Learning Path EXOOCO-2R Model in E-Module Based Reading and Writing Learning with Formative Assessment Tools

Giati Anisah[1], Pramesti Wulandari[2,*], Fiyan Ilman Faqih[3], Julia Binti Madzalan[4]

[1]Department of Islamic Education, Faculty of Tarbiyah, Universitas Nahdlatul Ulama Sunan Giri, Bojonegoro 62115, Indonesia
[2]Department of Islamic Education, Faculty of Tarbiyah, Universitas Nahdlatul Ulama Sunan Giri, Bojonegoro 62115, Indonesia
[3]Department of Indonesian Language and Literature Education, Faculty of Teacher Training and Education, Universitas Trunojoyo Madura, Bangkalan 69162, Indonesia
[4]Department of Language Education, Faculty of Education, Universiti Islam Antarabangsa Selangor, Bandar Seri Putra 43000 Kajang, Malaysia

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ABSTRACT

Literacy is the foundation of education; it allows students to understand, evaluate, and communicate information effectively. However, many challenges arise in developing these skills, including limited access to adequate reading materials, ineffective teaching methods, and insufficient support and motivation from the surrounding environment. This research aims to develop a learning path in literacy learning, especially reading-to-write, based on e-modules with formative assessment tools. The development of learning paths in e-module-based reading-to-write learning with formative assessment tools is carried out using the ADDIE development model. This research began with a needs analysis to identify gaps in literacy learning. The e-module design and formative assessment tools are designed to provide a clear structure and continuous feedback to students. Based on the results of the research that has been carried out, it can be seen that the feasibility test results obtained an average value of 95.14%. These results show that the EXOOCO-2R learning path, formulated as an e-module, is considered very suitable for use, and this is in line with students' positive response to the learning path, with 68% included in the good category.

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1. INTRODUCTION

Reading and writing literacy is the primary foundation in education, because this ability allows students to understand, evaluate, and communicate information effectively (Davy Tsz Kit, Luo, Chan, & Chu, 2022; Suganda, 2022). Strong literacy supports academic success across a wide range of subjects and prepares students to participate fully in society (Duke, Halvorsen, Strachan, Kim, & Konstantopoulos, 2021). However, many students face challenges in developing these skills, including limited access to adequate reading

***Corresponding Author**: Pramesti Wulandari pramesti.pw@unugiri.ac.id

materials, less effective teaching methods, and insufficient support and motivation from the surrounding environment (Kaynar, Sadik, & Boichuk, 2020; Mudra, 2020). These challenges can hinder students' literacy development, so it is important to implement innovative, supportive learning methods, such as e-modules and formative assessment tools, to help overcome these obstacles and improve students' literacy skills.

In an increasingly diverse educational environment, the need for more interactive and adaptive learning methods becomes very important (Muñoz et al., 2022). Students have different learning styles, abilities, and interests, so a one-size-fits-all approach is often ineffective. Interactive learning methods, such as e-modules, enable students to be actively involved in the learning process through multimedia content, interactive exercises, and dynamic assessments (Suyatna, 2020). Adaptive methods that adapt to each student's pace and level of understanding help ensure that all students receive the support they need to succeed (Kem, 2022). Thus, the application of interactive and adaptive learning methods can help create a more personalized and effective learning experience that meets the needs of diverse students and improves their overall learning outcomes.

Learning path in a learning system refers to a sequence of learning objects designed to help students improve their knowledge or skills in a particular subject (Muhammad, Zhou, Beydoun, Xu, & Shen, 2016). Research on learning paths focuses on developing and improving learning paths in learning systems. Subramanian & Bertolino (2016) propose alignment of learning tasks and creating appropriate learning paths. Ramos et al. (2021) introduce a graph-based model for visualizing learning paths and suggesting group formation, demonstrating its usefulness in analyzing student behavior patterns. Muhammad et al. (2016) review learning path adaptation research, discussing adaptation parameters and implementation challenges. Nabizadeh et al. (2020) provide a comprehensive survey of personalized learning path methods, highlighting various techniques, their advantages and disadvantages, and evaluation approaches. The results of these studies emphasize the importance of personalization in the learning path, taking into account students' competencies, backgrounds, and goals.

Technology, especially through the use of e-modules, has brought about revolutionary changes in the learning experience. E-modules are digital learning tools that allow students to access learning content flexibly on electronic devices, such as computers or tablets (Apriani & Yulikifli, 2021; Ma'rifatullah, Umamah, Marjono, Sumardi, & Surya, 2021). Through e-modules, students can access a variety of learning materials, including text, images, audio, and video, designed to enrich their learning experience. Additionally, e-modules often include interactive features, such as quizzes, exercises, and simulations, that help increase student engagement and understanding (Daud et al., 2024; Ningrum & Ambarwati, 2022). With the adoption of this technology, learning is no longer limited by time and space, but becomes more flexible and accessible anytime, anywhere. Therefore, the use of e-modules has opened the door to more inclusive and innovative education, bringing great benefits to students in improving the quality and efficiency of learning.

E-modules are digital teaching materials that are arranged systematically and interactively to facilitate the learning process (Ningrum & Ambarwati, 2022). The benefits of using it in education, especially in learning to read and write, are very significant. E-modules enable the delivery of more engaging and dynamic material through features such as multimedia, animations, and interactive quizzes, thereby increasing student engagement (Daud et al., 2024). The benefits of using it in education, especially in learning to read and write, are very significant. E-modules enable the delivery of more engaging and dynamic

material through features such as multimedia, animations, and interactive quizzes, which increase student engagement. Dalaila, Widiyaningrum, & Saptono (2022) and Ismaniati & Iskhamdhanah (2023) showed a significant increase in students' reading and writing abilities using e-modules compared to conventional methods.

