Development of Heyzine-assisted handout on human respiratory system material in the eighth grades of junior high school

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Abstract: E-handout is one form of teaching material that can be used by teachers and students in the learning process. This research aims to develop teaching materials in the form of e-handouts using Heyzine to determine the feasibility and practicality of e-handouts on human respiratory system material in the 8th grade of junior high school. The research method used is Research and Development with the Analysis, Design, Develop, Implement, and Evaluate (ADDIE) model. However, this study only carried to the implement stage. The data sources of this study were 18 9th-grade students from SMP Negeri 6 Menyuke; 3 science teachers from SMP Negeri 29 Pontianak, SMP Negeri 5 Menyuke, and SMP Negeri 6 Menyuke; and 2 lecturers of Biology Education FKIP UNTAN. The results of validation of the e-handout were obtained, namely 0.95, which was categorized as valid. The interrater reliability results using the Intraclass Correlation Coefficient (ICC) obtained results of 0.430, which falls into the fair to good category. The e-handout practicality test results obtained 83.53%, which falls into the very practical category. It can be concluded that the development of a Heyzine-based e-handout on human respiratory system material for class VIII students is considered valid and very practical as teaching material. However, this study has several limitations. Research was only carried out up to the implementation stage in the ADDIE model, so the effectiveness of e-handouts in increasing student understanding cannot yet be measured thoroughly.

Keywords: e-handout; Heyzine; human respiratory system; practicality; teaching materials

Introduction

The advancement of science and technology in education shows a positive direction in developing learning designs to improve the quality of education and increase the effectiveness of the learning process (Safriana, et al., 2023; Sitorus, et al., 2023). Educators need competencies to encourage participation in electronic technology so that they will be able to utilize technology effectively and develop learners' electronic competencies (Starkey, 2020; Yuliza, 2023). Teachers must be more creative and try to utilize technology in learning so that the learning process can run well (Mago, et al., 2022; Putri, et al., 2023). The pedagogic competence of a teacher in delivering material relies on more than existing teaching materials. Teachers must develop teaching materials creatively to present exciting and meaningful learning (Bajuri & Baiti, 2019).

It should be noted that the distribution of teaching materials in Indonesia is not proportional to the number of schools available; the inequality of teaching materials results in an imbalance in supporting the teaching and learning process carried out by educators (Ginting et al., 2022). This is supported by research Juventia & Yuan (2024) which states that social inequality in the education sector in Indonesia is still a serious problem that has an impact on people's welfare. This inequality is caused by various factors, such as poor educational facilities and infrastructure, lack of qualified teaching staff, high educational costs, and differences in access between urban and rural areas. In addition, conventional teaching materials have many disadvantages, such as being easily damaged, monotonous material, and requiring space to carry, so it is not attractive (Utami, & Atmojo, 2021). To overcome these problems, it

is necessary to develop teaching materials to support a more exciting learning process for students.

Based on the results of interviews with science teachers at SMP Negeri 4 Menyuke, SMP Negeri 5 Menyuke, and SMP Negeri 6 Menyuke and questionnaires of students' needs, it is known that in the learning process, the teacher only uses conventional teaching materials so that students are not interested and tend to get bored. This aligns with Utami & Atmojo (2021) that using conventional teaching materials is unattractive to students. Based on the needs questionnaire, it is known that students have difficulty learning independently. In addition, students prefer to learn to observe text accompanied by images and videos and are more interested in electronic teaching materials than conventional teaching materials. The students' daily test scores show that the average daily test scores on human respiratory system material are lower than other materials. According to the science teacher interviewed, human respiratory system material involves many components of the human respiratory structure and many scientific terms. Noviyanto, et al., (2015); Telaumbanua (2023) stated that human respiratory system material is challenging to understand because of the large amount of material. Therefore, teaching materials are needed to support students' understanding of the material. One of the teaching materials that can be developed is e-handout.

The development of teaching materials that are relevant to teaching materials and the needs of students will undoubtedly create active, innovative, practical, exciting, and more meaningful learning than before so that the expected learning objectives can be achieved maximally and satisfactorily (Bajuri & Baiti, 2019; Trinaldi, et al., 2022). Teaching materials in this case are teaching materials developed to support the learning process. These teaching materials can be printed materials such as books and modules, or digital materials such as e-handouts. The aim of developing these teaching materials is to make learning more active, innovative, practical, interesting and meaningful, so that students can achieve learning goals optimally and satisfactorily (Magdalena et al., 2020). The development of electronic teaching materials is expected to increase the interest and enthusiasm of students in the learning process (Sarita et al., 2021). E-handouts are practical, easy to use, and carry everywhere compared to printed teaching materials (Rahmatina et al., 2023). E-handouts can also be used for self-study (Khalida et al., 2024; Khotimah et al., 2022; Sarita et al., 2021). The existence of teaching materials in the form of e-handouts can facilitate the role of the teacher when learning takes place and help students understand the material (Khalida et al., 2024). E-handouts contain concise and precise material, so they can encourage students to think systematically and increase their interest and motivation (Ramadan et al., 2020; Sirumahombar, 2023). E-handouts in this study used Heyzine. The teaching materials produced with Heyzine are flipbooks in HTML format, which can be accessed via smartphones, tablets, laptops, and PCs (Muhaimin et al., 2024).

