Development of Interactive E-Modules Based on Problem Based Learning on the Material of Human Sight and Hearing Senses

Chyntia Berliana[*], Aldina Eka Andriani

Elementary School Teacher Education, Faculty of Education and Psychology, Universitas Negeri Semarang, Semarang, Indonesia
[*]e-mail: chyntiaberliana831@students.unnes.ac.id

Abstract: The limited variety of stimuli and problem-solving activities in teaching materials causes low learning outcomes for students. This study aims to describe the development design, test the feasibility and effectiveness of Interactive E-Modules based on Problem-Based Learning to improve student learning outcomes on the material of the senses of human vision and hearing in class IV SDN Kalibanteng Kidul 03 Semarang City. The type of research used is Research and Development (R&D) with the Borg and Gall model. The research subjects were fourth-grade students of SDN Kalibanteng Kidul 03, which amounted to 23 students. Data collection techniques using tests (pretest and posttest) and non-tests (observation, interviews, questionnaires and document data). Data analysis techniques used normality test, t-test, and N-Gain test. The results showed that the development design of interactive E-Modules based on Problem Based Learning using the Canva application consisted of the main page, instructions for use and activities, table of contents, learning outcomes and objectives, concept maps, learning materials based on Problem Based Learning syntax, visual media in the form of 3D images using (Assemblr EDU), learning videos, glossary, interactive quizzes (Wordwall), bibliography and developer profile. The feasibility of interactive E-Modules based on Problem-Based Learning from material experts, 92.5% of the criteria are very feasible, and media experts, 90% of the criteria are very feasible, supported by the results of the teacher response questionnaire, 95% with very feasible criteria and 100% of student responses with very feasible criteria. The effectiveness of interactive E-Modules based on Problem Based Learning is shown from the increase in pre-test and post-test scores by 39.3, this result is supported by the results of the t-test showing a significance value (2-tailed) <0.000 which based on the criteria the value is below 0.05 and the results of the N-gain test of 0.6706 medium criteria. The conclusion of this study shows that the interactive E-Module based on Problem-Based Learning was successfully developed, very feasible, and effective for improving the learning outcomes of the material of the senses of vision and human hearing in fourth-grade students of SDN Kalibanteng Kidul 03, Semarang City.

Keywords: Interactive E-Module; Learning Outcomes; Problem-Based Learning; Sense of Sight; Sense of Hearing.

Introduction

Education has a very important role in shaping human quality, intelligence, and character through the learning process [1]. The learning process will run well if the learning tools are selected appropriately and are adaptive to the development of science, technology and art (IPTEKS) [2]. The selection of the right learning tools is very important so that these learning tools can be used optimally in the learning process, one of which is in the IPAS learning process [3].

IPAS is a science study that discusses living things and their interactions with the environment and the universe [4]. IPAS learning has 2 main elements, namely IPAS understanding (science and social), and Process skills. The element of IPAS understanding helps students in understanding various phenomena holistically, while the process skills element trains students' ability to think critically, analytically, and apply scientific methods in solving problems [5]. Through IPAS learning, students are expected to be able to practice these values not only during the implementation of learning in the classroom but also to apply them in everyday life. This aims to make students have

critical, systematic, creative, and independent thinking and can work together with others [6] .

Teachers can do several things to make IPAS learning more interesting and not boring, one of which is by using technology-based teaching materials [7]. Information and learning materials in teaching materials can be arranged to make it easier for students to learn in accordance with the applicable curriculum, to achieve predetermined competency standards [8]. Teaching materials consist of several types, such as printed modules, videos, software, or electronic modules (e-modules) that can be used by teachers and students [9]. However, printed modules are often less desirable because they are considered boring. Therefore, it is necessary to develop more innovative teaching materials, such as interactive E-Modules that contain materials, methods, images, illustrations, and videos that are designed in an attractive and structured manner [10].

Based on pre-research data obtained through observations, interviews, questionnaires, and documentation conducted on grade IV teachers and grade IV students of SDN Kalibanteng Kidul 03 Semarang City, it shows that teachers have not been optimal in applying technology-based teaching materials. The teaching materials used by teachers

are only sourced from the Teacher's Handbook & Student Book of the Ministry of Education and Culture in 2023. In the teaching material component, there are components of the intended competencies, namely Learning Outcomes (CP) and Learning Objectives (TP). CP IPAS phase B, which contains Learners, analyses the relationship between the form and function of body parts in humans (five senses), is not contained in the Teacher's Manual & Student's Book. Teachers use additional teaching materials with other relevant IPAS book sources related to the five senses material. The type of teaching materials applied in the learning activity process affects the learning outcomes of students. The use of technology-based teaching materials can increase students' interest and learning outcomes [11].

