International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 51 No. 2 July 2025, pp. 444-456

# *Discord-Based Flipped Guided Inquiry Learning: An Innovative Model For Periodic Table*

Gustiara Putri[1], Mawardi Mawardi[1], Okta Suryani[1], Reza Akmar[1]

[1]Department of chemistry, Faculty of Mathematic and Natural Science, Universitas Negeri Padang Indonesia

Corresponding Author: Mawardi Mawardi. E-mail: mawardianwar@fmipa.unp.ac.id



**Abstract— The periodic table is chemistry material that must be learnt by students as a foundation to improve their knowledge of chemistry, if students find it difficult to understand the periodic table of elements, it will be very difficult for them to understand subsequent topics. The application of the flipped guided inquiry learning model can improve student learning outcomes. The purpose of this study is to develop and determine the validity and practicality of the Flipped Guided Inquiry Learning (FGIL) based learning system using the Discord application on the material of the periodic system of elements. In this study, the type of research applied is development research, namely Educational Design Research or EDR with the Plomp model which consists of 3 phases, namely Preliminary research, Development or Prototype phase, and Assessment Phase. This research is limited to the development and prototyping stages. The research results on content validation obtained a valid product with an average of 0.90, with content validation assessments for the content component scoring 0.90, the presentation component value 0.91, the language component value 0.91, and the graphic component value 0.88. Meanwhile, the construct validation was 0.91 with a valid category; the display component value 0.90 and the ease component value 0.91. The practicality from teachers obtained 97% with a very practical category, while from students the result was 89% with a very practical category, thus resulting in a valid and practical flipped guided inquiry learning (FGIL)-based learning system product using the Discord application on the periodic table of elements material.**

**Keywords—** ***Flipped Classroom; Discord; Guided Inquiry; Periodic Table***

## I. INTRODUCTION

Chemistry is one of the important disciplines to be taught to students, because it can increase the creative mindset of students. which discusses what matter is, the nature of matter, how and why substances can combine or separate, as well as the energy that accompanies changes [1].The periodic system of elements is chemistry material that must be learned by students as a foundation for increasing their knowledge of chemistry, if students find it difficult to understand the periodic table of elements, it will be very difficult for them to understand subsequent topics [2].

The learning outcomes of students on the periodic system of elements in research conducted by class X students in 2014-2015 only reached 42.70% of learning completeness, which shows the amount of learning that is still low. Many students with low scores indicate that most students still have difficulty understanding the concepts of the subjects taught [3]. Teachers must be creative in implementing learning in the classroom so that the material can be understood by students, this can be done by utilizing technology and adjusting the curriculum for students and choosing the right approach, such as blended learning. [4].

Blended learning is a flexible approach to learning, allowing the incorporation of various learning moments and spaces. Blended learning not only reduces the distance between students and teachers, but also strengthens the interaction between them [5]. Blended

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 51 No. 2 July 2025, pp. 444-456

learning basically applies synchronous and asynchronous learning to select and determine the right combination of methods and technologies at the time of learning [6]. The application of this model significantly improves student learning outcomes. Various studies have shown that students' motivation and learning outcomes have improved significantly after the implementation of this model [7]. By implementing blended learning, the teacher still has control over the lesson plan that has been created by the teacher, but the incorporation of learning allows students to have more opportunities to interact with the teacher during the learning process in the classroom [8].

Flipped classroom applies learning with material outside the classroom by looking at pictures or watching learning videos provided by the teacher, while in the classroom students solve problems by discussing between groups of students [9]. Flipped classroom learning is student centered learning. Advantages of Flipped classroom Learners have more time to learn the material before entering the class because the teacher has provided teaching materials before learning in class and learners can access the material anytime and anywhere so it is easy to understand the concept [10]. Flipped classroom learning increases student participation, produces better learning outcomes, and helps adapt to evolving education [11]. This Flipped Classroom learning model can be used by educators to improve student learning outcomes with relatively short face-to-face learning time [12].

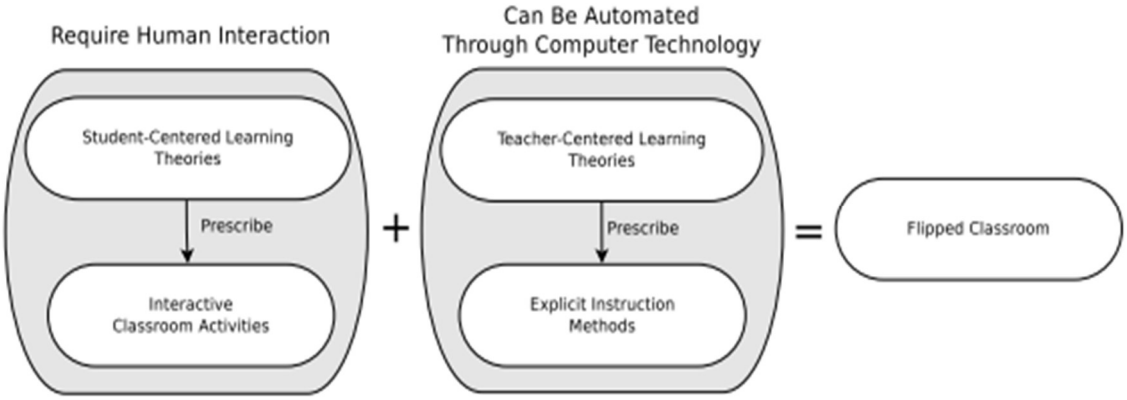


*Fig 1. Flipped classroom* [13]

