International Journal of Multidisciplinary Research and Growth Evaluation.

Discord Integrated Flipped Guided Inquiry Learning System Design on Buffer Solution: An Innovative Development Study

Naqqiya Sabrinna [1], Mawardi Mawardi [2*], Okta Suryani [3], Reza Akmar [4]
[1, 2, 3, 4] Departmen of Chemistry, Padang State University, Indonesia.Semarang State University, Indonesia

* Corresponding Author: **Mawardi Mawardi**

Article Info

ISSN (online): 2582-7138
Volume: 06
Issue: 03
May-June 2025
Received: 08-04-2025
Accepted: 01-05-2025
Page No: 985-994

Abstract
Education in the Society 5.0 Era requires the utilization of advanced information technology that enables the quick and effortless distribution of diverse knowledge in educational activities, unbound by time and space limitations. Technology integration in education is a crucial factor for the efficacy of the learning process. This study aims to create a flipped guided inquiry learning system utilizing the Discord application for buffer solution content and to assess its validity and practicality. The goal of this study is to provide a different approach to chemistry teaching that matches the requirements of the Merdeka Curriculum and the Society 5.0 period, particularly with regard to the content of buffer solutions. This study was carried out over six months, employing the Plomp and Educational Design Research (EDR) Models. The research involved conducting preliminary studies and prototyping phases. The participants in this study comprised lecturers and teachers as experts, together with nine students. Construct validity and content validity data were examined using Aiken's V formula and practicality percentage, respectively. The study's results indicated that the value of 0.89 for content and construct validity fell inside a valid category. Practical outcomes, with a score of 92%, are categorized as a practical category. Consequently, it can be confirmed that the developed learning system is both valid and practical, allowing for its efficiency to be evaluated in subsequent studies.

DOI: https://doi.org/10.54660/.IJMRGE.2025.6.3.985-994

Keywords: Buffer solution, discord application, flipped classroom, guided inquiry learning

1. Introduction

In the current globalization era, it is impossible to ignore the rapid growth of information technology, which has an impact on the educational field. The impact of globalization necessitates that the educational sector continually adapts to technological advancements to enhance educational quality. Technology utilization in education can address learning requirements in the Society 5.0 era, necessitating advanced information technology that enables the rapid and effortless dissemination of diverse information in educational activities, unconstrained by time and space limitations (Khaira *et al*., 2021) [15]. Technology, particularly social media platforms like WhatsApp, YouTube, Zoom Cloud Meeting, Google Classroom, Google Meet, and Instagram, has been utilized in educational contexts (Absor, 2020) [1]. Currently, several communities have also emerged in the field of education using media that are more popular and sophisticated among young people but are not yet well known to the general public. One of these media is Discord (Setyawan *et al*., 2024) [24].

Discord is a free social media platform that supports making phone calls, video conferences, screen sharing, public and private chats, and exchanging voice messages. In addition, Discord can evaluate student knowledge, provide feedback, and enable collaboration and discussion among all students without the need for direct face-to-face involvement (Dewantara *et al*., 2020). Discord is a complete platform that can create interactive and fun classes, able to support various learning styles, including blended learning such as flipped classrooms (Ghazali, 2021).

The flipped classroom paradigm seeks to improve learning quality through the implementation of a student-centered approach (Mubarok, 2017) [18]. This educational style involves completing assignments typically done in class done at home, while assignments usually done at home are completed in class (Agustini, 2021) [2]. According to research by DeMatteo (2019) [7], combining the guided inquiry learning paradigm with the flipped classroom learning system significantly increased student performance. According to Yulianis and Mawardi (2022) [10] indicate that the experimental group achieved higher average initial and final exam scores compared to the control group, so illustrating the significant effect of Flipped Guided Inquiry Learning (FGIL) on student learning outcomes.

One of the student-centered learning approaches is the guided inquiry approach (Insani *et al*., 2022; Nengsih & Mawardi, 2021) [12, 17]. Guided inquiry learning requires instructors to pose a sequence of questions to assist students in discovering concepts from their studies (Kardena & Mawardi, 2020) [14]. The Flipped Guided Inquiry Learning system integrates the flipped classroom approach with the principles of guided inquiry learning, resulting from the application of the flipped classroom paradigm to guided inquiry learning (Siregar & Mawardi, 2022) [16]. The implementation of Flipped Guided Inquiry Learning utilizes two learning modalities, wherein education occurs in reverse through pivotal questions that enable students to independently investigate learning concepts at home (asynchronous) prior to inperson instruction at school (synchronous) (Waer & Mawardi, 2021) [19].

The study of chemistry needs to start with basic concepts and progressively advance to facilitate the building of complicated concepts. Three levels of representation are used to teach scientific concepts: macroscopic, sub-microscopic, and symbolic (Johnstone, 1993). However, research by Ulva *et al*. (2016) revealed that students' understanding of buffer solution ideas at the sub-microscopic level was markedly deficient. The application of technology accomplishes the amalgamation of the three tiers of chemical representation via educational media (Wu *et al*., 2000).

A study was conducted to create a flipped guided inquiry learning (FGIL) system utilizing the Discord platform for buffer solution content and to evaluate its validity and practicality. This is anticipated to be an educational system that employs technology through the Discord social media platform. Implementing a Merdeka Curriculum and student-centered learning can facilitate students' comprehension of buffer solution concepts in chemistry education.

2. Method

The employed research methodology is development research, also referred to as educational design research (EDR). This research is a cyclical process involving analysis, design, assessment, and modification, repeated until a balance is attained between the ideal answer and its practical implementation. This study examines educational research designed to construct a Flipped Guided Inquiry Learning approach utilizing the Discord program to explore buffer solutions in phase F of Senior High School. This study employs the Plomp development paradigm, comprising three stages: preliminary research, prototype phase, and assessment phase (Plomp & Nieveen, 2007) [22].

