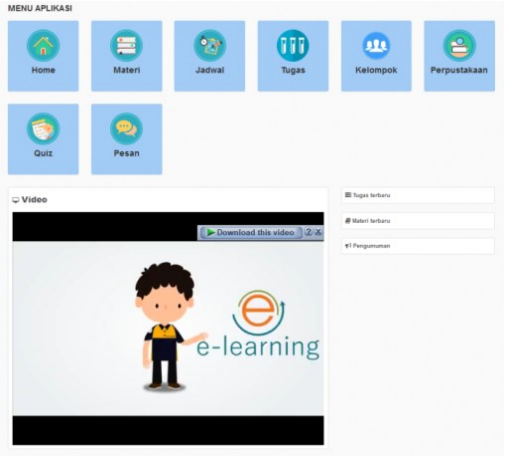
The development products also consist of syllabus, lesson plans, and concept understanding instruments. The concept understanding test uses multiple-choice questions consisting of 15 questions. Each aspect of the device developed has a relationship with each other. One of them is the phenomenon observation video available in the online class, used to formulate problems and propose hypotheses which will later be written on the student worksheet. After the product is finished, the product is ready to be tested.

The purpose of the validation test conducted by experts is to obtain an assessment that will determine the product's level of validity and identify its vulnerabilities. This is achieved by soliciting suggestions for enhancement from the validator in order to enhance the product that has been developed. Furthermore, suggestions from validators are used as a reference in revising the product to make it better. Some examples of the display of e-learning media development results validated by 3 (three) expert validators are as follows:

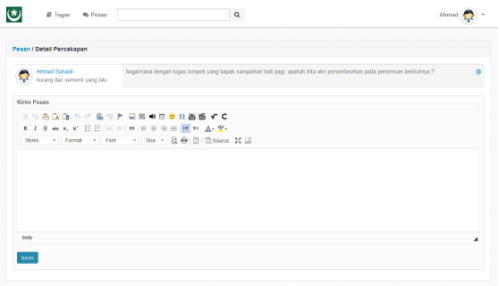
(a) Front Page of e-learning media



(b) Announcement page of e-learning media



(c) E-learning media Menu page



(d) E-learning media Message page

Fig. 3. E-learning display

The front page display can be accessed on the page http://e-learningnw.id/ by filling in the contents on the login form used to enter the next page consisting of username and password. If the username and password do not match, you cannot enter the next learning page. The main menu page consists of several learning menu options including the home menu, material, lesson schedule, assignment, library, learning video, quiz, and message. The content contained in the main menu is designed to make it easier for students to access materials both during school hours and outside of school hours

The announcement page serves to provide the latest information to students related to learning activities, assignments, and quizzes given by the teacher. On this page, students can see the latest announcements (updates) related to learning information, assignments, and quizzes made by the teacher. Message page display, serves to provide information messages and questions or responses to educators and between students. Through this message menu, students are facilitated to be able to ask directly to other students or to the teacher outside of school hours if the student has not understood the material or assignments given by the teacher.

The aim of this research is to produce e-learning media based on blended models in the covid 19 pandemic era that are feasible, practical, and effective for improving students' concept understanding. This is done as an effort to provide an alternative learning system that can be applied by teachers during a pandemic which is useful for improving students' ICT skills and for delivering abstract and microscopic chemical material that is difficult to explain in more detail by students and teacher textbooks (Hadisaputra et al., 2019). Validation of development products in the form of lesson plans, e-learning, and student

concept understanding instruments was carried out by three expert validators who are competent in media and chemistry learning. The results of expert validation obtained are listed in Table 3.

Table 3. Expert validation results

Validator	Lesson plan (%)	E-learning media (%)	Concept Understanding Instrument (%)
I	92,8	89,6	89,5
II	91,0	90,0	85,4
III	82,1	75,8	79,1
Average	88,6	85.1	84,6

Based on Table 3, shows that the average percentage of the feasibility of lesson plans is 88.6% (very feasible), e-learning media is 85.1% (very feasible criteria), and the concept understanding instruments is 84.6% (very feasible). In line with Rochmad (2012), and Habibi et al. (2016), the product development results that get decent criteria from expert validators can then be used as a trial in the learning process.