Using Heyzine, teaching materials can be added with videos, images, sounds, and links. Students can read by feeling like they are reading a physical book because there is an animation effect that can move so that the page will look like opening a physical book (Hadiyanti, 2021; Erawati et al., 2022; Saraswati & Salsabila, 2021). Compared to other e-handout platforms such as FlipHTML5 or Canva, Heyzine offers a seamless page-flipping animation that closely resembles a physical book, which may enhance students' reading engagement. Additionally, Heyzine supports offline access once downloaded, making it more accessible in areas with limited internet connectivity. While other platforms may offer similar multimedia integration, Heyzine's ease of use, lightweight design, and compatibility across various devices make it a more practical choice for developing e-handouts in this study (Puspitaningrum & Witanto, 2024).

Previous research related to the development of e-handouts has been carried out. Among these studies are (Awlia & Febrianti, 2023; Khotimah,et al., 2022; Laoli et al., 2023). These studies state that the development of e-handout teaching materials can be very valid, increase student learning motivation, and be very practical to use as teaching materials. The research by Awlia & Febrianti (2023) explains the development of an e-handout for cell bioprocess material in 11th-grade science classes using the 4D model. The developed e-handout serves as enrichment material for students who have met the minimum competency criteria (KKM), making it more focused on high-achieving students. The research results indicate a very high level of validity and practicality. The main gap here lies in the difference in material focus, where this study targets students struggling with learning, whereas Awlia & Febrianti's research aims to provide additional material for students who have already understood basic concepts.

The research by Khotimah et al., (2022) examined the development of an e-handout on the human respiratory system in high school, based on Flip HTML5. The research model used was 4D (Define, Design, Develop, Disseminate), with a broader scope extending to the dissemination stage in schools. The results showed that the e-handout was highly suitable, feasible, and received positive feedback from students. In contrast, this study discusses differences in educational levels (high school vs. middle school) and the e-handout development platforms used (Flip HTML5 vs. Heyzine).

Lastly, the research by (Laoli et al., 2023) focused on developing an Indonesian language e-handout to enhance students' learning motivation. This study used the ADDIE model more comprehensively, including the evaluation stage, and involved expert validation in terms of content, language, and design. The results indicated a very high level of validity and practicality. The difference is that this study

emphasizes the feasibility and practicality of e-handouts in the field of Biology, whereas Laoli et al. focus more on student motivation in learning the Indonesian language.

Based on these differences, it is evident that this research is important as it focuses on developing electronic teaching materials (e-handouts) to enhance learning effectiveness, particularly for the human respiratory system material in 8th-grade middle school students. Therefore, this study develops a Heyzine-based e-handout that allows multimedia integration, such as videos, images, audio, and links, thereby increasing student engagement in the learning process. The use of technology in education not only helps overcome the limitations of printed teaching materials but also supports students in learning independently and more flexibly. This research is expected to contribute to the field of education by presenting a digital teaching material model that is valid, practical, and implementable in various schools, especially in areas with limited access to quality learning resources.

Method

This research uses the Research and Development (R&D) method with the Analysis, Design, Develop, Implement, and Evaluation (ADDIE) model, presented in Figure 1. However, this research was only conducted until the fourth stage, Implement. The main reason the evaluation stage was skipped due to limited time and available resources. Evaluations in the ADDIE model typically involve long-term testing of the effectiveness of open-ended materials, requiring more time to see their impact on student learning outcomes. This research focuses more on the development and implementation of Heyzine-based e-handouts and assessing their feasibility and practicality in learning, so that a comprehensive evaluation of increasing student understanding may not have been a top priority (Yuliana, 2016). This research uses the ADDIE model because the steps are systematic, clear, and easy to understand (Ivaningtias et al., 2024).
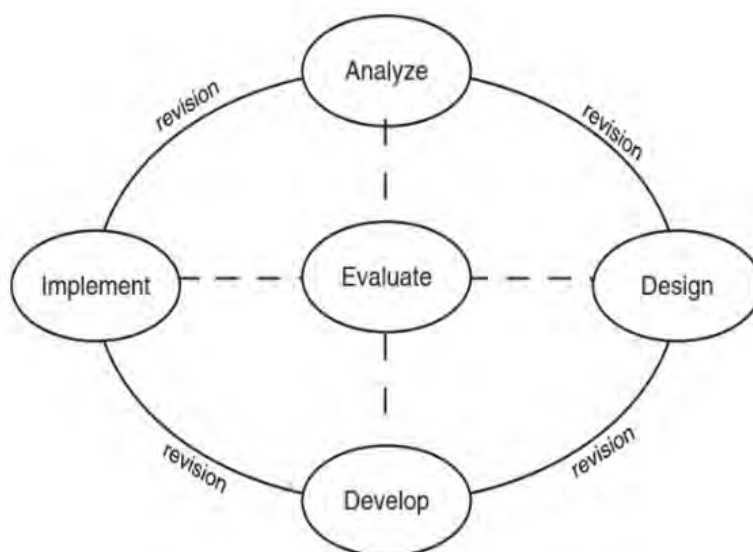

Figure 1. ADDIE development model (Branch, 2009)

The data collection techniques used in this study were interviews and questionnaires. In the questions on the questionnaire, this study used a Likert scale with 4 categories. This aims to avoid neutral bias in respondents' answers. In a 5-point Likert scale, there is a middle category that allows respondents to choose a neutral option without actually expressing their opinion. By using only 4 scales, this research can encourage respondents to give more firm answers, both positive and negative.

