JPPIPA 11(9) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Integrating Flipped Classroom with Guided Inquiry Based on Digital Literacy Using Discord on Chemical Kinetics for First Year Chemistry Students

Mega Sofyan[1], Reza Akmar[1], Mawardi Mawardi[1*], Alizar Ulianas[1], Okta Suryani[1]

[1] Department of Chemistry, Universitas Negeri Padang, Padang, Indonesia.

Received: January 24, 2025
Revised: July 17, 2025
Accepted: September 25, 2025
Published: September 30, 2025

Corresponding Author:
Mawardi Mawardi
mawardianwar@fmipa.unp.ac.id

DOI: 10.29303/jppipa.v11i9.10482

Abstract: To response the needs for 21st century competencies among chemistry students, a novel approach on learning in higher education is paramount. This study presents the development and evaluation of a flipped classroom learning system for chemical kinetics, designed to enhance digital literacy and guided inquiry through Discord. This research followed the Educational Design Research (EDR) model outlined by Plomp and Nieveen and limited to development studies; yielding a refined learning system prototype. The developed learning system was validated by five lecturers from Universitas Negeri Padang, resulted in content (0.85), and construct validity (0.82). Meanwhile, the practicality of the learning system was also evaluated by students and lecturers, resulted in practicality indexes of 88% and 85%, respectively. All of the results suggest high level of validity and practicality meaning the learning system has achieved the quality criteria content, structure, and usage wise. These results imply for the utilization platforms like Discord for higher education learning to promote student-centered learning and digital literacy.

Keywords: Chemical kinetics; Digital literacy; Discord; Flipped classroom; Guided inquiry learning

Introduction

Rapid development of the industrial revolution 4.0 has led to the spread of information and technology (IT) in all areas of life, including education. The spread of IT occurs in every segment of the learning process, including in Higher Education. In order to keep up with this revolution, education sector need to adapt to the latest IT for the learning process (Assidiqi & Sumarni, 2020). The utilization of modern IT in education can shift the learning scheme from teacher-centered to student-centered (Putriani & Hudaidah, 2021).

Industrial revolution 4.0 has changed the educational landscape that can be seen by the newly emerging demand of 21st Century Competencies. 21st century competencies are defined as a set of skills that students needed to thrive in the age of information. This competency comprises three major sets of abilities: learning skills, literacy skills, and life skills. The learning skills are grouped under the term '4Cs,' which includes critical thinking, creativity, collaboration, and communication (Kearney et al., 2012). Literacy skills include information, media, and technology literacy, while life skills composed of essential skills like leadership, initiative, etc. Among the mentioned skills, digital literacy stands out in an era dominated by information and technology. Proficiency in digital technology is no longer optional, as in the past, but rather crucial for students in higher education to navigate the academic world, engage in collaborative learning, and most importantly, enter global workforce (Farias-Gaytan et al., 2023).

In this regard, the Minister of Education and Culture, Research and Technology (Mendikbudristek)

How to Cite:
Sofyan, M., Akmar, R., Mawardi, M., Ulianas, A., & Suryani, O. (2025). Integrating Flipped Classroom with Guided Inquiry Based on Digital Literacy Using Discord on Chemical Kinetics for First Year Chemistry Students. *Jurnal Penelitian Pendidikan IPA*, *11*(9), 19–26. https://doi.org/10.29303/jppipa.v11i9.10482

launched a curriculum as a response these demands and as an effort to overcome educational problems that occur in Indonesia. The curriculum was named Merdeka Belajar Kampus Merdeka (MBKM) curriculum for tertiary education. In order to achieve widespread implementation of MBKM there must be supported by the availability of appropriate supporting teaching materials. MBKM emphasized student-centered learning by providing challenges and opportunities for the development of innovation, creativity, personality, and self-independence in seeking and obtaining knowledge through authentic and real-world issues. By this means, MBKM intended students in higher education are able to develop their hard and soft skills and meet the 21st-century competencies (Kemdikbud, 2020). It is outlined in the guideline that the objectives of MKBM will be achieved by a few selected recommended learning methods, which amongst all includes flipped learning and inquiry learning (Nizam & Partiwi, 2023).

Flipped learning is a subset of blended learning, a type of learning method that combines face-to-face and digital-based activities both online and offline. Blended learning, which includes flipped learning, has potential to be one of the means to achieve 21st century learning (Bonk & Graham, 2012). One way to implement the blended learning process is to use the flipped classroom system (Ninda & Mawardi, 2022). The flipped classroom learning system can help students to be more active in the learning process (Bishop & Verleger, 2013). In addition, it can increase student cooperation during discussions in class and can encourage students to think and adjust their learning styles by adjusting the speed of learning.