Formative assessment is an evaluation process that is carried out continuously during learning to monitor student progress and provide constructive feedback (Kulasegaram & Rangachari, 2018). The benefits of formative assessment in literacy learning are critical, as they allow teachers to identify students' strengths and weaknesses in real-time and adapt instruction to individual needs (Lyon, Nabors Oláh, & Caroline Wylie, 2019). Continuous feedback from formative assessments helps students understand their mistakes, correct gaps in understanding, and develop more effective learning strategies. In addition, formative assessment encourages students' active involvement in the learning process, increases motivation, and creates an adaptive and responsive learning environment. Research such as that by Gustafson, Nordström, Andersson, Fälth, and Martin (2019) shows that formative assessment can produce significant improvements in academic achievement, particularly in literacy, by providing support focused on the ongoing development of reading and writing skills.

Based on the research background explained previously, this research aims to develop a learning path in learning to read and write based on e-modules with formative assessment tools. This research began with a needs analysis to identify gaps in literacy learning. In this case, e-modules and formative assessment tools are designed to provide a clear structure and continuous feedback to students. Next, the module is tested on a small scale before being implemented widely. In this case, the analysis results include an evaluation of effectiveness, based on formative assessment and feedback from students and teachers.

2. METHOD

2.1 Research Design

This study employed a Research and Development (R&D) design to both develop an educational product and empirically test its effectiveness. The R&D approach was selected because the primary objective was not merely to describe an existing phenomenon but to develop and validate a novel instructional model, the EXOOCO-2R learning path, integrated within an e-module featuring formative assessment tools. The development process was systematically structured using the Analyze, Design, Development, Implementation, and Evaluation (ADDIE) model (Branch, 2009). The ADDIE framework was deemed particularly appropriate for this research as it provides a flexible yet rigorous iterative cycle, ensuring that the developed learning path is theoretically sound, empirically grounded in user needs, and practically viable. Its sequential phases enabled continuous refinement through expert validation and field testing, which were crucial for developing a complex, multi-stage pedagogical intervention like the EXOOCO-2R model.

Analyze consists of activities (a) analysis of learning outcomes in the Independent Curriculum, (b) analysis of facts, concepts, principles, and procedures for reading-to-write material, (c) study of student characteristics, and (d) form of e-module development required students to improve competence. At the Design stage, the activities carried out are (a) determining the learning path for learning to read to write, (b) determining learning materials that are in accordance with facts, concepts, principles, procedures, time

allocation, Learning Goal Achievement Criteria (KKTP), (c) design formative assessment, and (d) display design using the Canva and Flip PDF Professional applications.

The research stage consists of Development, Implementation, and Evaluation. Development consists of activities (a) producing e-modules according to a predetermined design, (b) carrying out expert validation with material experts, language learning experts, and language experts, and (c) revising product 1 according to the results of the questionnaire and suggestions from validators. Implementation was carried out with activities (a) small-scale trials, at which time questionnaires were also distributed to two teachers and students regarding practicality, (b) analysis of the results of small-scale trials, (c) product revision 2, and (d) testing try on a large scale, where at that time a questionnaire is also distributed to two teachers and students about practicality. Next, evaluation is carried out with the activities of (a) calculating product suitability based on field tests and (b) revising product 3 as the final product.

2.2 Participant and Context

This study was conducted in the context of Indonesian language teaching at the primary school level, focusing on Phase C, particularly in Grade 5. Purposive sampling was used to select participants who could provide the most relevant information for the development and testing phases. Participants were selected from MINU Unggulan Bojonegoro, which was identified as a school implementing the Merdeka Curriculum. The sample for the small-scale trial consisted of one class with 28 students, while the large-scale implementation involved two classes totaling 56 students. All participants were aged 11-12 years, which corresponds to the formal operational stage of cognitive development according to Piaget. This phase was chosen because learning outcomes in reading and writing non-fiction texts become more complex, requiring a structured and metacognitive approach offered by the EXOOCO-2R model. Two experienced Phase C classroom teachers also participated as expert validators and practical implementers during the trial.

2.3 Instrument and Data Collection

Multiple instruments were developed and utilized to ensure comprehensive data collection across the ADDIE phases, capturing both qualitative and quantitative insights. First, observation guidelines were used, particularly during the Analysis and Implementation phases. In the Analysis phase, non-participant classroom observations were conducted to understand the prevailing teaching methods, student engagement levels, and the practical challenges of integrating reading and writing instruction. During implementation, observation focused on documenting student activities, interactions with the e-module, and their engagement with each stage of the EXOOCO-2R learning path.

Second, semi-structured interview protocols were designed for teachers. During the initial needs analysis, interviews explored teachers' perceptions of students' literacy challenges, their current use of technology and assessment, and their expectations for a new learning tool. Post-implementation, follow-up interviews gathered qualitative feedback on the e-module's practicality, the clarity of the learning path, and the usefulness of the formative assessment features from an instructional perspective.

Third, questionnaires served as the primary quantitative data collection tools. These included:

a. Expert Validation Questionnaires: These were administered to the two classrooms' teacher-validators during the Development phase. The questionnaires assessed the e-module's feasibility across three key indicators: effectiveness (alignment with learning outcomes), material quality (accuracy and appropriateness of content), and readability (clarity of language and instructions). Items were rated on a Likert scale with space provided for qualitative suggestions.
b. Student Response Questionnaires: Distributed after the large-scale implementation, these questionnaires measured students' perceptions of the e-module and the EXOOCO-2R learning path. It consisted of seven statements related to engagement, ease of use, and perceived usefulness of the learning stages, also using a Likert scale.

To ensure instrument quality, validity, and reliability were addressed. Content validity of the questionnaires was established through a panel review by three experts in educational technology, language education, and measurement, who evaluated the items for clarity, relevance, and comprehensiveness. For the expert validation questionnaire, reliability was determined by calculating the inter-rater agreement between the two validators using a percentage of agreement formula. The student response questionnaire's internal consistency was ensured through its development based on established indicators of e-module acceptance. It was further supported by triangulating its quantitative results with observational and interview data.

