Jurnal Akademika Kimia, 14(3): 144-150, August 2025
ISSN (online) 2477-5185 | ISSN (print) 2302-6030
https://jurnalfkipuntad.com/index.php/jak/

OPEN ACCESS
Research Article

Development of an E-Handout Based on Discovery Learning on The Reaction Rate for Class XI Students

***Nurul Faudia, Ajat Sudrajat, & Nurfajriani**
Chemistry Education Study Program/ Faculty of Teacher Training and Education – Universitas Negeri Medan, Medan – Indonesia 20221

Received 20 June 2025, Revised 11 July 2025, Accepted 24 July 2025
doi: 10.22487/j24775185.2025.v14.i3.pp144-150

Abstract

This study aims to determine the level of feasibility, practicality, and the students' readability response to e-handout-based discovery learning. This development research uses 4-D development models developed by S. Thiagarajan, Dorothy S. Semmel, and Melvin 1 Semmel. The 4-D development model has four stages: the Define stage, the Design stage, the Development stage, and the Disseminate stage, but this study is limited to 3-D: the Define stage, the Design stage, and the Development stage. The subjects in this study were 3 material experts and media experts, five chemistry subject teachers, and the readability response of MIPA 1 class XI students, with 33 people. Data collection instruments include an interview sheet, an e-handout assessment sheet by a material expert validator and a media expert, a practicality sheet by a teacher, and a student reading response sheet. Data analysis techniques use qualitative and quantitative data. Based on the results of the study, an analysis of the needs of students showed that students agreed that it was necessary to develop an e-handout based on discovery learning on the reaction rate material. Then, assessment by material expert validators of an 85.00% well-deserved e-handout, assessment by media expert validators of an 86.00% well-deserved e-handout, teacher practicability of an 88.00% well-deserved or very practical e-handout, and 87.00% of students' readability response to e-handouts is said to be very decent or very high.

Keywords: Discovery learning model; e-handout; reaction rate

Introduction

The student-centered learning process is the main goal of education, namely, to help each student achieve a learning atmosphere and learning process so that students actively develop their potential. In the era of globalization that continues to expand rapidly, the world of education can no longer run in conventional ways. Therefore, the integration of technology in the world of education is no longer an option, but an urgent need so that education can continue to answer future challenges (Ashari et al., 2023).

High School level has lessons that include a variety of micro-conceptions, such as chemical structures, chemical processes, and calculations related to various chemical substances. In addition, there are discussions about complex chemical processes and abstract chemical ideas that can be linked to everyday life. The question related to these principles is the topic of reaction rate (Kusumaningtyas et al., 2023).

One of the abstract and sometimes confusing parts of chemistry is the topic of reaction rate. Therefore, there are still students who find it difficult to understand this topic (Farida et al., 2020). In the submaterials of collision theory and equations involving reaction rates and reaction orders, students often have difficulty understanding reaction rates, which causes poor learning outcomes.

Based on the results of the analysis of student needs, there are still students who experience difficulties in learning chemistry, especially in the material on reaction rates (Widarti et al., 2022). Students encounter problems because the learning is less interesting, and the learning media used are also less interesting. Teachers only use open materials in the form of student handbooks that tend to provide too much explanation. The lack of development of innovative and creative teaching materials is one of the main factors causing low student participation in learning activities in the classroom, because the material presented tends to be monotonous and less interesting to learn (Kandi et al., 2024).

Learning media that can support the learning process is an e-handout. An e-handout is an open material in digital form, which is usually a short document containing learning materials. An e-

*Correspondence:
Nurul Faudia
e-mail: nurulfaudia2406@gmail.com
© 2025 the Author(s) retain the copyright of this article. This article is published under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

handout is very appropriate as a learning aid because most high school students currently have Android devices (Sarita et al., 2021). The advantage of e-learning media is that it stimulates students' curiosity, students learn at their own pace, and it can repeat materials independently. In addition, e-handouts are more economical and easier to deploy because they are more practical and accessible from anywhere and anytime (Hasrah et al., 2022).

Related to these problems, teachers can apply appropriate learning models, learning models that encourage students to actively acquire knowledge through exploratory activities, experiments, and discussions, and are adjusted to their respective abilities and learning styles, known as discovery learning models. This model allows students to learn independently by discovering and investigating their own concepts, so that the understanding gained becomes deeper and lasts longer in memory (Prasetyo & Abduh, 2021).