The initial step begins with an assessment of needs and context, a literature evaluation, and the formulation of a conceptual framework. The requirements analysis seeks to examine the basic difficulties encountered in Senior High School about the chemistry learning process related to buffer solutions. Three chemistry educators from distinct institutions are interviewed for this study, and students in phase F of class XII are given a need questionnaire. Furthermore, a contextual analysis is performed on the syllabus utilized in schooling. A literature study entails collecting relevant resources related to the research to identify and assess the obstacles faced by educators and students in the chemical learning process. The formulation of a conceptual framework depends on the evaluation of needs and conditions. The analysis results are corroborated by a literature review that delineates the rationale for the development of this learning system.

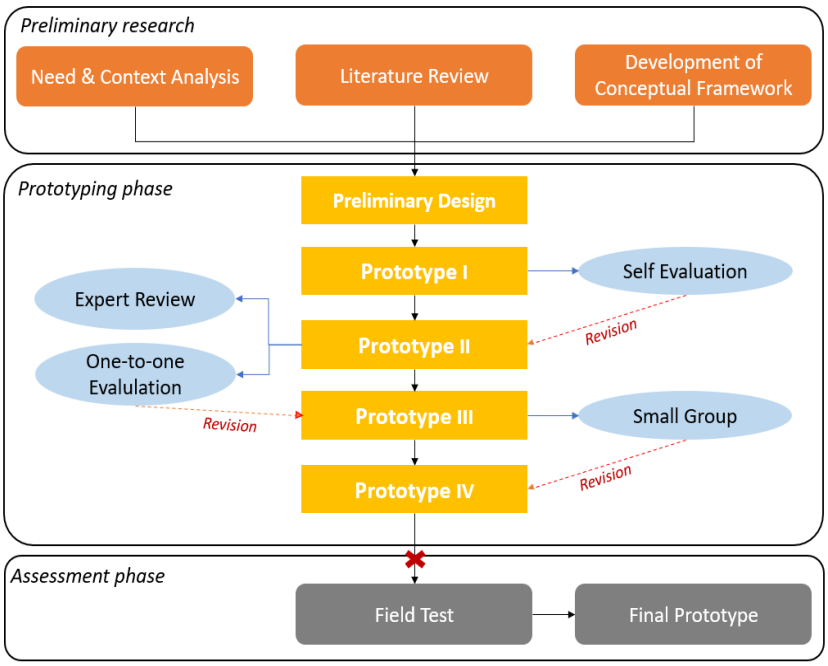

Fig 1: EDR Development Steps (Handri *et al*., 2023) [9]

The second stage encompasses the creation of prototypes I, II, III, and IV. The prototypes are the outcome of formative evaluation, which aims to enhance product quality by pointing out flaws in the research object and generating ideas for enhancements. This evaluation has four steps, notably self-evaluation, wherein the individual appraises the product in development using a checklist methodology. A comprehensive evaluation by three chemistry lecturers from the Department of Chemistry Education at Padang State University and two chemistry teachers from SMAN 8 Padang will yield assessments and recommendations for improving the product in development. One-to-one evaluation and personal discussions with students following observations and supervision of their use of the product. The expert review and individual evaluation stages comprise the validity assessment of the product throughout its development. Finally, small group will assess the feasibility of the product during development.

This study employs two types of instruments: validation instruments and practicality instruments. The data from this study will be analysed with descriptive statistics to provide percentages and averages, employing Aiken's V scale for validity analysis. The formula for Aiken's V:

$$V = \frac{\sum s}{n\,(c-1)}$$

$$s = r - Io$$

Descriptions:
V = Aiken's V scale
$\sum s$ = the sum of all s values from all validators
n = number of validators
c = the highest validity number (= 5)
r = the number chosen by validator
Io = the lowest validity number (= 1).

Table 1: Validity Category

Aiken's V scale	Category
V ≥ 0.80	Valid
V < 0,80	Invalid

Source*:* (Aiken, 1985)

The practicality assessment is obtained through students completing a response questionnaire, which is then assessed using the revised formula:

$$P = \frac{R}{MS} \times 100\%$$

Descriptions:
P = percent value sought
R = raw score by students
MS = maximum score of the test concrened

Table 2: Practicality Level Category

Score	Practicality
86% - 100%	Very Practical
76% - 85%	Practical
60% - 75%	Practical Enough
55% - 59%	Not Practical Enough
≤ 54%	Not Practical

Source*:* (Purwanto, 2010)

3. Results and Discussion

Preliminary Research

Need analysis

The research has concluded and produced several phases in the execution of the Plomp development method. The initial phase of this study entails the evaluation of needs and circumstances. The needs assessment is performed to determine the challenges faced by pupils in the educational process. Interviews were conducted with three chemistry educators from SMAN 1 Padang, SMAN 8 Padang, and SMAN 13 Padang, and a needs analysis questionnaire was administered to the XII class.

According to interviews with chemistry teachers, the teaching of chemistry education now uses the Merdeka Curriculum. Teachers noted that the implemented learning paradigm has not facilitated the exploration of concepts independently, which causes teachers to have to provide an understanding of basic concepts during class and reinforce concepts at home. It found that some teachers considered the material on buffer solutions difficult to understand because it is abstract and complicated, supported by the learning media used, which did not cover sub-microscopic representations. Thus, the implementation of student-centered learning was considered suboptimal.

Ninety students from three different schools were given needs analysis questionnaires, and the results showed that 60 of them had difficulty understanding the information on buffer solutions. Furthermore, 58 students expressed dissatisfaction with the learning media used on buffer solutions, which included PowerPoint presentations, printed books, student worksheets, E-modules, and E-worksheets. The characteristicsof learning media preferred by students include 55 students favoring accessibility and ease of use, 46 students selecting portability for use anytime and anywhere, and 34 students opting for affordability. Thus, the Discord app can be utilized for technology-based learning, which can be an alternative to the learning media that students want.