2.4 Data Analysis

Data analysis employed both quantitative and qualitative techniques, aligned with the objectives of each ADDIE phase. Quantitative data derived from Likert-scale items on the expert validation and student response questionnaires were analyzed using descriptive statistics. The scores for each indicator from the validator questionnaires were summed, converted to percentages, and then averaged to determine the overall feasibility of the e-module. The resulting percentage was interpreted using a pre-defined categorization scale (e.g., 0-20% = not feasible, 21-40% = less feasible, 41-60% = sufficiently feasible, 61-80% = feasible, 81-100% = very feasible). Similarly, student response data were analyzed by calculating the percentage of agreement for each statement and an overall average percentage, which was then categorized to gauge the level of student acceptance (e.g., 0-20% = poor, 21-40% = fair, 41-60% = good, 61-80% = very good). Inter-rater reliability for the validator assessments was calculated using a percentage agreement formula.

Qualitative data from interview transcripts, observation notes, and open-ended questionnaire responses were analyzed using thematic analysis. The data were systematically coded to identify recurring themes related to the strengths and weaknesses of the learning path, the practicality of the e-module, and the perceived impact on student learning. These qualitative findings were primarily used to provide rich, contextual explanations for the quantitative results and to guide specific revisions during the formative evaluation stages of the ADDIE model.

3. RESULTS AND DISCUSSION

The source of inspiration for writing is reading. Johar and Rupley have investigated the impact of independent reading on writing performance based on experimental research over the past 49 years. As a result, independent reading improves the overall quality of narrative and descriptive writing. In addition, independent reading also improves output,

mechanics, spelling accuracy, grammatical content, and text organization (Jouhar & Rupley, 2021).

The ability to read-to-write nonfiction texts is an important ability to develop in students, especially in cultivating literacy skills. As is known, Indonesian language subjects for all levels are intended to develop literacy skills. Literacy is considered a necessary ability for lifelong learning and work (Badan Standar Kurikulum dan Asesmen Pendidikan Kemendikbud, 2022). When students are asked to read a text and then write based on knowledge or inspiration from the reading results, this means that students need to explore non-fiction texts, dig in-depth for information to gain a complete understanding, and transform this understanding into written form in the correct way (Harvey, 2023; Ng, 2023). There is a reciprocal relationship between reading and writing, so these two abilities need to be integrated well in learning (S. Graham et al., 2018; Steve Graham, 2020).

Various methods need to be used to increase reading motivation while simultaneously developing writing skills. One way that can be attempted is to develop a learning path that suits your reading-to-write abilities with the help of e-modules accompanied by formative assessment tools. E-modules enable the provision of more interactive and engaging material for elementary school students. The e-module can be accessed via laptop, tablet, or smartphone. This also allows students to study anytime, anywhere, making it more flexible (Astalini, Darmaji, Kurniawan, Anwar, & Kurniawan, 2019; Irons & Elkington, 2021). Formative assessment tools should be included in e-modules because they provide students with feedback. Formative assessment has the potential to improve teaching and learning in the classroom (Schildkamp, van der Kleij, Heitink, Kippers, & Veldkamp, 2020). Apart from that, formative assessment can also improve students' self-regulation abilities (Granberg, Palm, & Palmberg, 2021).

3.1 Learning Path Membaca-untuk-menulis EXOOCO-2R

This research develops the EXOOCO-2R learning path, which is a route or plan for preparing a journey for learning to read-to-write non-fiction texts. The EXOOCO-2R learning path is formulated step by step in a reading-to-write e-module, which is equipped with formative assessment tools. The EXOOCO-2R learning path consists of six stages as follows.

3.1.1 Explaining

Explaining is an activity in which students provide their classmates with an explanation of the text's content. In the research, students were asked to read a text about changes in the shapes of objects. Then, students are asked to explain the contents of the text to their classmates. Previously, students were given a guide containing several steps: reading the text carefully and thoroughly, identifying the text's content, understanding the main idea of each paragraph, integrating the main ideas, and drawing conclusions about the text's content. When students can provide an explanation of the text they read correctly, it can be ensured that they have well understood the content.

Several studies have shown that explaining text content verbally improves understanding of complex and difficult texts; explaining text in general can also improve understanding (Jacob, Lachner, & Scheiter, 2020; Lachner, Backfisch, Hoogerheide, van Gog, & Renkl, 2020). For texts with a medium to high level of difficulty, oral explanation is more effective than written explanation because it triggers social awareness, such as

providing examples and analogies that are easier for other students to understand (Jacob et al., 2020).

3.1.2 Observing

Observation is the activity of observing an object or phenomenon that will become an inspiration for writing. In the research, after students explained the text's content on changes in the form of objects, they were asked to observe the phenomenon of changes in the form of objects in everyday life. The example taken for this research is the change in state of an object from liquid to solid (freezing), which occurs when melting ice cream. Students are invited together to carry out experiments on making ice cream. Students observe the ingredients needed, the tools used, the measurements of the ingredients, the steps for making ice cream, and the length of time for the object to change shape.

Observation plays an important role in writing, especially in developing critical thinking and generating ideas that are relevant, objective, and accurate (Nurrokhma, 2021). Observation in collaborative learning is also effective in improving observational writing skills because it can motivate students and increase their knowledge, understanding, and self-confidence (Kurniati, 2023).

3.1.3 Organizing

Organizing is the activity of creating a framework for the text to be written. In this research, a text framework for observation results is presented, consisting of a title, general statement, object description, and conclusion. Initially, students were asked to fill in these sections with the important points they found while making observations. They are then asked to develop these points into a complete text.