To put simply, flipped classroom is an inverted class. Traditionally, lesson was done through lecture in the class then proceeded by assignments and homework that students must do and finish after lesson was over. By inverting this common practice, lecture and other class-bound activities now being done at home whilst after-class activities like doing homework at the class. (Agustini, 2021). The flipped classroom system is carried out in two learning conditions known as synchronous and asynchronous. Synchronous learning occurs at the same time, but does not necessarily have to occur in the same place, could be done either face-to-face or virtual class (Anis, 2013). Meanwhile, asynchronous learning is a learning process that is carried out in different places and times. Students do the learning activities outside the learning schedule independently supported by a learning system management such as the use of Google Classroom, Moodle, Edmodo. or Blackboard (Insani et al., 2022). The implementation of the flipped classroom which consists of these two learning conditions is known to increase student learning activities. This increase in student activity is of course also supported by good learning plan by the teacher (Mujiyati, 2020).

To compliment the flipped classroom learning design, one learning model could be added to enhance the process and in this research inquiry learning was selected. Apart from being one of the suggested models in the MBKM student-centered learning guidelines, inquiry learning is suitable for chemistry settings, especially in helping students understand and formulate concepts based on their own prior knowledge and understanding. There are four level of inquiry learning in regard of the level of scaffold provided by the instructor (open, controlled, guided, and structured). With level of learning independency in mind, guided inquiry was chosen to give students appropriate amount of support while also not stifle their inquiry process.

The syntaxes or steps of guided inquiry consists of orientation, exploration, concept formation, application, and closing. The guided inquiry model has been proven to make students more active and have higher motivation so that the learning outcomes obtained also increase (Asra et al., 2016; Bell & Binns, 2005). This guided inquiry model can be applied to various chemical materials, one of which is chemical kinetics. Chemical kinetics is one of the topics studied in the second semester of General Chemistry course for first-year students (Brady, 2012). Sub-topics in the reaction rate material include the definition of reaction rate, instantaneous reaction rate, average reaction rate, factors that affect reaction rate, reaction rate law, and half-life (Chang, 2010; Ebbing & G, 2017; Petrucci, 2017). The reaction rate material is classified as abstract material so that many students have difficulty understanding the material (Marthafera et al., 2018; Pahriah & Hendrawani, 2018).

Given these points, it should be possible to design a flipped classroom learning system integrated with guided inquiry learning for chemical kinetics. However, the available, widely used LMS often poses with compatibility which could hinder the effectiveness of the implementation of such approach. Many LMS platforms, while robust and notably used, may lack the real-time and in-application features that necessary for a truly flipped-guided inquiry learning settings. For example, Moodle may have all of the essential features for blended learning but users still have to rely on external platforms for simple feature like real-time communication (Kruglyk et al., 2020). Lecturers, in this case, often opt for Zoom or Team, which by themselves are not fully integrated to the LMS. Therefore, an alternative for more flexible platform is needed to bridge this gap, and Discord emerges as one of them.

Discord is generally known as a social media that is used by gamers to interact and communicate online

(Efriani et al., 2020). As many online games require players to actively present during the game, Discord offers an abundance way to communicate, which includes simple chat, direct message, voice chat, and video chat; all in one platform **(Salim, 2021;** (Huda, 2022). This feature important to achieve the dynamicity of flipped-guided inquiry learning. Additionally, Discord is compatible with many operations system (OS) and can be accessed from browsers making it readily available for students. Not only that, Discord is relatively 'lighter' in term of capacity or storage compared to other LMS (Arifianto & Izzudin, 2021).

Discord application can be combined with other learning media which makes this application more flexible and safer for users, offering various advantages for use as a digital tool in an educational environment (Rakhmawan et al., 2020; Ysla et al., 2021). Prior studies have designed and evaluated the utilization of Discord for flipped-guided inquiry-based learning system for secondary school and higher education (Handri et al., 2023; Ismail et al., 2023). In this studies, further exploration was done in developing and evaluating Discord learning system for chemical kinetics.