The instruments used were interview guideline sheet, students' needs questionnaire, product validation sheet, and practicality questionnaire. The instruments used in this research consisted of an interview guide sheet, student needs questionnaire, product validation sheet, and practicality questionnaire. The validity of the instrument was tested using the expert judgment method, where the results of validation by experts showed a validity value of 0.95, which is included in the valid category. For reliability, calculations using the Interclass Correlation Coefficient (ICC) produce a value of 0.430, which is categorized as fair to good. Apart from that, the practicality of the e-handout was tested with a questionnaire which showed a result of 83.53%, which is included in the very practical category. Product validation sheets and practicality questionnaires use a Likert scale that refers to Nengsih et al., (2019) which is presented in Table 1.

Table 1. Likert scale in this research

Scale	Criteria
1	Not good
2	Fairly good
3	Good
4	Very good

The product validation sheet contains 26 statements divided into four aspects: content, presentation, language, and visual appearance. The product validity test was carried out using a product validation sheet filled in by five validators, namely two lecturers of Biology Education FKIP UNTAN and three science subject teachers, who were then analyzed using Aiken's validity index (Aiken, 1985). According to Aiken (1985), the minimum validation index must be obtained is 0.87 if a 95% confidence level is used, five validators, and the highest validity assessment number is 4. Aiken's validity index of <0.87 is categorized as invalid, while Aiken's validity index of ≥0.87 is categorized as valid.

Furthermore, interrater reliability was measured using the Intraclass Correlation Coefficient (ICC) test with IBM Statistic SPSS software version 27. The ICC test values obtained were then categorized according to Zaki (2017), as presented in Table 2.

Table 2. ICC test values category

ICC Test Value	Category
< 0.4	Poor
0.4 ≤ ICC < 0.75	Fair to good
≥ 0.75	Very good

A practicality test is carried out after the e-handout is declared valid and reliable. The practicality questionnaire contains 15 statements divided into three aspects: ease of use, benefits obtained, and effectiveness of learning time. The practicality test scores obtained using Formula 1 were then categorized according to Riduwan (2010) as presented in Table 3.

$$\text{Practicality percentage} = \frac{\text{Score obtained}}{\text{Maximum score}} \times 100\%$$

Table 3. Practicality category

Percentage (%)	Criteria
81-100	Very practical
61-80	Practical
41-60	Fairly practical
21-40	Impractical
0-20	Very impractical

Results and Discussion

The research results showed that the Heyzine-assisted e-handout developed for material on the human respiratory system for class VIII students was considered valid and very practical. Based on the validation results from five validators, an average Aiken's Validity Index value of 0.95 was obtained, which is included in the valid category. The four aspects assessed, namely content, presentation, language and visual appearance, received high marks, indicating that the e-handout developed is in accordance with learning objectives and is easy for students to understand.

On develope stage, it aims to produce valid Heyzine-assisted e-handouts that can be used as suitable teaching materials in the teaching and learning process and help students learn independently. The product validation process is carried out by giving questionnaires to five validators who aim to assess the feasibility of the e-handout developed. The aspects validated on the e-handout are content, presentation, language, and visual appearance. Based on the test results from the validator, the e-handout obtained an average of 0.95 with the category of valid and feasible to use. The validation results can be seen in Table 4.

Table 4. Validation results

No.	Indicators	Aiken's Validity Index	Category
	Content Aspect		
1	The accuracy of concepts and definitions	1.00	Valid
2	The accuracy of figures and videos	1.00	Valid
3	Completeness of materials in accordance with learning objectives	1.00	Valid
4	Broadness of the materials	0.87	Valid
5	Depth of the materials	1.00	Valid
6	Encourage students' curiosity	0.87	Valid
7	Creates the ability to ask questions	0.87	Valid
	Average	**0.94**	**Valid**
	Presentation Aspect		
8	The conciseness of the concepts presented	0.93	Valid
9	Consistency of presentation systematics	0.87	Valid
10	The presentation of evaluation questionis is in accordance with the learning objectives	1.00	Valid
11	Simple operation	0.93	Valid
12	E-handout runs well and does not hang easily	0.93	Valid
13	E-handout makes it easy for students to learn independently	1.00	Valid
14	The availability of videos and figures makes it easier for students to understand the materials	0.93	Valid
15	The backsound on the e-handout is clear and does not interfere with students' focus	1.00	Valid
16	Presentation of feedback and follow-up	0.87	Valid
	Average	**0.94**	**Valid**
	Language Aspect		
17	Accuracy of sentences structure	0.93	Valid
18	The language used in the e-handout is easy to understand	1.00	Valid
19	Sentences effectiveness	1.00	Valid
20	Standardization of terms	0.93	Valid
21	The suitability of the statements used in accordance with good and correct grammar based on *Ejaan yang Disempurnakan*	1.00	Valid
	Average	**0.97**	**Valid**
	Visual Appearance Aspect		
22	Layout consistency	1.00	Valid
23	The use of text, figures, videos, and questions are proportional	0.87	Valid
24	Background display, cover, video, image, and color selection	0.93	Valid
25	Consistency of e-handout content with table of contents	0.87	Valid
26	Clarity of font display and use of spacing	1.00	Valid
	Average	**0.93**	**Valid**
	Average of All Aspects	**0.95**	**Valid**

In the content aspect, the criterias assessed are "The accuracy of concepts and definitions", The accuracy of figures and videos", "Completeness of materials in accordance with learning objectives", "Broadness of the materials", "Depth of the materials", "Encourage students' curiosity", and "Creates the ability to ask questions". The results of validation from the content aspect of teaching materials as a support for learning the material of the human respiratory system obtained a result of 0.94 with a valid category. These results indicate that the teaching materials prepared are based on the learning objectives and material. Other studies also confirm that teaching materials that are valid from the content aspect play an important role in supporting learning and encouraging students' curiosity through presenting relevant and engaging material (Agustina et al., 2023; Wati et al., 2022).

