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Validity and Practicality of E-Module Based on Phenomenon Based Learning Using Articulate Storyline on Material Colligative Properties of Solutions

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Abstract: This research aims to produce an E-Module of Colligative Properties of Phenomenon-Based Learning-Based Solutions Using the Articulate Storyline Application for 21st Century Skills Mastery. This research is a type of research and development or R&D using a 4-D model consisting of 4 stages, but this research is only at the development stage. The results of the research carried out are in the form of electronic modules (e-modules) on colligative chemistry materials that are valid and practical. The validity aspect is determined from the validator's assessment and the practicality aspect is determined from student responses to this E-module. The results for the validity aspect of the e-module were declared very valid with a presentation of 96.667%. The research results on the practical aspect of e-modules received a very good response from teachers with a presentation of 97.188% and very good from students with a presentation of 99.44%. These results indicate that the e-module on colligative properties of solutions developed is valid and practical for use as an alternative teaching material in the learning process.

Keywords: Colligative Properties of Solutions; E-Module; Phenomenon Based Learning

Introduction

Learning is an effort to provide stimulation, guidance, direction and encouragement to students so that the learning process occurs. The learning process is characterized by changes in student behavior as a result of student interaction with their environment. The student learning process in school occurs because of educational interactions between teachers and students which are based on good goals in the form of knowledge, attitudes and skills. One of the lessons provided at the Senior High School (SMA) level is learning about chemistry. Chemistry is a science that studies matter and its changes. Chemistry studies the properties of matter on a microscopic and macroscopic scale as well as related phenomena (Firdaus et al., 2022). Chemistry is a science that studies chemical facts, concepts and principles. Chemistry studies processes, products and attitudes. Chemistry seen from a process perspective includes the ability to observe, measure, group, ask questions, formulate hypotheses, conduct experiments and draw conclusions. From the attitude aspect of chemistry, it includes caring for the environment, being curious, tenacious, honest, patient, critical, diligent, disciplined, careful, paying attention to work safety, and working together. Some of these skills are process skills, and aspects of attitude which are often referred to as scientific attitudes (Sukmawati, 2019). Chemistry is closely related to everyday life. One of the topics discussed in chemistry in high school which is closely related to everyday life is acids and bases. Acids and bases are a key concept in chemistry and must be studied thoroughly, because they will continue to be implemented in subsequent chemistry concepts (Abdullah, 2020). Therefore, studying chemistry requires experience related to daily life or through experiments to discover and prove theories, laws and

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concepts. This aims to strengthen students' understanding of concepts about chemistry.

Understanding concepts is very necessary in understanding chemistry. One of the characteristics of chemistry is that it tends to be abstract and complex. Because of this abstract nature, a way to study chemistry as a whole is needed. According to Suja (Ni'mah & Kamaludin, 2023). This abstraction is sometimes difficult to imagine or see with the sense of sight, so chemistry subjects require direct analogy depictions. To study a complex and abstract concept according to Coll (Sukmawati, 2019) Three levels of representation are required, including macroscopic, submicroscopic and symbolic levels. The macroscopic level is an aspect that explains things that happen in everyday life, while the submicroscopic level explains daily life events from a microscopic perspective, while the symbolic level explains real phenomena expressed in the form of symbols or images. Chemistry learning will be more meaningful if it can be applied in real life (Zannah & Gustita'iroha, Siti Asvisiu Rohmahb, 2019). One approach to chemistry learning that can be applied and is beneficial for students' lives is Phenomenon based learning.

Phenomenon based learning is learning based on phenomena that exist in everyday life, where students will play an active role in creating an understanding of these phenomena and solving the problems given. Phenomenon based learning was first implemented in Finland in 2016 as a curriculum by requiring teachers to teach based on a phenomenon-based learning approach which utilizes the environment outside the school and innovative technology plays an important role in involving, attracting and activating students in learning. Finland is also one of the countries that is used as a mecca for education (Wakil et al., 2019). The facts above show that there is a need to implement an integrated learning model with the modules used being based on natural phenomena whose learning process involves students. This learning model emphasizes that in all learning process students are active and build their own knowledge (*student centered)* by analyzing phenomena to increase understanding of concepts.