The guided inquiry learning model is an educational approach that emphasizes the process of discovering concepts and relationships between concepts, where students develop their own experimental procedures [14]. guided inquiry learning process that allows students to search and investigate a problem systematically, critically, logically so that students can present their findings with confidence. The guided inquiry learning model is used to encourage students and improve their skills. The guided inquiry learning model can increase students' activeness in the learning process. There are five stages in guided inquiry, starting with the orientation, exploration, concept formation, application and closing stages [15]. Each stage of the guided inquiry model is very supportive to improve student learning outcomes [16]

Discord is an application that has been widely used to communicate that makes it easier when playing online games. In addition to playing games, teachers can also utilize Discord to facilitate the learning process [17]. In contrast to social media such as WhatsApp for learning, which has the capacity to eliminate learning resources because it is buried by the chatter of extensive discussions [18]. Discord application can provide convenience in the learning process because of the completeness of these features.

Based on the description above, the researcher designed a study with the aim of developing and determining the validity and practicality of the Flipped Guided Inquiry Learning (FGIL) based learning system using the discord application on periodic system material. This learning system is expected to help students in understanding the material of the periodic system of elements and increase activeness in the learning process.

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 51 No. 2 July 2025, pp. 444-456

## II. METHODOLOGY

In this study, the type of research applied is development research, namely Educational Design Research or EDR with the Plomp model. The goal of EDR research is to develop research-based solutions to complex problems in education. This type of research involves careful analysis, design and systematic evaluation of educational interventions. This study uses the Plomp development model developed by Tjeer Plomp which consists of 3 phases, namely the preliminary research phase whose main emphasis is on content validity, development or prototyping, the assessment phase in the form of practicality and effectiveness. This research is limited to the development and prototyping phase [19].

The first stage, Initial Investigation, consisted of needs and context analysis, literature review and conceptual framework development . At the needs and context analysis stage, it is carried out to find out the problems and difficulties experienced by teachers and students during the learning process at school on the material of the periodic system of elements. At this stage, interviews were conducted with 3 chemistry teachers in different schools in Padang, namely SMA Negeri 10 Padang, SMA Negeri 8 Padang, and SMA Pertiwi 1 Padang. The context analysis carried out on the independent curriculum consisting of Learning Outcomes, Learning Objectives and Learning Objective Flow will be analyzed and adjusted to the material of the periodic system of phase E elements.

The literature review stage is carried out by looking for various reading sources that are relevant to the research to be carried out. These sources can be in the form of books, articles, theses, and theses related to Educational Design Research, guided flipped inquiry and the use of Discord applications in the learning process and Periodic System of Elements material. In the conceptual framework development stage, it is carried out by identifying and compiling the main concepts to be carried out, starting with analyzing the needs and context after the results are obtained, it is made in the form of a concept map or table that explains the concepts obtained [20]. The results of this conceptual development will be used as the basis for designing a guided inquiry-based learning system integrated with a flipped classroom using the Discord application on the material of the periodic system of elements. The results of the conceptual framework can be seen in the figure below.

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 51 No. 2 July 2025, pp. 444-456