Context Analysis

The content of the buffer solution's contextual analysis aligns with the Merdeka Curriculum's learning goals. This investigation constitutes a content standard evaluation; that is, students are able to explain, differentiate, and ascertain the relationship between the pH of acid, base, and salt solutions in buffer systems, apply mathematical concepts in chemical equations, understand and explain the application of buffer solutions in everyday life.

Literature Study

The next stage involves a literature review conducted to gather diverse reference materials, including books, papers, journals, and other pertinent resources related to the topic. Helfira and Dj (2022) [11] found that guided inquiry learning significantly improved student learning outcomes in buffer solution material compared to the guided discovery learning model. According to a study by DeMatteo (2019) [7], A flipped classroom model integrated with a guided inquiry learning approach can improve student-teacher interaction and elevate cognitive abilities.

Harahap and Mawardi (2022) [20] conducted research employing the Moodle platform to create a learning system that integrates guided inquiry learning with a flipped classroom methodology, concentrating on the topic of buffer solutions. The flipped classroom facilitates student

comprehension of the topic. It allows for lesson repetition at home, as demonstrated by student access to Moodle, while the guided inquiry model subsequently enhances student engagement. However, the application is paid, so the public cannot access it, so a more sophisticated application is needed, and that is the Discord application. Research conducted by Wulanjani (2018) [32] indicates that the utilization of the Discord application in educational settings can alter students' attitudes towards listening to instructor explanations during classroom instruction. Students become active, interactive, and motivated.

a study conducted by Delfianza *et al*. (2023) [6] successfully developed a flipped class learning system integrated with guided inquiry using the Discord application for digital literacy valid and practical in thermochemistry material. The use of the Discord application allows students to find their concepts independently. Subsequent research by Akmar *et al*. (2024) [4] evaluated the effectiveness of incorporating Discord learning materials with guided inquiry learning and flipped classrooms on reaction rates to improve student learning outcomes. The study showed that the N-gain value in the experiment group was 0.70, while in the control group, 0.33. This study found that the guided inquiry learning approach, when used in conjunction with Discord as a learning tool in the flipped classroom system, significantly enhanced student learning outcomes. Similar research was conducted by Research by Violin *et al*. (2024) [30] the data analysis results indicate that using Discord learning media in conjunction with flipped classrooms that use guided inquiry on chemical equilibrium material effectively enhances student learning outcomes.

Conceptual Framework

The research progressed to the conceptual framework design phase, informed by needs and context analysis with a literature assessment, culminating in the development of a product: a flipped guided inquiry learning system utilizing the Discord application for the subject of buffer solutions. Figure 2 illustrates the outcomes of the research's conceptual framework.

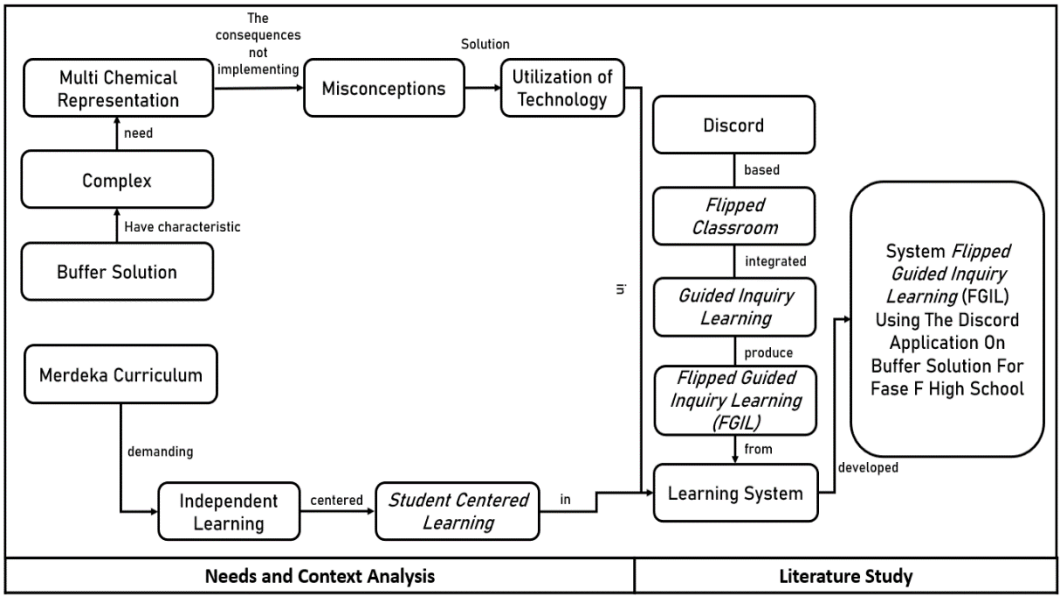

Fig 2: Development of conceptual framework

Prototyping Phase

Prototype I

The prototyping phase commences with the preliminary design, subsequently leading to the creation of four prototypes. The initial design phase produces a reversed flipped guided inquiry learning model that employs the Discord application, implemented under two educational settings (Ismail *et al*., 2023) [13]. Figure 3 depicts the subject of this study. Learning transpires under two conditions: synchronous and asynchronous. The orientation, exploration, and concept formation phases will be conducted asynchronously on the Discord platform. The application and closing processes will occur simultaneously or via in-person instruction conducted synchronously.