Phenomenon based learning emphasizes phenomena in lessons, the relationship between students and learning activities, as well as teaching and reflection on students (Ang et al., 2022). In increasing students' learning motivation, the learning resources used by teachers must also be varied so that students do not feel fed up and bored (Masaguni et al., 2023). Learning resources can be in the form of textbooks, modules, LKPD and other materials that students can learn from. Module learning resources are very suitable for independent study. Little interaction with teachers can be overcome by using appropriate modules. Phenomenon-based learning is a learning model that presents model phenomena from the natural phenomena being reviewed. To support this learning process, appropriate modules are needed to support a good learning process.

Today's world situation requires that learning be carried out in various ways, including online, hybrid and offline. Qualified teachers must be able to design learning for various learning situations, without reducing the skills that students must have, especially 21st century skills. 21st century learning assessment refers to 3 aspects that can be carried out both formatively and summatively, namely assessment as a learning process, assessment for the learning process, and assessment during learning. Assessments are designed to see students' progress (Febriya et al., 2023). Therefore, teachers are expected to be able to compile learning resources that can be used for every learning situation, one of which is a module. The type of module used for various situations is an electronic module (e-module). E-Module is one of the media which is the embodiment of technological development. E-modules are one of the appropriate teaching materials to support the implementation of learning models. In its use, E-Module uses multimedia elements in the form of animation, video scribes, audio visuals, and so on. (Luthfiani & Yerimadesi, 2022). The use of multimedia like this is able to increase students' interest because the content is very varied, not only limited to the appearance of the material, but also displays videos and illustrations that are appropriate to the material. (Ningsih & Mahyuddin, 2021) . For this reason, software is needed that supports the creation and application of this E-Module. One software that can be used is Articulte Sroryline.

Learning resources in the form of E-Modules must have uniqueness and characteristics that make them interesting so that students enjoy using them. One application that can be used for this purpose is Articulate Storyline. Articulate storyline is one application that can be used to achieve this goal. (Yulistya et al., 2022) stated that articulate storyline is software that can be used in learning because it has an attractive and fun appearance. This is in line with opinion (Munawarah et al., 2021) which states that the articulate storyline application has the advantage that it can contain interactive text, sound, video, animation and images, the results of which will be in the form of an application file or web which of course can be run on a laptop or smartphone. Articulate Storyline is suitable for producing interactive learning media, apart from that the output produced is also varied, starting from IOS, Android and PC user formats. Apart from that, the

output from Articulate Storyline itself can also be converted into an application, making it easier to use.

The colligative properties of solutions are a type of chemical material that contains many various phenomena in it. Colligative properties of solutions study things that are microscopic, such as the effect of solutes on reducing vapor pressure, increasing boiling point, lowering freezing point, and osmotic pressure. Students' understanding of the colligative properties of solutions is demonstrated by students' ability to connect the macroscopic, submicroscopic and symbolic levels in the context of problem solving (Farida et al., 2018). Apart from that, colligative properties are abstract and can give rise to misconceptions (Ni'mah & Kamaludin, 2023) . One of the basic competencies (KD) in the colligative properties of solutions is analyzing the phenomenon of colligative properties of solutions in life. Based on this KD, students are required to observe a phenomenon of colligative properties of solutions. This observation activity can arouse students' curiosity about the material on the colligative properties of solutions (Pradnyamita et al., 2019). In addition, students are asked to present the results of searching for information related to the application of the principles of colligative properties of solutions in everyday life. Therefore, we need teaching materials that have a variety of elements in the form of E-Modules based on Phenomenon Based Learning which can help students learn each learning process so that students are active in building their own knowledge (student centered) by analyzing phenomena to improve understanding of concepts and students' interests and motivation.

The development of e-modules based on phenomenon based learning has been carried out by several researchers, including research conducted by Maisarmah 2022 with the title "Development of a Chemistry Learning E-Module Based on Phenomenon Based Learning to Direct Students' Critical Thinking Skills" obtained research results with the feasibility of the e-module for the material aspect of 75% (Good/feasible), for the media aspect of 83.27% (Very good/decent), the teacher response was 90% (Very Good), and the student response was 81% (Very good), based on these results, it was identified that the Phenomenon Based Learning e-module for chemistry learning was suitable for use as a learning resource.