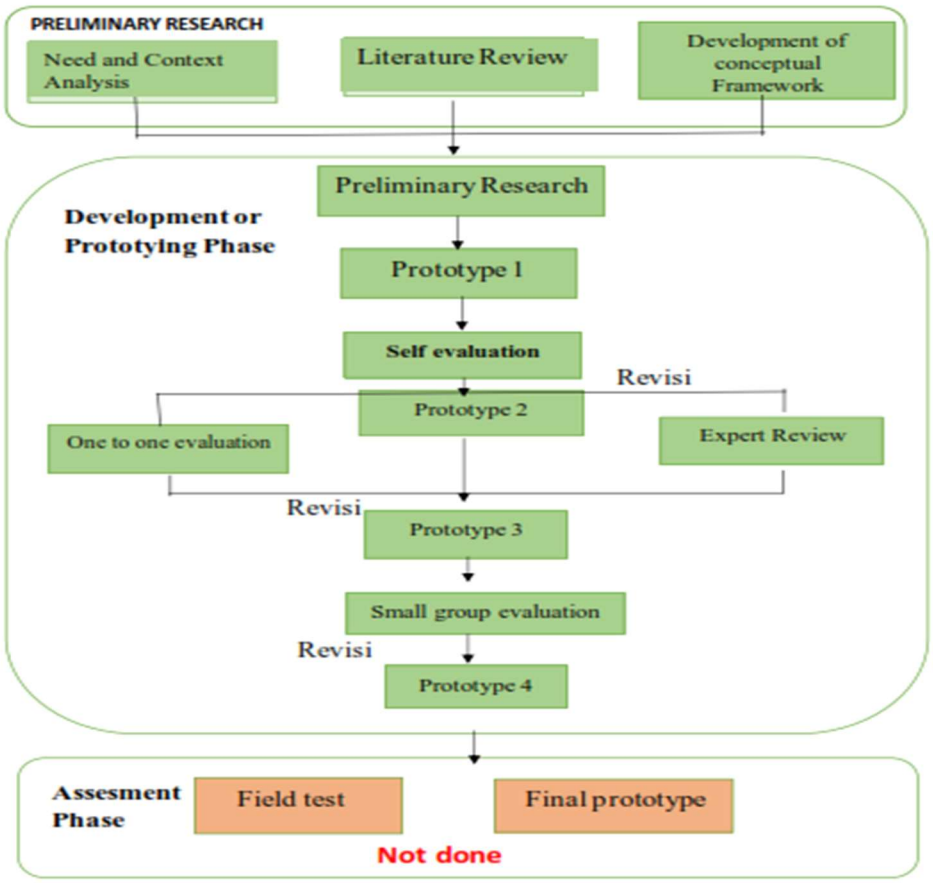


Fig 2. Stages of EDR

The next phase is the prototyping phase which will produce prototype I, prototype II, prototype III and prototype IV which is the result of formative evaluation consisting of Self-assessment is carried out by assessing the products developed in terms of specification characteristics using a check list, Expert Assessment This stage is carried out by experts related to products in research. Expert review was conducted by 3 chemistry lecturers at Padang State University and 2 chemistry teachers at SMAN 8 Padang, Individual Assessment At this stage, interviews were conducted directly to students regarding the products that had been developed, In small groups, a questionnaire of practicality was given to students on a small scale to measure the practicality of the products developed [19].

Data from observations and interviews are processed in the form of conclusions while data from expert assessments are processed using Aiken's V formula with the formula below.

$$V = \frac{\varepsilon s}{n(c-1)} \quad ; \quad s = r - lo \qquad (1)$$

Description:

S: The score assigned by the validator minus the lowest score

r: Selected category score

lo: The lowest score in the scoring category

n: Many validators

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 51 No. 2 July 2025, pp. 444-456

c: Many validator-selected categories (highest validity score

Table 1. Criteria index validitas Aiken's *V*

| Aiken's *V* Indeks | Category |
|---|---|
| V ≥ 0.80 | Valid |
| V < 0.80 | Invalid |

While the data obtained during the small group will be processed with the practicality formula with the formula.

$$NP = \frac{\mathrm{R}}{\mathrm{SM}}\ x\ 100\% \qquad (2)$$

Description:

NP: Expected value

R: Score obtained from students

SM: Ideal maximum score of the test

Table 2. Criteria of Practical level

| Values | Category |
|---|---|
| 86%-100% | Very practical |
| 76%-85% | Practical |
| 60%-75% | Practical enaugh |
| 55%-59% | Not Practical enaugh |
| ≥54% | Not Practical |

## III. RESULT AND DISCUSSION

Research on the learning system based on Flipped Guided Inquiry Learning (FGIL) using the Discord application on the Periodic Table of Elements material for 10th grade phase E has been conducted by applying the Plomp development model. This research consists of 3 stages as follows:

### *A.* Preliminary Research

The initial investigation stage consisted of needs and context analysis, literature review, and conceptual framework development. The needs analysis was conducted to find out the problems and difficulties experienced by teachers and students during the learning process at school. This stage was conducted by interviewing three different high school chemistry teachers namely SMAN 10 Padang, SMAN 8 Padang and SMA Pertiwi 1 Padang. Based on the results of the interviews, the average high school in Padang has used the independent curriculum in the learning process. Teachers apply various learning models depending on the characteristics of the material to be studied. In the learning process students are quite difficult in finding concepts independently so the teacher must guide in the learning process. Context analysis is conducted after the needs analysis. At this stage, an analysis of the curriculum is carried out which includes learning outcomes, learning objectives and the flow of learning objectives. based on interviews with teachers, students have difficulty understanding the concept of the periodic system because they need to understand chemical elements, so the right learning method is needed to support the learning process, in context analysis it is necessary to pay attention to resources that support the learning process such as teaching materials, textbooks and so on [21].

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 51 No. 2 July 2025, pp. 444-456

The literature study stage is carried out by looking for various reading sources that are relevant to the research to be carried out. These sources can be in the form of books, articles, theses, and theses related to Educational Design Research, flipped guided inquiry learning and the use of Discord applications in the learning process and Periodic System of Elements material. The sources are then analyzed to understand concepts related to the research, while also identifying shortcomings so that they can be used as opportunities in the research conducted. Developed and found the validity and practicality of the Flipped Guided Inquiry-based learning model developed for high school students. Based on the results of the study, a validity of 0.96 was obtained which indicates that the learning system is valid and 0.93 for the validity and reasonableness value obtained by 93% of teachers and students in small groups stating that this model has high validity [22]. The integration of synchronous and asynchronous learning through flipped classroom with guided inquiry learning enables students to develop their own understanding of learning concepts, complemented by in-depth key questions that guide students in comprehending these concepts. The Discord learning media integrated with guided inquiry learning has proven effective [23].

The conceptual framework is very important because in this stage the researcher identifies important concepts related to the research and then analyzes them to determine the relationship between these concepts. this stage begins with analyzing the needs and context as well as literature studies, after being obtained, it is made into a concept map. In the process of developing a conceptual framework, the researcher will identify variables related to the research topic used as the basis for the research.

