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Leveraging Technology to Improve Learning Independence in Chemistry: A Study on Moodle Integration

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Abstract

This study addresses the issues of the low level of learning independence of students, especially in understanding abstract chemical materials such as chemical bonds, as well as limited learning time, which often results in suboptimal comprehension and the omission of some sub-materials. In addition, the use of media in the learning process rarely incorporates technological advancements. This study aims to determine if a website integrated with Moodle can enhance the learning independence of students in chemical bonding material. This study employed the research and development method using the 4D model, which comprises four stages. However, this study only included three stages, namely define, design, and develop. The target population consisted of 29 eleventh-grade high school students. The instruments used to collect data were validation sheets, an independence questionnaire, and pretest-posttest assessments. The feasibility of the integrated chemistry learning website with Moodle was evaluated through validity and effectiveness tests. The validity test involved three validators, consisting of two lecturers and one teacher. Meanwhile, the effectiveness was analyzed using the n-gain from the results of the independence questionnaire and pretest-posttest assessments. The results of this study indicated that the chemistry learning website integrated with Moodle significantly enhanced the learning independence of students with the validation results of 5 for content validity and 4 for construct validity, while the n-gain results from the independence questionnaire and pretest-posttest assessments fall into the high category. In conclusion, this media effectively promoted independence across five indicators of learning independence.

Keywords: chemical bonding, learning independence, leveraging technology, moodle integration

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1. Introduction

Education comes from the word educate which means to maintain and provide training (teaching, leadership) regarding the morals and intelligence of the mind. Meanwhile, according to Indonesian Law No. 21 of 2003, it is stated that education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, and skills needed by themselves, society, nation, and state (Barni, 2019). A good learning process can improve the quality of education. With good quality education, it can determine the quality of human resources that correlate with the civilization of the Indonesian nation

in the future. One of the innovations to improve the quality of education in the current era is the race to the student learning approach or student-centered learning. Learner-centered learning can influence learning outcomes (Satriaman, Pujani and Sarini, 2019). Learners will also tend to be active and independent in learning (Sari *et al.*, 2024).

The rapid development of technology in this era of globalization raises challenges in all aspects, one of which is education. Education is currently oriented toward graduates who have achievements to be able to meet the demands of the 21st century and can compete globally (Pratiwi, Bramastia and Purnama, 2022). To get through this era, we must make friends with artificial intelligence to survive in facing it. Indonesia must immediately improve the capabilities and skills of human resources and education must utilize advances in digital technology (Sosialita, 2022). The use of technology in education must focus on three things, namely accessibility. The existence of digital technology makes it easy for students to access information or learning resources easily. Second, interactive learning. With technology, learning media becomes a lot of choices that make children enthusiastic about learning. Third, is adaptive learning. With technology, the learning process can adjust to the conditions, needs, and environment of students to learn. In the world of education, technology can be integrated into the learning process, one of which is in the form of e-learning media (Panjaitan, R. G. P, Titin, 2023).

Learning media can stimulate the imagination, abilities, and skills of students so that it can encourage the learning process. The utilization and use of technology in learning media can be seen as an innovative approach to making a good delivery media design, user-centered, interactive, and has various conveniences for anyone, anywhere, and anytime (Sundari *et al.*, 2021). The selection of appropriate learning media in the learning process must be a concern for teachers who are expected to be able to improve student learning outcomes (Antara *et al.*, 2022). The learning outcomes obtained are one indicator of the achievement of learning objectives. High learning outcomes also indicate that students have understood the learning material. Learning independence is a self-regulatory attitude so that students can organize, monitor, and evaluate the learning process with the aim that students can find learning strategies, develop, and improve their learning abilities in solving a problem (Fauziah, Maarif and Pradipta, 2018).

Learning independence needs to be owned by students to achieve success in school and academic success (Julaecha and Baist, 2019). One way to bring up high learning independence is the high curiosity of each learner. The lack of learning independence of students can be observed by students who are not motivated to be able to learn independently, are less diligent in learning, are not serious when listening to the material taught by the teacher, lack discipline, are less responsible with their tasks, and are easily bored (Yuliawan and Nusantoro, 2020). Conversely, if students already have high learning independence, they will have a willingness and curiosity related to developing and advancing knowledge. Learners' learning independence can also be seen from several indicators such as self-confidence, responsibility, discipline, initiative, and high motivation to learn (Mustofa and Hastuti, 2023). The purpose of students having high learning independence is the curiosity attitude of each student to find new things.

Chemical bonding material is one of the basic materials in chemistry which consists of abstract concepts and characteristics

because it includes macroscopic, microscopic, and symbolic. Chemical bonding is a chemical material that explains how atoms form bonds, both with the same atom and different atoms (Widarti, Safitri and Sukarianingsih, 2018). Understanding this material is very important for understanding other chemical materials (Maimunah, 2022). Chemical bonding material is material that is far from everyday experience, for example not being able to see atoms, structures, and how they react with other atoms (Mufarohah and Dwiningsih, 2018). The tendency that occurs when students learn abstract concepts is that students tend to only memorize existing theories without understanding them, which students will also get bored quickly when learning them.

One way to overcome this is to use web-based learning media or web-based learning. Web-based learning media is a tool that facilitates teachers and students to interact communicatively and educationally, where the media is planned and systematic and designed in the form of a collection of several pages on the internet that contain learning material content. The advantage of the website compared to other learning media is the ease of website media to be developed in the future and its use can be operated on many platforms (Dalimunthe, M, 2023). One application that can be used is a learning management system (LMS) using Moodle (Siagian, Enjelina, 2021). Moodle stands for a modular object-oriented dynamic learning environment which means that teachers and students carry out learning activities in the online form (Arini, 2021). Learning using Moodle can increase learners' learning independence, where learners are required to be responsible for themselves, by completing assignment bills, managing their discipline, making the best decisions, and actively learning on their own will (Nasution, 2018). Moodle has many features that can be used to make learning more optimal, effective, and interesting, such as discussion features, task collection, multimedia integration, and so on. From these features, teachers can periodically monitor the activities carried out by students, and teachers can also assist and help students if there are obstacles or material that has not been understood during the learning process. Therefore, when integrated with Moodle, a website will be more optimal when used in learning. Because of the features in Moodle, it makes it easier for teachers to monitor students' activities, and students are easier to use, such as uploading answers, discussing with friends, asking questions to the teacher, and can be accessed even outside of learning.