Revolution 4.0 shows the importance of 21st century skills consisting of learning skills, literacy skills and life skills (Rios et al., 2020). This situation requires 21st century students to master and combine skills, knowledge and attitudes. This can be realized by utilizing technological advances so that learning becomes more effective (Husniyah & Ramli, 2023). In addition, the use of learning models that must be adapted to current conditions requires problem-based learning where students will work independently and collaboratively to solve the problems presented (Nainggolan et al., 2020). In an effort to show the novelty of research and provide solutions in chemistry learning, this research was carried out by creating an innovative electronic teaching material that supports independent learning based on learning models with the aim of improving students' 21st century skills in the material on colligative properties of solutions. These teaching materials will then be tested for validity and practicality before being implemented in high schools. Validity is seen from the appropriateness aspect of the content, presentation aspect, linguistic aspect, graphic aspect, characteristic aspect of Phenomenon Based Learning, appearance aspect and software utilization aspect. In this research, we will study whether the e-module based on phenomenon-based learning uses the articulate storyline application on the material on the colligative properties of solutions for class Can the characteristics of Phenomenon Based Learning, display aspects and software utilization aspects be developed? After a valid e-module is produced that will be studied, how will users (teachers and students) respond if the e-module is used in the learning process? It is hoped that this research will produce an e-module on the colligative properties of solutions that is valid and can be used as an alternative teaching material that is interesting and innovative and can be used as an independent learning resource for students.

Method

This type of research was designed using a research and development design based on *Research and Development* (R&D) using the 4-D model. The model used is a 4-D model development. The 4-D (*Four D)* development model is a learning device development model. This model was developed by (Thiagarajan et al., 1974). The 4D development model consists of 4 main stages, namely: *Define* , *Design* , *Develop* and *Disseminate*. The basis for choosing to use this 4D model is because each step in the development procedure stage is explained in detail, what the researcher will do when developing a product in the form of teaching materials, books, or other teaching materials. This method and model was chosen because it aims to produce a product in the form of an E-Module based on *Phenomenon Based Learning* with *Articulate Storyline* to improve 21st century skills in the material of colligative properties of solutions. The 4-D development flow is described in the following diagram:

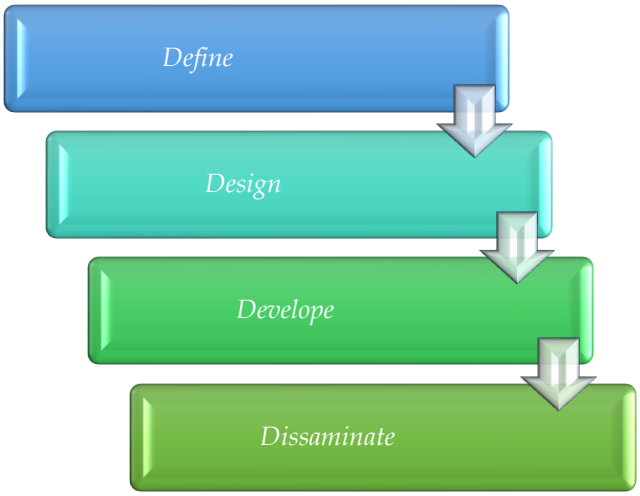

Figure 1. 4-D development diagram

This research was carried out at the Chemistry Education Study Program, Faculty of Teacher Training and Education (FKIP), Riau University, Pekanbaru, with a trial at SMAN 1 Pekanbaru, with the research period being September to September - December 2022. The subjects in the research carried out were three students with different basic abilities to be tested in a one-on-one trial, 20 class XII students at SMAN 1 Pekanbaru who had studied colligative properties material to be tested in small groups using a user response questionnaire. As well as testing with two chemistry teachers to ask for user responses regarding the appropriateness of the contents of the E-Module.

The validation sheet instrument is used to obtain assessments and responses from validators regarding the E-Module. According to (Sugiyono, 2016) product validation can be done by inviting several experts or experienced experts to assess the newly designed product. Meanwhile, design validation is an activity process for assessing a particular product made by a researcher. In this research, the product being assessed is the E-Module for the colligative properties of the solution.

The student and teacher response questionnaire instrument is used to determine the opinions or assessments or responses of students and teachers regarding the practicality of the E-module which includes student responses to the E-module developed by researchers, in this case the E-Module, colligative properties of solutions during the learning process. taking place. When filling out the questionnaire regarding the E-Module, the colligative properties of solutions are done by selecting answers according to predetermined criteria.

Data analysis is the process of systematically searching and compiling data obtained from interviews, field notes, documentation, by organizing the data into categories, describing it into units, synthesizing it, and arranging it into patterns, sorting out which ones are important. studied and made conclusions so that they are easily understood by oneself and others (Sugiyono, 2016). Data obtained from the validator's assessment of the E-Module for colligative properties of solutions and the practicality of the E-Module for colligative properties of solutions from the responses of students and teachers were then analyzed using the following analysis.