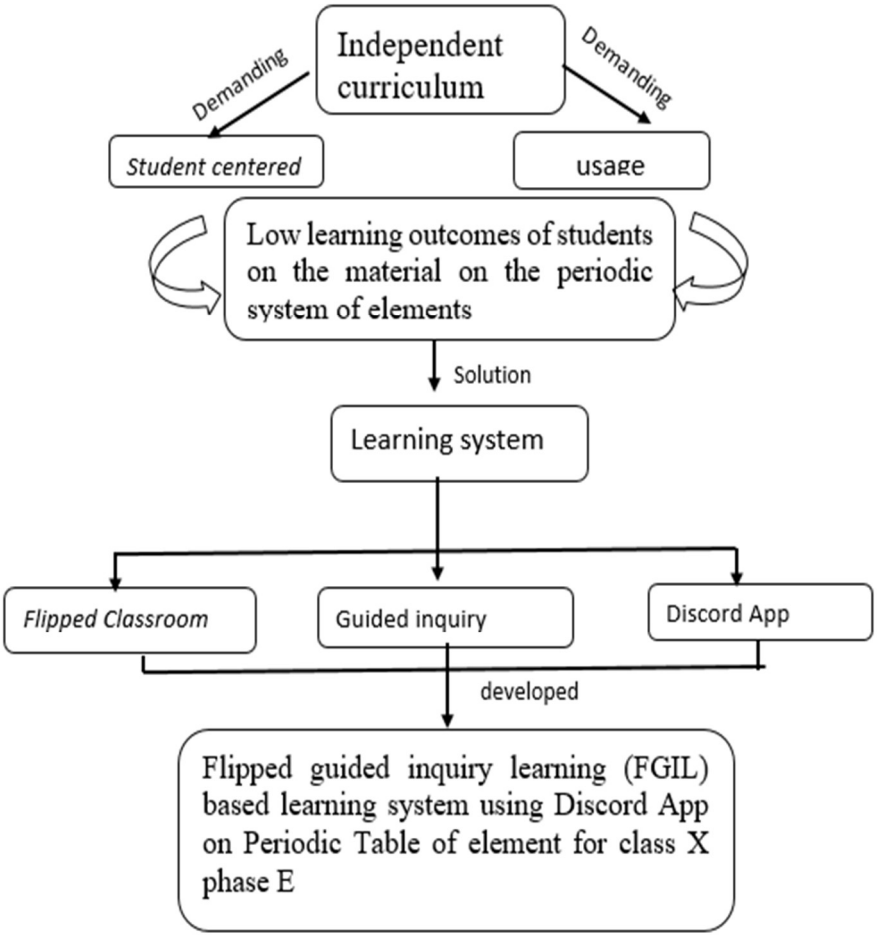


Fig 3. Conceptual Framework

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 51 No. 2 July 2025, pp. 444-456

*B.* Development or Prototyping Phase

At the prototype stage, formative evaluation is carried out to periodically revise the developed product so that there are minimal errors. At the prototype I stage, researchers developed the initial concept, made an initial design and developed a system that would be made by designing products resulting from the Preliminary Research stage. The result of prototype I is a learning system based on flipped guided inquiry learning (FGIL) using Discord application on Periodic System of Elements material for class X phase E. The product designed by the researcher consists of instructions for using the Discord application, learning designs that are incorporated into the Discord application [24].

The product produced in prototype I will enter the first formative evaluation stage, namely self evaluation. At this stage of prototype II, researchers evaluate the product and analyse the shortcomings contained in the product. After knowing the shortcomings of the product, the researcher makes improvements to improve the quality of the product produced. After conducting a self evaluation, the product developed is physically complete and contained in the Discord application [25]. The flipped guided inquiry learning (FGIL) based learning system using Discord application on Periodic System of Elements material is conducted asynchronous and synchronous. In the asynchronous stage carried out on the Discord application at different times and places, this stage is carried out in the guided inquiry syntax of orientation, exploration and concept formation. Synchronous is applied to the application and closing guided inquiry syntax carried out in the classroom at the same time and place. The following are the stages of learning flipped guided inquiry learning (FGIL) based learning system using Discord application.

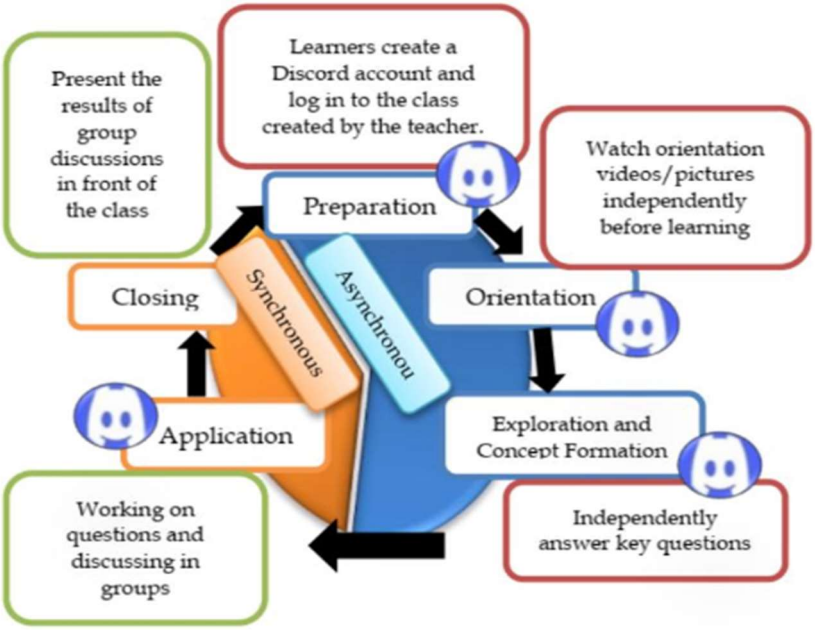


*Fig 4. The cycle of Guided Inquiry based flipped classroom model.*[25]

