# Development of a Problem-Solving-Based Interactive E-Magazine on the Respiratory System Material

**Khairina Mirda[1], Rasyidah[2]**

[1,2] Biology Education Study Program, Faculty of Tarbiyah and Teacher Training, State Islamic University of North Sumatra, Medan, Indonesia

| Article Info | ABSTRACT |
|---|---|
| | The objective of this study was to develop a problem-solving-based interactive E-Magazine on the respiratory system material that is valid, practical, and effective. This research employed a Research and Development (R&D) approach, using the 4D development model which consists of four stages: Define, Design, Develop, and Disseminate. This study was limited to the development stage due to constraints in time and resources. The dissemination stage was not carried out, as it requires a longer period of implementation, involving broader application and continuous evaluation.Based on the validation results from both content and media experts, the E-Magazine received a score of 92% from the content expert and 97% from the media expert, indicating a very valid category. The practicality test showed that the E-Magazine scored 92% from teachers and 89% from students, categorizing it as highly practical.Furthermore, the effectiveness test results revealed that the average pretest score of students was 37.4, which significantly increased to 82.4 in the posttest. This improvement corresponds to an N-Gain score of 0.72, which falls into the high category.These findings demonstrate that the developed E-Magazine is not only feasible and easy to use, but also effectively enhances students' problem-solving abilities in learning about the human respiratory system. |

**Corresponding Author:**
Khairina Mirda,
Biology Education Study Program, Faculty of Tarbiyah and Teacher Training State Islamic University of North Sumatra, Medan,Indonesia
Jalan William Iskandar Street, Pasar V, Medan Estate, Percut Sei Tuan Subdistrict, Deli Serdang Regency, North Sumatra 20371, Indonesia
Email: khairinamirda@uinsu.ac.id

## 1. INTRODUCTION

Currently, Indonesia is undergoing the era of the Industrial Revolution 4.0, which is characterized by rapid advancements in digital technology and the internet, making access to information significantly easier (Fauziah et al., 2023). According to (Ma'wa et al., 2023), this era of technological progress is believed to bring about transformative changes across various sectors, including education. The advancement of digital technology has significantly influenced teaching and learning practices. The integration of technology into education has shifted traditional learning methods toward more modern approaches through the utilization of information and communication technology. This transformation has made the learning process more enjoyable, less monotonous, and more engaging for students, thereby fostering greater enthusiasm for learning (Widiyanto, 2023). In educational activities, the use of instructional media is essential as a supporting tool to make the teaching and learning process more appealing and capable of stimulating students' thinking skills, creativity, and motivation in the (Gunarso *et al*., 2024).

Instructional media are tools used in student learning activities to assist teachers in delivering information or subject matter. These media play a crucial role in ensuring the success of the learning process, making instruction more effective (Sipayung et al., 2020) Instructional media support teachers in explaining content, helping to convey messages more clearly and making the material easier for students to understand. Therefore, it can be concluded that instructional media serve as teaching aids that facilitate the delivery of lessons by teachers, thus enabling learning objectives to be achieved more effectively (Sari *et al*., 2024).

Instructional media that capture students' attention and interest today can take the form of electronic media. Electronic media refer to learning tools that utilize electronic devices to assist in creating, developing, delivering, and facilitating the learning process interactively, anytime and anywhere (Anggreni & Sawitri, 2020. )Electronic instructional media come in various forms, such as e-books, e-modules, e-posters, e-magazines, and others. One of the key advantages of electronic media is that it allows students to learn at their own pace—whether fast or slow—according to their individual capabilities. It can be accessed anytime and anywhere, encourages students to think more actively and creatively, and expands their knowledge (Azhari *et al.*, 2023). In the past, education in Indonesia relied heavily on traditional, text-based books; however, this has gradually shifted toward the use of digital products such as e-magazines.

An e-magazine, or electronic magazine, is a publication that no longer relies on paper-based materials. Its content is presented in digital format, making it more accessible anytime and anywhere (Janah *et al.*, 2023). According to Jariati & Yenti (2020) an e-magazine is also a medium that contains engaging content and images, presented in a simple and appealing format to facilitate the understanding of concepts or material provided within. The primary advantage of an e-magazine lies in its ease of access via the internet, whether through computers, laptops, or smartphones, providing flexibility for learning anytime and anywhere. The attractive and interactive format of e-magazines allows for the integration of text, images, and videos into a single platform, thereby creating a more meaningful and immersive learning experience. Its ability to incorporate interactive elements—such as hyperlinks, "Did You Know" sections, and animations—actively engages students in the learning process. Additionally, e-magazines support the development of content delivery skills, enabling both teachers and students to design materials tailored to individual learning styles. Due to their accessibility and practicality, e-magazines serve as relevant learning tools in the digital age, supporting active, creative, and inclusive learning approaches (Annisa, 2024).