Several studies show that organizing text content with various strategies, such as creating concept maps and storyboards, significantly improves the quality of writing, including in terms of content, organization, and overall writing results (Abdel Latif, 2021; Seals, 2023; Zainudin, Nair, & Wider, 2023). Prior knowledge and the organization of text content play an important role in predicting coherent writing outcomes (Chang, Tsai, & Chen, 2020).

3.1.4 Correcting

Correcting is the activity of correcting written results by paying attention to the quality of the writing in terms of ideas, text organization, coherence, and spelling. In this research, correcting, revising, and reflecting activities were formulated in the form of formative assessment. Students collect texts on the links provided in the e-module. Then, the teacher scrambles the text and distributes it to students for correction. Students are given correction signs and fill in their correction results in the link provided. Each student gets the results of their writing correction. The teacher will also provide general corrections to all students. In this case, students receive two feedbacks for their writing, namely the results of peer correction and correction from the teacher.

Peer correction significantly improved students' academic self-concept in the area of academic writing, with a strong causal effect (Simonsmeier, Peiffer, Flaig, & Schneider, 2020). Teacher intervention in peer feedback results in more accurate revisions in students' writing, with direct correction having higher adoption and revision rates than other types (Sun & Wang, 2022).

3.1.5 Revising

Revising is an activity to improve text based on peer correction or teacher correction. Students improve the text by refining ideas, organization, paragraph structure, and coherence. Several studies show that revision improves text quality by correcting grammatical errors, rearranging text to make it easier to read, and improving text structure (Kim, Du, Raheja, Kumar, & Kang, 2022). In this case, students are asked to apply the R3 method in carrying out revisions. R3 is read, revise, repeat (Du, Kim, Raheja, Kumar, & Kang, 2022). This revision activity is also a series of formative assessment activities.

3.1.6 Reflecting

Reflecting is the activity of contemplating, assessing oneself, and gaining meaning from a series of reading-to-write activities that have been carried out. Reflection after learning to write helps develop critical thinking, deep understanding, and lifelong learning (Scheidegger, 2020). In this research, reflection uses the 4F method, namely fact, feeling, finding, and future.

The 4F reflection method is a reflection model developed by Dr. Roger Greenaway. This model is designed to assist individuals and groups in reflecting on their experiences and drawing lessons from them. At the fact stage, the focus of reflection is identifying objective facts from the experience or event being reflected on. At the feeling stage, students are asked to engage in exploration of the feelings and emotions that arise during and after the experience. In the finding stage, students are asked to identify insights and lessons from this experience. Finally, in the future stage, students are asked to consider how the knowledge and insights gained can be applied. The overall analysis results were developed into the EXOOCO-2R Learning Path in Figure 1 below.

Figure 1. EXOOCO-2R Learning Path Chart

3.2 Feasibility of Learning Path Model for Reading-to-Write Learning Model Assisted by E-Modules with Formative Assessment Tools

Based on several studies on learning paths, several requirements include suitability to student profiles, learning styles, levels of knowledge, curriculum, and the effectiveness of learning paths (Al-Muhaideb & Menai, 2011; Dwivedi, Kant, & Bharadwaj, 2018).

3.2.1 Suitability of the Learning Path to the student profile of Phase C elementary school students

The Indonesian government changed the structure for distributing learning outcomes from being based on class to being based on phase. These phases are adapted to the theory of child and adolescent development and the structure of educational levels. The term 'phase' is used because a single phase can encompass several classes at once. This change is the application of learning principles according to the stages of learning achievement, which is also known as teaching at the right level. The division of phases in the Merdeka curriculum is shown in Table 1 as follows.

Table 1
Division of Independent Curriculum Phases

Phase	Class	Level
A	1-2	Elementary School
B	3-4	Elementary School
C	5-6	Elementary School
D	7-8-9	Junior High School
E	10	Senior High School
F	11-12	Senior High School

This research focuses on phase C, namely grades 5-6 of elementary school. Their age is around 11-12 years. At ages 11-12, children are in the formal operational cognitive development phase. According to Piaget's theory, the cognitive development of children aged 11-12 years is characterized by the ability to think logically and abstractly (Barrouillet, 2015; Hijriani, 2021). This can be seen from their ability to solve problems related to concrete experiences (Hijriani, 2021). However, not all children in this age group can develop their cognitive abilities to the maximum (Nungki & Rachmani, 2021). Their cognitive knowledge is formed gradually through experience and interaction with their environment (Lubis, Lubis, & Hilmi, 2022).

Researchers conducted observations and interviews and analyzed students' writing to obtain data on the suitability of the learning path for student profiles in phase C. Children began to be able to think abstractly and conceptually. They not only rely on concrete experiences but can also understand more complex concepts. In the learning path, formulated as an e-module, students are asked to understand the text's concept through observations. They understand the difference between the concept of observational text and other types of text, for example, narrative and descriptive text. They can also estimate the content of each part of the text structure of the observations, including the title, general statement, object description, and conclusion. However, not all children develop at the same pace, so the e-module also includes concrete examples of texts from observations to help students understand the concept of texts from observations. Figure 2 shows the results of e-module development tailored to learning outcomes.

(a) (b)

Figure 2. (a) Phase C E-Module Cover; (b) Student Profile Achievements of Phase C Students

Figure 2 presents the initial development output of the Phase C e-module aligned with the EXOOCO-2R learning path. As shown in Figure 2(a), the e-module cover reflects the target user group, namely Phase C elementary students (Grade 5-6), and visually represents the integration of reading-to-write activities within a structured digital learning environment. The cover design emphasizes thematic relevance, digital accessibility, and alignment with the Merdeka Curriculum framework. Figure 2(b) illustrates the alignment between the developed e-module and the expected student profile achievements for Phase C. This section demonstrates how the instructional content, learning objectives, and activity structure are systematically designed to support students' cognitive development at the formal operational stage, including abstract reasoning, conceptual understanding, and early metacognitive skills. The displayed profile achievements confirm that the e-module content is not only curriculum aligned but also developmentally appropriate for students aged 11-12 years.