This blended model-based e-learning media can be used independently. The device includes media, lesson plans, syllabi, practice questions, and concept understanding instruments. The lesson plan developed by the researcher aims to be used by teachers as a guideline in learning. Then, the e-learning developed is equipped with instructions to guide students' learning. The e-learning developed is also designed as well as possible so that students are interested in learning and engaging. Some students think using e-learning media is very interesting (Hadisaputra et al., 2020). Furthermore, Yilmaz (2017) asserts that student satisfaction and motivation influence the e-learning and self-directed learning sub-factors. This demonstrates that students' motivation toward e-learning increases, and they possess more self-directed learning skills.

The e-learning media provides an overview of the learning design, so that students are not confused in using the media. As previously reviewed, the e-learning media is divided into 5 activities with the division of three main activities in each activity, namely online-face-to-face - and online. Researchers also developed handouts that students can use as reading material before learning begins. In the handout, sample problems are given for each submaterial. Student worksheet and handouts that have been packaged in online classes. The online class is made to carry out the online stage before face-to-face and online after face-to-face. In each online activity, there is also a comment column that can be used by students as an expression of opinion. E-learning media is also supported by the existence of practice questions. practice questions are given with 5 repetitions of work, with a random system. Where in the first working process, the arrangement of questions will be different from the second, third and so on. The development of questions in the media aims to train students' understanding of the concepts learned.

Numerous studies have demonstrated that online learning has been extensively implemented in the context of higher education (Crews et al., 2017; Mather et al., 2018). Online learning offers advantages by eliminating physical barriers that impede learning in the classroom, thereby ensuring that all individuals have access to education (Abdull Mutalib et al., 2022; ahmed, 2018; Ng, 2021). Pilkington (2018) contends that not all

learning can be converted into an online learning environment, despite the fact that it is perceived as an effective solution, particularly in higher education.

Limited scale test

Gunawan et al. (2019) explained that limited trials were to determine the practicality and readability of the media developed. This test was conducted by teachers and students because both were users of the e-learning media developed. The practicality test of e-learning was carried out with the implementation of learning and teacher and student responses. The results of the practicality test on the implementation of learning with e-learning for teachers and students are listed in Table 4.

Table 4. Observation data of learning implementation

Meeting	Average Value (%)	Category
I	75	Practical
II	82	Very practical
III	80	Very practical
IV	78	Pratical
Average	78,7	Pratical

Based on Table 4, it shows that in the first meeting, students had difficulty operating the e-learning media. This difficulty was not long experienced by students, the enthusiasm of students using e-learning in learning continued to increase when the teacher explained the instructions for using e-learning. Students' enthusiasm continued to increase since the implementation of learning using e-learning media. Every student is so active, and excited when the learning takes place. The findings of the study are consistent with the research accomplished by Gunawan et al. (2020) which states that at the first meeting of learning using the device developed students still experience difficulties because the device developed is still new to students. The results of teacher and student responses to e-learning media are listed in Table 5.

Table 5. Student and teacher response data

Aspect	Student	Aspect	Teacher
The attractiveness of e-learning media	83%	Quality of Content and Purpose	82%
Ease of Use	80%	Learning and Instructional Quality	84%
The role of e-learning media in the learning process	75%	Average	83%
Average	79,3%		

Based on Table 5, shows that the percentage of teacher and student responses on all aspects of learning has very practical criteria, so it can be concluded that the use of e-learning media in learning chemistry is practical.

Implementation stage

This stage is the stage where e-learning is applied in the teaching process for students of class X MIA SMA NW Mataram with large-scale trials. The large-scale test aims to discover the effectiveness of e-learning media in improving students' concept understanding. Based on the final test results data (post-test), it is known that students' concept understanding

before and after using e-learning media has a significant difference. A comparison of student concept understanding test results is listed in Table 6.

Table 6. Average results of student concept understanding tests

Class	Average		N-Gain Average (%)	N-Gain Criteria
	Pre-test	Post-test		
X MIA 1	56,4	85,2	70	Moderate
X MIA 2	59,3	85,4	64	Moderate
Average			67	Moderate

Based on Table 6, the average N-Gain score of students' concept understanding in experimental class I obtained a score with moderate criteria, while in experimental class II obtained a score with moderate criteria.