Through the use of e-magazines, students are encouraged to solve problems by engaging with content based on problem-solving approaches. They are guided to understand concepts through case studies, interactive simulations, and challenging tasks that stimulate critical thinking. E-magazines can include various features such as interactive videos, animations of respiratory processes, and discussion forums. These interactive elements allow students to visualize how the respiratory system functions, understand potential disorders, and explore solutions to presented cases. Moreover, a problem-solving approach helps students not only comprehend concepts but also apply them to real-life situations. The development of this e-magazine is expected to enhance students' understanding, critical thinking skills, and interest in learning biology—particularly on the topic of the respiratory system (Bahri *et al.*, 2018). Students equipped with problem-solving skills are capable of applying their knowledge to address real-world problems they encounter. This skill is highly relevant in the learning process, as it moves students beyond passive learning activities such as listening, note-taking, and rote memorization. Instead, it fosters active thinking, comprehension, communication, data analysis, and independent conclusion-drawing (Palennari *et al.*, 2021).

Biology is one of the subjects that can help students develop problem-solving skills. This is reflected in the basic competencies outlined in the 2013 Curriculum, which require students to be able to address and resolve problems related to each topic studied. This is particularly relevant as biology is closely connected to real-life contexts. One such topic that supports the development of problem-solving abilities is the respiratory system. Within this topic, students encounter issues such as respiratory diseases, which can be explored and discussed to encourage analytical thinking. Therefore, the teaching of the respiratory system should employ strategies specifically designed to foster and strengthen students' problem-solving abilities (Hanifa *et al.*, 2018).

The results of observations and interviews with biology teachers at Madrasah Aliyah Laboratorium UINSU Medan revealed that the use of e-magazines in teaching the respiratory system has never been implemented. Additionally, the material has not been linked to the development of students' problem-solving abilities. As a result, students are not yet able to systematically identify, analyze, and find solutions to given problems. Teachers also rarely incorporate instructional media during the learning process. The most commonly used tools are PowerPoint presentations and textbooks. The lecture method remains the dominant teaching approach, and students are typically asked to summarize the learning material. The limited use of diverse learning resources contributes to students feeling bored or disengaged during lessons.

Previous studies have shown that a considerable number of researchers have developed biology e-magazines. For instance, Sari & Adlini (2024)developed a biology e-magazine integrated with *Wahdatul Ulum* as a learning medium for the reproductive system. Saraswati (2022) developed an e-magazine as teaching material for the musculoskeletal system for Madrasah Aliyah students. Hanifa (2024)created an e-magazine focusing on the sub-topic of the benefits of biodiversity for Grade X senior high school students. Febriani & Ferazona (2024) conducted an analysis of the development of an e-magazine for the excretory system, while Annisa (2024) developed a biology e-magazine on the topic of the coordination system. However, there remains a lack of research focused on the development of problem-solving-based e-magazines, particularly on the topic of the respiratory system. This gap forms the basis for conducting research aimed at developing an e-magazine that incorporates problem-solving approaches within the respiratory system topic. It is expected that this e-

magazine will facilitate students' learning and enhance their understanding, especially in studying the respiratory system.

Based on the background described above, the researcher is interested in conducting a study entitled *"The Development of an Interactive E-Magazine Based on Problem-Solving Skills in the Respiratory System Topic."* This study aims to investigate the effectiveness of a problem-solving-based e-magazine in helping students understand the subject matter and improve their ability to solve problems related to the respiratory system.

## 2. RESEARCH METHOD

This study employs a Research and Development (R&D) approach using the 4D model, which consists of four main stages: Define, Design, Develop, and Disseminate (Fayrus, 2022). The 4D model is commonly used for the development of instructional materials. This study was limited to the development stage due to constraints in time and resources. The dissemination stage was not carried out, as it requires a longer period of implementation, involving broader application and continuous evaluation.
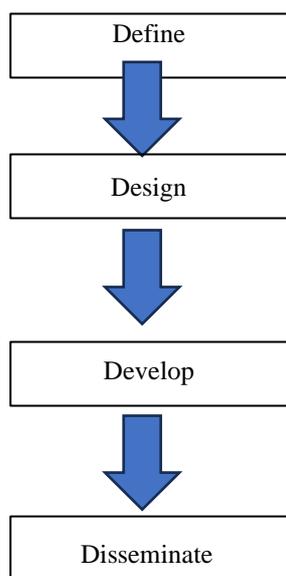
```
┌──────────────┐
│    Define    │
└──────────────┘
       ↓
┌──────────────┐
│    Design    │
└──────────────┘
       ↓
┌──────────────┐
│   Develop    │
└──────────────┘
       ↓
┌──────────────┐
│  Disseminate │
└──────────────┘
```

Figure 1. Stages of the 4D Development Model

The detailed stages of the development process are as follows:Define stage this stage consists of several steps, namely: (1) Front-end analysis: Conducted to identify the potential and problems that may arise in the development of the learning media. (2) Learner analysis: Carried out by distributing questionnaires to students to determine their learning needs. (3) Concept analysis: Conducted through interviews with biology teachers to identify difficult parts of the material to teach and to determine the content to be included in the instructional media. (4)Task analysis: Aimed at identifying the learning tasks that students must complete. (5) Specifying instructional objectives: This step allows the researcher to determine the types of instruments or assessment tools needed, construct a test blueprint, and evaluate the validity and appropriateness of the instruments for measuring student learning outcomes.