Based on the results of a pre-research questionnaire that was conducted with 34 respondents, 85.29% of students stated that chemistry subjects are difficult, and the average student learning outcomes are at a value of 34, that the percentage of difficulty of chemical bond material is 91.3% in the difficult category. Then the level of learning independence of students is at a percentage of 54.47% which is included in the category of very less independent. Then based on the results of interviews with students, one of the factors that chemistry lessons have not been deeply understood by students is the lack of learning time so some material is not delivered or delivered but not maximized. In addition, from the results of teacher interviews, it was also explained that the learning independence of students was still lacking or not optimal, because there were still many who were lazy or less motivated during learning, especially chemical learning on chemical bonding material. So far, the learning that has been carried out has also never used media in the form of a website.

Therefore, a learning media is needed that can increase students' learning independence. Learning independence is an important aspect that can support the success of student learning. The purpose of this study is to determine whether the chemistry learning website integrated with Moodle can be used as a learning media that can increase students' learning independence and the effectiveness of learning time.

Research on the development of chemistry learning websites integrated with Moodle to increase students' learning independence has relevance to previous research. Such as the relevance of research conducted by Huda & Dwiningsih (2021) in terms of Moodle-integrated chemistry learning websites to improve student learning outcomes. The results showed that the website developed was feasible to use as seen from the average percentage of content and construct suitability of 89.59% and 86.67% respectively in the very valid category. The learning outcomes of students increased which was seen based on the increase in pretest-posttest results, obtained a percentage of 100% with an average n-gain score of 0.708 in the high category. Relevance to (Aisah, 2018) in terms of analyzing student learning independence in chemistry subjects. The results showed that students' learning independence was good as seen from students who were disciplined with a percentage of 90.81%, students could take responsibility with a percentage of 44.7%, students who had initiative with a percentage of 42.81%, and students were able to motivate themselves with a percentage of 72.07% included in the good category.

2. Method

This research on the development of an integrated chemistry learning website with Moodle uses the 4D development model by Thiagarajan. In this research model there are four stages consisting of the defining stage (define), the design stage (design), the development stage (develop), and the dissemination stage (disseminate) (Thiagarajan, 1976). However, this research is only limited to the development stage through limited trials to determine the feasibility of the products developed.

The defining stage is useful for determining and defining the needs in the learning process and collecting various information related to the product to be developed. This stage consists of five steps, namely: a) front-end analysis, b) learner analysis, c) task analysis, d) concept analysis, and e) specifying instructional objectives. The results of the front-end analysis were obtained through pre-research consisting of observations, interviews, and tests. From the front-end analysis, problems were found regarding the lack of learning independence of students and learning media that still minimally use technology according to the times which finally made the idea for research on website-based media integrated with Moodle.

The design stage contains the process of making learning media designs that will be developed. In this case, an integrated chemistry learning website with Moodle. At this stage four steps must be taken, namely: a) test preparation, b) media selection, c) format selection, and d) initial design. At this stage, the initial draft of the developed media is produced. And then enter the development stage (develop).

The development stage contains activities to realize the product design. There are several steps at this stage, including review, revision of review results, validation, and testing. At the review stage, the initial draft that has been finished will be given input and suggestions by the reviewer. The instrument

used is a review sheet. After getting suggestions and input from the reviewer, then revisions are made. The results of the revision are then called draft two. The finished draft two will then be validated by the validator.

The validation stage was carried out by 2 chemistry lecturers and 1 chemistry teacher. Two aspects of validation are assessed, namely construct validation (appearance, language, and presentation) and content. Construct validation is that each component in the developed product has consistency with each other, while content validation is the authenticity and correctness of knowledge concepts. The instrument used is a validation sheet containing aspects that must be assessed by the validator based on the scope of content and construction including appearance, presentation, and language. The assessment of the validation results uses a Likert scale of 1 to 5, with a statement if the value of 5 is very bad (STB), the value of 4 is good (B), the value of 3 is less good (KB), value 2 is not good (TB), and 1 is very bad (STB) (Widoyoko, 2018). The validator will provide an assessment on the validation sheet by checking the rating scale with a range of 1-5. The data from the assessment of each indicator is analyzed using the mode value. Based on the results of this analysis, the learning media can be declared valid with a minimum score of 4 with the description "Good" (Lutfi, 2021). After getting the validation value and the integrated chemistry learning website media with Moodle is declared valid, the next stage is the trial run.

At the stage of testing the instruments were carried out, namely the questionnaire sheet of learning independence and pretest-posttest questions. The learning independence questionnaire sheet contains statements related to the five indicators of student learning independence. Examples of some statements related to the independence questionnaire are as follows: a) responsibility indicator: I always do the assignments given by the teacher, b) initiative indicator: I will look for other references in books or the internet if the material explained has not been understood by me, c) discipline indicator: I collect assignments on time, d) self-confidence indicator: I do everything without hesitation and do not give up easily, and e) motivation indicator: I always set a minimum target score that I have to get every test. The questionnaire was filled in before and after using the learning website in each meeting. The statements in the questionnaire consist of positive statements and negative statements that are placed randomly. This aims to make students more careful when filling in. Learners fill in the questionnaire by ticking the Likert scale of 1 to 4. For positive statements, a value of 4 means strongly agree (SS), a value of 3 means agree (S), a value of 2 means disagree (TS), and a value of 1 means strongly disagree (STS). For negative statements, it is also like that, but the opposite applies. The data from the questionnaire results of students' learning independence, were then analyzed using the following formula.

"Independence score = score obtained: maximum score x 100%"

The increase in students' learning independence can be calculated using the analysis method in the form of n-gain with the following formula.

"<g> = (Spost – Spre) : (Smax – Spre)"

Notes:

<g> = n-gain
S_{pre} = score *pretest*
S_{pre} = score *postest*
S_{max} = score maksimal

The pilot test activities were carried out with the target of 29 students in grade XI SMA. The selection of the research sample is

based on several criteria that have been adjusted to the research objectives, namely students who have received chemical bonding material and the selected schools have used the independent curriculum.