With a validity value of 0.94, teaching materials have been proven to be appropriate to the learning objectives and material taught, so that they can increase learning effectiveness. High validity ensures that the material presented is complete, broad and in-depth, thereby helping students understand concepts better. Apart from that, valid teaching materials are also able to arouse students' curiosity and encourage them to ask questions, which is an important indicator of active learning.

Research Warman (2025) supports this because this research confirms that valid teaching materials play a role in increasing student involvement, motivating them to explore the material further, and strengthening conceptual understanding through presenting relevant and interesting material.

In the presentation aspect, the criterias assesed are "The conciseness of the concepts presented", "Consistency of presentation systematics", "The presentation of evaluation questions is in accordance with the learning objectives", "Simple operation", "E-handout runs well and does nat hang easily", "E-handout makes it easy for students to learn independently", "The availability of videos and figures makes

it easier for students to understand the materials", "The backsound on the e-handout is clear and does not interfere with students' focus", and "Presentation of feedback and follow-up". The validation results of the presentation aspect of teaching materials obtained a result of 0.94 with a valid category. These results indicate that the e-handouts presented are easy to understand and the flow of presentation is systematic (Yuli & Mufit, 2021). This is in line with the findings of (Maulida & Sinaga, 2019) which state that the design of teaching materials that are systematic and easy to understand can increase students' understanding. Research by (Kustandi & Ibrahim, 2021) states that the use of electronic teaching materials that are simple and easy to operate can facilitate students in the learning process, and the features contained in e-handouts can support independent learning because students can access material more flexibly. The selection of appropriate backsound significantly affects the learning atmosphere (Fitriyani et al., 2024).

In the language aspect, the criterias assessed are "Accuracy of sentences structure", "The language used in the e-handout is easy to understand", "Sentences effectiveness", "Standardization of terms", and "The suitability of the statements used in accordance with good and correct grammar based on *Ejaan yang Disempurnakan*". The validation results from the language aspect obtained a result of 0.97 with a valid category. These results indicate that the e-handout developed uses language that is easy to understand and there is clarity of effective and efficient information (Jannah, 2018).

Efficient information in an e-handout means that the material is delivered concisely, clearly and without redundancy, so that students can understand the content quickly and easily. This information efficiency includes several aspects, such as simple sentence structures, use of communicative language, and avoidance of terms that are too technical without adequate explanation. Some researchers support this by showing that simple and easy-to-understand language in teaching materials can increase engagement and facilitate understanding of the material in the learning process (Gustiar et al.,, 2023; Wibowo et al., 2018). In addition, using clear and structured language can reduce student confusion and make it easier for students to learn independently (Khairani et al., 2019). According to Kustandi, & Ibrahim, (2021), the use of vocabulary and terms presented must be based on students' education level; the goal is to make it easier for students to understand the materials presented.

In the visual appearance aspect, the criterias assessed are "Layout consistency", "The use of text, figures, videos, and questions are proportional", "Background display, cover, video, image, and color selection", "Consistency of e-handout content with Table of Contents", and "Clarity of font display and use of spacing". The validation results of the visual appearance aspect obtained a result of 0.93 with a valid category. These results indicate that the overall appearance of e-handouts, such as layouts, images, and videos, is appropriate to attract students' attention to learning (Nengsih et al., 2019). This is in line with the research of Rahmi et al. (2022); Annisa et al (2023); Magdalena et al. (2020), which shows that the use of images, videos, and clear layouts can increase the effectiveness of e-handouts as teaching materials. According to (Afridayanti & Azizah, 2020), readers will more easily understand the content of teaching materials if the material presented is arranged in a good order.

Furthermore, the reliability test used the Intraclass Correlation Coefficient (ICC) with IBM Statistic SPSS software version 27. Based on the results of the interrater reliability analysis using ICC on e-handout teaching materials conducted to 5 assessors or raters, getting a test result of 0.430 makes the ICC reliability test get fair to good results so that it can be continued to the next stage (Zaki, 2017). The results of interrater reliability is presented in Table 5.

Table 5. Test results of interrater reliability using ICC

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.131[a]	.001	.332	1.761	25	100	.026
Average Measures	.430[c]	.003	.713	1.761	25	100	.026

Description:
Two-way mixed effects model where people effects are random and measures effects are fixed.
a.   The estimator is the same, whether the interaction effect is present or not.
b.   Type A intraclass correlation coefficients using an absolute agreement definition.
c.   This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

Revisions were made based on criticisms and suggestions from the five validators. The revisions made to the e-handout are presented in Table 6.

Table 6. E-handout revisions

No.	Revisions	Before Revisions	After Revisions
1	Add Table of Contents and page numbers		
2	Add instructions for use		
3	Add formative tests and feedback in each meeting		
4	Add materials to create students' curiosity and ability to ask questions		

At implement stage, the entire design of the e-handout will be applied or tested in small groups (limited test) of 18 students of SMPN 6 Menyuke to determine whether students can accept the e-handout. The results of the students' practicality test of Heyzine-assisted e-handout on human respiratory system material can be seen in Table 7.