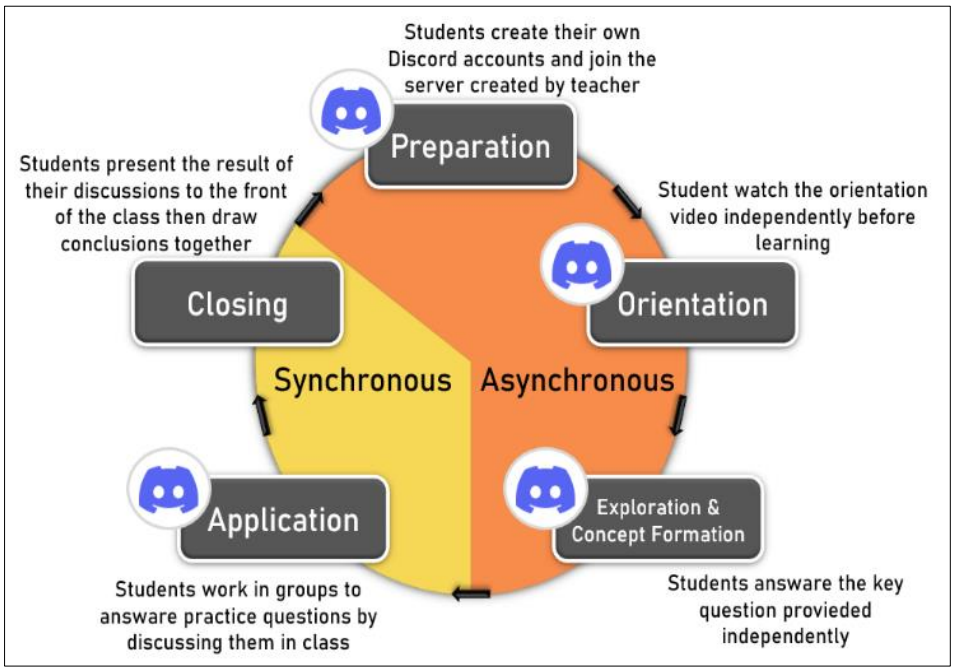

Fig 3: The cycle of flipped classroom system based on guided inquiry learning model using Discord (Mawardi *et al*., 2021) [31]

The initial part of guided inquiry learning is the orientation stage, which prepares students for the learning process (Lenggogeni & Mawardi, 2022) [23]. At this juncture, the educator uploads a video to the Discord channel that stimulates student engagement and piques their interest in the issue of buffer solutions. This orientation stage is crucial as it will impact student enthusiasm to learn. The study demonstrates that the orientation video on Discord possesses clear audio and graphics, along with intelligible text, as illustrated in Figure 4.

The exploration and concept development phase, wherein pupils can grasp the presented material, is illustrated in Figure 5. At this point, a model and key questions are important to help students understand (Tuti *et al*., 2023) [29]. When it comes to understanding abstract and complex concepts in chemistry, the use of models is important (Halim *et al*., 2013) [8]. As a result, choosing the right models is important for preventing misconceptions and concept misunderstandings among students. To minimize this, the abstract conceptual model employs a comprehensive multi-representation (Orgill & Sutherland, 2008) [21].

The application stage is when students reinforce and broaden the principles they have developed. This phase serves as a venue to implement the concepts picked up in the previous stage. As can be seen in Figure 6, activities and questions are presented to students at this application stage. Exercises provide students the opportunity to cultivate self-confidence in basic environments and familiar contexts. This application stage is carried out synchronously (face-to-face and virtual) with a group discussion method (Ninda & Mawardi, 2022) [25]. This stage will assess the student's comprehension of the provided content to ensure the attainment of the learning goals.

The final stage is the closing stage, at which students and teachers collaboratively draw conclusions related to the learning that has been carried out (Syafe'i & Mawardi, 2022) [26]. The teacher will validate and strengthen the concepts obtained by students directly, both in online class conditions and in direct face-to-face class conditions (Sitanggang *et al*., 2022) [26], as seen in Figure 7.