The success of increasing students' concept understanding is inseparable from the use of e-learning media because the microscopic and abstract chemical material contained in e-learning can be explained in more detail through pictures, animations, and learning videos. In line with the research of Sudiarta et al. (2019) showed that the blended learning model assisted by animated videos can improve students' concept understanding. Furthermore, Ketsman (2019) asserted that educators are content and have a positive outlook on implementing blended learning to instruct the subject matter. It is still uncertain whether student involvement in blended learning really motivates them compared to traditional face-to-face classes. However, many vocational teachers believe that integrating technology in teaching requires adopting blended learning rather than traditional formats.

The success of learning or media is contingent upon the characteristics of the students. Nakayama et al. (2014) have divulged that the literature suggests that not all pupils will flourish in online learning. This is a result of variations in student characteristics and learning environment factors. Students' motivation is one factor contributing to their academic success (Damopolii et al., 2018; Nasir et al., 2023; Sirait et al., 2022). The results showed that the improvement of students' concept understanding was also influenced by group discussion activities in the face-to-face learning phase. In this phase, students become more active, and more practiced in discussing and students can express chemical concepts presented in the reading in the seeking of information phase carried out previously. Group discussion is an activity where learners and other students share ideas and change their opinions to get the right concept from the data they collect (Damopolii et al., 2019)

Group discussions in this phase also motivated students to learn chemistry. In the second phase of the blended learning model, namely the acquisition of information fese, the teacher encourages students to bring out ideas that already exist in the minds of students based on the information/knowledge gained in the seeking of information phase, namely students reading chemical materials displayed with pictures, animations and learning videos. This is certainly a motivation for each student to improve their understanding of concepts in atomic structure and electron configuration material. Mulyani et al., (2021) stated that students who have prior knowledge will find it easier to understand and master new concepts.

Students' concept understanding can increase, this can be influenced by the application of learning using e-learning based on blended models. According to Gunawan

(2015), the blended model has advantages, including: (1) Learning can be more focused, more delivered, quickly and on time; (2) Learners can interact with tutors, peers, and other experts; (3) The use of varied techniques can utilize different technologies variably. In addition to the advantages, this blended learning tool also has some disadvantages, namely accessing online classes requires an adequate internet network, and good connectivity is needed (Wahyudi, 2017). Subagiyo (2019) demonstrated that the integrated blended learning can enhance students' comprehension of concepts. The results of another study on the impact of integrated blended learning on the physics reasoning and concept mastery of grade X students demonstrated that it can enhance students' comprehension of physics concepts (Hermawannto et al., 2013)

The research results of Setianingrum et al. (2013) mentioned that the use of learning media can improve concept understanding, this happens because by using media students can observe through visualization some abstract concepts to make it look real, so that learning will become more meaningful. Success during this learning process has an impact on students' concepts understanding. This understanding of student concepts can be seen in the results obtained by students after working on multiple-choice questions. The questions are not far from the material presented in the e-learning media so that to answer these questions students do not have much difficulty. Students do not need to struggle to memorize learning materials with all kinds of difficulties because this has been facilitated by the products applied in the classroom. This is because all materials have been presented when students carry out learning using e-learning media. Microscopic and abstract concepts that are difficult to explain in more detail by student worksheet and other student handbooks can be explained through e-learning media. Mashami et al. (2018) also substantiate this viewpoint, asserting that the subject matter's complexity can be simplified through the use of media. Certain words or sentences can be used by media to depict what the instructor is unable to express.

To the demands of the 21st century graduates produced by the learning process must have skills using ICT (Wahyu et al., 2020). This makes blended learning useful in the future (Herayanti et al., 2020). Given the shift in how students seek information from time to time, who used to be able to find information through books only, now the process of finding information can be done by utilizing internet facilities. Another supporting factor is that the IT infrastructure is also getting better along with the times and the paradigm, mindset, and psychology of students who are starting to change.

Evaluation stage

This stage accomplished improvements based on the assessment, input, and suggestions from validators at each stage, as well as a comprehensive evaluation based on the test subjects as users of e-learning media.

CONCLUSION

Based on the results of data analysis and discussion, it can be concluded that e-learning media and learning tools (lesson plans, concept understanding instruments) are very feasible to use; the use of e-learning media in the trial gets teacher responses with very practical categories and student responses with practical categories. E-learning media effectively improves students' concept understanding with an average N-gain value of 67

with moderate criteria. It can be concluded that e-learning media is very feasible, practical, and effective in improving students' understanding of concepts in Chemistry learning.

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