Periodic system material is given in each guided inquiry syntax. Starting with the orientation syntax, a video is given on the Discord application which contains an introduction to the material of the periodic system of elements at the meeting. The video will provoke the curiosity of students so that they are interested in learning the material. In the exploration and formation of concepts, questions are given in the form of coherent key questions that will require students to find concepts independently. Learners are given a picture of the periodic table in the key question, then answer the questions coherently in the Discord application. Application and closing learners will discuss questions in groups in the classroom and present the results of their discussions [26]. At this stage, activeness in learning is prioritised so that students' understanding of the material of the periodic system of elements can be known.

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 51 No. 2 July 2025, pp. 444-456

At the prototype III stage, formative evaluation was carried out in the form of expert review and one-to-one evaluation and then revised to obtain a product with minimal errors [19]. The expert assessment stage was carried out by five experts consisting of three lecturers from the Chemistry Department FMIPA UNP and two chemistry teachers from SMAN 8 Padang. The products that have been produced will be carried out content and construct validation. After validation, if there are deficiencies, revisions will be made. Products that will be validated consist of two categories, namely content validation and construct validation. In content validation there are 4 components assessed by the validator. The results of the assessment of content validity can be seen in the table below.

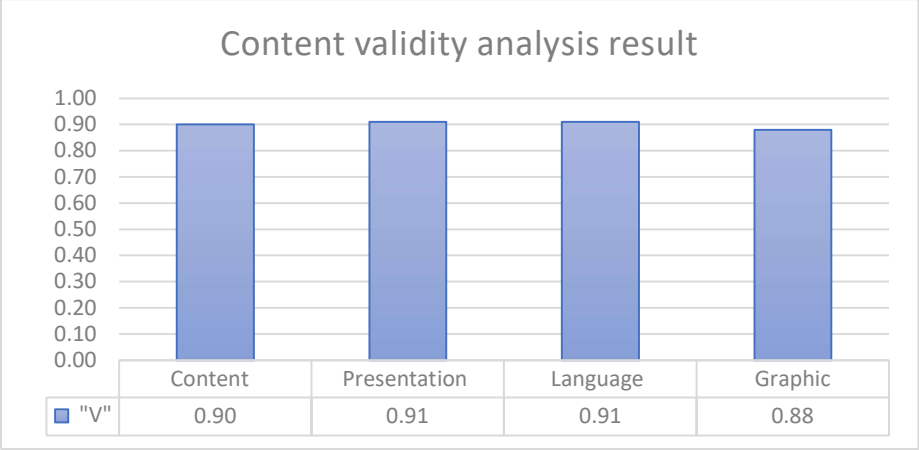


*Fig 5. Content validity analysist result*

The results of the questionnaire filled in by the validator will be processed using the Aiken's V formula so that the content validation assessment on the content component obtained a value of 0.90 with a valid category, the presentation component obtained a value of 0.91 with a valid category, the language component obtained a value of 0.91 with a valid category and the graphick component obtained a value of 0.88 with a valid category so that for content validation a valid product is obtained with an average of 0.90. While construct validation obtained an assessment on the display component obtained a value of 0.90 with a valid category and a convenience component of 0.91 with a valid category so that the value obtained on construct validity is 0.91 with a valid category. The results of construct validity can be seen in the table below.

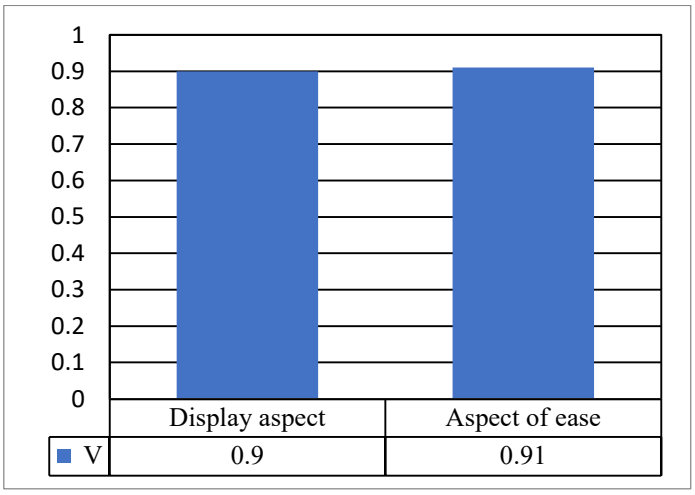


*Fig 6. Construck analysist result*

In the individual assessment stage, interviews were conducted with three students of SMAN 8 Padang with different cognitive levels to determine the efficiency of the products produced and the acceptability by students [27]. Based on the results of the

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 51 No. 2 July 2025, pp. 444-456

interview, the material of the periodic system of elements has been studied before so that it makes it easier to understand the learning system developed, the appearance on the Discord application is clear and easy to understand, the instructions on the key questions are coherent and easy to understand making it easier to answer questions, and the model used can help in the learning process but still needs guidance from the teacher, and in general when using the Discord application there are no difficulties but constrained by the internet network and the application usage guide is very useful so as to facilitate the learning process.