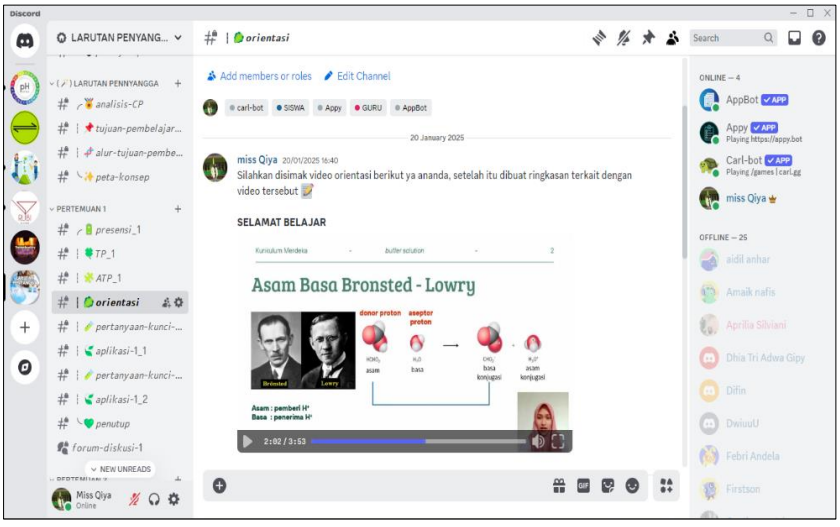

Fig 4: View of Oriented video on Discord

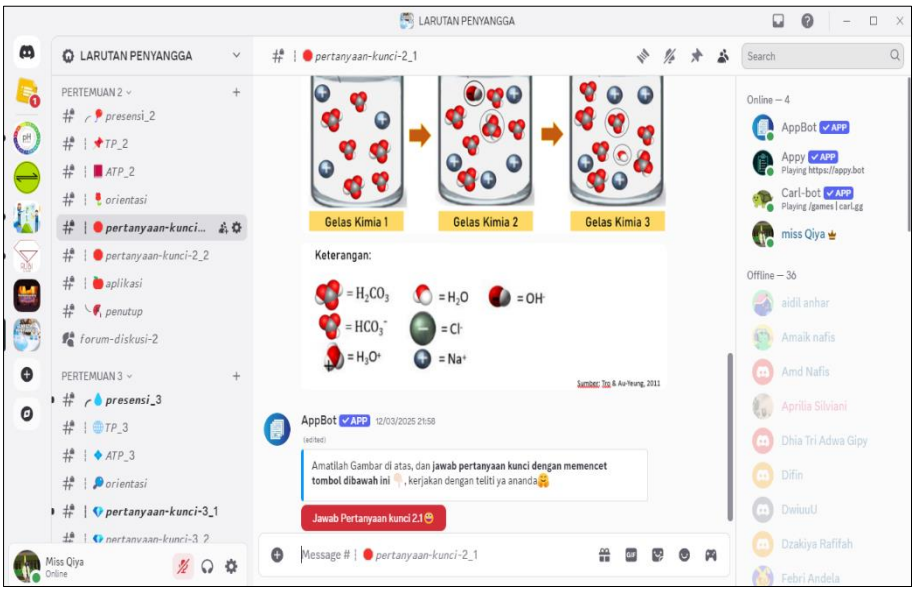

Fig 5: Key questions on Discord

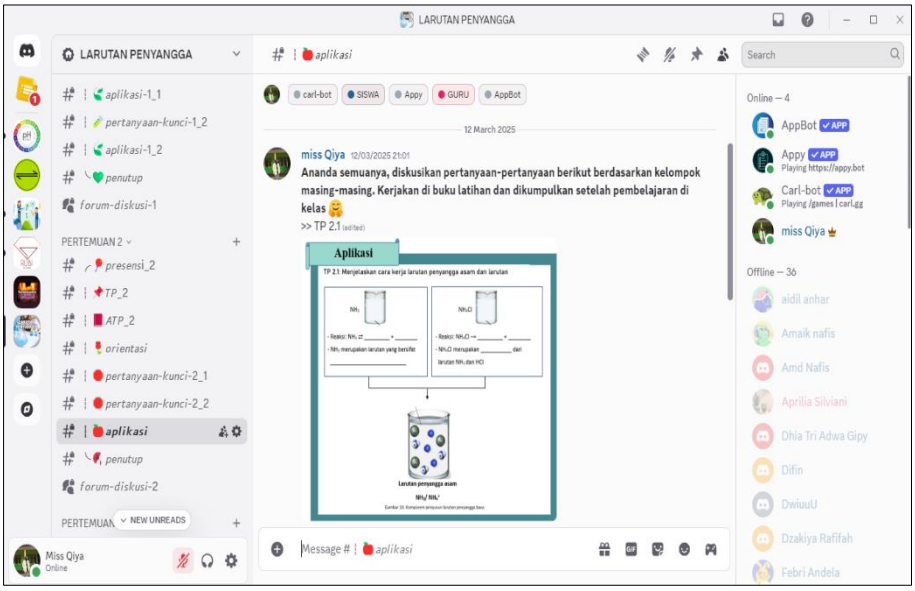

Fig 6: Application stage on Discord

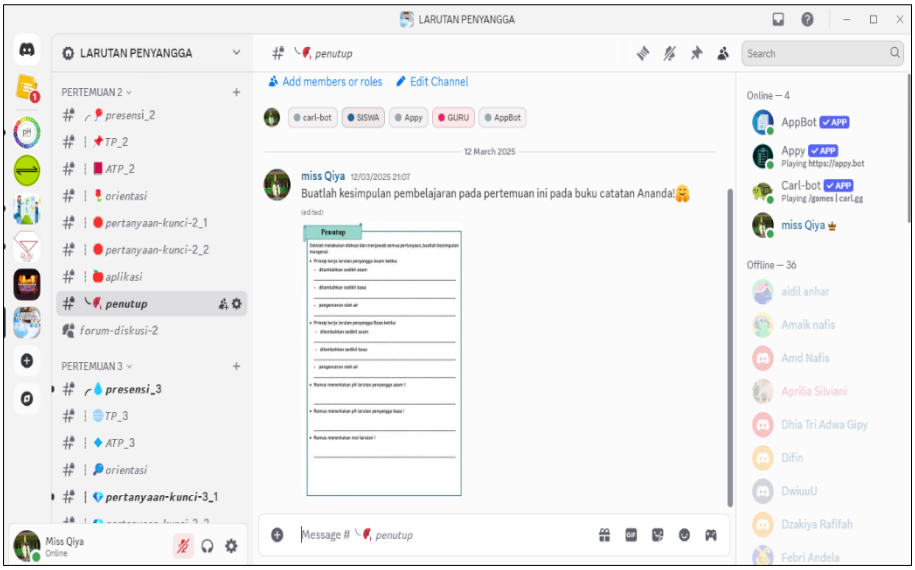

Fig 7: View of closing stage on Discord

Prototype II

The product will thereafter proceed to the prototype I development phase, during which it will undergo self-assessment, signifying the initial formative evaluation stage. The author will assess the generated product by filling out a questionnaire and validating the pertinent criteria. Following the completion of the self-evaluation form, the components are revised in accordance with the assessment results. Furthermore, if it is finished in accordance with the FGIL system, the components are submitted to the Discord application. Furthermore, the Evaluation will produce prototype II (Ananda *et al*., 2023) [5].

Prototype III

At this point, an expert review and one-on-one assessment will be conducted (Sari & Mawardi, 2022) [27]. One-to-one evaluations are conducted on grade XII students who have studied the buffer solution topic. This Evaluation aims to analyze student reactions to the resulting prototype II. In order for the findings to be representative of all pupils, three students were chosen based on their high, medium, and low ability levels. The interview's findings demonstrated that the final product was aesthetically pleasing, the orientation video's audio was clear, the questions and content were simple to comprehend, the model was clear, the directions were clear, and it might assist students in answering important questions.

The expert review seeks to achieve a valid scientific prototype. This is accomplished via the validation of prototype II. The utilised instrument is questionnaire validation, with two types: content validity and construct validity. The validator will assess four elements in the content validity questionnaire: content, presentation, language, and graphics. The validator will assess two elements in the construct validity: appearance and presentation.