In addition to the results of the learning independence questionnaire, there are pretest-posttest questions. The pretest-posttest question contains 9 questions in the form of descriptions covering chemical bonding material with sub-materials of ion bonds, covalent bonds, covalent bond polarity, and metal bonds. The description questions were chosen so that students could write answers according to their understanding. Data from pretest-posttest results are used to determine the completeness of students. The improvement of students' learning outcomes can be calculated using an analysis method in the form of N-gain analysis with the same formula as the calculation of the increase in the results of the learning independence questionnaire.

3. Result and Discussion

A learning media can be used in a lesson, it must pass the feasibility test stage, one of which is the validity test including content and construct validity. Validation is used to describe the validity of the developed learning website. Content validity (relevance) is the authenticity and correctness of knowledge concepts. Consists of content correctness and suitability for purpose. Construct validity (consistency) is that each component in the developed product has consistency with each other. This aspect of validity is very important because it aims to find out whether the media developed is suitable for trial use. The following are the validation results of the integrated chemistry learning website with Moodle.

a. Content Validity Results

There are 11 aspects assessed by the validator based on the content of the integrated chemistry learning website with Moodle. Of those 11 aspects, 5 of them contain indicators of learning independence, which is the main objective in the development of this website. Validators can give scores ranging from 1 to 5.

The three validators assessed the overall content of the chemistry learning website integrated with Moodle to increase students' learning independence. 5 statements get a mode of 5 which means they are in the very valid category and 6 statements that get a mode of 4 which means they are in the valid category. This shows that the learning website meets the criteria for content validity according to the Likert scale. In the 5 aspects that contain indicators of independence, the value for indicators of self-confidence, motivation, and initiative gets a mode of 4 with a good category, and for indicators of responsibility and discipline gets a mode of 5 with a very good category.

b. Construct Validity Results

The construct validity statement on the display aspect relates to the visual design of layout and writing, the selection of text size and color, font, background, and images is appropriate, legible, and attractive. In the display aspect, there are 4 statements. In the statement of visual layout design and appropriate and attractive writing get mode 5 with a very valid category. Likewise, the statement of choosing the size and color of the text is solid getting mode 5 with a very valid category. Then on the font statement, text color, background, and matching images get mode 4 with a valid category. As well as on the statement of text and images appropriate and legible get mode 5 with a very valid category. From the validator's assessment, it can

be interpreted that the appearance starting from the layout, background, font selection, and images on the chemistry learning website integrated with Moodle is appropriate. This is in line with Sugiharni's research (2018) which states that the selection of appropriate colors, fonts, and backgrounds can help in understanding the concepts of students and the appearance of learning media is one of the important things because it is the main attraction for users.

The construct validity statement on the linguistic aspect relates to the use of language that is common and easily understood by students, as well as the use of language following the General Guidelines for Indonesian Spelling (PUEBI). In the linguistic aspect, there are 3 statements. In the sentence statement on the learning website using sentences that are following PUEBI get mode 5 with a very valid category. Then in the statement of writing commands, content coverage, and question exercises stated clearly and communicatively get mode 5 with a very valid category. Similarly, the language statement used is easy to understand and also gets mode 5 with a very valid category. So that the chemistry learning website integrated with Moodle can be stated to have used language that is by the rules, easy to understand, clear, and communicative (Rosyidah, 2021). Easy-to-understand language can also make it easier for learners to learn and master concepts (Wardhana and Hidayah, 2022).

c. Learning Independence Results

After the learning website is declared valid, then a limited trial is conducted. There are two instruments used, namely a questionnaire sheet for learning independence and pretest-posttest questions. The trial was conducted for 3 meetings, with the following details.

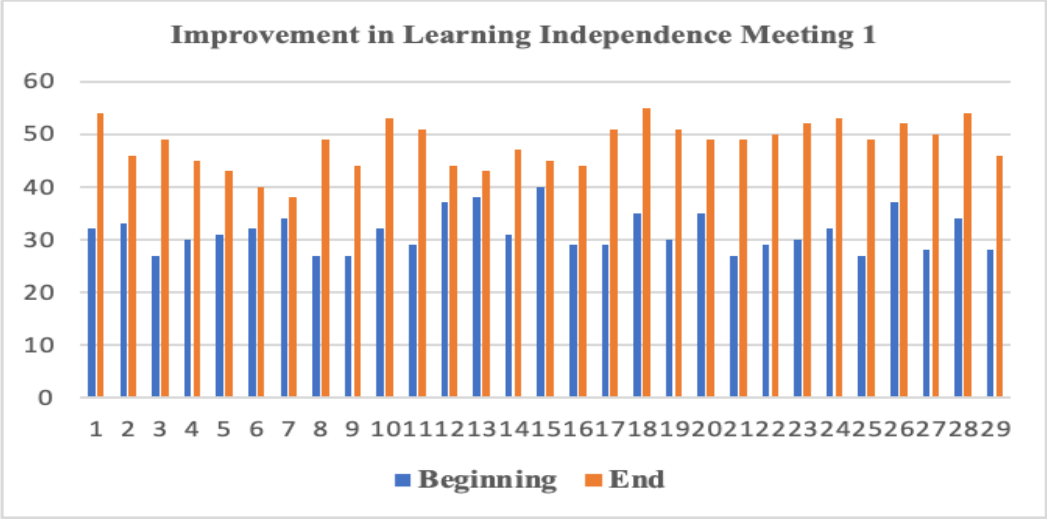

Figure 1. Improvement in Learning Independence Meeting 1

Figure 1 above shows that all students experienced an increase in learning independence at meeting 1. 15 students got n-gain with a range of 0.3 ≤ G> 0.7 with a moderate category, and 14 students got n-gain of G < 0.3 with a low category. The results of increasing independence at meeting 1 found that the autonomy of students was still in the low category, this was because students were new to knowing and using an integrated learning website with Moodle, so students were still adapting and understanding the features on the website. Increasing students' learning independence

occurs gradually and teachers need to provide innovations that are on the characteristics of students (Patimah and Sumartini, 2022). In addition, the use of technology-based media, such as websites, can increase learning independence in supporting information search activities, increasing motivation, and problem-solving processes (Aulia, Susilo and Subali, 2019). The importance of increasing learning independence is also based on the objectives of character education initiated by the Ministry of Education and Culture in which there are 18 character values, of which students are required to be independent (Failla Aulia Denansa, Anita Trisiana and Ratna Widyaningrum, 2023).