Method

The method of this research followed Educational Design Research (EDR) approach coined (Plomp & Nieveen, 2009). This approach highlighted by the micro-cycle of research inside each phase to achieve adequate quality of the design prototype. EDR is composed of three main phases: preliminary research, prototyping, and assessment. Each phase carries a distinct aim and purpose which will be outlined in the subsequent paragraph.

Preliminary research acts as the foundation for giving the issues, contexts, and directions for the next phase. The research begins with needs and contexts analysis, followed by literature review and development of conceptual framework. Needs analysis was conducted through structured interview, where the researchers interviewed the interviewees with pre-existing questions. The interviewees were three UNP chemistry lecturers who have taught in General Chemistry courses. Context analysis was done by analyzing chemical kinetics material in college textbooks and literature studies. Then an analysis is also done on the UNP Chemistry Study Program Curriculum (S1) in 2024 and the General Chemistry Semester Lesson Plan with Document Number SOP.01.001.00, date of publication 10th January 2019, revision number 06, date of creation July 18th 2024 to observe the scope of the material studied in the chemical kinetics material.

Conceptual framework was developed based on the results of the analysis carried out at the needs and context analysis stage, then supported by a literature study to produce a conceptual framework that describes a summary of the thinking process related to the reasons for conducting the research.

Validity of the developed learning system is measured by validation questionnaire. Each validator assigned values to the questionnaire categories and the validity level is calculated by Aiken's V formula, as can be seen in Equation (1) and (2) (Aiken, 1985).

$$V = \left(\frac{S}{n(c-1)}\right) \quad (1)$$

$$S = r - I_0 \quad (2)$$

Where V is the value of Aiken validity coefficient, n is the number of validators, r is the score of a category, I0 is the lowest score in the scoring category, S is the validator's score minus the lowest score. The range and category can be seen in Table 1.

Table 1. Range and category for validity

Range	Category
V ≥ 0.80	Valid
V < 0.80	Not valid

(Aiken, 1985)

Meanwhile, practicality is measured by student response through questionnaire in small group test. Equation (3) is used to calculate the percentage of practicality, where NP is the expected percentage, R is the student's raw score, and SM is the maximum score (Purwanto, 2020).

$$P = \frac{R}{SM} \times 100\% \quad (3)$$

Table 2. Range and practicality level

Range (%)	Practicality
80 < P ≤ 100	Very high
60 < P ≤ 80	High
40 < P ≤ 60	Moderate
20 < P ≤ 40	Low
0 ≤ P ≤ 20	Very low

(Purwanto, 2020)

However, due to time and resource constraints, the study was limited until final prototype achieved. Thus, the assessment phase was not included in the study.

Result and Discussion

Preliminary Research

According to interviews with three chemistry lecturers, Universitas Negeri Padang have used MBKM curriculum and student-centered learning approach that includes group discussions, case method model, PBL, and PJBL. Lecturers typically use social media as one of the means of communication, such as WhatsApp, but the features offered by WhatsApp are limited. Some lecturers are already aware of the social media platform Discord but have never used it in the classroom. According to Tjahjadi et al. (2021), the use of Discord in Indonesia is still quite uncommon and limited. Therefore, this could be an opportunity to develop a chemistry learning media using social media to attract students' interest in learning and implement student-centered learning, especially on chemical kinetics material.

Afterward, literature review was done to pinpoint and examine the difficulties that instructors and students encounter when teaching and learning chemical kinetics. Numerous prior findings regarding utilization of Discord in blended learning and chemistry was analyzed and served as a basis for the next stage. Following this, conceptual framework is developed through needs and context analysis and literature review results.

When incorporated into a flipped classroom approach, guided inquiry learning has been demonstrated in numerous studies to improve students' cognitive skills and teacher-student interaction. High degrees of validity and applicability were shown by earlier research by Delfianza et al. (2023); Handri et al. (2023); Ismail et al. (2023); Tuti et al. (2023). Furthermore, a significant improvement in learning outcomes was found on the efficacy of Discord-based instructional learning that included flipped classroom and guided inquiry learning for reaction rate topics (t-count = 8.11 > t-table = 1.99). These results imply that student learning can be successfully supported by a Discord learning system that combines guided inquiry and flipped classroom approaches.

Development Studies

Early design of the guided inquiry-based flipped classroom learning system in the Discord was created during the Prototype I stage. The prototype was made to include a model that aligns with the learning objectives, key questions, practice problems, and other Discord application components. The learning cycle of flipped guided inquiry can be seen in Figure 1. The developed prototype takes the form of a worksheet that can be moved and modified within Discord.