Table 7. Results of the students' practicality test of Heyzine-assisted e-handout on Human Respiratory System Material

No.	Indicators	Score (%)	Category
	Ease of Use Aspect		
1	E-handout can be used easily	81.94	Very practical
2	E-handout can be accessed at any time	76.39	Practical
3	The language is easy to understand	80.56	Practical
4	The figures in the e-handout are clear and easy to understand	84.72	Very practical
5	The presentation of the materials is more practical	81.94	Very practical
6	E-handout can be used individually or in groups	80.56	Practical
7	E-handout is practical to use	81.94	Very practical
	Average	**81.15**	**Very practical**
	Benefits Obtained Aspect		
8	E-handout can increase students' interest in reading	93.06	Very practical
9	E-handout makes it easier for students to understand the concept of the materials	84.72	Very practical
10	E-handout increases students' curiosity	84.72	Very practical
11	Learning with e-handout is fun	90.28	Very practical

No.	Indicators	Score (%)	Category
12	The materials presented is useful for everyday life	86.11	Very practical
13	E-handout can help students learn independently	81.94	Very practical
	Average	**86.81**	**Very practical**
	Effectiveness of Learning Time Aspect		
14	Learning using e-handout is more effective and optimal	84.72	Very practical
15	Learning is more efficient by using e-handout	80.56	Practical
	Average	**82.64**	**Very practical**
	Average of All Aspects	**83.53**	**Very practical**

The practicality test results show that the Heyzine-assisted e-handout obtained an average score of 83.53%, which falls into the "very practical" category. In terms of ease of use, the e-handout received a score of 81.15%, indicating that students find it easy to access anytime and anywhere, allowing for independent learning. These findings align with the research by Maskur & Safitri (2021), which states that electronic-based teaching materials can enhance students' skills and abilities in learning while providing flexibility in accessing educational content. Meanwhile, in the aspect of benefits obtained, the e-handout scored 86.81%, demonstrating that its use can increase students' reading interest, facilitate concept comprehension, and foster a higher level of curiosity. This is consistent with the findings of Ratiyani et al. (2014), which suggest that electronic teaching materials help students better understand the material and improve learning effectiveness.

However, although the practicality test results indicate a very practical category, the score has not yet reached 100%, suggesting that there are still some limitations or areas that need improvement. One of the challenges faced is limited access to electronic devices or internet connectivity in certain areas, which may hinder the optimal use of the e-handout. Despite being considered highly practical, some students may still struggle with operating certain features, especially those who are not yet familiar with digital-based teaching materials. This is supported by research Pratiwi et al., (2024), which states that a survey conducted in the test class revealed that 93.8% of students reported never having been provided with electronic handouts, and 87.5% indicated that additional teaching materials in the form of electronic handouts were not available.

The novelty of this research lies in its approach which combines ease of accessibility with the effectiveness of learning through the Heyzine platform, which has not been widely used in developing interactive teaching materials. With a practicality test result of 86.81% in the very practical category, this e-handout has been proven to increase students' reading interest, facilitate understanding of concepts, and encourage students' curiosity in a more interesting way than conventional teaching materials. Another advantage is its ability to support independent learning, where students can learn anytime and anywhere without relying completely on the teacher. In addition, interactive design and the use of digital technology enable the presentation of material that is more visual, concise and easy to understand, which is in line with students' learning styles in the digital era.

In the effectiveness of learning time aspect, the criterias assessed are "Learning using e-handout is more effective and optimal" and "Learning is more efficient by using e-handout". The results of the practicality test on the aspect of the effectiveness of learning time obtained results of 82.64% in the very practical category. Aiken, (1985); Maskur et al. (2021) stated that the selection of electronic teaching materials in the learning process can be easily used and can attract students' attention to increase the motivation and interest of students in learning activities.

The results of the analysis of the students' practicality test on the use of e-handout, which was attended by 18 students at the limited trial stage, showed that the e-handout assisted by Heyzine on respiratory system material had an overall average of 83.53%, included in the very practical category. Thus, the high percentage of positive responses students give proves that teaching materials in e-handouts are attractive and practical (Ananda et al., 2024; Maskar & Dewi, 2020; Sahida, 2020). This is in line with research conducted by Muliani et al. (2024), which states that web-based teaching materials are attractive and practical for students because they can help students with obstacles in learning and make it easier for them to learn independently.

Conclusion

The conclusion of this research shows that the development of a Heyzine-based e-handout on human respiratory system material for class VIII students is considered valid and very practical. The validation results by five validators show the Aiken validity index of 0.95, which is included in the valid category. Apart from that, the interrater reliability test using the Intraclass Correlation Coefficient (ICC) obtained a value of 0.430, which is included in the fair to good category. The practicality test by students resulted in an average score of 83.53%, which was categorized as very practical. Thus, this e-handout is suitable

for use as teaching material that can support more interactive and interesting learning.The suggestion from this research is that it is necessary to carry out an evaluation stage in the ADDIE model so that the effectiveness of e-handouts in improving student understanding can be tested further. Additionally, e-handout development can be expanded with the integration of other interactive features such as online quizzes or 3D animations to increase student engagement. For further research, it is recommended to test this e-handout on a wider scale and compare its effectiveness with other learning methods to obtain more comprehensive results.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author Contributions

T. M. Natalia: writing original draft, data curation, and formal analysis; **E. S. Wahyuni,** and **T. Titin:** methodology, formal analysis, supervision, and review & editing.