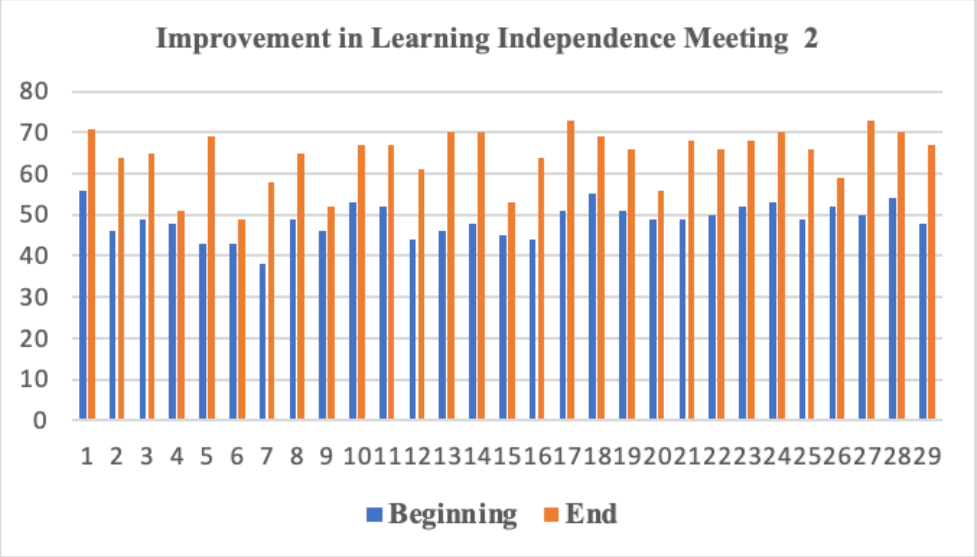

Figure 2. Improvement in Learning Independence 2

Figure 2 above shows that all students experienced an increase in learning independence at meeting 2. 23 students got n-gain with a range of 0.3 ≤ G> 0.7 in the moderate category, and 6 students got n-gain of G < 0.3 in the low category. The results of increasing independence at meeting 2 began to experience changes from the previous meeting. The autonomy of students began to increase, namely in the moderate category. This is because students have begun to understand the use of the features in the learning website integrated with Moodle. In addition, the materials or activities designed on the website have been made by adjusting to the indicators of students' learning independence. A teacher has an important role, namely determining the right learning strategy, one of which is by making media that suits students (Fitriani, Maryani and Atikah, 2023). The combination of using text, video, animation, images, and audio in a learning media will make the learning process more meaningful (Meduri, Firdaus and Fitriawan, 2022). Therefore, the effectiveness of learning can be measured by the achievement of goals, which are obtained after the teaching and learning process by providing self-learning opportunities or the widest possible activities for students to learn (Muniroh, 2021).

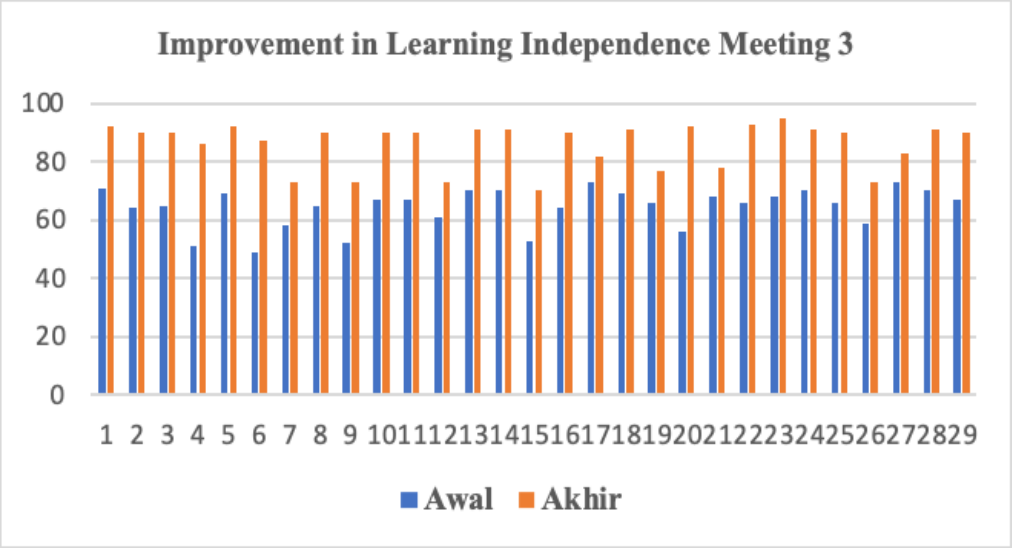

Figure 3. Improvement in Learning Independence Meeting 3

Figure 3 above shows that all students experienced an increase in learning independence at meeting 3. 20 students got an n-gain with a range of G ≥ 0.7 in the high category and 9 students got an n-gain of 0.3 ≤ G> 0.7 in the medium category. At the 3rd meeting, the independence of students had increased in the high category. This indicates that students already understand the usefulness of this website and make it easier for them to learn, especially on chemical bonding material. The results of each meeting show an increase in learning independence after using an integrated website with Moodle, this is in line with research conducted by Nurfadhillah (2021) that website-based learning media can increase students' interest in learning. When students have a high interest in learning, their learning independence will also increase (Saidah, 2023). The use of website-based media with supporting features in it can make students play an active role in the learning process (Riyanto and Alexon, 2019). The use of this website media also helps students learn not only in the classroom but outside the classroom, so that students can deepen their understanding wherever and whenever (Figna, Rukun and Irfan, 2020).

Integrating technology such as websites or LMS in learning allows students to interact with their peers outside the classroom. In addition, such technology makes it easier for teachers and students to collect homework (Zamzami and Keumala, 2018). E-learning also has the potential to support self-directed learning (Verstegen *et al.*, 2016). The supporting features on Moodle are one of the factors that make learning run effectively. Educators can design virtual learning spaces as well as possible according to the characteristics of their learners (Megayanti, 2022; Setyaningsih et al, 2022). The use of features in Moodle can stimulate collaboration and interaction between individuals, so that students can also interact and exchange opinions between other students (Cahyaningrum and Cuhanazriansyah, 2023). Moo-dle-based learning media can be accessed anywhere and anytime, so that students can review the lessons they have received at home. With this familiarization, students will grow awareness of the importance of learning to support the achievement of success in understanding the material (Priyasmara, Masitoh and Bachri, 2022). The use of this media by optimizing existing features and tailored to

the material to be delivered can help increase students' learning independence.