After obtaining Prototype I, the early prototype was formatively self-evaluated using a check questionnaire sheet. Based on the examination and verification, it was concluded that the necessary elements were appropriate, accessible, and usable. The researcher discovered that the elements of the guided inquiry-based flipped classroom learning system in Discord chemical kinetics has fulfilled the quality criteria to move onto the next stage.

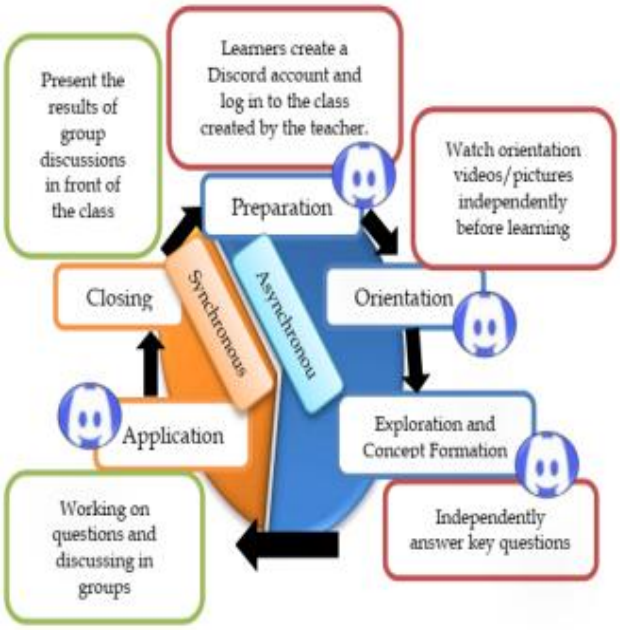

Figure 1. Learning cycle of flipped guided inquiry learning

In the orientation stage, students will be presented with a video containing the introduction to chemical kinetics (Figure 2). The video is designed to ignite students' motivation before entering the following step (Khairunnisak et al., 2023). Next, in exploration and concept formation, students are given a model related to the learning topic (Figure 3) (Lenggogeni & Mawardi, 2022). The given model is equipped with key questions arranged accordingly based on their difficulty level from low- to high- order thinking. By answering and following these key questions, students form concepts within their own understanding (Hanson, 2005). Additionally, by providing visual model, students are assisted with the necessary information and context to answer the key questions (Stobaugh, 2013). The models are also designed with chemical multiple representation principle, presenting the complex and dynamic concepts of reaction kinetics in multitude representation (Gilbert & Treagust, 2009).

Figure 2. Orientation stage in Discord

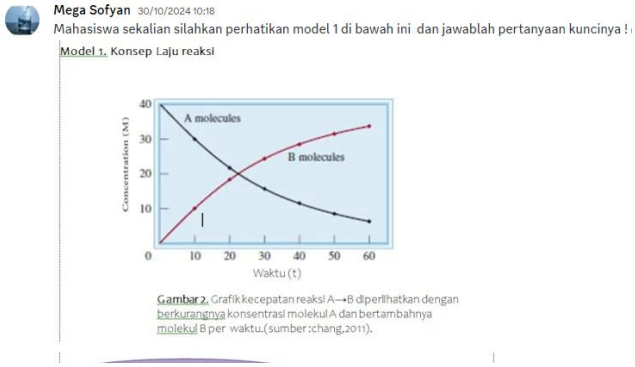

Figure 3. Exploration and concept formation stage on Discord

Figure 4. Application stage on Discord

This syntax is done by students asynchronously and entirely provided in the Discord server. At the application stage, students are given questions that are useful as exercises to strengthen the concepts obtained in the previous syntax (Figure 4) (Siregar & Mawardi, 2022). This syntax is implemented synchronously, either face-to-face on campus or in the Discord channel. Students work on the questions given through group discussions. Lastly, in the closing syntax, students present the results of the discussions that have been carried out on the application syntax in front of the class. Similar to the application, this syntax is implemented in class or Discord synchronously.

Next. Prototype II went through another series of formative evaluations in the form of expert reviews and individuals (one-to-one evaluation). Expert review assesses the learning system developed in terms of its content and construct. The results of content validation show that all aspects of the components assessed have achieved a good level of validity with V > 0.80. The same thing applies to construct validation where all components have achieved high validity. Meanwhile, in one-to-one evaluation, three chemistry students who had studied chemical kinetics beforehand tested and then give their constructive feedbacks about the Discord learning system. The results of the interviews revealed that the orientation video posted to the Discord channel was clear in terms of appearance, images, and information, but it can be refined for the sounds and audio aspect. Furthermore, it was easy to understand the language used, the key questions posed, the instructions, and the models on display.