The innovative learning model applied by teachers has not been optimal in creating meaningful, fun and challenging learning. The innovative learning model applied by teachers is Problem-Based Learning (PBL). The implementation and the learning applied by the teacher are teacher-centered. Teachers have not been optimal in applying syntax 1 and syntax 2 in the Problem-Based Learning (PBL) learning model. In syntax 1, problem orientation to students through stimulus variation has not been carried out by the teacher. Teachers only use learning videos that contain learning material. The absence of stimulus variations provided by the teacher causes students who feel bored, not concentrating in the learning process, such as leaning their heads on the table and chatting with their colleagues when learning takes place [10]. In syntax 2, the grouping of students has not been based on the interests, learning styles and knowledge levels of students. Learners' learning styles determine how they understand and master lessons easily [12]. The learning model must run according to its syntax in order to improve the results of students' learning achievement [13].

The results of the cognitive diagnostic assessment of students on the material of the senses of vision and human hearing are still relatively low, namely, 82.6% or 19 students have not been able to fulfil KKTP. Understanding of material about the senses of human vision and hearing is still low because students have difficulty understanding foreign terms that are rarely known in everyday life, such as cornea, retina, cochlea, and eardrum. Unvaried learning activities cause low student learning outcomes [14].

Learners have difficulty understanding the parts of the ear, especially the outer, middle and inner ear, because the ear that is visible is only the outer ear. This happens because of the misconceptions experienced by students. Misconceptions are learners' understanding of concepts that are wrong or not in line with scientific concepts, usually influenced by learners' experiences [15]. In this material, students learn to recognize the role of each sense in responding to stimuli, thus increasing knowledge about the structure and parts of the eye and ear, so as to train critical thinking skills [16]. One effective way to overcome misconceptions is through practicum activities, because through practicum activities, students are given the opportunity to experience the learning process in a real and concrete way [17].

Based on the existing problems, improvements are needed in IPAS learning. These efforts include teachers needing to present technology-based interactive teaching materials that present material in the form of text, images,

and audio and video so as to optimize learning outcomes, one of which is the E-Module [18]. E-module is a learning tool that is compiled with a digital base where how to use it using a smartphone, laptop, or tablet [19]. (Lastri, Y. 2023) states that the E-Module component contains various components, namely: main page, preface, instructions for use, and table of contents [20]. The E-Module component is composed of various parts, namely: main page, table of contents, preface, learning objectives, learning activities, material summary, formative tests, answer key [21]. The E-Module components used by researchers refer to the opinions of the two experts, consisting of the main page, instructions for use, activities, table of contents of learning outcomes and objectives, learning concept maps, learning materials, material summaries, evaluations, glossaries, bibliographies and developer profiles. There are five characteristics that describe a good e-module, namely: self-instruction, self-contained, stand-alone, adaptive, and user-friendly [22]. E-Modules provide a new learning atmosphere, so that students do not quickly feel bored in following the ongoing learning [23].

The interactive e-module is combined with the Problem-Based Learning model. The Problem-Based Learning model is a learning approach that encourages students to understand how to learn independently, work together in groups, and find solutions to problems related to real life [21]. The Problem-Based Learning learning model produces flexible learning, full of student collaboration, and prepares students to understand the information provided by educators [24]. The researcher developed an interactive E-Module based on Problem Based Learning using the Canva application which is equipped with visual media in the form of 3D images based on human vision and hearing organ technology that can improve students' visualization understanding of the structure of the eye and ear organs, designed using the Assemblr EDU application, and interactive quizzes that can be accessed through Wordwall to create fun learning. E-modules based on Problem-Based Learning are designed to encourage students to develop the ability to analyze and solve problems so as to improve students' critical thinking skills [25].