Design stage this stage involves the preparation of the product design to be developed. (1) Media Selection: The selected media is a problem-solving-based e-magazine supported by Android devices, aimed at facilitating the learning process in a way that aligns with the characteristics of the material and the needs of students. (2) Format Selection: This is done to ensure compatibility with the content being taught. During the development process, format selection is intended to design the instructional content, including materials, images, and texts used in the learning media. (3) Initial Draft: At this stage, the instructional materials developed by the researcher are reviewed by a supervising lecturer. Feedback from the lecturer is used to revise and improve the materials before they are finalized. Following the revisions, the draft will proceed to the validation stage.

Develop stage this stage consists of the following activities: (1) Expert Validation: Involving validation by experts on both the media and the content to ensure the accuracy, relevance, and quality of the e-magazine. (2) Development Testing: The e-magazine is distributed to students at Madrasah Aliyah Laboratorium UINSU Medan for use in the learning process to observe its practical application. (3) Validation Testing: Conducted by collecting feedback from both teachers and students through questionnaires to evaluate the quality of the e-magazine being developed.

This study involved Grade XI MIA 2 students at Madrasah Aliyah Laboratorium UINSU Medan as the trial subjects. The instruments used included interview sheets and student needs analysis questionnaires. Additionally, validation sheets consisting of assessments from subject matter experts and media experts were used to evaluate the validity of the developed product. Response questionnaires were also administered to both teachers and students to assess the practicality of the developed instructional media, namely the E-Magazine. Finally, pre-tests and post-tests consisting of 20 multiple-choice questions with five answer options were conducted to determine the effectiveness of the E-Magazine in helping students develop problem-solving skills.

**Data Analysis Techniques**

The data analysis technique used in this study involved the application of a Likert scale with five response options: very good, good, fair, poor, and very poor. The Likert scale was employed to measure opinions, attitudes, or perceptions of individuals regarding the subject under investigation.

Table 1. Likert Scale

| Category | Score |
|---|---|
| Very Good (VG) | 5 |
| Good (G) | 4 |
| Fair (F) | 3 |
| Poor (P) | 2 |
| Very Poor (VP) | 1 |

Source: (Sugiyono, 2019)

**Media and Content Feasibility Analysis**

The results of the validation by subject matter experts and media experts, as well as the responses from teachers and students, were analyzed to determine the level of feasibility using the following percentage formula:

$$Persentase = \frac{Total\ Score\ Obtained}{Maximum\ Possible\ Score}\ X\ 100\%$$

The feasibility criteria used in the development of this E-Magazine are based on the percentage level of achievement, as shown in the following table:

Table 2. Validility Criteria

| Prensentase | Category |
|---|---|
| 81-100% | Very Feasible |
| 61-80% | Feasible |
| 41-60% | Less Feasible |
| 21-40% | Not Feasible |
| 0-20% | Very Not Feasible |

Source: (Ernawati & Sukardiyono, 2017)

**Practicality Test Analysis**

To determine the practicality of the E-Magazine media and content, response questionnaires from teachers and students were analyzed. The teacher response questionnaire was analyzed using the following formula:

$$Persentase = \frac{Total\ Score\ Obtained}{Maximum\ Possible\ Score}\ X\ 100\%$$

Table 3. Practicality Assessment Criteria

| Prensentase | Category |
|---|---|
| 81%-100% | Very Feasible |
| 61%-80% | Feasible |
| 41%-60% | Less Feasible |
| 21%-40% | Not Feasible |
| 0-20% | Very Not Feasible |

Source: (Mahadiraja & Syamsuarnis, 2020)

**Effectiveness Test Data Analysis**

The instrument used to assess the effectiveness of the developed media was a test, consisting of a pre-test and a post-test. These tests were administered before and after students used the E-Magazine, respectively. The aim was to measure how effective the problem-solving-based approach was in improving students' understanding of the respiratory system. To determine the level of improvement in student learning outcomes, the Normalized Gain (N-Gain) formula was used. The formula is as follows:

$$N\ Gain = \frac{Posttest\ Score - Pretest\ Score}{Ideal\ Score - Pretes\ Score}$$

Description of Variables:
N-Gain : Normalized gain
S post : Average posttest score
S pre : Average pretest score
S maks: Ideal score (maximum possible score)

Table 4. Kriteria Interpretasi Skor Normalized Gain (N-Gain)

| Skor N-Gain | Category |
|---|---|
| g > 0,7 | High |
| 0,3 ≤ g ≤0,7 | Medium |
| g< 0,3 | Low |

Meanwhile, the division of the interpretation categories of N-Gain score acquisition activities in the form of percentage (%) can be seen in the following table.