Based on the data from the improvement of independence in each meeting, it can be observed that from meeting 1 to meeting 3, the independence of the students has increased. This improvement is based on the habituation of the student's learning patterns that train them to be independent in seeking the information needed to understand chemistry material. Students will indirectly realize their need to comprehend the material being studied. Students can search for learning resources and complete exercises provided on the integrated learning website with Moodle. This website can be accessed anytime and anywhere, allowing students to learn both inside and outside of formal instruction. Technology-based learning media like this website facilitate teachers with the hope of creating students who can think critically and have independence in learning while also meeting the demands of the digital era (Lillihata *et al.*, 2022). The use of Moodle in learning can help students become active, creating adaptive and collaborative learning, as the features available in Moodle greatly support the learning process (Gamage, Ayres and Behrend, 2022). The integration of the Moodle platform into learning helps students review what they have learned, allows students to complete assignments anywhere and anytime, and assists teachers in course administration and obtaining real-time analysis, enabling teachers to monitor student activities (Gudkova *et al.*, 2021). After knowing the improvement in the independence of individual students at each meeting, the increase in students' learning independence can also be determined from 5 indicators of independence, namely: responsibility, initiative, discipline, self-confidence, and motivation. The results of the improvement in learning independence for each indicator and its analysis are presented below.

1) Responsibility

Table 1. Improvement in Responsibility Indicator

No	Result of	*Pretest*	*Posttest*	N-Gain
1.	Meeting 1	6,34	9,97	0,27
2.	Meeting 2	10,17	13,72	0,69
3.	Meeting 3	13,72	19,17	0,96

The learning independence of students on the responsibility indicator has increased at each meeting. Meeting 1 gets an n-gain score of 0.27 which indicates that there is an increase in responsibility in the low category. Meeting 2 gets an n-gain score of 0.69 which indicates that there is an increase in responsibility in the moderate category. Then at meeting 3, the n-gain score was 0.96, indicating that there was an increase in responsibility in the high category. Responsibility is an important attitude that students must possess because the enhancement of potential through learning according to needs can be carried out by someone responsible (Yulita, Sukmawati and Kamaruzzaman, 2021). Being responsible in learning is an obligation for every student to complete the assigned tasks with maximum effort (Setiawan *et al.*, 2021). A person who has a sense of responsibility will encourage themselves to become an individual with awareness of their responsibilities, demonstrate behavior that complies with various rules, and be able to identify their own state, both feelings and thoughts, without feeling bur-

dened by their responsibilities (Millah, 2019).

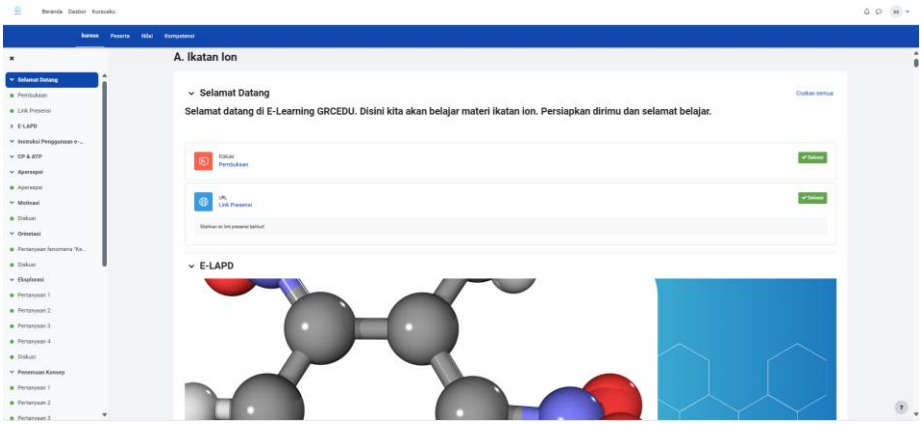

Figure 4. Course views and assignments on the website

The increase in students' responsibility is influenced by the use of chemistry learning websites integrated with Moodle during learning. The website can help in increasing the responsibility of students because there are questions that must be resolved coherently so that students' understanding can be maximized and intact. According to (Amelia Yulita, 2021), an effort to improve responsibility is to streamline the learner agenda through regular assignments. The results showed that regular assignments or homework had greater benefits for students' student achievement when they go on to higher education. Good homework can help teachers predict students' academic achievement, motivate them to study and improve self-regulation, and the more time they dedicate to homework is associated with better academic results (Songsirisak and Jitpranee, 2019). Learner responsibility is one of the things related to learner learning achievement. Research conducted by (Ayish and Deveci, 2019) states that the trait of responsibility is very important for students to possess because, with this trait, students will consciously take on the role of ensuring that their needs to achieve success in learning are met. Therefore, this trait of responsibility is crucial to enhance; with a high sense of responsibility, students will do their utmost to complete their tasks, one of which is success in the educational world. To improve this trait of responsibility, facilities that can assist or support the enhancement of this trait are needed. One of them is appropriate learning media, such as a website integrated with Moodle.

2) Initiative

Table 2. Improvement in Initiative Indicators

No	Result of	*Pretest*	*Posttest*	N-Gain
1.	Meeting 1	6,69	9,90	0,24
2.	Meeting 2	9,97	13,24	0,66
3.	Meeting 3	13,24	18,90	0,94

The learning independence of students on the initiative indicator has increased at each meeting. Meeting 1 gets an n-gain score of 0.24 which indicates that there is an increase in initiative in the low category. Meeting 2 gets an n-gain score of 0.66 which indicates that there is an increase in initiative in the moderate category. Then at meeting 3,

the n-gain score was 0.94, indicating that there was an increase in initiative in the high category. The initiative within students can be marked by the students' willingness to achieve something desired. If learners have initiative in themselves, then these learners will try to find solutions to the problems they are facing through various ways without relying on others (Muh Rizal Kidjab, 2019). Learners who have high initiative will complete the assigned tasks despite experiencing obstacles (Setiawan *et al.*, 2021). A high sense of initiative will make learners able to solve the difficulties experienced while learning (Audhiha *et al.*, 2022).