Previous research entitled the development of interactive E-Modules based on Problem-Based Learning to solve mathematical problems of speed and discharge material in elementary schools concluded that the interactive E-Modules developed were valid, practical, and effective [26]. Another study that discussed interactive E-Modules in science subjects concluded that interactive E-Modules based on Problem-Based Learning were feasible and well implemented in elementary schools [27].

Based on previous research that discusses interactive E-Modules, the conclusion is that interactive E-Modules are very feasible and well applied in elementary schools. Researchers developed an interactive E-Module based on Problem-Based Learning on the material of the senses of sight and hearing of humans, with the novelty of using Canva and Assemblr EDU applications, applying the Problem-Based Learning learning model, compiling and designing learning materials equipped with visual media in the form of technology-based 3D images, additional audio sounds, learning songs on the senses of sight and hearing and interactive quizzes from Wordwall.

Based on the description of the background above, the researcher will conduct development research with the title Interactive E-Module Based on Problem-Based Learning to improve the learning outcomes of fourth-grade students of SDN Kalibanteng Kidul 03 Semarang City on the material of the senses of sight and hearing of humans with the aim of: describing the development design of Problem-Based Learning based Interactive E-Module, testing the feasibility of Problem-Based Learning based interactive E-Module, testing the effectiveness of Problem-Based Learning based Interactive E-Module.

Research Methods

This type of research is Research and Development (R&D) using the Borg and Gall development model. The research and development step consists of 10 steps, namely: 1) potential and problems, 2) data collection, 3) product design, 4) design validation, 5) design revision, 6) product trial, 7) product revision, 8) usage trial, 9) product revision 10) mass production. Researchers took 10 stages in conducting this research.
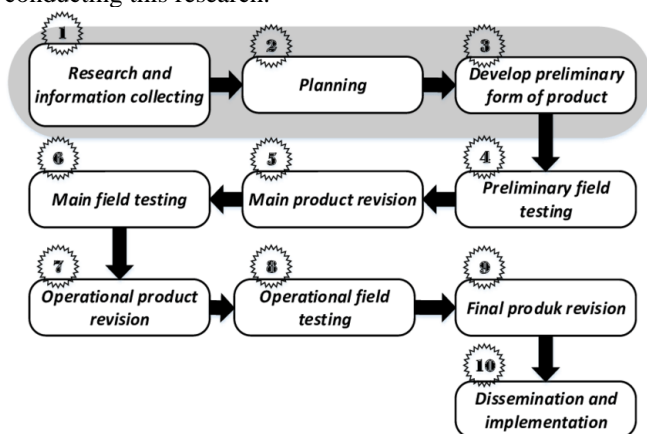
Gambar 1. Borg and Gall's Research Design

The subjects of this study were fourth-grade students of SDN Kalibanteng Kidul 03, totalling 23 students, with details of small group trials totalling 6 students and large group trials totalling 17 students. Data collection techniques consisted of tests (pre-test and post-test) and non-tests (observation, interviews, questionnaires, and documentation). Data analysis techniques are used to test interactive E-Modules based on Problem-Based Learning using normality tests, t tests, and N-Gain tests.

Research Methods

This research focuses on the development of design, feasibility, and effectiveness of interactive E-Modules based on Problem-Based Learning on the material of the senses of human vision and hearing to improve the learning outcomes of fourth-grade students of SDN Kalibanteng Kidul 03, Semarang City.

Development of Interactive E-Module Design Based on Problem-Based Learning

This research is development research using the Borg and Gall model up to stage 10, namely:

Potential and Problems

The first stage is the analysis of potential and problems. At this stage, researchers collect information about the potential and problems studied through observation, interviews, questionnaires and document data [28]. Researchers conducted pre-research at SDN Kalibanteng Kidul 03, Semarang City. The results of the pre-research showed that at SDN Kalibanteng Kidul 03 there were problems in the IPAS learning process; namely, limited stimulus variations and problem solving activities in teaching materials, teachers have not been optimal in applying innovative learning models, low student learning outcomes in the scope of the material of the senses of human vision and hearing, students experience misconceptions and difficulty understanding foreign terms in the senses of sight and hearing. This can be seen from the cognitive diagnostic assessment of the material of the senses of vision and human hearing, which shows that 82% of students have not reached the criteria for achieving learning objectives (KKTP).