Table 5. N-Gain Effectiveness Interpretation Category

| Score Range | Criteria |
|---|---|
| <40 | Not Effective |
| 40-55 | Less Effective |
| 56-75 | Moderately Effective |
| >76 | Effective |

Source: (Hake, 2002)

## 3. RESULT AND DISCUSSION

Based on the results of the research conducted, a learning media in the form of a problem-solving-based E-Magazine was developed for Grade XI MIA 2 students at Madrasah Aliyah Laboratorium UINSU Medan. The development of the E-Magazine followed the 4D model (Define, Design, Develop, and Disseminate). However, due to budget constraints, this study was limited to the development stage only. The following is a detailed explanation of each stage involved in the development process of the E-Magazine in this study.

a. Define

The definition stage in the 4D development model began with a **front-end analysis**, which aimed to identify potentials and existing problems. The analysis revealed that teachers had never utilized E-Magazine media in the learning process and had not integrated the respiratory system material with problem-solving skills. As a result, students were not yet able to think systematically. Therefore, the researcher decided to develop a learning medium in the form of a problem-solving-based E-Magazine to address these issues.

**Learner analysis** was conducted through the distribution of questionnaires, which revealed that students often felt bored due to monotonous teaching methods and the limited use of instructional media. **Concept analysis** was carried out through interviews with Biology teachers, who indicated that the respiratory system topic is relatively difficult to teach and requires engaging and interactive media. **Task analysis** highlighted the need for learning activities that include tasks embedded within the E-Magazine, such as observing, analyzing, and solving problems related to the respiratory system.

In the **Specifying Instructional Objectives** stage, learning outcome indicators were determined based on Regulation of the Minister of Education and Culture (Permendikbud) No. 37 of 2018 and the 2013 Curriculum (K13). Referring to Basic Competencies (KD) 3.8 and 4.8, the learning objectives for the human respiratory system material include: (1)Through discussion and observation activities guided by the E-Magazine, students are able to accurately explain the definition of the respiratory system. (2)Through discussion and observation activities guided by the E-Magazine, students are able to identify the organs of the respiratory system as well as disorders affecting those organs. (3) Through discussion and observation activities guided by the E-Magazine, students are able to understand the mechanisms of the respiratory system. (4) Through discussion and observation activities guided by the E-Magazine, students are able to understand lung volume and capacity. (5) Through discussion and observation activities guided by the E-Magazine, students are able to analyze technologies related to the respiratory system. (6) Through discussion, observation, and literature review guided by the E-Magazine, students are able to identify respiratory system disorders and the causes of respiratory system dysfunction.

b. Design

In the Design stage, the first step taken was to select a learning medium that aligns with the characteristics of the students and the subject matter to be taught. The chosen medium was an interactive problem-solving-based

E-Magazine. This E-Magazine was designed using the Canva application for layout and visual design, and presented in an interactive digital format through the Flipbook platform, which is accessible via Android devices.

In the format selection stage, the E-Magazine was designed with a layout size of 21 x 29 cm, optimized for display on digital device screens while providing sufficient space to proportionally present text, images, and interactive elements. The design also considered principles of readability, aesthetics, and ease of navigation to promote active student engagement throughout the learning process.

As the initial draft of the E-Magazine content, the instructional material covers the human respiratory system, presented in informative narrative paragraphs using a communicative language style appropriate to the students' cognitive level. The initial content includes the definition of the respiratory system, its component organs and related disorders, breathing mechanisms, lung volume capacity, and technologies associated with the respiratory system. Each subtopic is accompanied by visual illustrations, contextual practice questions, and problem-based case studies designed to support the development of students' critical thinking skills.

c. Develop

At the development stage, the problem-solving-based E-Magazine underwent media and content validation, practicality testing, and effectiveness testing.

Table 6. Validation Results of Media and Material

| Expert | Aspect of Assessment | Number of statements | Score Obtained | Maximum Score | Persentase | Average Score | Criteria |
|--------|---------------------|---------------------|----------------|---------------|------------|---------------|----------|
| Media | E-Magazine Dimensions | 2 | 10 | 10 | 100% | 97 % | Highly Valid |
| | E-Magazine Cover Design | 5 | 23 | 25 | 92% | | |
| | E-Magazine Design | 10 | 50 | 50 | 100% | 94,5% | |
| Material | Content Coverage | 2 | 9 | 10 | 90% | 92 % | |
| | Presentation Technique | 6 | 29 | 30 | 97% | | |
| | Conceptual Accuracy | 2 | 9 | 10 | 90% | | |

Based on the validation results, the media obtained a score of 97%, indicating that it is highly valid and appropriate for use in the learning process. However, there are several revision notes that should be addressed to further optimize the media. These include improvements to the cover design, the addition of a watermark, and a more systematic organization of the table of contents. It is also recommended to include a glossary to facilitate understanding of important terminology. Furthermore, clearer captions for the images are necessary, along with page number adjustments, and the replacement of video links with scannable barcodes to provide more practical and efficient access to video content. By implementing these improvements, the quality and usability of the media will be significantly enhanced.