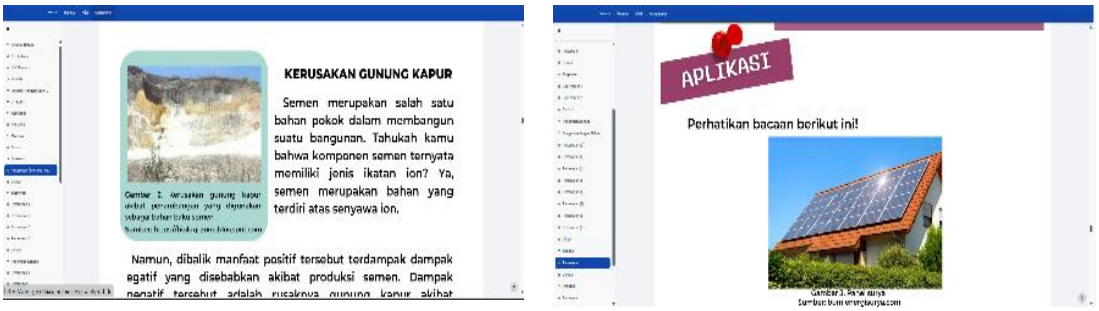

Figure 5. Phenomena Presented in Web-based Learning

The increase in students' initiative is influenced by the use of chemistry learning websites integrated with Moodle during learning. The website can help in increasing initiative because there are phenomena that can attract students to answer some questions even though there is no command to answer them. In addition, this website using the POGIL Inquiry model can encourage students to be more active in finding sources of information to support the formulation of the concept of the material being studied (Apriliyanto & Harsoyo, 2023). On the learning website, there is also a discussion forum that can be used by students to discuss with each other related to the material being studied. In the discussion forum, students can take the initiative to start or answer a discussion. The use of a website integrated with Moodle can serve as a facility in the learning process for students, where students can promote their critical thinking and other students can provide feedback, while the teacher can provide clarification if there are misunderstandings among the students. In this way, the initiative within the students will gradually increase, as they can freely express their ideas (Suherman and Budiamin, 2020). The initiative is the ability of students to seek learning resources on their own without being prompted by the teacher, to ask questions or respond to questions, and the willingness of students to achieve something they desire. Initiative is an important psychological aspect for students in planning their future and enhancing learning effectiveness. By having initiative, students can identify their learning needs, plan activities to achieve their goals, and determine the facilities and steps necessary to reach their learning objectives (Audhiha *et al.*, 2022). When students possess initiative, they will strive to find solutions to the problems or learning difficulties they face without relying on others.

3) Discipline

Table 3. Improvement of Discipline Indicators

No	Result of	*Pretest*	*Posttest*	N-Gain
1.	Meeting 1	6,34	10,07	0,27
2.	Meeting 2	10,24	13,69	0,68
3.	Meeting 3	13,69	18,41	0,92

The results of students' learning independence, and discipline indicators, have increased at each meeting. Meeting 1 got an n-gain score of 0.27 which shows that there was an increase in discipline in the low category. Meeting 2 received an n-gain score of 0.68, which shows that there has been an increase in discipline in the medium category. Then at meeting 3, they got an n-gain score of 0.92, which shows that there has been an increase in discipline in the high category. Discipline is an attitude that shows a person's willingness to obey the applicable rules. This is because discipline is closely related to students' compliance with the regulations that apply at school (Solichah, 2020). According to Sugiarto (2019) in (Arumingtyas, 2021), it is explained that success in the learning process largely depends on the disciplined attitude possessed by the learners. This disciplined attitude plays an important role in shaping the character of the learners, which will be a valuable asset in the future. Examples of the discipline expected from learners include active participation in learning, listening to the material presented by the teacher, and completing assigned tasks within the specified deadline. One of the strategies teachers use to overcome student discipline problems is positive discipline, a teaching model that facilitates children to develop character, responsibility, self-control, and compliance with rules (Prasetyarini, Hikmat and Thoyibi, 2021). One of them is the rule of giving deadlines on the assignments given.

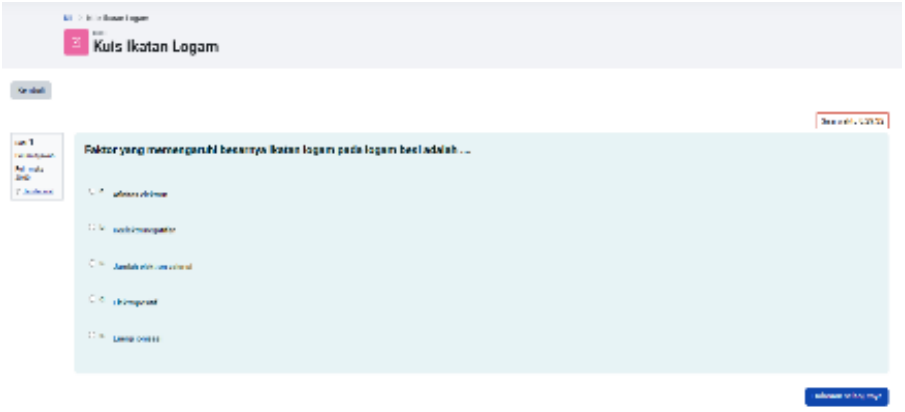

Figure 6. Display of Deadlines on Quizzes on the Website

Increasing student discipline is influenced by the use of learning websites in the learning process. This is because each assignment or quiz is given a deadline for completing it. So, if students are late in submitting assignments, information will appear on the learning website (Sugiarto, Suyati and Yulianti, 2019). Giving a deadline for each question helps students to be able to use their time more effectively and efficiently which can later influence students' discipline in their activities. (Ulfiah, 2019). Discipline is an important trait that students should possess. The purpose of this discipline is to help students provide self-control or boundaries while participating in the teaching and learning process (Arumingtyas, 2021).