Apart from having the ability to think abstractly, students are able to idealize and imagine various possibilities. At this stage, children begin to imagine the ideal qualities of objects they know. At the formal operational stage, students are also able to develop deductive hypotheses to solve problems and reach conclusions systematically (Marinda, 2020). In the e-module developed, students are invited to design an experiment to make ice cream by utilizing the theory of changing a liquid to a solid (freezing). In this experiment, students drew systematic conclusions, as shown in Figure 3, as follows.

Condition + influencing things = conclusion

(initial form of object) + (influencing conditions) = change in shape of an object

Liquid + cold temperature of ice cubes = frozen

Frozen + hot temperature of the air = liquid

Figure 3. E-Module Material Experiment Scheme

Figure 3 illustrates the structural framework and implementation flow of the EXOOCO-2R learning model embedded within the developed e-module. Figure 3 represents the sequential stages of learning activities, beginning with exploration and orientation phases, followed by observation, organization, and conceptual construction processes, and concluding with the two reinforcement components (2R), namely reflection and reinforcement. The diagram highlights how each stage is systematically interconnected to support students' higher-order thinking skills, particularly reading-to-write competence. It demonstrates the pedagogical logic underlying the model, where students are guided from initial exposure to content toward deeper conceptual understanding and structured written expression. Additionally, the figure clarifies the integration between instructional design, cognitive scaffolding, and literacy development within the digital learning environment.

However, not all children develop at the same pace, so the e-module also includes concrete examples of text from observations to help students. At this formal operational stage, students are also able to think about their own thoughts (metacognition). In the e-module, students are invited to reflect by answering questions about their own thoughts. The reflection method used is 4F, namely fact, feeling, finding, and future. In general, the EXOOCO-2R learning path is in accordance with cognitive development at the age of 11-12 years, characterized by increased ability to think abstractly and logically, better understanding of complex concepts, and the ability to think about their own thoughts (metacognition). This development allows them to learn and understand the world more in depth and in a more structured way.

3.2.2 Suitability of Learning path to Phase C student Learning Style

Research on the learning styles of students aged 11-12 years shows that there are various preferences. Visual, auditory, and kinesthetic learning styles are common learning styles among this age group (Sholihah & Wijayanti, 2023). Teachers need to understand these styles to create a supportive learning environment. Teachers also need to adapt their teaching methods to suit students' learning styles.

Based on research results, Phase C students have diverse learning styles. However, the most dominant is kinesthetic. This is accommodated by the EXOOCO-2R learning path, which creates an experimental activity to be observed during the observing stage. They are more enthusiastic when they do experimental activities. They record everything related to the experiment so they can later develop it into a text describing the results of their observations. This supports the mastery of competencies by adapting to students' learning styles. Figure 4 below shows the observation activities carried out by students.

Figure 4. Student Experimental Activities

Figure 4 presents the implementation of student experimental activities conducted during the learning process using the EXOOCO-2R-based e-module. The figure illustrates how students actively engage in hands-on investigation, data observation, and collaborative discussion as part of the structured learning stages. The experimental activities are designed to promote inquiry-based learning, allowing students to construct conceptual understanding through direct experience. During the process, students follow guided procedures provided in the e-module, record observations, analyze findings, and communicate results in written form. This activity supports the integration of scientific reasoning, literacy skills, and higher-order thinking development.

Research on kinesthetic learning styles in students has revealed various characteristics and challenges. Khoiriyah (Khoiriyah, 2020) and Gustina (Gustina, 2021) found that students with a kinesthetic learning style often have difficulty thinking critically and solving problems in subjects such as mathematics. However, this research shows that students with a kinesthetic style are enthusiastic and achieve good learning outcomes in language lessons. This aligns with Khoiriyah (2020), who noted that these students can excel in social-emotional domains. These studies collectively underscore the need for tailored teaching strategies to support kinesthetic students in their academic development. The EXOOCO-2R learning path has facilitated the need for the suitability of this kinesthetic learning style at the observing stage by creating an experiment.

3.2.3 Suitability of Learning Path with Prior Knowledge of Phase C students

Prior knowledge plays an important role in learning, especially in subjects such as mathematics and science. Prior knowledge serves as a foundation for new information and significantly influences the learning process (Panggabean & Tamba, 2020; Toharudin, 2023). Understanding students' prior knowledge is critical to effective teaching, as it allows educators to adapt their approaches to students' existing understanding and address gaps or misconceptions (Panggabean & Tamba, 2020). In addition, prior knowledge can contribute to students' self-regulation in learning, with a significant correlation between the two (Toharudin, 2023). Therefore, it is essential for teachers to assess and consider students' prior knowledge before teaching, because this can greatly influence their learning outcomes.

Before developing the EXOOCO-2R learning path, researchers conducted an analysis of students' initial abilities. Ideally, a diagnostic assessment should be carried out to determine prior knowledge. However, in this study, the researchers replaced it by listing the material that the teacher had taught and creating a learning goal achievement matrix based on students' summative assessment scores. This is considered equivalent to a diagnostic test because the summative test results measure students' achievement of competency in the material that has been taught.

Based on the results of this analysis, it was revealed that students had learned about the material of changes in the form of objects as a theme to be written as an observation report, and students had also understood the concept of sentences, paragraphs, and text. This is a prerequisite ability before learning to write observation results using the EXOOCO-2R learning path. Figure 5 shows the e-module content regarding sentences and paragraphs.