The content validity questionnaire produced an average score of 0.90 across 24 items. The result exceeds 0.8 on Aiken's V scale, signifying validity. The FGIL system created on Discord has satisfied the criteria outlined in the validity questionnaire for application in educational environments. The mean determined for content validity was derived from five evaluators. The validators comprised three chemistry specialists from Padang State University and two chemistry instructors from SMAN 8 Padang. The questionnaire contains a section for the validator to provide comments and suggestions on the product under development. The recommendations, input, and opinions will serve as guides for enhancing the product. If enhancements are necessary, they are implemented to ensure the final product is of superior quality and aligns with its intended purpose.

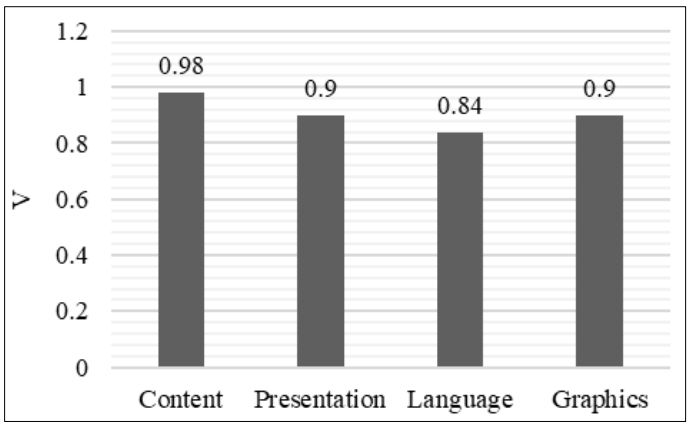

Fig 8: Content validity results analysis

The construct validity questionnaire will need the validator to evaluate two aspects: the appearance component and the presentation component. The validator received an average score of 0.88 from the 15 statement items tested. This validity result meets the valid criteria on the Aiken V scale.

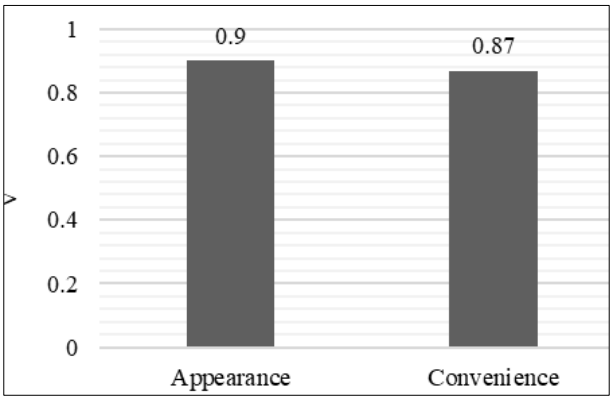

Fig 9: Analysis of construct validity results

Following an expert evaluation and the acquisition of a legitimate product, prototype III was developed, which would subsequently undergo the practicality testing phase for teachers and students utilizing a practicality questionnaire. Two chemistry teachers participated in this practical test, which was conducted in small groups with nine students of varying ability levels (high, medium, and low) in accordance with their suggestions.

The researcher divided the students into several study groups and thereafter conducted a simulation using Discord and instructional strategies designed in accordance with the integrated guided inquiry learning paradigm of the flipped classroom, concentrating on one cycle of the buffer solution sub-material. Students were asked to respond to a questionnaire that the researcher handed them, including complaints and recommendations.

Prototype IV

Evaluating the usability and functionality of the created product. The results of the practicality assessment will be derived from a small group evaluation. A survey was

distributed to chemistry educators. A later analysis of the teacher and student assessment scores was performed. Enhancements will be implemented based on feedback from students and educators to elevate the quality of the prototype IV product. Additionally, students must complete a practicality questionnaire, the results of which will be employed to evaluate the degree of practicality. At this juncture, data is sourced from two chemistry instructors at SMAN 8 Padang and nine pupils. Figure 10 illustrates the outcomes of the feasibility assessment.

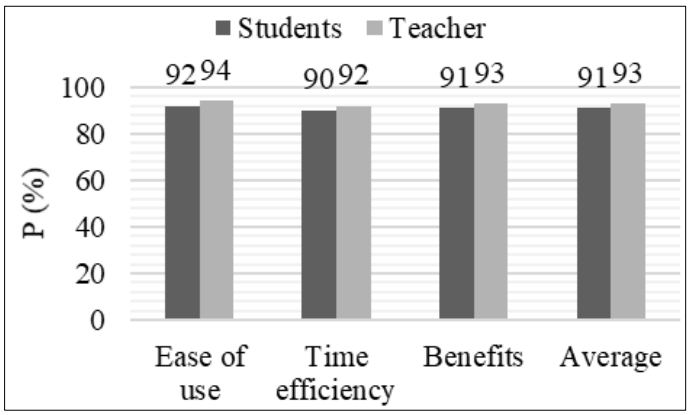

Fig 10: Analysis of practical results

Figure 10 demonstrates that the practicality of each item averages 92%, classifying them as Very Practical. This signifies that the designed product offers user-friendliness, time efficiency, and advantages. Subsequently, these discoveries were modified to develop a viable and functional prototype IV. One of the key questions that Students have to answer is the basics illustrated in Figure 11, which necessitates comprehension of the operational principle of buffer solutions. Three students' responses were examined to ascertain how well they understood the provided model.