The potential of SDN Kalibanteng Kidul 03 is that it has quite complete facilities. The facilities at SDN Kalibanteng Kidul 03 support the learning process, with projectors, loudspeakers and WiFi in every classroom. SDN Kalibanteng Kidul 03 also gives permission to high-grade students to use devices during the learning process to support access to digital learning resources, and facilitates the use of technology-based learning media [29].

To overcome the problems in learning IPAS, technology-based teaching materials combined with innovative learning models are needed to create a learning process that is more interesting, interactive, meaningful and able to improve student learning outcomes [30]. Therefore, researchers will develop an interactive E-Module based on Problem-Based Learning with the scope of material on the senses of human vision and hearing.

Data Collection

The second stage is data collection. Data collection is a step taken to collect various information, which will be used as a basis for designing a product [31]. Researchers distributed a needs questionnaire to fourth-grade teachers and participants in class IV SDN Kalibanteng Kidul 03, Semarang City. The results of the analysis of the teacher needs questionnaire show that the teacher needs an interactive E-Module based on Problem-Based Learning on the material of the senses of human vision and hearing. Teachers agree with the interactive E-Module as a form of development of learning teaching materials.

Based on the questionnaire analysis of the needs of students, it shows that students experience misconceptions and difficulties in understanding the material of the senses of vision and human hearing and the learning outcomes of cognitive assessment on the material of the senses of vision and human hearing need to be improved. Learners need technology-based teaching materials consisting of visual media, audio visual equipped with a variety of activities, one of which is practicum activities, a variety of stimuli is needed to direct students in solving problems and can facilitate the learning style of students through interactive E-Modules, with attractive color criteria, instructions for use

that help students in, visual media in the form of technology-based 3D images, and learners choose the *Problem Based Learning* model to be applied in the interactive E-Module.

Product Design

The third stage is product design. At this stage, researchers began designing the initial form of the product to be developed based on the needs of product users [32]. Researchers designed products according to the needs of teachers and students using the results of the questionnaire. Interactive E-modules based on Problem-Based Learning are based on the results of the questionnaire analysis of the needs of teachers and students [33].

Researchers design products using Canva, Assembler Edu and Heyzine applications, which contain covers, instructions for use, concept maps, learning materials based on Problem-Based Learning syntax, technology-based 3D images, learning videos, glossaries, interactive quizzes, bibliographies and developer profiles. Interactive e-Modules based on Problem Based Learning facilitate learners to improve learning outcomes with the presence of materials, 3D-based technology images, learning videos, and learning songs as a place for learners to deepen students' understanding of the five human senses (senses of sight and hearing) as well as interactive quizzes from Wordwall that can be used to measure the level of understanding of student learning outcomes. The syntax of Problem-Based Learning includes: (1) orienting students to the problem, (2) organizing students to learn, (3) guiding individual/group investigations, (4) developing and presenting results, (5) analyzing and evaluating the problem-solving process [34].

Figure 2. Main page, Learning Outcomes & Learning Objectives and Concept Map in *Problem Based Learning Based* Interactive E-Module

The researcher designed the main page of the interactive E-Module based on Problem-Based Learning by combining elements in the Canva application and using colours that are attractive to students. Learning outcomes and learning objectives were prepared based on the references contained in the Decree of the Head of BSKAP No.032/H/KR/2024 Year 2024. The concept maps prepared include: structure, function and mechanism of the senses of sight and hearing. Concept maps function as a tool to convey complex ideas systematically, so that they can simplify the thinking patterns of students and support the creation of a more meaningful learning process [35].
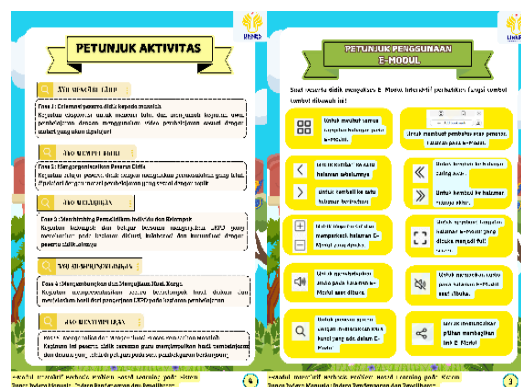

Figure 3. Instructions for Use and Activities in Problem Based Learning Based Interactive E-Module