Figure 5. E-Module content about sentences and paragraphs

Figure 5 presents a sample of the e-module content focusing on the development of students' understanding of sentences and paragraphs. The figure illustrates how the instructional materials are structured to guide learners from recognizing sentence components to organizing coherent paragraphs within the reading-to-write framework. The content includes explanations of sentence structure, examples of well-formed sentences, paragraph organization, and guided exercises that encourage students to construct meaningful written texts. The activities are systematically arranged to strengthen students' syntactic awareness, logical sequencing, and cohesion in writing. Additionally, scaffolding elements are embedded to support gradual progression from basic sentence formation to integrated paragraph development. By paying attention to students' initial abilities, the EXOCOO-2R learning path simply reviews the basics of composing sentences and paragraphs briefly before giving students writing assignments.

3.2.4 Correspondence of Learning Path to Phase C Reading and Writing Learning Outcomes

Conformity of the learning outcomes with the EXOOCO-2R learning path is ensured by conducting a curriculum analysis before compiling the learning path. The results of the curriculum analysis produced the reading-to-write learning objectives shown in Table 2.

Table 2
Phase C Reading and Writing Learning Outcomes

Achievement of reading elements
Students are able to read words with various letter combination patterns fluently and beautifully, and understand new information and vocabulary that have denotative, literal, connotative, and figurative meanings to identify objects, phenomena, and characters. Students are able to identify the main ideas of descriptive, narrative, and exposition texts, as well as the values contained in literary texts (prose and pantun, poetry) from texts and/or audiovisuals.
Achievement of writing elements
Students are able to write explanatory texts, reports, and persuasive expositions from ideas, observations, experiences, and imagination; explain causal relationships, as well as present the results of observations to convince the reader. Students are able to use linguistic and literary rules to write texts that are appropriate to context and cultural norms; use new vocabulary with denotative, connotative, and figurative meanings. Students convey feelings, based on facts and imagination (from themselves and others), beautifully and interestingly, in the form of prose and poetry, with a creative use of vocabulary.

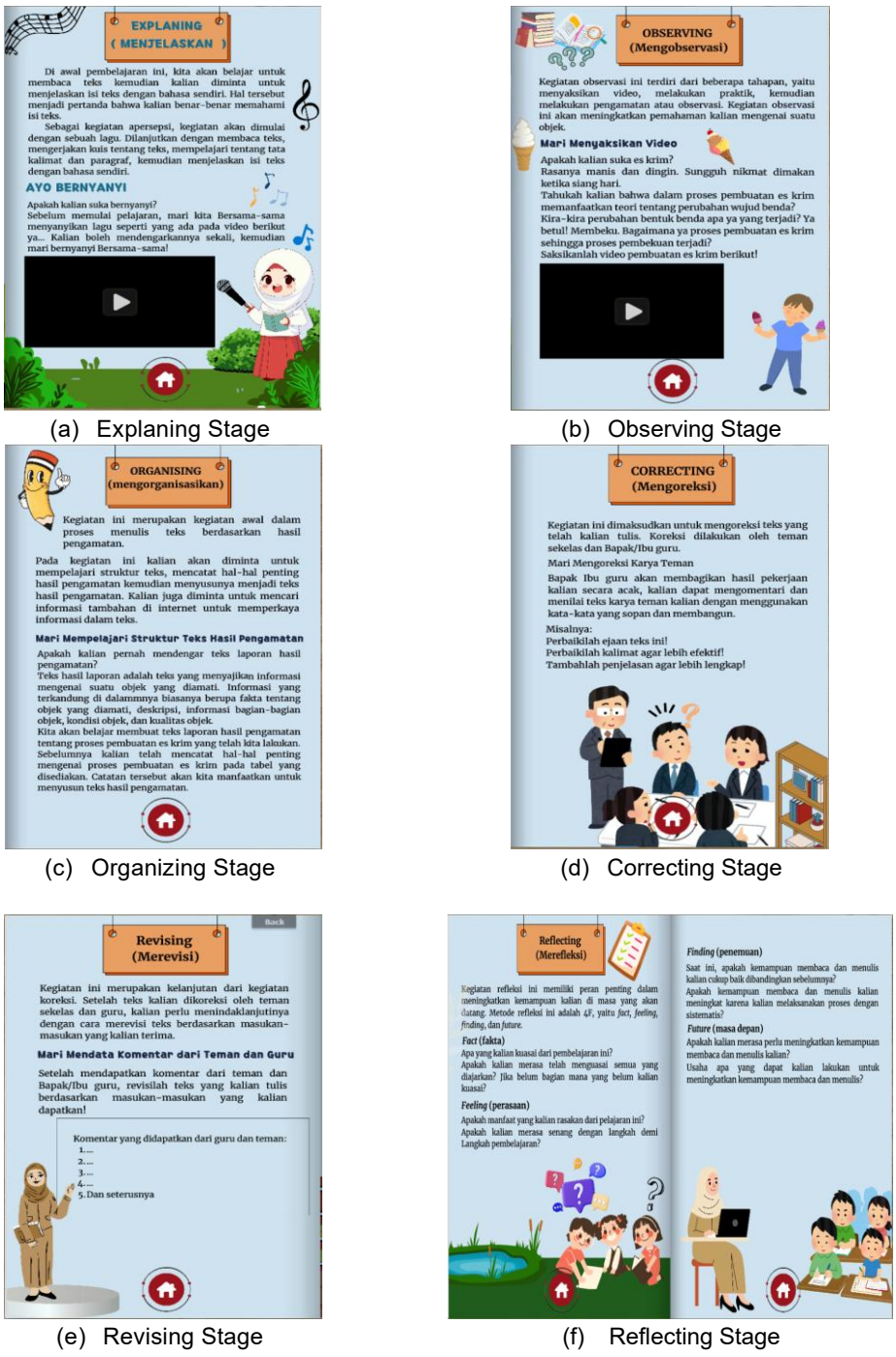
Table 2 presents the specified learning outcomes for reading and writing competencies at the Phase C level. The table outlines the expected competency standards that students must achieve, including comprehension of various text types, identification of main ideas and supporting details, interpretation of information, and the ability to produce structured written texts. The reading outcomes emphasize students' capacity to analyze explicit and implicit information, evaluate textual content, and synthesize ideas from different sources. Meanwhile, the writing outcomes focus on the development of coherent sentences and paragraphs, appropriate use of vocabulary and grammar, logical organization of ideas, and clarity of written expression. These competencies reflect the progression toward higher-order literacy skills suitable for upper elementary learners. Furthermore, Table 2 serves as the foundational reference for designing the e-module content, learning activities, and assessment instruments. By aligning the instructional design with the stated learning outcomes, the developed EXOOCO-2R-based e-module ensures curricular consistency and supports measurable competency achievement.