Validator Assessment Data Analysis

Analysis of the validity of the E-Module development product for the colligative properties of the solution was carried out in terms of material, construction and language, content substance, learning design, display (visual communication) and *software utilization.* The analysis technique is carried out by calculating the percentage of people's assessments. The data used in this research, namely the scores resulting from expert review, were calculated on average to determine validity. The validation sheet uses an attitude measurement scale with a score of 1-4 in the form of *a checklist* (√). Alternative positive attitude statements are converted into scores using a four-choice *Likert scale* to obtain quantitative data, as in table 1. The purpose of choosing a four-choice *Likert scale* is to anticipate the selection of neutral points. Each score has certain assessment criteria, such as a rubric that will be attached.

Table 1. Likert scale for validation stage

Statement	Score
Agree	4
Simply Agree	3
Disagree	2
Don't agree	1

(Sugiyono, 2016)

The eligibility criteria for percentage analysis can be seen in Table 2.

Table 2. Eligibility criteria for percentage analysis

Percentage	Information
81.00 – 100	Very Good/ Very Valid/ Very Decent
61.00 – 80.00	Good/ Valid/ Appropriate
41.00 – 60.00	Good enough/Valid enough/Decent enough
21.00 – 40.00	Not Good/ Invalid/ Inadequate
<20.00	Not Good/ Invalid/ Not Eligible

(Riduwan, 2012)

User Rating Data Analysis

Teacher Response Analysis

Analysis of teacher responses uses a teacher response questionnaire which is measured based on a *Likert scale* in the form of *a checklist* (√). The answer to

each instrument item is in the form of an alternative positive attitude statement starting from very positive to very negative (Sugiyono, 2016). These alternative positive attitude statements were converted into scores using a four-choice *Likert scale* to obtain quantitative data, as in Table 3.

Table 3 Alternative scores for positive statements

Statement	Score
Agree	4
Simply Agree	3
Disagree	2
Don't agree	1

The eligibility criteria for percentage analysis can be seen in Table 4.

Table 4. Teacher response criteria

Percentage	Information
81.00 – 100	Very good
61.00 – 80.00	Good
41.00 – 60.00	Pretty good
21.00 – 40.00	Not good
<20.00	Not good

(Arikunto, 2016)

Analysis of Student Responses

Analysis of student responses uses a student response questionnaire which is measured using a *Likert scale* in the form of *a checklist* (√). The answer to each instrument item is in the form of an alternative positive attitude statement which has been determined to have a gradation from very positive to very negative (Sugiyono, 2016). These alternative positive attitude statements are converted into scores using a four-choice *Likert scale* , as in Table 5.

Table 5. Alternative scores for positive statements

Position Statement	Score
Agree	2
Don't agree	1

(Widoyoko, 2012)

The eligibility criteria for percentage analysis can be seen in Table 6.

Table 6. Criteria for student responses

Percentage	Information
81.00 – 100	Very good
61.00 – 80.00	Good
41.00 – 60.00	Pretty good
21.00 – 40.00	Not good
<20.00	Not good

(Yamasari, 2010)

Results and Discussion

Results

The teaching material developed is an electronic module on acid-base material. The e-module created has gone through the recommended instructional principles, starting from conducting an instructional analysis, syllabus, to becoming a teaching material. With the ease in using the teaching materials created, it shows a positive impact on teachers, namely that they will have more time to guide students in the learning process, help students to acquire new knowledge from various sources or references used in teaching materials, and the role of the teacher as one -the only source of knowledge is reduced. This teaching material is made in the form of a module for the concept of independent learning for students because in essence students have the ability to work independently and are more responsible for their actions. The following is a cover image of the e-module being developed.

Figure 2. E-Module cover page

This colligative properties material e-module is divided into 3 sub-lessons. In each sub-learning, students will be oriented to phenomena that will later be linked to learning. In its application, several phenomena that are integrated into this learning are as follows : Learning activity 1 about Solution concentration and decrease in vapor pressure of non-electrolyte solutions (An example of the phenomenon is the floating pool in the phenomenon orientation section); Learning activity 2 about Increase in boiling point and decrease in freezing point of non-electrolyte solutions (An example of the phenomenon is the difference in boiling point and making cut ice in the orientation of the phenomenon), and Learning activity 3 about Osmotic pressure of non-electrolyte solutions and colligative properties of electrolyte solutions (An example of a phenomenon is the use of intravenous fluids in the phenomenon orientation section)

In each learning activity, the module contains phenomena related to the material discussed to train

students' critical abilities. In this section, space is given to discuss in groups and share opinions to improve students' collaboration and communication skills. At the end of the module, exercises are created to train students' HOTs skills. The module closes with conclusions and evaluation questions to test students' HOTs abilities.