Instructions for use in Problem-Based Learning-based interactive E-Modules provide information to learners on how to access and utilise various features in the e-module, such as the return menu to the previous and next pages, audio features, videos and interactive quizzes. This helps learners in exploring the material independently and effectively [33]. The activity consists of several activities based on the syntax of the Problem-Based Learning model. The activities in the Problem-Based Learning-based E-Module are designed to stimulate learners in developing critical thinking and problem-solving skills [36].
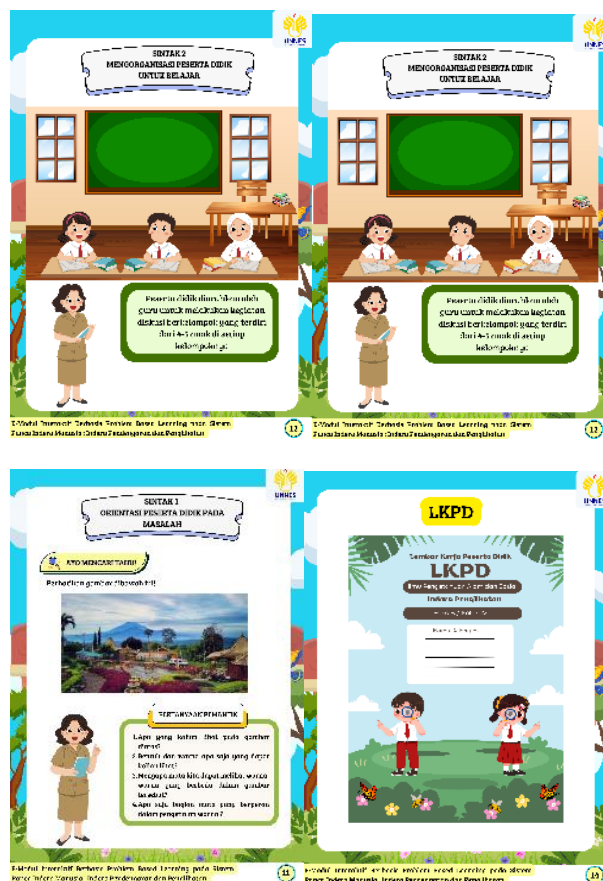
Figure 4: Learning Syntax of Problem-Based Learning on Interactive E-Modules Based on Problem-Based Learning

The advantages of interactive E-Modules based on Problem-Based Learning lie in their syntax, which has a variety of stimuli. In syntax 1, the stimulus is presented in the form of images in the first lesson and story text in the second lesson [37]. Syntax 2 is organized based on learning readiness, learning style and the level of knowledge of learners, including very proficient, proficient and requires guidance. In syntax 3, learners receive the worksheet and start solving the problems in it. The researcher used bright colors and pictures that are appropriate for elementary school students to make it interesting for learners.
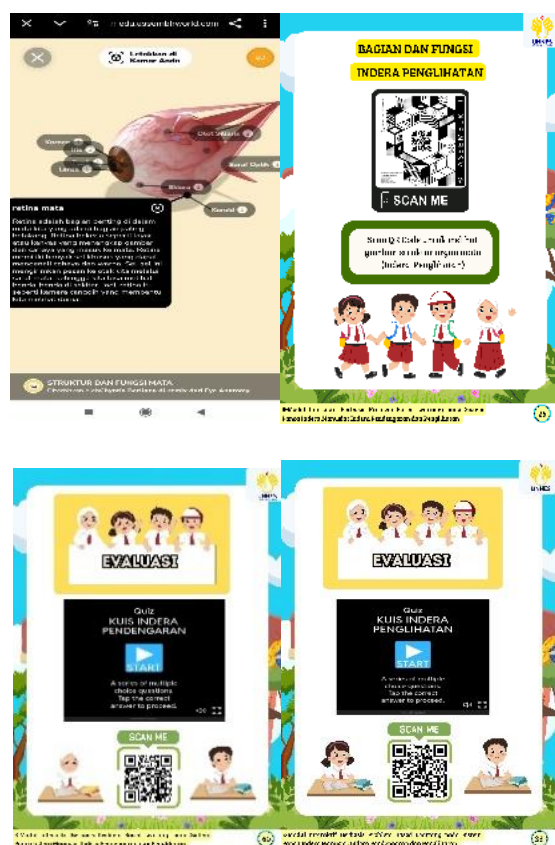

Figure 5. 3D Barcode of Sight Sense Organ and 3D Image of Sight Sense Organ in Interactive E-Module Based on Problem-Based Learning

Researchers designed visual media in the form of 3D images using the technology-based Assemblr EDU application and then incorporated it into an interactive E-Module based on Problem-Based Learning. The presence of visual media in the form of technology-based 3D images can be a solution to create learning that is fun and not monotonous [38].