After conducting Prototype III, then a small group trial was conducted on nine students of SMAN 8 Padang. At this stage students conduct learning with a flipped guided inquiry learning (FGIL) based learning system using the Discord application on Periodic System of Elements material, after learning, students conduct an evaluation by filling out a Practicality questionnaire consisting of an assessment of ease of use, time efficiency and usefulness.

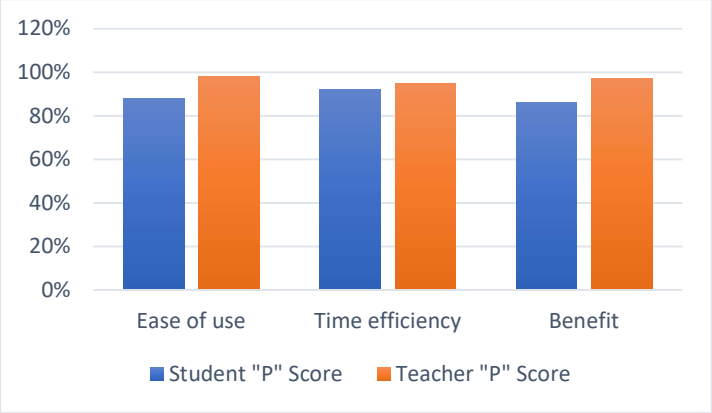


*Fig 7. Small Group Practical Result*

Based on the analysis of the practicality questionnaire from the teacher, 97% was obtained with a very practical category, while the students obtained 89% with a very practical category. After prototype IV is revised, a valid and practical product will be obtained.

One of the questions in the key question that learners must answer can be seen in the figure 9. students are given questions related to the development of the periodic system of elements in meeting 1. Presented with a table consisting of elements in triades, learners are expected to understand the development of atomic theory according to Dobereineer.

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 51 No. 2 July 2025, pp. 444-456

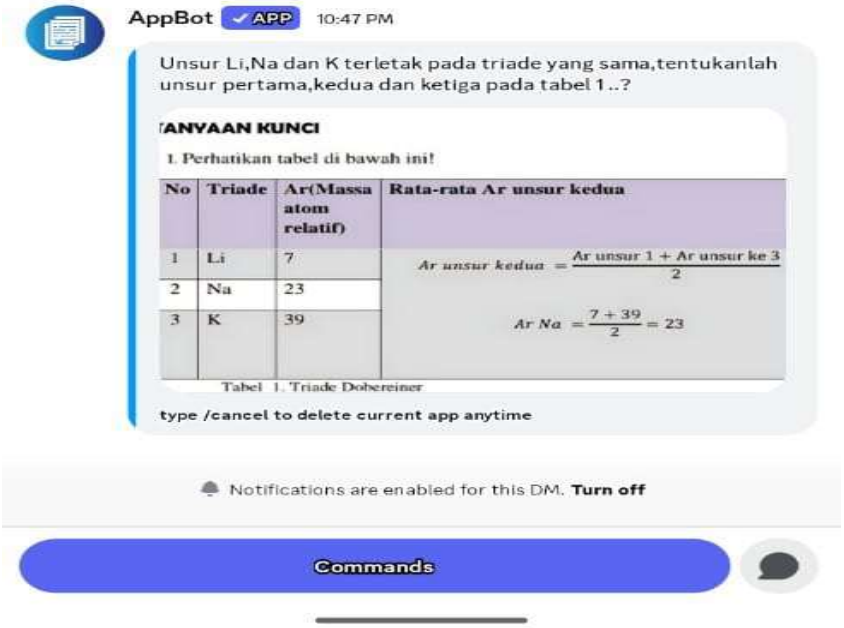


*Fig 8.* Key question for meeting 1

Student 1 had a complete understanding of Dobereineer's periodic system. Where he correctly mentioned the name of the element in one triade complete with its relative atomic mass. He also explained how to get the relative atomic mass of the second element correctly. Whereas Student 2 had sorted the elements in one triade but he did not understand how to obtain the relative atomic mass of the second element. Student 3 only mentioned the elements in one triade without sorting the first, second and third elements. Based on this answer, students already understand the theory of the development of the periodic system of elements, namely Dobereiner grouped three elements based on the similarity of properties and the increase in their relative atomic mass. This theory is called the Triade. A triade is three elements arranged by increasing relative atomic mass (Ar), so that the Ar of the second element is approximately equal to the average Ar of the first and third elements . For more clarity, take a look at the students' answers in the table

Table 3. Describe of students answer's key questions in figure 9

| Student | Answer |
|---|---|
| 1 | There are 3 elements where the first element is Li with a relative atomic mass of 7, the second element is Na with a relative atomic mass of 23 and the third element is K with a relative atomic mass of 39. The relative atomic mass of the second element is the sum of the first element plus the third divided by 2 so that 7 plus 39 divided by 2 becomes 23. |
| 2 | In the table there are 3 elements, namely Na (first element), Li (second element), and K (third element). Where to find the second element by adding the first element with the third element divided by 2 |
| 3 | There are 3 elements in the table, namely the element Li has Ar 7, Na with Ar 23 and K with Ar 39. |

In studying the periodic system of elements, it is important to understand the characteristics of elements in each class and period, as well as how the properties of elements change within a class and period [28]. Thus, we can understand the properties of chemical elements and how they interact with other elements.