4) Self-Confident

Table 4. Increased Confidence Indicator

No	Result of	*Pretest*	*Posttest*	N-Gain
1.	Meeting 1	5,86	9,03	0,22
2.	Meeting 2	9,10	11,48	0,57
3.	Meeting 3	11,48	13,59	0,68

The results of students' learning independence, and discipline indicators, have increased at each meeting. Meeting 1 received an n-gain score of 0.22, indicating that there was an increase in discipline in the low category. Meeting 2 received an n-gain score of 0.57 which shows that there has been an increase in discipline in the medium category. Then at meeting 3, they got an n-gain score of 0.68, which shows that there has been an increase in discipline in the medium category. Self-confidence is an attitude of confidence in one's abilities which causes a person to be less anxious in all his actions, feel free to do things he likes, be responsible for his actions, and have the drive to achieve (Yuniar & Ramlah, 2021). Self-confidence is a person's belief in their abilities and strengths, which enables them to achieve their life goals (Nurjanah, 2018). With high self-confidence, it can foster courage in students, such as the courage to ask questions about material that has not been understood, so that the understanding gained can be maximized. Students with a high level of self-confidence will be active in participating in learning (Failla Aulia Denansa, Anita Trisiana and Ratna Widyaningrum, 2023).

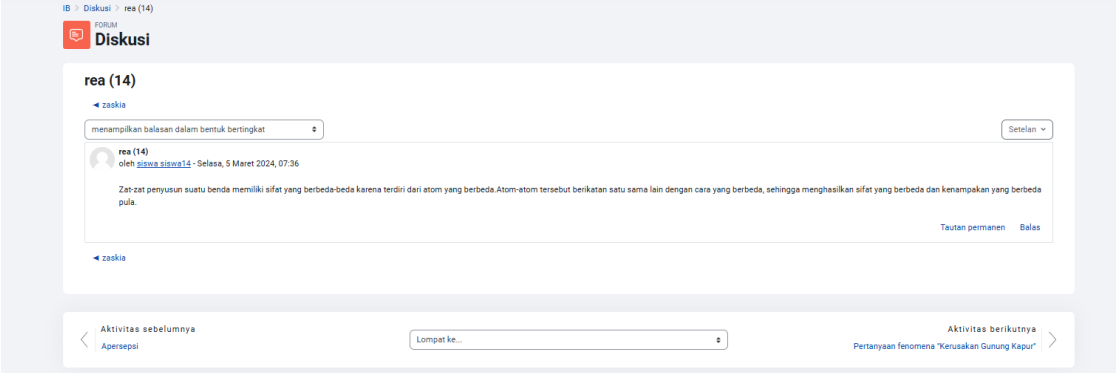

Figure 7. Discussion Forum on the Website

Increased self-confidence because on the learning website, there is a discussion forum, where students can write opinions or respond according to their understanding (Rahmawati and Purwaningrum, 2022). In addition to increasing student participation, it is said that online discussions affect interaction and communication between students themselves and between students and teachers significantly, these forums can shape students' social relationships and identities (Gasmi, 2022). Participants in online discussions often negotiate friendships with other like-minded participants. They often read and comment on their discussion posts and seek to build friendships with them outside of the teaching-learning context. Students who have good self-confidence in learning will be able to process their feelings and encourage themselves to be brave in expressing opinions, answering, or responding to what they

receive during the learning process (Bismala, 2022).

5) Motivation

Table 5. Improved Motivation Indicators

No	Result of	*Pretest*	*Posttest*	N-Gain
1.	Meeting 1	6,14	9,17	0,22
2.	Meeting 2	9,24	12,24	0,61
3.	Meeting 3	12,24	15,93	0,80

The results of students' independent learning and motivation indicators have increased at each meeting. Meeting 1 received an n-gain score of 0.22, indicating that there was an increase in discipline in the low category. Meeting 2 received an n-gain score of 0.61, which shows that there has been an increase in discipline in the medium category. Then at meeting 3, they got an n-gain score of 0.80, which shows that there has been an increase in discipline in the high category. Motivation is a drive that comes from within or outside a person, which can encourage the desire to learn. This is important in learning because it can create excitement and enthusiasm for studying (Destyana and Surjanti, 2021). Motivation in learning plays a crucial role in the progress and achievements of students. Students with high motivation tend to have a strong learning spirit, enabling them to overcome difficulties more effectively and achieve optimal learning outcomes (Pratama, Firman and Neviyarni, 2019). Someone who has high learning motivation has the possibility of obtaining high learning outcomes as well, this shows that the higher the learning motivation, the more effort put in, and the higher the learning achievement that will be obtained (Febrita & Ulfah, 2019; Syahmani et al, 2021).

The use of technology-based learning media such as websites can facilitate the communication process and are essential elements for creating a supportive school environment and increasing students' motivation to learn (Molina, F., Molina, M. D., & Molina, 2022). Increased motivation is due to the learning website providing phenomena that are close to everyday life so that students can be motivated to take part in learning and deepen their understanding of chemical bonding material. From the results that have been obtained for each indicator, it can be seen that the Moodle integrated learning website is feasible to use as a learning media to increase students' learning independence. This is in line with research conducted by (Febrita and Ulfah, 2019) which states that engaging media is one of the efforts to enhance student's learning motivation. Additionally, based on the research by (Meduri, Firdaus and Fitriawan, 2022), website-based learning media facilitates students in accessing learning resources and materials easily and allows them to learn flexibly, anytime and anywhere.