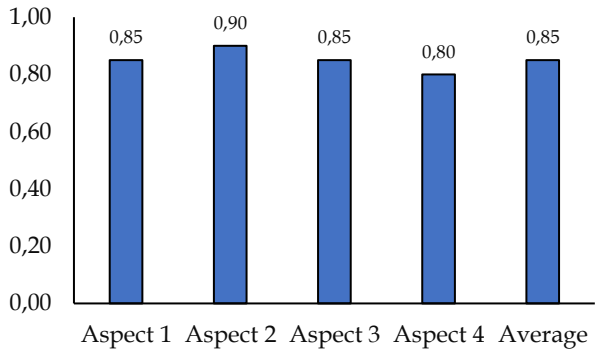

Figure 5. Results for content validity

As for content validity, it resulted to an average value of 0.85, with each aspect exceed 0.85. Aspect 1 refers to the suitability of the flipped classroom with the guided inquiry learning syntaxes; this means the system has designed inline between the used approach and model. Meanwhile, Aspect 2 and 4 relate to the suitability of the usage of Discord and its integration with guided inquiry syntaxes. In regard of the scores, it can be interpreted that the usage and integration are done logically so it is meet the intended purpose. And last, Aspect 3, relates to the material presentation based on guided inquiry syntaxes. Again, the measured validity indicates the presented materials in stages like exploration and concept formation and application are

properly aligned and include chemistry multiple representations (Tuti et al., 2023).

The content component of the Discord learning system showed an average validity score of 0.80, which falls within the valid category. This reflects the alignment of the included material with the objectives, supported by references, and visual resources derived from credible and relevant sources. Similarly, the presentation component reached an average validity score of 0.80, signifying a systematic and well-organized structure with no of extraneous material. The inclusion of engaging illustrations further enhances the instructional material's appeal and adhere to the importance of visual elements in stimulating student interest and clarifying complex subjects. The language component achieved an average validity score of 0.86, indicating easily comprehensible language use. This ensures that students encounter minimal confusion in understanding chemical concepts. Additionally, the graphic component of the Discord learning system was rated with a validity score of 0.87, categorized as valid. The selection of fonts, colors, and contrasts paired with high-contrast text and background combinations; enhances readability and visual comfort (Jasmine, 2024).

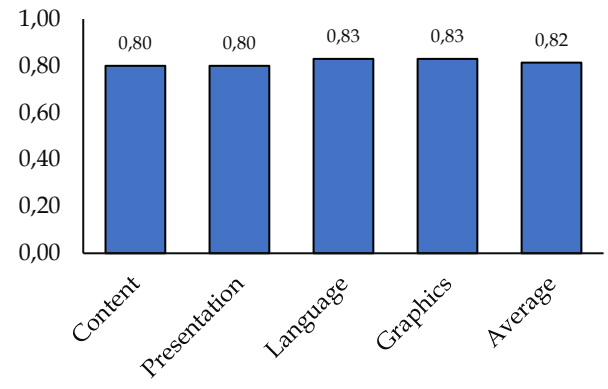

Figure 6. Results for construct validity

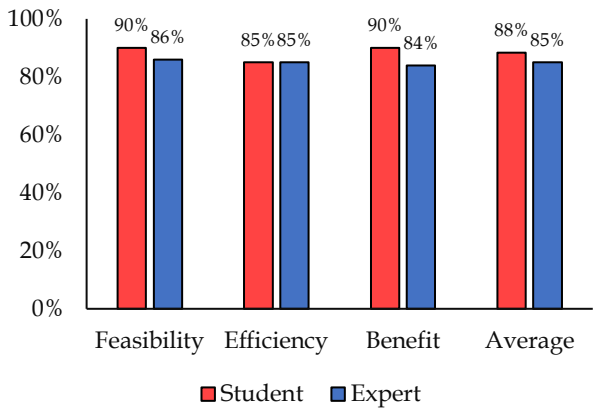

Figure 7. Results for practicality from student and expert

After Prototype III underwent revision based on formative assessment in the form of small group evaluation, Prototype IV was produced. All of the evaluated aspects fall into the practical or very practical category, according to Figure X. In terms of feasibility, 90% of users and 86% of lecturers find it practical. This means the Discord learning system is easy to use for both students as the users, and teachers or lecturers as the administrators (Ismail et al., 2023). It also means the learning system has been developed logically and thematically so it can be navigated without any necessay hindrance for the users.