## IV. CONCLUSION

The research results on content validation obtained a valid product with an average of 0.90, with content validation assessments for the content component scoring 0.90, the presentation component scoring 0.91, the language component scoring 0.91, and the graphic component scoring 0.88. Meanwhile, the construct validation was 0.91 with a valid category; the display component scored 0.90 and the ease component scored 0.91. The practicality from teachers obtained 97% with a very practical category, while from students the result was 89% with a very practical category, thus resulting in a valid and practical Flipped Guided Inquiry Learning (FGIL)-based learning system product using the Discord application on the periodic table of elements material.

## ACKNOWLEDGMENT

The author expresses gratitude for the assistance from various parties who have provided suggestions, guidance, motivation, support, and directions to complete this article. The author extends the greatest thanks to the honorable: Mrs. Fauzana Gazali, S.Pd., M.Pd, Mrs. Dwi Finna Syolendra, M.Pd, Mr. Nofri Yuhelman, M.Pd and Mr. Ifan Rivaldo S.Pd., Gr., M.Pd as expert validators, all students of grade XI SMAN 8 Padang as research subjects during the practicality stage, and all parties involved in the writing of this article.

## REFERENCES

[1] A. Priliyanti, I. W. Muderawan, and S. Maryam, "Analisis Kesulitan Belajar Siswa Dalam Mempelajari Kimia Kelas Xi," *J. Pendidik. Kim. Undiksha*, vol. 5, no. 1, pp. 11–18, 2021, doi: 10.23887/jjpk.v5i1.32402.

[2] A. F. Manggabarani and M. Masri, "Pengaruh Model Pembelajaran Blended Learning Terhadap Motivasi dan Hasil Belajar Siswa Kelas X SMA Negeri 1 Pitumpanua Kab . Wajo ( Studi Pada Materi Pokok Sistem Periodik Unsur ) The Effect Of ' Blended Learning ' Models On Motivation and Student Achieve," *J. Cemica*, vol. 17, pp. 83–93, 2016.

[3] K. S. Sitaresmi, S. Saputro, and S. B. Utomo, "Penerapan Pembelajaran Project Based Learning (PjBL) untuk Meningkatkan Aktivitas dan Prestasi Belajar Siswa pada Materi Sistem Periodik Unsur (SPU) Kelas X …," *J. Pendidik. Kim.*, vol. 6, no. 1,pp.54-61,2017, [Online].Available: https://jurnal.fkip.uns.ac.id/index.php/kimia/article/viewFile/9405/7476

[4] Afrianto, "English Language Teaching And Research Being a Professional Teacher in the Era of Industrial Revolution 4.0: Opportunities, Challenges and Strategies for Innovative Classroom Practices Afrianto Faculty of Teachers Training and Education (FKIP), Universita," *Being a Prof. Teach. era Ind. Revolut. 4.0 Oppor. challenges Strateg. Innov. Classr. Pract. English Lang. Teach. Res.*, vol. 2, no. 1, pp. 2–5, 2018.

[5] I. Syarif, "Pengaruh Model Blended Learning Terhadap Motivasi Dan Prestasi Belajar Siswa Smk the Influence of Blended Learning Model on Motivation and Achievement of Vocational School Student," *J. Pendidik. Vokasi*, vol. 2, no. 2, pp. 234–249, 2012.

[6] M. Kaur, "Blended Learning - Its Challenges and Future," *Procedia - Soc. Behav. Sci.*, vol. 93, pp. 612–617, 2013, doi: 10.1016/j.sbspro.2013.09.248.

[7] Burhanuddin, "Efektivitas penerapan model pembelajaran blended learning terhadap kemampuan menulis artikel ilmiah," *EKSPOSE J. Penelit. Huk. dan Pendidik.*, vol. 20, no. 2, pp. 1280–1287, 2021.

[8] S. Patrick and C. Sturgis, "Maximizing Competency Education and Blended Learning Insights From Experts," *Int. Assoc. K-12 Online Learn.*, no. March, pp. 1–47, 2015, [Online]. Available: http://www.competencyworks.org/resources/stripping-off-the-ceiling-of-the-education-system-with-blended-learning/%5Cn

[9] O. Dakhi, J. Jama, and D. Irfan, "Blended Learning: a 21St Century Learning Model At College," *Int. J. Multi Sci.*, vol. 1, no. 7, pp. 50–65, 2020.

[10] N. Karjanto and M. J. Acelajado, "Sustainable Learning, Cognitive Gains, and Improved Attitudes in College Algebra Flipped Classrooms," *Sustain.*, vol. 14, no. 19, pp. 1–18, 2022, doi: 10.3390/su141912500.

[11] M. I. Baig and E. Yadegaridehkordi, "Flipped classroom in higher education: a systematic literature review and research challenges," *Int. J. Educ. Technol. High. Educ.*, vol. 20, no. 1, 2023, doi: 10.1186/s41239-023-00430-5.