Table 3
Phase C Reading and Writing Learning Objectives

Learning objectives
1. Read
Students are able to read and understand new information and vocabulary with denotative and literal meanings to understand the phenomenon of changes in the form of objects.
Learning Objective Achievement Criteria (KKTP)
a. Students can understand the main idea of the text they read
b. Students can explain the content of the text
c. Students can interpret new vocabulary from reading
d. Students can briefly explain in their own language the contents of the text they read
2. Write
Students can write texts based on observations
Learning Objective Achievement Criteria (KKTP)
a. Students can make observations about an object
b. Students can organize observation results in the form of an observation result text
c. Students can correct texts written by friends
d. Students can revise the text based on comments from friends
e. Students reflect on the reading-to-write activities that have been carried out

Table 3 details the specific learning objectives derived from the Phase C reading and writing learning outcomes. The table translates the broader competency standards into measurable instructional objectives that guide classroom implementation. Each objective specifies the expected student performance in terms of observable behaviors, such as identifying key information in a text, organizing ideas systematically, constructing coherent sentences, and developing structured paragraphs. The reading objectives emphasize analytical comprehension skills, including locating main ideas, interpreting supporting details, and synthesizing information across texts. In parallel, the writing objectives focus on productive literacy skills, particularly the ability to transform reading inputs into organized written outputs. This alignment reflects the reading-to-write orientation adopted in the e-module design. Moreover, Table 3 functions as an operational framework for instructional planning, activity sequencing, and assessment development. By clearly articulating targeted learning objectives, the table ensures instructional coherence between curriculum standards, learning activities within the EXOOCO-2R model, and evaluation criteria used to measure student achievement.

The results of the analysis were developed into a Learning Path EXOOCO-2R, where at each stage, there are indicators of achievement that must be achieved by students in Phase C. The E-module with the Learning Path EXOOCO-2R was developed in accordance with the learning achievements in reading and writing in Phase C to produce a product draft, as shown in Figure 6 below.



(a) Explaning Stage (b) Observing Stage

(c) Organizing Stage (d) Correcting Stage

(e) Revising Stage (f) Reflecting Stage

Figure 6. Implementation of EXOOCO-2R Learning Path in E-Module

Figure 6 illustrates how the EXOOCO-2R learning path is operationally embedded within the structure of the developed e-module. The figure demonstrates the sequential integration of the EXOOCO stages, beginning with exploration and orientation, followed by

observation, organization, and conceptual construction, culminating in the two reinforcement components (reflection and reinforcement). The visual representation clarifies how each phase is translated into concrete learning activities within the digital module, including guided reading tasks, structured analysis, collaborative discussion, experimental or investigative activities, and structured writing exercises. The 2R components function as metacognitive consolidation stages, in which students reflect on their conceptual understanding and strengthen their literacy outputs through revision and reinforcement tasks.

3.2.5 Effectiveness of Learning Path

The feasibility of developing a learning path for e-module-based reading and writing learning with formative assessment tools is assessed across three aspects: effectiveness, material quality, and readability. These three aspects were assessed by two validators from class teachers in phase C. The results of the e-module feasibility validation are shown in Table 4.

Table 4
E-Module Feasibility Validation Results

Validator	Indikator	Validity Results	Average	Category	Reliability Results	Category
Validator 1	Effectiveness	92,5%	94,72%	Very Valid	98,67%	Reliable
	Material Quality	100%				
	Legibility	91,67%				
Validator 2	Effectiveness	95%	95,56%	Very Valid		Reliable
	Material Quality	100%				
	Legibility	91,67				
	Average		95,14%	Very Valid	98,67%	Reliable

Based on the validation results, the effectiveness aspect obtained from validator 1 was 92.5%, the material quality aspect was 100%, and the readability aspect was 91.67%. So the average obtained from validator 1 was 94.72%. Meanwhile, the values obtained from validator 2 for the effectiveness, material quality, and readability aspects were 95%, 100%, and 91.67%, respectively. So the average obtained from validator 2 was 95.56%. The average result from the two validators is 95.14%. The reliability value obtained from the results of validator 1 and validator 2 is 98.67%.

The validation results from the two validators, in terms of effectiveness, material quality, and readability, demonstrate that developing a learning path for e-module-based reading and writing learning with formative assessment tools is highly feasible to implement with students. Like research conducted by Pradana and Uthman (2023), which states that the validation score is above average, proving that the media developed is very suitable for use by students. The results of student responses are shown in Table 5 below.

Table 5
Student Response Results

Statement	Total score	Percentage (%)	Information
Statement 1	76	68	
Statement 2	73	65	
Statement 3	77	69	
Statement 4	73	65	
Statement 5	82	73	
Statement 6	81	72	
Statement 7	74	66	
Average		68	Good

Based on student responses to the development of learning paths for e-module-based reading and writing learning with formative assessment tools, an average of 68% was obtained, indicating that student responses were considered good. So it can be said that the e-module product developed can be accepted and utilized well by students. From the development of this e-module, it is hoped that students, especially in phase C, can improve their literacy, especially in reading-to-write.