References

Afridayanti, R., & Azizah, U. (2020). Validitas lembar kerja peserta didik (LKPD) dengan model pembelajaran learning cycle7e untuk melatihkan keterampilan berpikir kritis pada materi asam basa di SMA Kelas XI. *Unesa Journal of Chemical Education*, *9*(1), 53–58. https://doi.org/https://doi.org/10.26740/ujced.v9n1.p53-58

Agustina, N., Sustiono, E., Adesti, A., & Susila, H. R. (2023). Development of valid, practical, and potential web-based learning materials for higher education. *Teknodika*, *21*(1), 49–55. https://doi.org/https://doi.org/10.20961/teknodika.v21i1.69880

Aiken, L. R. (1985). Three coefficients for analyzing the reliability and validity of ratings. *Educational and Psychological Measurement.*, *45*, 131–142. https://doi.org/10.1177/0013164485451012

Ananda, P. N., Nerita, S., & Kasmari, R. (2024). Pengembanan e-handout berbasis mindmap pada materi sistem koordinasi kelas XI SMA/MA. *Jurnal Pendidikan Tambusai*, *8*(1), 8263–8272. https://doi.org/https://doi.org/10.31004/jptam.v8i1.13623

Annisa, A., Nerita, S. ., & Safitri, E. (2023). Validitas e-handout pada materi keanekaragaman hayati kelas X SMA. *Jurnal Pendidikan Tambusai*, *7*(1), 381–384. https://doi.org/https://doi.org/10.31004/jptam.v7i1.5306

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/https://doi.org/10.19109/bioilmi.v9i2.13999

Bajuri, D. A., & Baiti, M. (2019). Pengembangan bahan ajar IPA integratif berbasis pendekatan kontekstual. *Jurnal Pendidikan Dan Pembelajaran Dasar*, *5*(2), 184–197. https://doi.org/https://doi.org/10.24042/terampil.v5i23173

Branch, R. M. (2009). Instructional design: The ADDIE Approach. Spinger Science. https://link.springer.com/book/10.1007/978-0-387-09506-6

Fitriyani, F., Panjaitan, R. G. P., Titin, T., & Caiping, Z. (2024). The development of video learning media on cell division subtopic for ninth grade students. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *10*(3), 1011–1019. https://doi.org/https://doi.org/10.22219/jpbi.v10i3.36851

Ginting, R. R., Ginting, E. V., Hasibuan, R. J., & Perangin-angin, L. M. (2022). Analisis faktor tidak meratanya pendidikan di SDN 0704 Sungai Korang. *Jurnal Pendidikan Indonesia*, *3*(4), 407–416. https://doi.org/https://doi.org/10.59141/japendi.v3i04.778

Gustiar, A. W., Saepurokhman, A., & Irianto, A. (2023). Analisis kelayakan isi dan penggunaan bahasa dalam buku teks bahasa indonesia kelas IX SMP Karya Agus Trianto, dkk. sebagai upaya pemilihan bahan ajar bermutu. *Literat - Jurnal Pendidikan Bahasa Dan Sastra Indonesia*, *2*(1), 62–70. https://ejournal.lppmunsap.org/index.php/literat/article/view/693

Hadiyanti, A. H. D. (2021). Pengembangan modul pembelajaran ipa elektronik berbasis flipbook untuk pembelajaran daring di sekolah dasar. *Jurnal Elementaria Edukasia*, *4*(2), 284–291. https://doi.org/https://doi.org/10.31949/jee.v4i2.3344

Ivaningtias, Y., Indana, S., & Indah, N. K. (2024). Validity of problem-based learning biodiversity e-book integrating Ruwat Petirtaan Jolotundo's local wisdom for science literacy. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *10*(3), 874–886. https://doi.org/https://doi.org/10.22219/jpbi.v10i3.36690

Jannah, W., & E. (2018). (2018). Validitas dan praktikalitas modul larutan penyangga berbasis pendekatan saintifik dengan menerapkan teknik probing prompting untuk kelas XI SMA/MA. *Menara Ilmu*, *12*, 101–111. https://jurnal.umsb.ac.id/index.php/menarailmu/article/view/1092/945

Juventia, D., & Yuan, S. A. (2024). Ketimpangan sosial dalam bidang pendidikan dan dampaknya terhadap kesejahteraan masyarakat. *MOTEKAR: Jurnal Multidisiplin Teknologi Dan Arsitektur*, *2*(1), 418–427. https://doi.org/10.57235/motekar.v2i1.2335

Erawati, N.K., Kadek, N., Purwati, R., Dewa, I., Putrı, A., & Saraswatı, D. (2022). Pengembangan e-modul logika matematika dengan heyzine untuk menunjang pembelajaran di SMK. https://doi.org/10.20527/jmscedu.v4i1.10297

Khairani, M., Sutisna, S., & Suyanto, S. (2019). Studi meta-analisis pengaruh video pembelajaran terhadap hasil belajar peserta didik. *Jurnal Biolokus: Jurnal Penelitian Pendidikan Biologi Dan Biologi*, *2*(1), 158–166. https://doi.org/http://dx.doi.org/10.30821/biolokus.v2i1.442

Khalida, N., Noorhidayati, N., & Amintarti, S. (2024). Pengembangan bahan ajar konsep pengantar bioteknologi untuk peserta didik fase E berbentuk e-handout. *Journal of Bio-Creaducation*, *1*(1), 1–7. https://ppjp.ulm.ac.id/journals/index.php/bioco/article/view/13071