[12] R. Meilisa and D. Pernanda, "Model Pembelajaran Flipped Classroom Pada Mata Kuliah Algoritma Dan Struktur Data," *J. Ilm. Pendidik. dan Pembelajaran*, vol. 4, no. 3, pp. 571–577, 2020.

[13] J. Lowell, B. Utah, M. A. Verleger, and D. Beach, "The Flipped Classroom : A Survey of the Research The Flipped Classrom : A Survey of the Research," 2013.

[14] M. Sarumaha and D. Harefa, "Model Pembelajaran Inquiry Terbimbing Terhadap Hasil Belajar Ipa Terpadu Siswa," *Ndrumi J. Ilmu Pendidik. dan Hum.*, vol. 5, no. 1, pp. 27–36, 2023, doi: 10.57094/ndrumi.v5i1.517.

[15] D. M. Hanson, "Instructor ' s Guide to Process Oriented Guided Inquiry Learning by With Contributions from other POGIL project personnel : Instructor ' s Guide to Process Oriented Guided Inquiry Learning," p. 56, 2013.

[16] U. Tidar, "The Effectiveness of the Process Oriented Guided Inquiry Learning (POGIL) Model in Educational Psychology Learning," vol. 2, no. 2, pp. 375–388, 2018.

[17] M. B. Huda, "Pemanfaatan Discord Sebagai Alternatif Media Pembelajaran Secara Daring," *Inspirasi J. Ilmu-Ilmu Sos.*, vol. 19, no. 2, pp. 659–667, 2022.

[18] M. A. P. Putra, A. Salim, and A. H. Utama, "Pemanfaatan Aplikasi Discord Sebagai Alternatif Media Pembelajaran Online di Masa Pandemi COVID-19," *J-INSTECH J. Instr. Technol.*, vol. 2, no. 2, pp. 75–85, 2021.

[19] T. Plomp and N. M. Nieveen, "An introduction to educational design research," 2010.

[20] M. U. Sari and M. Mawardi, "Development of a Guided Inquiry-Based Moodle E-Learning System on the Topic of Salt Hydrolysis," *J. Pendidik. MIPA*, vol. 23, no. 1, pp. 244–255, 2022, doi: 10.23960/jpmipa/v23i1.pp244-255.

[21] A. S. Harahap and Mawardi, "Development of Guided Inquiry-Based Flipped Classroom Learning System Using Moodle on Buffer Solution Material For the Industrial Revolution 4.0," *J. Pendidik. dan Pengajaran Kim.*, vol. 11, no. 1, pp. 109–120, 2022, doi: 10.23960/jppk.v11.i1.2022.11.

[22] I. Ananda Ismail and M. Mawardi, "Flipped Classroom Learning System Guided Inquiry On Thermochemical Materials For High School Students Class XI," *Int. J. Progress. Sci. Technol. (IJPSAT*, vol. 30, no. 1, pp. 280–287, 2021, [Online]. Available: http://ijpsat.ijsht-journals.org

[23] R. Akmar, M. Mawardi, A. Ulianas, and F. Q. Aini, "Effectiveness of Discord Instructional Media Integrated with Flipped Classroom and Guided Inquiry Learning on Reaction Rates on Students Learning Outcomes," *J. Penelit. Pendidik. IPA*, vol. 10, no. 1, pp. 108–115, 2024, doi: 10.29303/jppipa.v10i1.6385.

[24] V. G. Fani and M. Mawardi, "Flipped classroom learning system based on guided inquiry using moodle on acid-base solutions," *J. Pijar Mipa*, vol. 17, no. 3, pp. 361–368, 2022, doi: 10.29303/jpm.v17i3.3476.

[25] E. Delfianza, M. Mawardi, and O. Suryani, "Development of Flipped Classroom Based Guided Inquiry Learning System with Digital Literacy Using Discord Application on Thermochemistry," *J. Penelit. Pendidik. IPA*, vol. 9, no. 7, pp. 5228–5235, 2023, doi: 10.29303/jppipa.v9i7.4245.

[26] I. Khairunnisak, M. Mawardi, H. R. Widarti, and S. Yamtinah, "Effectiveness of Guided Inquiry Based Student Worksheet Integrated with Flipped Classroom System on Reaction Rate Material on Students' Ability to Think Critically," *J. Penelit.*

*Pendidik. IPA*, vol. 9, no. 5, pp. 2431–2437, 2023, doi: 10.29303/jppipa.v9i5.3271.

[27] S. S. Syafei and M. Mawardi, "POGIL Model Integrated Flipped Classroom Assisted Learning Management System (LMS) for Learning Solution in ERI 4.0," *J. Penelit. Pendidik. IPA*, vol. 8, no. 2, pp. 444–451, 2022, doi: 10.29303/jppipa.v8i2.1298.

[28] R. Kusumawardhani, S. Suryati, and Y. Khery, "Pengembangan Media Pembelajaran Berbasis Android Untuk Penumbuhan Literasi Sains Siswa Pada Materi Sistem Periodik Unsur," *Hydrog. J. Kependidikan Kim.*, vol. 5, no. 2, p. 48, 2019, doi: 10.33394/hjkk.v5i2.1589.