Figure 2. Front cover before (A) and after (B) revision based on expert suggestions
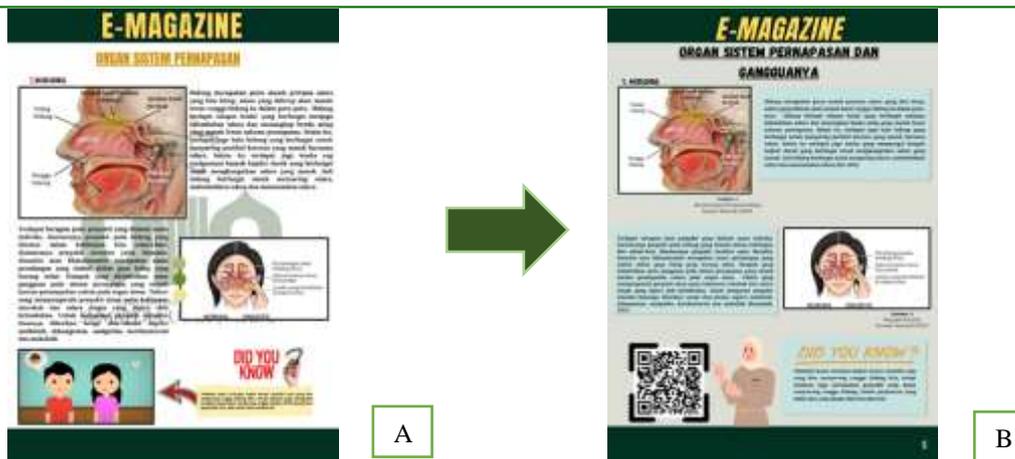
Figure 3. Background before (A) and after (B) revision based on expert suggestions

Based on the validation results conducted by the subject matter expert, a score of 92% was obtained, which falls into the "very valid" category. This indicates that the developed material meets the general criteria for content feasibility and is appropriate for use in instructional activities. However, the expert also provided several suggestions for improvement to enhance the completeness and depth of the material. The suggested revisions include the addition of content on lung capacity and volume, which is essential to provide students with a more comprehensive understanding of the human respiratory mechanism. In addition, it was recommended to include a discussion on respiratory system-related technologies, such as modern respiratory aids or relevant medical technologies, to provide students with contextual and applicable knowledge aligned with current scientific advancements.

Theoretically, a high validation score reflects the alignment of the material with learning objectives and student needs. As stated by (Nieveen, 1999) the validity of instructional materials refers to the extent to which the content is accurate, complete, and aligned with learner characteristics. In addition to content, media-related aspects such as the e-magazine format, cover design, and overall layout also received high validation scores. This can be explained through instructional media design theory, particularly as outlined by (Mayer, 2024) in Multimedia Learning, which emphasizes that effective learning media should adhere to principles such as coherence, signaling, and spatial contiguity to facilitate learner comprehension. Consistency in dimensions, an integrated layout, and visually engaging elements such as color, typography, and illustrations in the e-magazine contribute significantly to enhancing student focus and motivation.

Furthermor (Arsyad, 2015) asserts that well-organized and visually appealing design enhances readability and supports the efficient absorption of information. Therefore, the high validation score in media aspects indicates that the design elements applied are consistent with effective instructional design principles. By implementing the recommended revisions, both in terms of content and presentation, the quality of the instructional material is expected to become more comprehensive, relevant, and capable of improving student understanding more effectively.



Figure 4. Suggestions from the subject matter expert to add content related to lung capacity and volume, as well as technology in the respiratory system

Table 7. Practicality The Results

| Respomdent | Item Statements | Score |
|---|---|---|
| Students (n;12) | 10 | 44,7 |
| Teachers | 10 | 46 |
| **Total Score** | | **90,7** |
| **Persentase** | | **91%** |
| **Criteria** | | **Very Pratical** |

The results of the practicality test showed that the learning media received a score of 92% from teachers and 89% from students, both of which fall into the "very practical" category. These scores indicate that the media is easy to use, efficient, and effectively supports the learning process. Teachers found the media helpful in delivering material without requiring significant adjustments, while students perceived it as easy to understand, engaging, and supportive of independent learning.