The researcher designed a learning evaluation using Wordwall. The evaluation consists of 10 multiple-choice HOTS questions. Wordwall is used as an evaluation platform because it allows teachers or facilitators to create engaging and interactive learning activities, such as quizzes, crosswords, and multiple-choice-based games. The use of Wordwall supports active learning and increases learner participation significantly due to the gamification elements implemented [39].

Design Validation

The fourth stage is design validation. At this stage, validation is carried out to determine the level of validity and analyze the suitability of the material content with the developed product [40]. Design validation was carried out by testing the validity of material experts and media experts. Researchers made a validation questionnaire for material experts and media experts. Researchers gave a validation questionnaire to material experts and media experts. Then, the results of the material expert questionnaire and material and media expert questionnaires were analyzed to determine whether or not the product was feasible to be applied in learning activities. The result of the validation Material and media experts validation of material and media experts obtained very feasible criteria.

Design Revision

The fifth stage is design revision. Design revisions are carried out based on the assessment and suggestions of material and media experts until the product is suitable for testing [41]. Design revisions are carried out with the aim of correcting deficiencies and perfecting the product to make it more effective and according to user needs. Overall, the material and media aspects of the Interactive E-Module based on Problem-Based Learning are appropriate. Suggestions given for improvements to the Problem-Based Learning-based Interactive E-Module product are: adjusting the size and position of the font size, logo, author's name and adding the class & curriculum phase on the main page of the Problem-Based Learning-based interactive E-Module.

Product Trial

The sixth stage is product testing. At this stage, researchers conducted product trials (small groups) to obtain an overview, suggestions and improvements to teaching materials based on interactive E-Module technology based on Problem-Based Learning [42]. Researchers conducted product trials in class IV of SDN Kalibanteng Kidul 03 involving six students who had varying levels of knowledge: two students were very proficient, two students were moderately proficient, and two students needed guidance. To assess the improvement of learning outcomes, researchers used pre-test and post-test instruments.

Table 1. Results of Pre-test and Post-test of Small Group Product Trial

Action	Average	Improvement
Pre-test	41.64	38.36
Post-test	80	

Table 1 shows that the average pre-test of the product trial was 41.64, and the average post-test of the product trial was 80, so there was an increase of 38.36. So, there is an increase in student learning outcomes before and after using interactive E-Modules based on Problem-Based Learning.

Table 2. Results of Teacher and Learner Responses to Product Trials

Response	Percentage (%)	Criteria
Teacher	95	Very Feasible
Learners	100	Very Feasible

Table 2 shows that the teacher's response is 95% with very feasible criteria, and 6 students get an average of 100% with very feasible criteria. The results of the teacher response questionnaire analysis show that E-Modules interactive Problem-Based Learning is in accordance with the characteristics of students, interesting, easy to use, and able to improve students' understanding of the material through the senses of vision and human hearing. The results of the analysis of the learner response questionnaire show that the interactive E-Module based on Problem-Based Learning is interesting, easy to use, and increases understanding of the material of the senses of vision and human hearing. This, the interactive E-Module based on Problem-Based Learning, is suitable for learning activities.

Product Revision

The seventh stage is product revision. Product revision is carried out to evaluate the feasibility and effectiveness of the product [43]. Product revision is based on the results of teacher and learner response questionnaires at the product trial stage. The results of the product trial showed that there were no revisions from teachers or learners. Teachers and learners gave positive responses, and researchers received a feasibility score based on very feasible criteria.

Trial Usage

The eighth stage is the trial of use. The trial of use is carried out on a larger group in order to assess the effectiveness of the product that has been developed and obtain useful input to make improvements through revisions to the final stage product [44]. Researchers conducted a trial of use on 17 fourth-grade students of SDN Kalibanteng Kidul 03 using written tests (pre-test and post-test). Testing was carried out to determine whether learning IPAS material on the senses of human vision and hearing using interactive E-Modules based on Problem-Based Learning that researchers developed was effective.