In terms of time efficiency, both lecturers and students rate practicality at 85%. This scores relate to the time required for sharing the information either from students to lecturers or vice versa. Furthermore, 84% and 90% of lecturers and students, respectively, rate the benefits aspect as practical. Benefits can be interpreted how the students could gain knowledge from the learning system (Syafei & Mawardi, 2022). Considering how high the score is, it safe to say that the Discord learning system is beneficiary as a learning resource or material. All things considered, the developed learning system can be hold as useful for educational purposes.

Conclusion

Discord learning system, integrating a flipped classroom and guided inquiry for chemical kinetics, has been successfully developed. The result is presented in the form of final prototype that has been formatively evaluated by its validity and practicality. The learning system demonstrates fairly strong content (0.85) and construct (0.82) validity, and high practicality (88% by students, 85% by lecturers), making it a valid and practical tool for learning or further research. This study has implications for the potential of integrating platforms like Discord into higher education to promote student-centered learning and 21st century competencies. It also highlights the critical need for digital literacy training for both educators and students to maximize the benefits of technology-enhanced learning.

Acknowledgments

The authors would like to express gratitude to all lecturers and students in Department of Chemistry, Universitas Negeri Padang who participated in this study. Their contribution and feedback are invaluable, and without them, this study would not have been possible.

Author Contributions

Conceptualization, M.M. and A.U; methodology, M.M; validation, M.M., A.U., and O.S.; formal analysis, M.S. and R.A.; investigation, M.S; resources, M.S; data curation, R.A; writing—original draft preparation, M.S.; writing—review

and editing, R.A; visualization, R.A; supervision, M.M.; project administration, M.S; funding acquisition, M.M. and A.U.

Funding
This research was funded by collaborative fund.

Conflicts of Interest
The authors declare no conflict of interest.

References

Agustini, M. (2021). Meningkatkan aktivitas dan hasil belajar siswa menggunakan model flipped classroom melalui aplikasi google classroom. *Indonesian Journal of Educational Development*, *2*(2), 280–289. https://doi.org/10.5281/zenodo.5244420

Aiken, L. R. (1985). Three Coefficients for Analyzing the Reliability and Validity of Ratings. *Educational and Psychological Measurement*, *45*(1), 131–142. https://doi.org/10.1177/0013164485451012

Anis, U. (2013). Merancang Model Blended Learning Designing. *Jurnal Teknodik*, *17*(4), 399–409. https://doi.org/10.32550/teknodik.v17i4.577

Arifianto, M. L., & Izzudin, I. F. (2021). Students' Acceptance of Discord as an Alternative Online Learning Media. *International Journal of Emerging Technologies in Learning (IJET*, *16*(20), 179. https://doi.org/10.3991/ijet.v16i20.22917

Asra, A., Latisma, D., & Mawardi, M. (2016). Peningkatan Aktivitas, Motivasi, dan Hasil Belajar Siswa Dengan Pendekatan Inkuiri Terbimbing di SMA Negeri 8 Padang. *Angewandte Chemie International Edition*, *6*(11), 951–952. Retrieved from https://ejournal.unp.ac.id/index.php/eksakta/article/view/6105

Assidiqi, M. H., & Sumarni, W. (2020). Pemanfaatan Platform Digital Di Masa Pandemi Covid-19. *Prosiding Seminar Nasional Pascasarjana (PROSNAMPAS)*, *3*(1), 298–303. Retrieved from https://shorturl.asia/tcEJn

Bell, R. L., & Binns, I. C. (2005). Simplifying inquiry instruction. *The Science Teacher*, *72*(7). Retrieved from https://shorturl.asia/2CUI6

Bishop, J., & Verleger, M. A. (2013). The flipped classroom: A survey of the research. *2013 ASEE Annual Conference & Exposition*. Retrieved from https://shorturl.asia/tS7UK

Bonk, C. J., & Graham, C. R. (2012). *The handbook of blended learning: Global perspectives, local designs*. Wiley & Sons, Inc.

Brady, J. E. (2012). *Chemistry: The Molecular Nature of Matter* (6th ed.). John Willey & Sons.

Chang, R. (2010). *Chemistry 10th Edition*. McGraw Hill.