The findings of this study provide broader implications for literacy-oriented instructional design in digital learning environments. The successful integration of the EXOOCO-2R learning path into an e-module demonstrates that reading and writing competencies can be developed simultaneously through a structured, inquiry-based sequence. This suggests that literacy instruction should not be treated as a fragmented skill domain, but rather as an integrated cognitive process where comprehension, reasoning, and written expression are systematically interconnected. In a broader educational context, the results support a shift from content-transmission pedagogy toward a constructivist, metacognitive learning paradigm that emphasizes active knowledge construction and reflective reinforcement.

From a curriculum development perspective, the study offers a practical model for aligning learning outcomes, learning objectives, instructional activities, and assessment within a coherent digital framework. The structured stages of EXOOCO-2R demonstrate how higher-order thinking skills can be scaffolded through sequential learning experiences that guide students from exploration to conceptual consolidation. This contributes a new understanding: digital modules are not merely delivery platforms but can function as pedagogically engineered systems capable of embedding cognitive scaffolding, literacy integration, and reflective reinforcement mechanisms in a unified design.

In the broadest context, the research highlights the potential of digitally mediated literacy instruction to strengthen 21st-century competencies, including critical thinking, analytical reasoning, and structured communication. By operationalizing reading-to-write processes within a systematic learning path, this study provides empirical support for integrating literacy development and inquiry-based learning at the upper elementary level. The results suggest that when instructional design, curriculum alignment, and metacognitive reinforcement are cohesively integrated, digital learning environments can move beyond technological innovation toward meaningful pedagogical transformation.

4. CONCLUSION

This study aimed to develop and validate the EXOOCO-2R learning path model within an e-module-based reading-to-write instructional framework integrated with formative assessment tools. Employing the ADDIE development model, the research systematically addressed the need for a structured pedagogical approach that guides students through the cognitive processes of explaining, observing, organizing, correcting, revising, and reflecting. The EXOOCO-2R model was designed to bridge reading comprehension and writing production by providing a sequential learning architecture that supports students' metacognitive engagement and skill development. The findings demonstrated that the EXOOCO-2R learning path model was highly feasible for implementation, achieving an average validation score of 95.14% from expert assessors across effectiveness, material quality, and readability indicators. The e-module proved instrumental in delivering interactive, multimedia-rich content that accommodated diverse learning styles, particularly kinesthetic learners, through hands-on experimental activities. The embedded formative assessment tools, encompassing peer correction, teacher feedback, and structured reflection using the 4F method, contributed substantially to students' iterative writing improvement and self-regulation, with student responses indicating positive reception (68% in the good category).

The study contributes theoretically to language education by operationalizing the recursive reading-writing connection through a systematically designed learning path, extending existing models of literacy instruction. Practically, it offers teachers a structured, technology-enhanced framework for integrating reading and writing instruction with continuous assessment, while providing students with clear learning progression and timely feedback. For instructional developers, the EXOOCO-2R model presents a replicable template for designing adaptive digital learning environments. Notwithstanding these contributions, the study was limited to a single educational context with a relatively small sample size, and the effectiveness measurement relied primarily on feasibility and perception data rather than direct comparative learning outcomes. Future research should investigate the model's impact on actual reading and writing achievement through experimental designs across diverse educational settings and explore its adaptability to different text genres and student populations. Longitudinal studies examining the sustainability of skill development and the model's integration with emerging artificial intelligence technologies for personalized feedback would further advance this line of inquiry.

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Not applicable

Competing Interests
The authors declare that they have no competing interests.

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Authors' Contribution
Giati Anisah worked on the project, developed the main conceptual ideas, and wrote the manuscript. Pramesti Wulandari and Fiyan Ilman Faqih conducted the statistical and numerical analysis, collaborated in data collection, provided the software, and performed data visualization. Julia Binti Madzalan proofread the manuscript and strengthened theoretical perspectives.

Authors' Information
GIATI ANISAH is a lecturer at the Department of Islamic Education, Faculty of Tarbiyah, Universitas Nahdlatul Ulama Sunan Giri, Bojonegoro, Indonesia. Her research interests include literacy pedagogy, reading–writing integration, formative assessment, and digital learning innovation in elementary education. She has published several works on curriculum implementation and technology-based instructional models.
Email: giati@unugiri.ac.id
PRAMESTI WULANDARI is a lecturer at the Department of Islamic Education, Faculty of Tarbiyah, Universitas Nahdlatul Ulama Sunan Giri, Bojonegoro, Indonesia. Her academic interests focus on literacy education, curriculum development, instructional design, and technology-enhanced learning in primary education. She has been actively involved in research and development projects related to e-modules, formative assessment, and innovative learning models.
Email: pramesti.pw@unugiri.ac.id; ORCID https://orcid.org/0000-0003-2652-4606
FIYAN ILMAN FAQIH is a lecturer in the Department of Indonesian Language and Literature Education, Faculty of Teacher Training and Education, Universitas Trunojoyo Madura, Bangkalan, Indonesia. His academic expertise lies in language education, literacy studies, text analysis, and instructional media development. He is actively engaged in research concerning reading comprehension strategies, writing instruction, and digital learning resources for language teaching.
Email: fiyan.faqih@trunojoyo.ac.id
JULIA BINTI MADZALAN is a lecturer at the Department of Language Education, Faculty of Education, Universiti Islam Antarabangsa Selangor, Kajang, Malaysia. Her research interests include language pedagogy, literacy development, educational assessment, and technology integration in education. She has been involved in cross-institutional academic collaborations focusing on innovative literacy instruction and formative assessment practices.
Email: julia@uis.edu.my

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