Theoretically, a high practicality score suggests that the media meets the principle of ease of use in instructional design. According to (Nieveen, 1999), a learning medium is considered practical if it can be used easily by both teachers and students without technical obstacles or the need for special training. Furthermore, (Tessmer, 1993) states that learning media is deemed practical if it can be directly implemented in teaching and learning activities efficiently in terms of time, effort, and cost. Practical media should also feature a simple interface, clear navigation, and easily understood instructions. This aligns with the results of the practicality test, where students found it easier to study independently using the media, and teachers did not need to make significant modifications or adaptations.

Therefore, based on both theoretical considerations and field test results, it can be concluded that this learning media is practical and feasible for use in educational activities. It is easy to use, efficient, and supports both teachers and students in achieving learning objectives.

Table 8. Effectiveness The Results

| Score | Avarage Score | Maximum Score | N-Gain Score | Criteria |
|---|---|---|---|---|
| Pretest | 37,40 | 100 | **0,72** | **Effective** |
| Posttest | 82,40 | 100 | | |

Based on the effectiveness test results, the average student score before using the E-Magazine learning media (pretest) was 37.4. After using the media (posttest), the average score increased significantly to 82.4. This substantial improvement indicates a notable enhancement in student learning outcomes. The calculated N-gain score was 0.72, which falls into the high category, suggesting that the E-Magazine effectively supported students in understanding and mastering the learning material. In addition to the quantitative results, qualitative feedback from students also showed positive responses. They noted that the interactive features made the learning experience more engaging, the easy navigation allowed them to move through the content smoothly, and the visually appealing design helped them stay focused and better comprehend the material.

Theoretically, this effectiveness can be explained by (Mayer, 2024) Cognitive Theory of Multimedia Learning. Mayer posits that learning becomes more effective when instructional content is presented through a combination of text, images, audio, and video. Such multimodal presentations optimize the functioning of both the visual and auditory channels of working memory, facilitating better processing and retention of information. As a result, multimedia-based instructional tools can enhance students' attention, memory, and understanding of the material.

In addition, the effectiveness of this media can also be understood through the lens of constructivist learning theory, which emphasizes that students construct their own understanding through active engagement with the content. Interactive and contextually relevant media can encourage deeper student involvement, allowing them to connect new information with prior knowledge and develop more meaningful understanding. Rather than passively receiving information, students engage in critical thinking, exploration, and reflective learning experiences.

In conclusion, this instructional media has been proven effective not only statistically but also theoretically. It promotes active, engaging, and meaningful learning experiences. Therefore, this media is well-suited for use in educational settings as it has a demonstrably positive impact on improving student learning outcomes.

The use of interactive E-Magazine based on problem-solving skills in the topic of the human respiratory system has proven to be highly effective and of excellent quality. This is evidenced by the results of media validation, practicality, and effectiveness tests. The media received a very high validation score, namely 96% for media validation and 92% for content validation, indicating that the E-Magazine is highly suitable for use as an instructional resource. In terms of practicality, the media was rated as very practical, with a score of 92% from teachers and 89% from students, suggesting that it is easy to use, engaging, and aligned with students' learning

needs. Regarding its effectiveness, the media significantly improved students' learning outcomes. The average pre-test score of 37.4 increased to 82.4 in the post-test, with an N-Gain score of 0.72, which falls into the high category. In other words, this instructional media is not only valid and practical but also effective in enhancing students' problem-solving abilities in learning the respiratory system.

These findings are supported by previous research. A study conducted by (Rochmiyatun, 2024) on the development of interactive E-Magazine media in biology subjects demonstrated that E-Magazines are highly effective in increasing students' learning interest and comprehension. In her study, the media was validated by experts and categorized as highly feasible, and it was also considered practical and easy to use in the learning process. Similarly, (Hajar, 2021) in her research on the development of E-Magazine for the immune system topic, found that interactive digital media could significantly enhance student motivation and learning outcomes. It also served as an effective solution for teachers in delivering abstract content in a more visual and engaging manner. The results of her study showed that Android-based instructional media with interactive design received expert validation scores of 96.42% for content and 92.78% for media, and significantly improved student participation and academic achievement.

Based on the findings of this study, supported by previous research, the use of interactive E-Magazines based on problem-solving skills shows strong potential for implementation in biology education, particularly in the topic of the respiratory system. This media can enhance the quality of learning by presenting content in an engaging manner, encouraging students to actively engage in problem-solving, and significantly improving learning outcomes. These results indicate that integrating technology with active learning methods not only facilitates a better understanding of the subject matter but also helps train students to be more prepared for real-world challenges by strengthening their critical and logical thinking skills.

## 4. CONCLUSION

Based on the results of this study, it can be concluded that the interactive E-Magazine based on problem-solving skills for the respiratory system material is feasible for use in teaching and learning activities. This feasibility is supported by a very high level of validation: 97% for media aspects and 92% for content. In terms of practicality, the media was found to be very easy to use by both students (89%) and teachers (92%). Furthermore, the media proved effective in improving student learning outcomes, as shown by an increase in the average pretest score from 37.4 to 82.4 in the posttest, with an N-Gain score of 0.72, categorized as high. However, this study has limitations as it only reached the development (Develop) stage and was not implemented on a broader scale. Therefore, further research is recommended to examine the dissemination stage and to expand the development of this E-Magazine for other biology topics.