Table 3. Large Group Pre-test and Post-test Usage Test Results

Action	Average	Improvement
Pre-test	41.64	39.3
Post-test	80.94	

Table 3 shows that the average pre-test of the usage trial was 41.64, and the average post-test of the usage trial was 80.94. So there was an increase of 39.3. So, there is an increase in student learning outcomes after using an interactive E-Module based on Problem-Based Learning.

Table 4. Results of Teacher and Learner Responses to the Usage Trial

Response	Percentage (%)	Criteria
Teacher	95	Very Feasible
Learners	100	Very Feasible

Table 4 shows that the response from teachers in the usage trial was 95% with very feasible criteria, and 17 students got an average of 100% with very feasible criteria. Thus, the interactive E-Module based on Problem Based Learning received a very decent response from teachers and students in the usage trial, so that the interactive E-Module based on Problem Based Learning is very feasible to use in learning.

Final Product Revision

The ninth stage is the final product revision. This stage is the final product revision stage [28]. Researchers improved the product by referring to the suggestions and input submitted by the teacher. The suggestion given by the teacher was to add a sound feature to the activity in the Problem-Based Learning interactive E-Module.

Dissemination and Implementation

The tenth stage is dissemination and implementation. Mass production is the stage of disseminating the developed product and applying it in the field [28]. At this stage, researchers disseminate products through links that are distributed to schools, teachers and students and can be accessed via smartphones, computers and laptops.

Feasibility of Problem Based Learning Based Interactive E-Module

The Feasibility Test is carried out by conducting product validation with material experts and media experts, aiming to assess the feasibility of product development. The assessment was carried out by filling out the validation instrument by both validators. The results of the validation process show that:

Table 5. the results of the material expert validation

Action	Percentage (%)	Criteria
Material Expert	92.5	Very Feasible
Media Expert	90	Very Feasible

Based on Table 5. shows that the results of the material expert validation obtained a score of 92.5% with very feasible criteria. Assessment of feasibility of

material is carried out using a questionnaire, the assessment instrument consists of 5 aspects of assessment including: 1) Accuracy with learning objectives, 2) Suitability to the level of thinking of students, 3) Support for the content of interactive E-Modules based on Problem Based Learning, 4) Stimulus can help understand the material, 5) Appropriate to support learning content [45]. The five aspects are in line with the principles of developing E-Modules based on Problem-Based Learning, which emphasizes the presentation of real problems, active involvement of students in the learning process, and the development of critical thinking and problem-solving skills [46]. The results of media expert validation obtained a score of 90% by meeting very feasible criteria. Media feasibility assessment is carried out using a questionnaire assessment instrument consisting of 3 aspects of assessment, including: 1) quality of content and objectives, 2) construction, and 3) technique and appearance. These three aspects are in line with the objectives of developing teaching materials, namely to present material that is relevant, easy to understand, and visually appealing, so as to increase learning effectiveness and encourage student motivation. Based on the results of the material expert validation questionnaire, which contains 20 statements, the interactive E-Module based on Problem Based Learning gets a score of 74 out of a maximum score of 80, thus getting a percentage of 92.5%. Based on the results of the media validation questionnaire, the interactive E-Module based on Problem Based Learning received a score of 58 out of a maximum score of 64, thus getting a percentage of 90% and meeting very feasible criteria.

So, the interactive E-Module based on Problem Based Learning is very feasible to use on the material of the senses of sight and hearing of humans in class IV SDN Kalibanteng Kidul 03 Semarang City. In addition, the feasibility of interactive E-Modules based on Problem Based Learning is also supported by the responses of teachers and students. The results of the fourth-grade teacher's response amounted to 95% with very feasible criteria. In addition, researchers also got a response from fourth-grade students in the trial use of 100% with very feasible criteria, so that the interactive E-Module based on Problem Based Learning is very feasible to use in learning.

This is supported by previous research that discusses interactive E-Modules in IPAS subjects, concluding that interactive E-Modules are very feasible to implement in elementary schools [47]. In line with previous research, research that discusses the feasibility of interactive E-Modules concludes that interactive E-Modules are declared feasible to use in learning based on the validation results of material experts, media experts, teacher response questionnaires and student response questionnaires.