Khotimah, K., Noorhidayati, N., & Hardiansyah, H. (2022). Pengembangan bahan ajar konsep sistem pernapasan pada manusia di sma berbentuk e-handout berbasis flip HTML5. *JUPENJI: Jurnal Pendidikan Jompa Indonesia*, *1*(2), 106–118. https://doi.org/https://doi.org/10.55784/jupenji.Vol1.Iss2.235

Kustandi, C., & Ibrahim, N. (2021). Pendampingan pembuatan bahan ajar elektronik bagi guru di sekolah dasar untuk meningkatkan literasi digital. *Jurnal Karya Abdi Masyarakat*, *5*(3), 415–422. https://doi.org/https://doi.org/10.22437/jkam.v5i3.16233

Laoli, M. S., Zebua, J. N., Hulu, N. P., & Waruwu, L. (2023). Pengembangan bahan ajar e-handout bahasa indonesia untuk meningkatkan motivasi belajar siswa di sekolah. *Journal on Education*, *6*(1), 4411–4417. https://doi.org/https://doi.org/10.31004/joe.v6i1.3582

Magdalena, I., Sundari, T., Nurkamilah, S., Ayu Amalia, D., & Muhammadiyah Tangerang, U. (2020). Analisis bahan ajar. *Jurnal Pendidikan Dan Ilmu Sosial*, *2*(2), 311–326. https://doi.org/https://ejournal.stitpn.ac.id/index.php/nusantara

Mago, O. Y. T., Yati, A., & Bunga, Y. N. (2022). No Title. *Jurnal Pendidikan MIPA*, *12*(2), 233–240. https://doi.org/https://doi.org/10.37630/jpm.v12i2.575

Maskar, S., & Dewi, P. (2020). Praktikalitas dan efektifitas bahan ajar kalkulus berbasis daring berbantuan geogebra. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *4*(2), 888–889. https://doi.org/https://dx.doi.org/10.24042/djm.v1i2.2279

Maskur, M., & Safitri, E. R. (2021). Efektivitas penggunaan bahan ajar digital berbasis android dalam pembelajaran IPA pada siswa berkebutuhan khusus. *Journal of Education and Instruction (JOEAI)*, *4*(1), 47–53. https://doi.org/https://doi.org/10.31539/joeai.v4i1.2149

Maulida, H., & Sinaga, P. (2019). Pengembangan bahan ajar IPA terpadu berbasis android berorientasi keterampilan berpikir kritis. *PETIK: Jurnal Pendidikan Teknologi Informasi Dan Komunikasi*, *5*(1), 70–76. https://doi.org/https://journal.institutpendidikan.ac.id/index.php/petik/article/view/1538

Muliani, Sukarni, S., Jumadil. (2024). English teachers' tecnological knowledge and some barriers on it: The basis for developing tpack teaching model. *JOLLT Journal of Languages and Language Teaching, 12 (1),499-510.* https://e-journal.undikma.ac.id/index.php/jollt/article/view/9628/5346

Muhaimin, M., Leny, L., & Almubarak, A. (2024). Increasing learning results with interactive digital materials PjBL assisted by heyzine flipbook maker. *Journal of Mathematics Science and Computer Education*, *4*(1), 9. https://doi.org/10.20527/jmscedu.v4i1.10297

Nengsih, N. R., Yusmaita, E., & Gazali, F. (2019). Evaluasi validitas konten dan konstruk bahan ajar asam basa berbasis REACT. *EduKimia*, *1*(1), 1–10. https://doi.org/https://doi.org/10.24036/ekj.v1i1.104017

Noviyanto, T. S. H., Juanengsih, N., & Rosyidatun, E. S. (2015). Penggunaan media video animasi sistem pernapasan manusia untuk meningkatkan hasil belajar biologi. *Edusains*, *7*(1), 57–63. https://doi.org/https://doi.org/10.15408/es.v7i1.1215

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://edukatif.org/edukatif/article/view/7642

Puspitaningrum, P. N., & Witanto, Y. (2024). E-module teaching materials based on heyzine flipbook on the meaning of NKRI for grade IV elementary school. *Journal of Educational Research and Evaluation*, *8*(3), 423–431. https://doi.org/10.23887/jere.v8i3.78326

Putri, H. R,. Yuliantri, R. D. A., & H. (2023). Pengembangan buku elektronik kerajaan sriwijaya berbasis flip book maker untuk siswa menengah atas. *Jurnal Program Studi Pendidikan Sejarah*, *11*(1), 63–76. https://doi.org/https://doi.org/10.24127/hj.v11i1.6937

Rahmatina, A., Noorhidayati, N., & Ajizah, A. (2023). The development of e-handout teaching materials for the sub-concept of structure and function of tissues in plants. *JURNAL EKSAKTA PENDIDIKAN (JEP)*, *7*(2), 239–253. https://doi.org/https://doi.org/10.24036/jep/vol7-iss2/744

Rahmi, B., Riefani, M. K., & Utami, N. H. (2022). Validitas buku ilmiah digital keanekaragaman tumbuhan semak di areal reklamasi pertambangan batubara. *EDUKATIF: Jurnal Ilmu Pendidikan*, *4*(4), 5818–5826. https://doi.org/https://doi.org/10.31004/edukatif.v4i4.2997

Ramadan, E. M., & Astuti, D. P. (2020). Application of e-handout based on PhET simulation to improve critical thinking skills and learning independence of high school students. *Journal of Physics: Conference Series*, *1440*(1). https://doi.org/DOI: 10.1088/1742-6596/1440/1/012025