In the Discovery Learning Learning method, teaching materials are not presented in the final form; students are required to carry out various activities to collect information, compare, categorize, analyze, integrate, reorganize materials, and make conclusions (Erlina et al., 2020).

In a study conducted by Hasrah et al. (2022), the development of discovery learning-based handout learning media at SMAN 17 Luwu showed that the results of practicality by teachers were 95% (very practical), while students' readability of the product was 71.05% (practical). Effectiveness was 85% (very effective). From these data, it is proven that e-handouts have a positive influence on student learning outcomes. Other research conducted by Swasti et al. (2022) shows that the development of interactive learning media based on Discovery Learning makes the press easy for students to use, easy to read, and students can access the media anywhere and anytime.

Starting from the identification of the problems that have been described, this study aims to test the development of an e-handout based on discovery learning on the topic of reaction rate for class XI of SMA.

Methods

This development research uses 4-D development models developed by S.Thiagarajan, Dorothy S. Semmel, and Melvin 1 Semmel. The 4-D development model, however, was limited and modified to 3-D, namely the Define stage, Design stage, and Development stage.

This development research was conducted on several subjects, including non-test validators, 3 expert material validator lecturers, and media experts who are chemistry lecturers in the FMIPA UNIMED environment. Practicality tests by teachers involving 5 chemistry subject teachers and student readability involving 1 class XI at SMAN 1 Secanggang, consisting of 33 students. Furthermore, the object of this research is a discovery learning-based e-handout on the reaction rate material.

Data collection instruments in the form of interview questionnaire sheets, student needs analysis questionnaire sheets, e-handout assessment questionnaire sheets by material expert and media expert validators, practicality questionnaire sheets by teachers, and student readability questionnaire sheets. Data analysis techniques use qualitative and quantitative data. The formula used to calculate the data on the charge of the lift by the validator is as follows:

$$P = \frac{\Sigma f}{\Sigma N} \times 100\%$$

Description:
P = Percentage of evaluation indicators
Σf = The number of scores obtained
ΣN = Maximal score count

The percentage of validity obtained is then interpreted qualitatively by referring to **Table 1**.

Table 1. Validation result category

Interval Percentage	Rating Category
81% - 100%	Properly Deserved
61% - 80%	Decent
41% - 60%	Decent Enough
21% - 40%	Not Worth it
< 21%	Highly Undeserved

(Sumber: Pratiwi et al., 2024)

The practicality assessment category by teachers from the calculation results using the formula above can be seen in **Table 2**.

Table 2. Practicality category by teachers

Interval Percentage	Rating Category
85,1 % ≤ P	Very Practical
70% ≤ P < 85%	Practical
60,1% < P ≤ 70%	Quite Practical
50,1% < P ≤ 60%	Less Practical
≤ 50%	Not Practical

(Pratiwi et al., 2024)

The category of student readability assessment from the calculation results using the formula above can be seen in **Table 3**.

Table 3. Student readability category

Interval Percentage	Rating Category
81-100 %	Very Good
61-80 %	Good
41-60 %	Quite Good
21-40 %	Not Good
0-20%	Not Good

(Pratiwi et al., 2024)

Results and Discussion

This definition stage includes five main steps, namely front-end analysis, learner analysis, task analysis, concept analysis, and specifying instructional objectives. This definition stage is

carried out to collect information related to the product being developed.