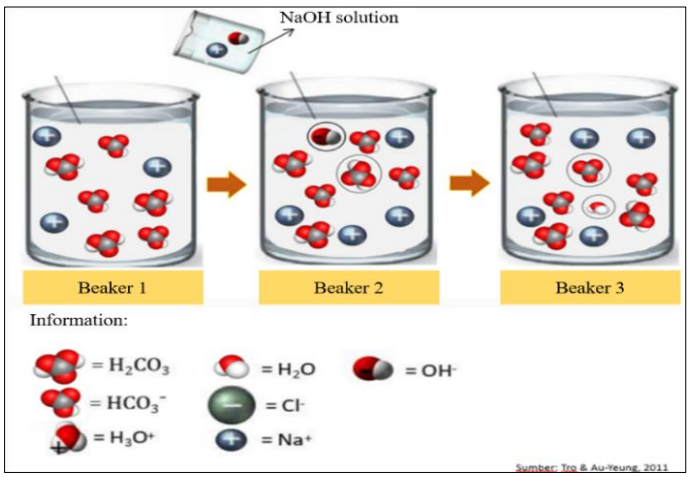

Fig 11: One models in exploration and concept formation (Tro, 2016) [28]

The image above depicts an acid buffer subjected to the introduction of a basic. It is evident from the research findings and the responses provided by students in Discord that the model can assist students in understanding the basic idea behind how a buffer solution operates. After counting the quantity of each component in the first beaker, students examine the model by adding NaOH to the second beaker, which results in a reaction between H_2CO_3 and OH^-. As a result of this reaction, HCO_3^- is produced with H2O in the third beaker. Students then estimate the number of components in the third beaker (the end of the reaction) and compare it to the number of components in the first beaker before adding the base (Tro, 2016) [28]. The subsequent text defines student comprehension as indicated in Table 1.

Table 3: Students' responses to the model in Figure 11

Students	Responses
Student 1	The H_2CO_3 component decreases while the HCO_3^- component increases in number. This is due to the reaction that occurs between H_2CO_3 and the added NaOH solution. This reaction produces HCO_3^- and H_2O components.
Student 2	The H_2CO_3 component, which was initially 3 components, decreases to 2 components, while the HCO_3^- component, which was initially 3 components, increases to 4 components.
Student 3	The H_2CO_3 component decreases while the HCO_3^- component.

Students should now be capable of appropriately responding to essential questions and recognizing concepts by employing sub-microscopic and symbolic representations to analyze the models or images associated with the important questions. Figure 11 illustrates the reaction of an acid buffer solution with the addition of a small quantity of base solution. Based on the examination of the responses, it can be concluded that Student 1 thinks more deeply than the other students because his responses were coherent and consistent with the source. Student 2 demonstrates moderate proficiency in elucidating the operational principle of the buffer solution since his responses remain incomplete. Concurrently, Student 3 exhibits limited comprehension.

Based on the research conducted by Waer & Mawardi (2021) [17], in order for students answers to the main questions to be truly in line with the current concept, they need to be provided with a clear model and represent the three levels of chemical multi-representation, that is macroscopic, sub-microscopic, and symbolic.

Students must effectively tackle substantial issues utilizing both macroscopic (visible) and sub-microscopic (molecular) representations. Moreover, symbolic representation using symbols or descriptions of a compound is crucial, as it preserves the integrity of the concepts comprehended by students, hence facilitating accurate conclusions. The integration of these three aspects of chemical representation enhances students' comprehension of concepts in the macroscopic, submicroscopic, and symbolic domains. Without these three elements, pupils would experience misunderstandings, and learning would be improved through chemical representation.

4. Conclusion

The development of a Flipped Guided Inquiry Learning (FGIL) system, confirmed by tests of validity and practicality, yielded results categorized as valid and highly practical categories. This indicates that the generated product can proceed to the effectiveness testing phase for implementation in the learning process. The validity value obtained was 0.89, with details of 0.90 for content validity and 0.88 for construct validity. The results of the practicality percentage were obtained at 92%, with details at 91% from teachers and 93% from students.