## 5. ACKNOWLEDGEMENT

## 6. REFERENCES

Anggreni, M. D., & Sawitri, S. (2020). Pengembangan Media Pembelajaran Elektronik Pola Digital di SMK Negeri 6 Semarang. *Fashion and Fashion Education Journal*, *9*(1), 19–27. https://journal.unnes.ac.id/sju/index.php/ffe.

Annisa, F. (2024). *Pengembangan Media Pembelajaran E-Magazine Sebagai Sumber Belajar Biologi Pada Konsep Sistem Koordinasi Kelas Xi Sma / Ma*. Universitas Islam Negeri Syarif Hidayatullah. https://repository.uinjkt.ac.id/dspace/bitstream/123456789/76258/1/11190161000059-ANNISA%20FEBRIANTI-(BAB%201%2C%203%2C%205).pdf.

Arsyad, A. (2015). *Media Pembelajaran*. Rajawali Pers.

Azhari, N. S., Tanjung, I. F., & Akhyar, S. (2023). Pengembangan E-Magazine Pada Materi Sistem Ekskresi Terintegrasi Nilai Keislaman. *Binomial*, *6*(2), 185–200. https://doi.org/10.46918/bn.v6i2.1963

Bahri, A., Putriana, D., & Idris, I. S. (2018). Peran PBL dalam Meningkatkan Keterampilan Pemecahan Masalah Biologi. *Sainsmat : Jurnal Ilmiah Ilmu Pengetahuan Alam*, *7*(2), 114–124. https://doi.org/10.35580/sainsmat7273642018

Ernawati, I., & Sukardiyono, T. (2017). *Uji Kelayakan Media Pembelajaran Interaktif Pada Mata Pelajaran Administrasi Server. Elinvo (Electronics, Informatics, and Vocational Education), 2 (2), 204–210. 2*(2), 204–210.

Fauziah, I. W., Maspupah, M., & Yuliawati, A. (2023). Keterampilan Pemecahan Masalah Siswa Melalui Media Pembelajaran Mobile Augmented Reality (Mar). *Gunung Djati Conference Series*, *30*, 15–24. https://conferences.uinsgd.ac.id/index.php/gdcs/article/view/1828.

Febriani, S., & Ferazona, S. (2024). Analisis Kebutuhan Pengembangan e-Majalah Biologi Berbasis Kontekstual Pada Materi Sistem Ekskresi Manusia kelas VIII SMP/MTS. *Bioedutech: Jurnal Biologi Dan Pendidikan Biologi*, *3*(1), 54–59. jurnal.anfa.co.id/index.php/biologi/article/view/2128

Gunarso, Wahyudin, Ranggana, A., Indah, P., Aprianti, Y., & Septiani, H. (2024). Tinjauan Kritis Makalah Terbaru tentang Media Pembelajaran : Keunggulan, Tantangan, dan Prospek Masa Depan. *Jurnal Penelitian Pendidikan*, *5*(1), 197–205.

Hajar, S. (2021). Pengembangan Media Pembelajaran Biologi Berbasis E-Magazine Pada Sistem Pernapasan Untuk Meningkatkan Kemampuan Berpikir Kristis Siswa Kelas XI. *3*(2), 295. https://doi.org/10.24252/asma.v3i2.25162

Hake, R. R. (2002). Assessment of Student Learning in Introductory Science Courses. *PKAL Roundtable on the Future: Assessment in the Service of Student Learning*, *5*, 1–24. http://www.physics.indiana.edu/~hake/ASLIS.Hake.060102f.pdf

Hanifa, N. I., Akbar, B., Abdullah, S., & Susilo. (2018). Analisis Kemampuan Memecahkan Masalah Siswa Kelas X Ipa Pada Materi Perubahan Lingkungan Dan Faktor Yang Mempengaruhinya. *Didaktika Biologi: Jurnal Penelitian Pendidikan Biologi*, *2*(2), 124. http://jurnal.um-palembang.ac.id/index.php/dikbio

Hanifa, S. (2024). Pengembangan Media Pembelajaran E-Magazine Submateri Manfaat Keanekaragaman Hayati Kelas X Sma Berbasis Tumbuhan Liar Sebagai Sumber Pangan. *Jurnal Biologi Dan Kependidikan Biologi*, *5*(2), 87–94. http://jurnal.untan.ac.id/pkp/indeks/

Janah, L. N., Maksum, A., & Siregar, R. (2023). Pengembangan E-Magazine Berbasis Andorid Pada Muatan Pelajaran Ips Kelas Iv Sekolah Dasar. *Jurnal Ilmiah Pendidikan Dasar*, *8*(1), 354–363. https://journal.unpas.ac.id/index.php/pendas/article/view/7156