The first step in the definition stage is the front-end analysis, which aims to determine the problems faced by teachers as educators in schools. In its implementation, the researcher interviewed one of the chemistry teachers at SMAN 1 Secanggang and conducted direct observations. The results of the interview revealed that most students had difficulty participating in learning because the implementation of differentiated learning had not been optimal, which ultimately had an impact on the low understanding and absorption of students towards the material presented. Fitriyah & Bisri (2023) stated that differentiated learning is learning that facilitates all the differences that students have openly, according to the needs of each student. This learning recognizes that students are different and dynamic, so there must be special planning to meet these needs. The findings from direct observations in the classroom also support this statement. It was found that in practice, teachers tend to use the lecture method more often, where learning is centered on the teacher. This is in line with the research of Dulyapit & Lestari (2024), which states that the lecture method has weaknesses that need to be considered. One of them is its tendency to create one-way learning, where students only listen to the teacher's explanation without being actively involved in the teaching and learning process. This can lead to low student involvement in understanding the material in depth and reduce opportunities for students to develop critical and creative thinking skills (Suyanto, 2020). Therefore, it is very important to evaluate the effectiveness of the lecture method in education, as well as how this method can be modified to increase student involvement. Meanwhile, the Independent Curriculum emphasizes student-centered learning, where each student is given space to develop their potential according to their interests, talents, and needs. Teachers act as facilitators who support deeper exploration of knowledge (Shim & Thompson, 2022). One of the main goals is to reduce the administrative burden on teachers so that they can focus on improving the quality of learning (Linden et al., 2021). This curriculum also gives schools the freedom to determine learning methods that are appropriate to the characteristics of students and the school environment (Puzio et al., 2020). In addition, teachers only rely on school textbooks as learning resources, where thick and heavy printed books often make students' interest in learning low. This is because books are impractical to carry and use at any time, so students become lazy or uninterested in reading or learning using these books, especially in subjects such as chemistry, where the books tend to be large and monotonous. This study emphasizes the need for innovation in teaching materials to better suit the needs and learning habits of the current generation, for example, through digitalization or the development of teaching materials. In addition, textbooks in schools do not yet contain discovery learning steps, such as the discovery of concepts by students individually or in groups. However, without support in the form of direction from teachers, students can have difficulty understanding the meaning of the concepts found, which risks causing misconceptions or conceptual confusion. According to the teacher's statement, students' ability to solve problems is still low. The learning model used previously during learning has not been able to solve problems. The learning model used so far is still teacher-centered; teachers tend to use the lecture method in the learning process.

E-Handouts are present as a real form of progress in science and technology. It is undeniable that in the current era of mobile technology development, many students are accustomed to using gadgets to access information on lesson materials that are not obtained at school. Students prefer learning using electronic media because it is more practical to use (Haleem et al., 2022). The material presented in the e-handout is made more concise and detailed, which makes it faster for students to find core information from the material. Based on the state of needs in schools as seen from the results of interviews and observations, it can be concluded that the development of the e-handout is needed. Discovery learning-based learning is very much required for this development research. This is in accordance with the opinion of Luthfi & Rosmi (2024), who stated that learning with a discovery approach (discovery learning) encourages students to actively search for and find concepts independently, so that it can increase understanding and active involvement of students in the learning process.

The next step taken is student analysis, where researchers conduct this analysis to determine the needs of students in the learning process of chemistry material, especially reaction rate material. The results of the student analysis were obtained through the distribution of Google Forms consisting of 24 questions with yes and no answers, which were distributed to one class XII who had studied the reaction rate material in class XI. The results of the analysis showed that 75.8% of students stated that they had difficulty learning chemistry, especially the reaction rate material in the sub-material of reaction rate equations and reaction orders, because there were calculations. 63.6% of students stated that their difficulties were due to less interesting learning, which was influenced by learning media that were not varied and predominantly used lecture methods by teachers in the learning process. Meanwhile, 81.8% of students stated that they agreed that the development of e-handout learning media based on Discovery Learning should be carried out on the reaction rate material as an alternative, and encouraged active student involvement in the learning process.

The next step in this process is the analysis task, which is carried out by identifying and determining open material based on the learning achievements that have been set in the Independent Curriculum, with the main goal that students can evaluate the material they have learned as a form of constructive feedback on the ongoing learning process. The next step of analysis is the concept used to identify, compile, and connect learning concepts with the main material. The sub-topics consist of collision theory, reaction rate concept, reaction rate equation, reaction sequence, and factors that influence reaction rate. The last stage is the specification of learning objectives. This stage is carried out in order to change the analysis task and concept into learning objectives. By carrying out learning objectives, researchers can determine the appropriate study that will be held in the Discovery Learning-based e-handout on the reaction rate material. Sarita et al. (2021) argue that e-handout teaching materials are very effective in learning.