Delfianza, E., Mawardi, M., & Suryani, O. (2023). Development of Flipped Classroom Based Guided Inquiry Learning System with Digital Literacy Using Discord Application on Thermochemistry. *Jurnal Penelitian Pendidikan IPA*, *9*(7), 5228–5235. https://doi.org/10.29303/jppipa.v9i7.4245

Ebbing, D. D., & G, S. D. (2017). *General Chemistry* (11th ed.). Cengage Learning.

Efriani, E., Dewantara, J. A., & Afandi, A. (2020). Pemanfaatan aplikasi Discord sebagai media pembelajaran online. *Jurnal Teknologi Informasi Dan Pendidikan*, *13*(1), 61–65. https://doi.org/10.24036/tip.v13i1.283

Farias-Gaytan, S., Aguaded, I., & Ramirez-Montoya, M.-S. (2023). Digital transformation and digital literacy in the context of complexity within higher education institutions: A systematic literature review. *Humanities and Social Sciences Communications*, *10*(1), 386. https://doi.org/10.1057/s41599-023-01875-9

Gilbert, J. K., & Treagust, D. (2009). Introduction: Macro, Submicro and Symbolic Representations and the Relationship Between Them: Key Models in Chemical Education. In *Dalam Multiple Representations in Chemical Education* (Vol. 4). Springer Netherlands. https://doi.org/10.1007/978-1-4020-8872-8

Handri, S., Mawardi, M., Aini, S., & Nizar, U. K. (2023). Learning System with Digital Literacy Based on Guided Inquiry Integrated Flipped Classroom Using Discord Application on Colloid. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 6012–6019. https://doi.org/10.29303/jppipa.v9i8.4471

Hanson, D. M. (2005). *Designing Process-Oriented Guided-Inquiry Activities*. Pacific Crest.

Huda, M. B. (2022). Pemanfaatan Discord Sebagai Alternatif Media Pembelajaran Secara Daring. *Jurnal Ilmu-Ilmu Sosial*, *19*(2), 661–666. Retrieved from https://core.ac.uk/download/pdf/552629838.pdf

Insani, M., Mawardi, M., & Ismail, I. A. (2022). The system of flipped classroom based on guided inquiry learning on redox reactions and electrochemistry using Moodle. *International Journal of Academic Pedagogical Research (IJAPR*, *6*(5), 53–56. Retrieved from https://shorturl.asia/5orFT

Ismail, I. A., Mawardi, M., Suryani, O., Insani, M., & Mulyanti, M. (2023). Innovative Pedagogical Approaches to the Periodic Table for Freshman Chemistry Student at the State University of Padang. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 12249–12257. https://doi.org/10.29303/jppipa.v9i12.5623

Jasmine, N. (2024). Development Of Teaching Materials To Support The Merdeka Curriculum In Redox

Reactions And Electrochemistry For Phase F Senior High School. *Chimica Didactica Acta (Journal of Chemistry & Chemistry Education*, *12*(2), 63–70. https://doi.org/10.24815/jcd.v12i2.41981

Kearney, M., Schuck, S., Burden, K., & Aubusson, P. (2012). Viewing mobile learning from a pedagogical perspective. *Research in Learning Technology*, *20*(1). https://doi.org/10.3402/rlt.v20i0/14406

Khairunnisak, I., Mawardi, M., Widarti, H. R., & Yamtinah, S. (2023). Effectiveness of Guided Inquiry Based Student Worksheet Integrated with Flipped Classroom System on Reaction Rate Material on Students' Ability to Think Critically. *Jurnal Penelitian Pendidikan IPA*, *9*(5), 2431–2437. https://doi.org/10.29303/jppipa.v9i5.3271

Kruglyk, V., Bukreiev, D., Chornyi, P., Kupchak, E., & Sender, A. (2020). Discord platform as an online learning environment for emergencies. *Ukrainian Journal of Educational Studies and Information Technology*, *8*(2), 13–28. https://doi.org/10.32919/uesit.2020.02.02.