Jariati, E., & Yenti, E. (2020). Pengembangan E-Magazine Berbasis Multipel Representasi untuk Pembelajaran Kimia di SMA pada Materi Larutan Elektrolit dan Non Elektrolit. *Journal of Natural Science and Integration*, *3*(2), 138–150. https://doi.org/10.24014/jnsi.v3i2.10131

Ma'wa, F. Z., Rokhmawati, R. I., & Amalia, F. (2023). Pengembangan Modul Digital Berbasis Website Menggunakan Metode 4D Untuk Meningkatkan Hasil Belajar Siswa Kelas X Rekayasa Perangkat Lunak SMK Negeri 1 Kepanjen Pada Materi UI/UX Firda. *Jurnal Pengembangan Teknologi Informasi Dan Ilmu Komputer*, *7*(6), 2785–2791. https://j-ptiik.ub.ac.id/index.php/j-ptiik/article/view/12855

Mahadiraja, D., & Syamsuarnis, S. (2020). Pengembangan Modul Pembelajaran Berbasis Daring Pada Mata Pelajaran Instalasi Penerangan Listrik Kelas XI Teknik Instalasi Tenaga Listrik T.P 2019/2020 Di SMK Negeri 1 Pariaman. *JTEV (Jurnal Teknik Elektro Dan Vokasional)*, *6*(1), 77. https://doi.org/10.24036/jtev.v6i1.107612

Mayer, E. R. (2024). The Past, Present, and Future of the Cognitive Theory of Multimedia Learning. *Educational Psychology Review*, *36*(1), 1–25. https://doi.org/10.1007/s10648-023-09842-1

Nieveen, N. (1999). *No TiPrototyping to reach product qualitytle*. K. Academic & Publisher .

Palennari, M., Lasmi, L., & Rachmawaty, R. (2021). Keterampilan Pemecahan Masalah Peserta Didik: Studi Kasus di SMA Negeri 1 Wonomulyo. *Diklabio: Jurnal Pendidikan Dan Pembelajaran Biologi*, *5*(2), 208–216. https://doi.org/10.33369/diklabio.5.2.208-216

Rochmiyatun, V. (2024). *Pengembangan Media Pembelajaran E-Magazine Interaktif Pada Mata Pelajaran Ilmu Pengetahuan Alam Dan Sosial (Ipas) Siswa Kelas V Di Sekolah Dasar Islam Terpadu Al-Qomar Giri Banyuwangi.* Universitas Islam Negeri Kiai Haji Achmad Siddiq Jember. https://digilib.uinkhas.ac.id/37895/1/Skripsi%20Vera%20Rochmiyatun%202_Sudah%20Edit.pdf

Saraswati, D. (2022). Pembuatan Bahan Ajar E-Magazine Materi Sistem Gerak Untuk Siswa Madrasah Aliyah. *EDU-BIO: Jurnal Pendidikan Biologi*, *5*(2), 110–114. https://doi.org/10.30631/edubio.v6i1.31

Sari, M., & Adlini, M. N. (2024). Biology E-Magazine Integrated On Wahdatul 'Ulum: Learning Media On Reproductive System Material. *BIO-INOVED : Jurnal Biologi-Inovasi Pendidikan*, *6*(2), 137–145. https://doi.org/10.20527/bino.v6i2.19162

Sari, M., Elvira, D. N., Aprilia, N., Dwi R, S. F., & Aurelita M, N. (2024). Media Pembelajaran Berbasis Digital Untuk Meningkatkan Minat Belajar Pada Mata Pelajaran Bahasa Indonesia. *Warta Dharmawangsa*, *18*(1), 205–218. https://doi.org/10.46576/wdw.v18i1.4266

Sipayung, M., Chastanti, I., Harahap, R. D., & Sari, N. F. (2020). Pengembangan Media Pembelalajaran Interaktif Berbasis Adobe Flash Terhadap Materi Sistem Pernapasan Di SMA Negeri 1 Aekkuasan Kabupaten Asahan. *Jurnal Pendidikan Informatika Dan Sains*, *9*(1), 59–65. https://doi.org/10.31571/saintek.v9i1.1228

Sugiyono. (2019). *Metode Penelitian Pendidikan*. CV. Alfabeta.

Tessmer, M. (1993). *Planning and Conducting Formative Evaluations: Improving the Quality of Education and Training.* Kogan Page.

Widiyanto, W. (2023). Pengembangan Modul Pembelajaran Blended Learning Berbasis Web Centric Course Moodle Pada Materi Koloid. *EDUTECH : Jurnal Inovasi Pendidikan Berbantuan Teknologi*, *3*(1), 99–114. https://doi.org/10.51878/edutech.v3i1.2119