Ratiyani, I., Subchan, W., & Hariyadi, S. (2014). Pengembangan bahan ajar digital dan aplikasinya dalam model siklus pembelajaran 5E (learning cycle 5E) terhadap aktifitas dan hasil belajar (siswa kelas VII DI SMP Negeri 10 Probolinggo tahun pelajaran 2012/2013). *Pancaran, 3*(1), 79–88. https://doi.org/10.1002/phbl.19500060613

Riduwan, M.B.A., M. P. (2010). Metode dan Penyusunan Tesis. Alfabet. https://onesearch.id/Author/Home?author=RIDUWAN

Safriana, S., Gumanti, V., & Ginting, F. W. (2023). Development of e-handout based on problem-based learning to improve students cognitive on rotation dynamics. *Asian Journal of Science Education*, *5*(2), 83–92. https://doi.org/https://doi.org/10.24815/ajse.v5i2.32112

Sahida, D. (2020). Praktikalitas handout berberntuk komik fisika berbasis Problem Based Learning untuk meningkatkan keterampilan berpikir kreatif peserta didik. *EDU RESEARCH*, *1*(2), 29–34. https://doi.org/https://doi.org/10.47827/vol1iss2pp29-34

Saraswati, R. R., & Salsabila, E. (2021). Pengembangan LKPD elektronik berbasis HOTS pada materi dimensi tiga. *Risenologi*, *6*(2), 17–25. https://doi.org/https://doi.org/10.47028/j.risenologi.2021.62.183

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*, *1*(12), 1265–1276. https://doi.org/10.17977/um0631i122021p1265-1276

Sirumahombar, A., R, & E. M. (2023). Pengembangan bahan ajar e-handout berbasis aplikasi melalui model problem based learning pada materi kecepatan di Kelas V. *INNOVATIVE: Journal of Social Science Research*, *3*(2), 4074–4085. https://j-innovative.org/index.php/Innovative/article/view/801

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. *Jurnal Pendidikan Sosial Dan Humaniora*, *2*(3). https://publisherqu.com/index.php/pediaqu/article/view/457

Starkey, L. (2020). A review of research exploring teacher preparation for the elektronik age. *Cambridge Journal Of Education*, *50*(1). Https://Doi.Org/10.1080/0305764x.2019.1625867

Telaumbanua, M. (2023). Penerapan model pembelajaran discovery learning untuk meningkatkan hasil belajar peserta didik pada materi sistem pernapasan manusia kelas VIII SMP Negeri 1 Idanotae TP 2022/2023. *Tunas: Jurnal Pendidikan Biologi*, *4*(1), 73–82. https://doi.org/https://doi.org/10.57094/tunas.v4i1.976

Trinaldi, A., Bambang, S. E. M., Afriani, M., Rahma, F. A., & Rustam, R. (2022). Analisis kebutuhan penggunaan bahan ajar berbasis teknologi infomasi. *Jurnal Basicedu*, *6*(6), 9304–9314. https://doi.org/https://doi.org/10.31004/basicedu.v6i6.4037

Utami, N., & Atmojo, I. R. W. (2021). Analisis kebutuhan bahan ajar elektronik dalam pembelajaran ipa di sekolah dasar. *Jurnal Basicedu*, *5*(6), 6300–6306. https://doi.org/https://doi.org/10.31004/basicedu.v5i6.1716

Warman, E. (2025). Pengembangan bahan ajar bahasa indonesia di Sekolah Dasar. *Jurnal Bahasa, Sastra, Pembelajarannya*, *8*(1), 61. https://doi.org/10.35194/jd.v8i1.4428

Wati, D. K., Saragih, S., & Murni, A. (2022). Kevalidan dan kepraktisan bahan ajar matematika berbantuan fliphtml5 untuk memfasilitasi kemampuan pemahaman matematis siswa kelas VIII SMP/MTs pada materi koordinat kartesius. *JURING (Journal for Research in Mathematics Learning)*, *5*(3), 177–188. https://doi.org/http://dx.doi.org/10.24014/juring.v5i3.17424

Wibowo, E., & Pratiwi, D. D. (2018). Pengembangan bahan ajar menggunakan aplikasi kvisoft flipbook maker materi himpunan. *Desimal: Jurnal Matematika, 1*(2), 147–156. https://doi.org/https://dx.doi.org/10.24042/djm.v1i2.2279

Yuli, F., & Mufit, F. (2021). Disain dan validitas bahan ajar berbasis konflik kognitif mengintegrasikan virtual laboratory pada materi optik untuk meningkatkan pemahaman konsep siswa SMA/MA. *Jurnal Penelitian Pembelajaran Fisika*, *7*(1), 101–112. https://doi.org/https://doi.org/10.24036/jppf.v7i1.111889

Yuliana. (2016). Peningkatan hasil belajar siswa melalui penerapan model desain pembelajaran addie pada mata pelajaran matematika siswa kelas V SDN Berangah Desa Beleka Kecamatan Praya Timur Lombok Tengah tahun pelajaran 2015/2016. https://etheses.uinmataram.ac.id/2609/1/Yuliana 151129005_opt.pdf

Yuliza, S. (2023). Pemanfaatan media pembelajaran berbasis teknologi informasi dalam meningkatkan minat belajar peserta didik di MTs Negeri Kota Bengkulu. *Jurnal Ilmu*, *2*(1), 33–48. https://doi.org/https://doi.org/10.58222/jurip.v2i1.249

Zaki, R. (2017). Validation of instrument measuring continuous variable, advances in statistical methodologies and their application to real problems. *Intech Open Science*, 217–237. https://doi.org/10.5772/66151