Lenggogeni, K., & Mawardi, M. (2022). Effectiveness of a Flipped Classroom Based on Guided Inquiry Learning System on Acid-Base Solutions. *Jurnal Penelitian Pendidikan IPA*, *8*(4), 1874–1881. https://doi.org/10.29303/jppipa.v8i4.1909

Marthafera, P., Melati, H. A., & Hadi, L. (2018). Deskripsi Pemahaman Konsep Siswa Pada Materi Laju Reaksi. *Jurnal Pendidikan Dan Pembelajaran Khatulistiwa (JPPK)*, *7*(1). https://doi.org/10.26418/jppk.v7i1.23493

Mujiyati, M. (2020). Penerapan Model Pembelajaran Inkuiri Terbimbing (Guided Inquiry) untuk Meningkatkan Hasil Belajar Kimia pada Siswa SMK. *Paedagogie*, *15*(2), 71–78. https://doi.org/10.31603/paedagogie.v15i2.4193

Ninda, A., & Mawardi, M. (2022). Validity and Practicality of Flipped Classroom Based on Guided Inquiry on Reaction Rate Material. *Entalpi Pendidikan Kimia*, *3*(2), 50–55. https://doi.org/10.24036/epk.v3i2.269

Nizam, N., & Partiwi, S. G. (2023). Panduan Implementasi Pembelajaran Berpusat Pada Mahasiswa. *Kementrian Pendidikan*. Retrieved from https://repositori.kemendikdasmen.go.id/29168/

Pahriah, P., & Hendrawani, H. (2018). Pengembangan Bahan Ajar Laju Reaksi Dengan Multipel Representasi Berbasis Inkuiri. *Hydrogen: Jurnal Kependidikan Kimia*, *6*(1), 32–42. https://doi.org/10.33394/hjkk.v6i1.1598

Petrucci, R. H. (2017). *General Chemistry: Principles and Modern Application* (11th ed.). Cross Media.

Plomp, T., & Nieveen, N. (2009). An introduction to educational design research. *Proceedings of the Seminar Conducted at the East China Normal University, Shanghai (PR China), November 23–26, 2007*. Retrieved from https://shorturl.asia/9azq4

Purwanto, M. N. (2020). *Prinsip-Prinsip dan Teknik Evaluasi Pengajaran*. Bandung: PT Remaja Rosdakarya.

Putriani, J. D., & Hudaidah, H. (2021). Penerapan pendidikan Indonesia di era revolusi industri 4.0. *Edukatif: Jurnal Ilmu Pendidikan*, *3*(3), 830–838. https://doi.org/10.31004/edukatif.v3i3.407

Rakhmawan, A., Juansah, D. E., Nulhakim, L., Biru, L. T., Rohimah, R. B., Suryani, D. I., & Resti, V. D. A. (2020). Analisis Pemanfaatan Aplikasi Discord dalam Pembelajaran Daring Di Era Pandemi Covid-19. *Prosiding Seminar Nasional Pendidikan FKIP*, *3*(1), 55–59. Retrieved from https://www.academia.edu/download/100989467/9905-24541-1-SM.pdf

Siregar, F. R., & Mawardi, M. (2022). Development of the Learning System of Flipped-Guided Inquiry-Based Learning (FGIL) Using Moodle on Chemical Equilibrium material. *Indonesian Educational*, *25*(1), 31–49. https://doi.org/10.26858/ijes.v25i1.33568

Stobaugh, R. (2013). *Assessing Critical Thinking in Middle and High Schools: Meeting the Common Core*. Routledge.

Syafei, S. S., & Mawardi, M. (2022). The POGIL model integrated flipped classroom assisted learning management system (LMS) for learning solution in ERI 4.0. *Jurnal Penelitian Pendidikan IPA*, *8*(2), 444–451. https://doi.org/10.29303/jppipa.v8i2.1298

Tjahjadi, E., Paramita, S., & Salman, D. (2021). Pembelajaran Era Pandemi Covid-19 di Indonesia (Studi terhadap Aplikasi Discord. *Koneksi*, *5*(1), 83. https://doi.org/10.24912/kn.v5il.10165.

Tuti, A. P. S., Mawardi, M., & Suryani, O. (2023). Flipped Classroom System Based on Guided Inquiry Learning Model Using Discord Application on Reaction Rate. *Prisma Sains: Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika Dan IPA IKIP Mataram*, *11*(3), 678. https://doi.org/10.33394/j-ps.v11i3.8131

Ysla, D. E., Medina, A. O., & Andrade-Arenas, L. (2021). Design Of The Discord Application As An E-Learning Tool At The University Of Sciences And Humanities. *Proceedings of the 19th LACCEI International Multi-Conference for Engineering, Education, and Technology. The 19th LACCEI International Multi-Conference for Engineering, Education, and Technology*. https://doi.org/10.18687/LACCEI2021.1.1.9