5. References

1. Absor NF. Pembelajaran Sejarah Abad 21: Tantangan dan Peluang dalam Menghadapi Pandemi Covid-19. Journal of History Education. 2020;2(1):30–35.
2. Agustini M. Meningkatkan Aktivitas Dan Hasil Belajar Siswa Menggunakan Model Flipped Classroom Melalui Aplikasi Google Classroom. Indonesian Journal of Educational Development. 2021;2(2):280–289.
3. Aiken LR. Three Coefficient for Analizyng the Reability, and Validity of Ratings. Educational and Psychological Meassurement. 1985;45:131–142.
4. Akmar R, Mawardi M, Ulianas A, Aini FQ. Effectiveness of Discord Instructional Media Integrated with Flipped Classroom and Guided Inquiry Learning on Reaction Rates on Students Learning Outcomes. Jurnal Penelitian Pendidikan IPA. 2024;10(1):108–115.
5. Ananda R, Mawardi M, Suryani O. Development of Flipped Guided Inquiry Learning (FGIL) System Using Discord Application on Chemical Equilibrium. Jurnal Penelitian Dan Pengembangan Pendidikan. 2023;10(3):746–759.
6. Delfianza E, Mawardi, Suryani O. Development of Flipped Classroom Based Guided Inquiry Learning System with Digital Literacy Using Discord Application on Thermochemistry. Jurnal Penelitian Pendidikan IPA. 2023;9(7):5228–5235.
7. DeMatteo MP. Combining POGIL and a Flipped Classroom Methodology in Organic Chemistry. American Chemical Society; 2019:217–240.
8. Halim NDA, Ali MB, Yahaya N, Said MNHM. Mental Model in Learning Chemical Bonding: A Preliminary Study. Procedia - Social and Behavioral Sciences. 2013;97:224–228.
9. Handri S, Mawardi M, Aini S, Nizar UK. Learning System with Digital Literacy Based on Guided Inquiry Integrated Flipped Classroom Using Discord Application on Colloid. Jurnal Penelitian Pendidikan IPA. 2023;9(8):6012–6019.
10. Harahap AS, Mawardi M. Development of Guided Inquiry-Based Flipped Classroom Learning System Using Moodle on Buffer Solution Material For the Industrial Revolution 4.0. Jurnal Pendidikan Dan Pembelajaran Kimia. 2022;11(1):109–120.
11. Helfira J, Dj L. Perbandingan Hasil Belajar Siswa Menggunakan Guided Inquiry Learning dan Guided Discovery Learning pada Materi Larutan Penyangga di SMAN 1 Tigo Nagari. Jurnal Pendidikan MIPA. 2022;12(3):437–442.
12. Insani M, Mawardi M, Ismail IA. The System of Flipped Classroom Based on Guided Inquiry Learning on Redox Reactions and Electrochemistry Using Moodle. International Journal of Academic Pedagogical Research. 2022;6(5):53–56.
13. Ismail IA, Mawardi M, Suryani O, Insani M, Mulyanti M. Innovative Pedagogical Approaches to the Periodic Table for Freshman Chemistry Student at the State University of Padang. Jurnal Penelitian Pendidikan IPA. 2023;9(12):12249–12257.
14. Kardena H, Mawardi M. Development of Guided Inquiry Based Student Worksheet for First College Student. International Journal of Scientific and Research Publications. 2020;10(10):375–379.
15. Khaira I, Susilawati E, Renaldi R. Implementasi Rancangan Pembelajaran Berbasis Tpack Sebagai Integrasi Pembelajaran Di Era Society 5.0 Untuk Meningkatkanhasil Belajar Mata Kuliah Ekonomi Kesehatan. Jurnal Teknologi Pendidikan. 2021;14(2):111–119.
16. Lenggogeni K, Mawardi M. Effectiveness of a Flipped Classroom Based on Guided Inquiry Learning System on Acid-Base Solutions. Jurnal Penelitian Pendidikan IPA. 2022;8(4):2168–2175.
17. Mawardi M, Aumi V, Sukmawati S, Fitriza Z, Suryani O. Penerapan Model Pembelajaran Flipped Classroom Berbasis Guided Inquiry (FGIL) Pada Pembelajaran Kimia SMA di Kabupaten Agam Sebagai Model Untuk Pembelajaran Digital di Masa Pandemi Covid 19. Pelita Eksakta. 2021;4(2):176.
18. Mubarok A. Model Flipped Classroom Dalam Memotivasi Belajar Siswa. In: Prosiding TEP & PDs Transformasi Pendidikan Abad 21; 2017:184–188.
19. Nengsih ZW, Mawardi M. Pengembangan Sistem Pembelajaran Flipped Classroom Berbasis Inkuiri Terbimbing pada Materi Hidrolisis Garam. Edukatif:

Jurnal Ilmu Pendidikan. 2021;3(4):1231–1244. doi:10.31004/edukatif.v3i4.546
20. Ninda A, Mawardi M. Validitas dan Praktikalitas Flipped Classroom Berbasis Inkuiri Terbimbing pada Materi Laju Reaksi. Entalpi Pendidikan Kimia. 2022;3(2):50–55.
21. Orgill MK, Sutherland A. Undergraduate chemistry students' perceptions of and misconceptions about buffers and buffer problems. Chemistry Education Research and Practice. 2008;9(2):131–143. doi:10.1039/b806229n
22. Plomp T, Nieveen N. An Introduction to Educational Design Research. In: Proceedings of the seminar conducted at East China Normal University. Shanghai: Netherlands Institute for Curriculum Development; 2007:23–26.
23. Sari MU, Mawardi M. Development of a Guided Inquiry-Based Moodle E-Learning System on the Topic of Salt Hydrolysis. Jurnal Pendidikan MIPA. 2022;23(1):244–255.
24. Setyawan A, Purnamasari Y, Mucholifah UH. Utilization Of Discord. Proceedings of International Conference on Applied Social Science in Education 2024. 2024;01(01):395–402.
25. Siregar FR, Mawardi M. Development of the Learning System of Flipped-Guided Inquiry-Based Learning (FGIL) Using Moodle on Chemical Equilibrium material INDONESIAN Educational. Indonesia Journal Of Educational Studies. 2022;25(1):31–49.
26. Sitanggang LO, Asra A, Mawardi M. Flipped Classroom Learning System Based on Guided Inquiry Using Moodle on Colloid. Jurnal Studi Keislaman Dan Ilmu Pendidikan. 2022;10(2):278–291.
27. Syafe'i SS, Mawardi M. The POGIL Model Integrated Flipped Classroom Assisted Learning Management System (LMS) for Learning Solution in ERI 4.0. Jurnal Penelitian Pendidikan IPA. 2022;8(2):444–451.
28. Tro NJ. Principles of Chemistry: A Molecular Approach. Pearson Education, Inc.; 2016.
29. Tuti APS, Mawardi M, Suryani O. Flipped Classroom System Based on Guided Inquiry Learning Model Using Discord Application on Reaction Rate. Jurnal Pengkajian Ilmu Dan Pembelajaran. 2023;11(3):678–690.
30. Violin P, Mawardi M, Suryani O, Akmar R. The Effectiveness of Discord Learning Media Integrated with Flipped Classroom Based on Guided Inquiry on Chemical Equilibrium Material on Student Learning Outcomes. International Journal of Multidisciplinary Research and Growth Evaluation. 2024;5(5):840–847.
31. Waer WP, Mawardi M. Integrasi Model Inkuiri Terbimbing Dan Pendekatan Flipped Classroom Pada Pembelajaran Materi Sifat Koligatif Larutan Untuk Siswa Kelas XII SMA / MA. EDUKATIF: Jurnal Ilmu Pendidikan. 2021;3(3):1029–1037.
32. Wulanjani AN. Discord application: Turning a voice chat application for gamers into a virtual listening class. English Language and Literature International Conference (ELLiC) Proceedings. 2018;2:115–119.
33. Yulianis F, Mawardi M. The Effect of The Flipped-Guided Inquiry Learning (FGIL) Learning System Toward Student Outcomes on Chemical Reaction Rate. Entalpi Pendidikan Kimia. 2022;3(2):1–8.