Design stage, this stage starts from selecting media that is appropriate to the material, namely open e-handout materials based on Discovery Learning using flipbook media, which is intended so that the final form of the e-handout is packaged in electronic form, making it easier for students to understand the reaction rate of the material. Then, the stage of selecting a format that is appropriate to the open material to be developed is carried out. The use of formats in developing e-handouts in this study was designed using Microsoft Word and Canva. After the plan has been made in PDF format, the e-handout file is input into the flipbook application so that the e-handout that has been created becomes interactive and can be easily accessed by teachers and students via the website. The e-handout typing format uses A4 paper size, Portrait paper orientation, margins (2.5 cm top, left, bottom, right), Times New Roman font, chapter size 14, sub-chapter 12, sub-chapter contents 12, image/table captions 11. The last stage is the initial design that is adjusted to the discovery learning model, which consists of 6 stages. At this stage, the opening section, content section, and closing section of the e-handout are designed. The e-handout design can be seen in **Figure 1**.

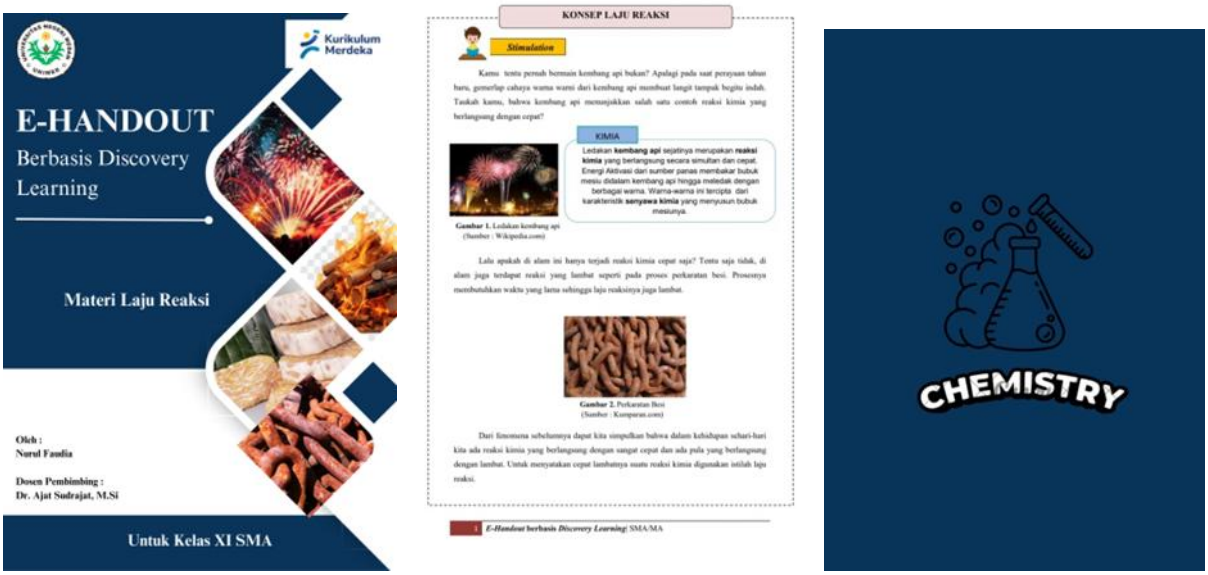


Figure 1. E-handout design

Validators conduct material assessments of e-handout feasibility for use as research material by assessing several aspects, including content feasibility, presentation feasibility, language feasibility, and display feasibility. The following is the average percentage of expert assessments found in **Figure 2**.

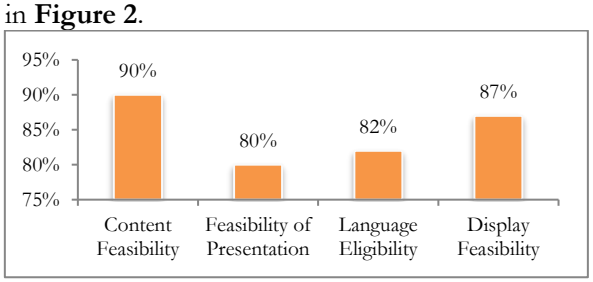


Figure 2. Material expert validation results graph

The validation results obtained by an average percentage of material assessment of 85% are said to be very feasible in **Figure 3**.