d. Cognitive Outcomes

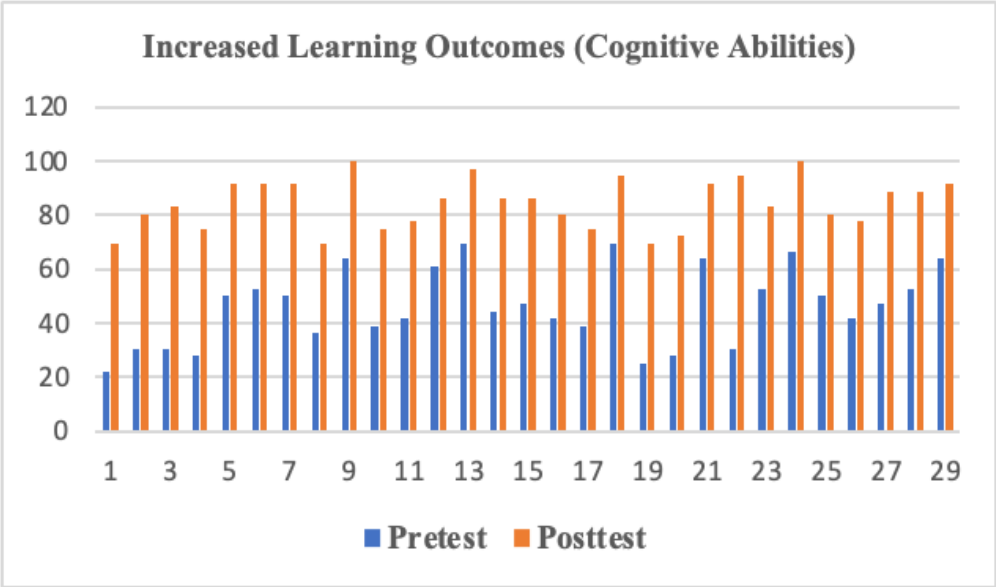

Figure 8. Increased Learning Outcomes

Based on Figure 8, it can be seen that on average students experienced an increase in learning outcome scores. This can be seen from the n-gain analysis of the pretest-posttest scores. Based on the n-gain score, 16 students got a score of G ≥ 0.7 in the high category and 13 students got a score of 0.3 ≤ G > 0.7 in the medium category. The improvement is due to the preparation of tests and the selection of learning resources included on the website used as support or reference for students in their studies. The combination of technology-based learning media, such as this learning website, with appropriate test preparation, allows for effective learning and maximizes the understanding gained by students. This aligns with cybernetic learning theory, which emphasizes the teaching and learning process using technology to obtain information quickly and accurately (Josip, 2022). In cybernetic theory, the process is prioritized over the outcome and is examined in the form of information systems in conveying messages from teachers to students. Furthermore, the cybernetic learning approach enables students to be independent and disciplined in completing assigned tasks, as well as facilitating interpersonal communication with other students and teachers (Kalifah and Prastowo, 2021). The formulation of tests available on the website is also linked to phenomena that are close to everyday life, so that students will be interested in studying them. This is to the cognitive learning theory by Jerome Bruner, which states that cognitive abilities can be enhanced by organizing the learning materials to be studied, and the learning process will proceed well if teachers provide opportunities for students to discover concepts from a phenomenon (Maulida *et al.*, 2022).The use of an integrated learning website with Moodle also allows students to learn more flexibly. This media can be used both in and out of the learning environment. This aligns with neuroscience learning theory, which focuses on brain-based learning. The human brain does not have a single learning style; therefore, e-learning content and activities need to be varied and diverse. The functional organization of the brain and mind depends on experience and the positive benefits from that experience (Afib Rulyansah, 2017).

This increase is due to the preparation of tests that have been adjusted to the results of the initial analysis which produces student characteristics and the goals to be achieved, namely increasing student learning independence (Masturoh and Anggita, 2023). Using an integrated learning website with Moodle allows students to learn more flexibly. Because this media can be used both in learning and outside of learning. This is in line with neuroscience learning theory which focuses on brain ability-based learning (Batubara and Supena, 2018). The human brain does not have a single learning style, therefore e-learning content and activities need to be varied and varied. The functional organization of the brain and mind depends on experience and benefits positively from that experience. Media pembelajaran berbasis *website* terintegrasi dengan *moodle* membantu explorasi peserta didik saat belajar, sehingga belajar dapat menjadi suatu hal yang menyenangkan (Gumilar and Hermawan, 2021).

e. Comparison to The Previous Studies

The development of an Integrated Chemistry Learning Website with Moodle to Increase Students' Learning Independence on Chemical Bonding Material that has been developed has several differences from previous research, such as in Makharany's research (2023) in terms of the implementation of website-based learning media on chemical bonding material to determine learning outcomes. The results showed that the implementation of learning media using the website on chemical bonding material obtained the students' chemistry learning outcomes were greater than the value of the minimum completeness criteria (KKM), namely with an average value of learning of 80. Relevance to Sukma's research (2020) in terms of e-learning quality based on Moodle LMS learning media. The results showed that the average value of students before using e-learning-based learning media using LMS Moodle was 57.0 or only about 52% were able to exceed the KKM and after using the learning media the average value increased by 77.0%. Relevance to the research of Julaecha & Baist (2019) in terms of the relationship between learning independence and the learning outcomes of class xii high school students in mathematics. The results of this study indicate that there is a positive relationship between learning independence and the learning outcomes of XII-grade vocational students in mathematics. Significantly, the magnitude of the relationship that occurs between learning independence and learning outcomes in this study is 0.400. The chemistry learning website integrated with Moodle that was developed has differences with previous studies. For example, this website is equipped with a quiz feature at the end of each lesson that can be used to determine the ability of students before continuing learning on the next sub-material, there is a discussion feature that can be used to ask or respond, learning videos, learning resources, and a message feature to the teacher so that students can ask questions both outside of learning hours.

4. Conclusion

Based on the research results, the validation of the chemistry learning website integrated with Moodle obtained a mode score of 4 for content validity with valid criteria and a mode score of 5 for construct validity with very valid criteria. Thus, it can be said that this website is suitable for use as a chemistry learning medium. These mode scores were obtained from the recapitulation of the validators' scores. Furthermore, in the effectiveness test, the n-gain value on the learning independence questionnaire and learning

outcome tests were in the high category. This means that the chemistry learning website integrated with Moodle can increase students' learning independence. In this development, it was also found that the features in the website integrated with Moodle can become an effective e-learning medium that supports learning.

In the implementation of this research, there were several limitations described as follows: 1) The research was limited to determining the feasibility of the chemistry learning website integrated with Moodle in three aspects, namely validity, practicality, and effectiveness. 2) Limited time during the research, so the development was only carried out up to the development stage. Additionally, besides using the chemistry learning website to increase students' learning independence, the habit of giving assignments and periodic assessments can be other supporting factors. In subsequent research, it may be carried out to the dissemination stage so that the use of this media can be more widespread. The chemistry learning website integrated with Moodle is a new learning medium for students, so simulation needs time. Therefore, further research is needed to see the consistency of media use on other materials.

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