Effectiveness of Interactive E-Modules Based on Problem-Based Learning

The effectiveness of the interactive E-Module based on Problem Based Learning was tested through a normality test, t-test, and N-gain test using SPSS 27.

Table 6. Normality Test Results

Action	Sig.	Criteria
Pre-test	0.093	Normal
Post-test	0.472	Normal

Based on Table 6, which refers to the Shapiro-Wilk normality test, the test results on the trial showed a pre-test significance value of 0.093> 0.05, so that the data distribution met the assumption of normality. The post-test normality test results show a significance value of 0.472> 0.05, so that the data distribution meets the assumption of normality. After the results of the pre-test and post-test on the trial use were stated, the data distribution met the assumption of normality, and the researcher conducted a t-test (Paired sample t-test).

Table 7. Paired Samples t-test Results

Action	Mean	Improvement	Sig. (2-tailed)
Pre-test	41.64	39.3	<0.000
Post-test	80.94		

Table 7 shows the average value of the pre-test of the trial use of 41.64 and the average value of the post-test of the trial use of 80.94, so that there was an increase of 39.3. Based on the results of the Paired Sample t-test, the significance value (2-tailed) is <0.000 and based on the criteria, the value is below 0.05, so H0 is rejected. The significance value (2-tailed) < 0.000 < 0.05, then H0 is rejected and Ha is accepted. So, there is a significant difference in student learning outcomes before and after using interactive E-Modules based on Problem Based Learning.

Table 8. N-Gain Test Results

Action	Mean	Improvement	N-gain	Criteria
Pre-test	41.64	39.3	0.6706	Medium
Post-test	80.94			

Based on the results of the N-Gain test in the usage trial (large group), an average value of 0.6706 was obtained. The results of the N-Gain test in the usage trial showed a result of 0.6706, included in the medium criteria.

Figure 7. Improved Learning Outcomes from the User Trial

The increase in the average pre-test and post-test scores was 39.3. The moderate category (N-Gain) is caused by several factors, namely the readiness and learning style of students [48]. Some aspects that need to be considered in learning readiness include ability, maturity, physical

condition and health, learning experience, learning achievement, stimulation and interest, perception, and other factors that support individuals to learn optimally [49]. Aspects of learning styles consist of visual, auditory, and kinesthetic. In recognizing the characteristics of students' learning styles, teachers can plan various learning activities in the classroom by applying appropriate models, strategies, and methods [50]. This is in accordance with previous research, which explains that the development of E-Modules is effective in learning, such as reducing paper usage, increasing learning motivation, and making learning more meaningful and memorable [51].

Data analysis conducted on the research obtained the results of the feasibility test showed a very feasible and practical category. The N-Gain test results showed a moderate category. So, the use of Interactive E-Modules based on Problem Based Learning on the material of the senses of vision and human hearing is effective for improving the learning outcomes of grade IV students.

Conclusion

The development of interactive E-Modules based on Problem Based Learning on the material of the senses of human vision and hearing uses the type of Research and Development (R&D) research with the Borg and Gall model. The results showed that the development design of interactive E-Modules based on Problem Based Learning using the Canva application consisted of a main page, instructions for use and activities, concept maps, learning materials based on Problem Based Learning syntax, visual media in the form of 3D images using (Assemblr EDU), learning videos, glossary, interactive quiz (Wordwall), bibliography and developer profile. The feasibility of interactive E-Modules based on Problem Based Learning from material experts with very feasible criteria of 92.5% and media expert criteria with very feasible criteria of 90%, teacher responses with very feasible criteria of 95% and student responses of 100% with very feasible criteria. The effectiveness of the Problem Based Learning-based Interactive E-Module is shown from the results of the paired sample t-test, namely there is an increase in the average value of the pre-test and post-test by 39.3 and the significance value of significance (2-tailed) which is 0.000 <0.05, and the N-Gain test results show a value of 0.6706 with moderate criteria. So the interactive E-Module based on Problem Based Learning is very feasible, successfully developed and effective for improving the learning outcomes of students on the material of the senses of sight and hearing of humans in class IV SDN Kalibanteng Kidul 03 Semarang City.

Author Contribution

Chyntia Berliana: contributed to product development, data analysis, and research writing. Aldina Eka Andriani: contributed to drafting and revising the research.

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