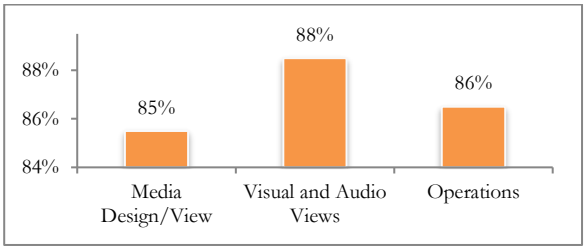


Figure 3. Media expert validation results graph

The media assessment results obtained by an average percentage of 86% are said to be very

feasible. Based on the validation results performed by the validator, it can be inferred that the medium of chemical e-handout materials based on discovery learning on reaction rate materials is suitable for use. This is in line with the opinion of Awlia & Febrianti (2023) that results of the assessment show that the quality of e-handouts from material experts gets 93.75% (very good category), 80.21% (very good category) media experts, based on the assessment results, e-handouts arranged are suitable for teaching materials. This was reinforced by Hasrah et al. (2022) that a learning medium in the form of a handout developed by the Discovery Learning approach can be found to be suitable for use in research activities in the field if it has met the validity criteria, either in the condition of requiring revision or not requiring revision. This suggests that the feasibility of a learning media device is not only determined by the results of perfect validation without revision, but also acceptable as long as it has met established standards of validity, although there are still some aspects that need to be refined.

Analysis of teachers' responses to see if a developed e-handout can be put to practical use. The researcher asked five chemistry teachers to respond before spreading the e-handout to the students. After giving assessments and suggestions, researchers revised some of the teacher's suggestions, such as the addition of learning videos to some materials. The following is a graph of the percentage of teachers' responses in **Figure 4**.

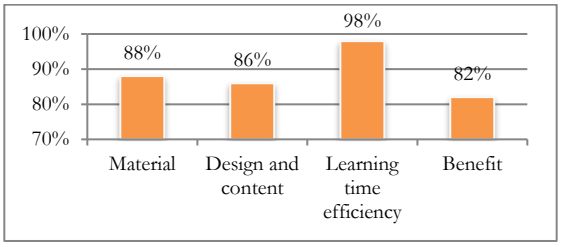


Figure 4. Graph of teacher assessment results

For the results of the practicality test obtained from teachers by providing an assessment that includes the feasibility of content, language, presentation, and benefits, the results of the practicality test received an average percentage of 88% which is said to be very feasible or practical, and is also accompanied by notes or suggestions for revising the material. Practicality, according to Taqiya et al. (2023), means the ease of a product, both in preparing, using, processing, and interpreting it. In addition, according to the big Indonesian dictionary, the word practical itself means easy and fun to use. This is in line with the research of Sitorus et al. (2023) showing that the results of the practicality by teachers got a percentage of 87.14% which, based on the criteria for product practicality, is a "very good" criterion. This means that the results of the practicality assessment of e-handouts by teachers show that e-handouts based on discovery learning on the topic of reaction rates have an easier learning process.

Analysis of the students' readability response to see if the developed e-handout can be put to practical use. The researcher asked for a readability response from students of class XI of SMAN 1 Secanggang, who have studied the reaction rate material. 33 students responded. The following is a graph of the percentage of students' readability responses in **Figure 5**.

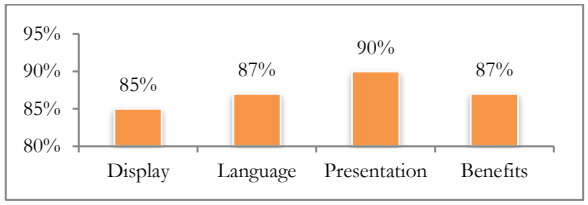


Figure 5. Student readiness responses results graph

The student readability test, covering appearance, presentation, language, and benefits, obtained an average percentage result of 87% which is said to be very feasible and can be used in the learning process. Research by Abdiah et al. (2023) stated that the results of student readability for the development of mind mapping and picture-based e-handouts at SMP Negeri 1 Woyla obtained a result of 97.7, with very good criteria. Research by Pratiwi et al. (2024) showed that the readability test was 77.8% (good). This indicates that the E-Handout is easy to understand, can be applied well in learning, and is effective in improving student understanding. This study concludes that the teaching materials developed are feasible to be used in the teaching and learning process.

Conclusions

The level of feasibility of Discovery Learning-based e-handouts on reaction rate material is 85% for the feasibility of material experts and 86% for the feasibility of media experts. The level of practicality by teachers towards Discovery Learning-based e-handouts on reaction rate material is 88%. Students' readability towards Discovery Learning-based e-handouts on reaction rate material is 87% so that the developed e-handouts are in the very feasible category. The conclusion is a summarizing paragraph that should present precise and concise results, which restate your major findings and contributions to the study.

Conflict of Interest

The writer asserts that there are no conflicting interests related to the research, composition, or dissemination of this piece.

Acknowledgment

The author would like to thank to all who the support and facilities for this research. **Funding**: This research received no specific grant from any commercial funding agency.

Author Contribution

AS: Conceptualization, Methodology. **Nurfajriani**: Validation, Writing - Review & Editing. **NF**: Investigation, Data Curation, Writing - Original Draft.

References

Abdiah, B., Mulyadi, & Hanim, N. (2023). Respon peserta didik terhadap pengembangan e-handout berbasis mind mapping dan gambar pada materi ekosistem di SMP Negeri 1 Woyla. *Prosiding Seminar Nasional Biologi, Teknologi dan Kependidikan*, (pp. 171–178). Banda Aceh: UIN Ar-Raniry. https://doi.org/10.22373/pbio.v11i1.19584

Ashari, V. R., Fatirul, A. N., & Walujo, D. A. (2023). Pengembangan e-modul kimia materi asam basa berbasis flip pdf professional untuk peserta didik kelas XI SMA Negeri 1 Menganti. *Edukasia: Jurnal Pendidikan dan Pembelajaran, 4*(2), 1391–1398. https://doi.org/10.62775/edukasia.v4i2.449

Awlia, Z., & Febrianti, N. (2023). Penyusunan e-handout pengayaan materi bioproses sel sebagai bahan ajar biologi siswa SMA kelas XI IPA. *Bioilmi: Jurnal Pendidikan*, *9*(2), 23-34. https://doi.org/10.19109/bioilmi.v9i2.13999

Dulyapit, A., & Lestari, S. (2024). Metode ceramah dalam pendidikan Madrasah Ibtidaiyah: Analisis literatur tentang implementasi dan dampaknya. *Al-Ihtirafiah: Jurnal Ilmiah Pendidikan Guru Madrasah Ibtidaiyah, 4*(2), 45-56. https://doi.org/10.47498/ihtirafiah.v4i2.4249

Erlina., Silaban. R., & Nurfajriani. (2020) Development of green chemistry practicum guidelines based on discovery learning. *Proceedings The 5th Annual International Seminar on Transformative Education and Educational Leadership (AISTEEL 2020)*, (pp. 147-150). Belanda: Atlantis Press. https://doi.org/10.2991/assehr.k.201124.032

Farida, M. T., Kurniati, T., & Fitriani. (2020). Pengembangan media pembelajaran buletin berorientasi HOTS (higher order thinking skill) pada materi laju reaksi. *Ar-Razi Jurnal Ilmiah, 8*(1), 9–15. https://doi.org/10.29406/ar-r.v8i1.1819

Fitriyah., & Bisri, M. (2023). Pembelajaran berdiferensiasi berdasarkan keragaman dan keunikan siswa sekolah dasar. *Jurnal Review Pendidikan Dasar: Jurnal Kajian Pendidikan dan Hasil Penelitian*, *9*(2), 67-73. https://doi.org/10.31004/innovative.v3i2

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers, 3*(May), 275–285. https://doi.org/10.1016/j.susoc.2022.05.004

Hasrah., Khaerati., & Yunus, N. M. (2022). Pengembangan media pembelajaran handout berbasis discovery learning di SMAN 17 Luwu. *Al-Nafis: Jurnal Biologi dan Pendidikan Biologi*, *2*(2), 77-89. https://doi.org/10.46339/al-nafis.v2i2.907

Kandi, N. N. A. S., & Wibawa, I. M. C. (2024). Natural and social sciences e-book based on inquiry learning to improve higher order thinking skills of fourth grade Elementary School Students. *Thinking Skills and Creativity Journal, 7*(1), 96-105. https://doi.org/10.23887/tscj.v7i1.80518

Kusumaningtyas, A. T., Sumarna, O., & Anwar, S. (2023). Creative thinking skill indicators in PjBL-based reaction rate student worksheets. *Jurnal Penelitian Pendidikan IPA, 9*(8), 6503-6509. https://doi.org/10.29303/jppipa.v9i8.4347

Linden, S. V. D., Meij, J. V. D., & McKenney, S. (2021). Teacher video coaching, from design features to student impacts: A systematic literature review. *Review of Educational Research, 92*(1), 114-165. https://doi.org/10.3102/00346543211046984

Luthfi, M., & Rosmi, F. (2024). Upaya meningkatkan berpikir kritis siswa dalam pembelajaran IPA kelas V pada materi ekosistem melalui metode discovery learning di SD LAB School FIP UMJ. *Proceedings of the National Seminar on Biology, Technology, and Education,* (pp. 153-159). Jakarta: Universitas Muhammadiyah Jakarta.

Prasetyo, A. D., & Abduh, M. (2021). Peningkatan keaktifan belajar melalui model discovery learning di sekolah dasar. *Jurnal Basicedu, 5*(4), 1717-1724. https://doi.org/10.31004/basicedu.v5i4.991

Pratiwi, E. P., Halang, B., & Widiyastuti, D. A. (2024). Pengembangan e-handout konsep perubahan lingkungan kelas X SMA berbasis flipbook. *Edukatif: Jurnal Ilmu Pendidikan, 6*(6), 6345-6358. https://doi.org/10.31004/edukatif.v6i6

Puzio, K., Colby, G. T., & Nichols, D. A. (2020). Differentiated literacy instruction: Boondoggle or best practice?. *Review of Educational Research, 90*(4), 459–498. https://doi.org/10.3102/0034654320933536

Sarita, V. R., Jati, S. S. P., & Ayundasari, L. (2021). Pengembangan bahan ajar e-handout berbasis Kodular materi Istana Gebang untuk pembelajaran Sejarah di SMA Negeri 1 Blitar. *Jurnal Integrasi dan Harmoni Inovatif Ilmu-Ilmu Sosial (JIHI3S), 1*(12), 1265–1276. https://doi.org/10.17977/um063v1i12p1265-1276

Shim, S. Y., & Thompson, J. (2022). Four years of collaboration in a professional learning community: Shifting toward supporting

students' epistemic practices. *Science Education, 106*(3), 674-705. https://doi.org/10.1002/sce.21704

Sitorus, R. T., Djulia, E., & Marpaung, R. (2023). Pengembangan e-handout berbasis kontekstual pada materi sistem pencernaan untuk meningkatkan hasil belajar siswa kelas XI di SMA Swasta Sultan Agung Pematang Siantar. *Pediaqu: Jurnal Pendidikan Sosial dan Humaniora, 2*(3), 10303–10315. https://doi.org/10.35931/pediaqu.v2i3

Suyanto, M. (2020). *Pendidikan karakter dan metode pembelajaran di Madrasah Ibtidaiyah*. Jakarta: Prenadamedia Group.

Swasti, M., Hutapea, N. M., & Suanto, E. (2022). Pengembangan media pembelajaran interaktif berbasis discovery learning. *Jurnal Cendekia: Jurnal Pendidikan Matematika, 6*(3), 2928-2941. https://doi.org/10.31004/cendekia.v6i3.1561

Taqiya, N. R., Oprasmani, E., & Nevrita, N. (2023). Development of e-handout based on discovery learning for respiratory system material. *Bioedukasi: Jurnal Pendidikan Biologi, 16*(1), 29-37. https://doi.org/10.20961/bioedukasi-uns.v16i1.69358

Widarti, H. R., Yamtinah, S., Mawardi, M., Rokhim, D. A., Siddiq, A. S., Syafruddin, A. B., Sriwahyuni, T., Rachmanita, Z. A., Amalia, E. R. F., Baharsyah, A., & Anggraini, T. (2022). Analysis understanding participant educate to theory rate reaction. *Jurnal Penelitian Pendidikan IPA, 8*(6), 3027-3033. https://doi.org/10.29303/jppipa.v8i6.2462