Validity of E-Module

Table 7. E-Module Validation Results for Solution Colligative Properties

Assessment Aspects	Score Percentage by Validator (%)
Content Eligibility	100
Characteristics of *Phenomenon Based Learning*	90
Serving	100
Grammar	100
Graphics	100
Display (Visual Communication)	91.67
Utilization of *Software*	95
Average Percentage Score	96.67
Validity Criteria	Very Valid

Assessment of the suitability aspect of the e-module content based on phenomenon based learning using the articulate storyline application on the colligative properties of solutions material for class material, suitability to the substance of the material, suitability to the needs of students and its usefulness. The average percentage obtained from validating the content feasibility aspect is 100%, with very valid criteria.

The assessment of the characteristic aspects of phenomenon based learning includes five indicators, namely orienting the phenomenon to students, organizing students to learn, individual or group investigation, presenting the results of investigating phenomena and analyzing and evaluating phenomena. The average percentage result for this aspect is 90% with very valid criteria. The presentation aspect assessment includes five indicators containing six statements to assess clarity, completeness, use of motivation, use of communicative aspects in the presentation of e-modules. The validation percentage result is 100% with very valid criteria. The grammatical aspect assessment includes two indicators containing five statements to assess the accuracy and correctness of grammar in the e-module. The average validation result is 100% with very valid criteria.

The graphic aspect assessment includes two indicators containing five statements to assess the suitability of the typography and design in the e-module. The average percentage result is 100% with very valid criteria. The appearance aspect assessment includes seven indicators that assess navigation buttons, typography, images, colors, videos, cover pages and layout on the e-module. The average percentage result is 91.67%, with very valid criteria. The assessment of software utilization aspects includes two indicators which include interactivity and supporting software in e-modules. The average percentage result is 95%, with very valid criteria. The average percentage of all validated aspects has a P score > 84% with very valid criteria so that trials can be carried out.

Teacher Response

The teacher response test was carried out with the aim of finding out the suitability of the e-module for the learning carried out by the teacher. The teacher provides responses according to the questionnaire which contains aspects of the appropriateness of the content, aspects of the characteristics of the *Phenomenon Based Learning model*, practical aspects and also aspects of appearance which are outlined in 23 statements with 5 aspects consisting of 16 indicators. The results of the teacher's responses are shown in the table 8.

Table 8. Teacher Response Questionnaire Results

Assessment Aspects	Average Percentage Per Indicator (%)
Content Eligibility	100
Characteristics of *Phenomenon Based Learning*	87.5
Ease of Use	100
Benefits of Use	100
Presentation Attractiveness	98.44
Total Presentation Average	97.188
Response Criteria	Very good

The use of e-modules based on phenomenon based learning using the articulate storyline application on the material on colligative properties of solutions for class XII SMA/MA equivalent benefits teachers because it can streamline learning time. According to the teacher at SMAN 1 Pekanbaru, the e-module developed has fulfilled all aspects and is proven by the response results of 97.188% with very good criteria.

Student Trial

One-on-one trial

The one-on-one test involved 3 class XII students at SMAN 1 Pekanbaru. Selection is based on differences in student abilities with the help of teachers who of course know the level of ability of the students. The implementation of this stage aims to identify errors/weaknesses/shortcomings of e-modules and opinions about e-modules when implemented in the learning process when used by students. The results of this one-on-one trial are in line with the validation results in the aspects of appropriateness of content,

presentation and use of the software. Students feel that using this e-module is very easy and also contains complete material on the colligative properties of solutions. In this test, students gave the opinion that this e-module was able to make learning easier for students because it contained complete material and added videos and animations. Students also suggest adding information about relative molecular masses to the questions so that they don't get confused when working.

Student Response

Table 9. Results of Student Response Questionnaire

Assessment Aspects	Average Percentage (%)
Ease of Use	100
Benefits of Use	100
Presentation Attractiveness	98
Average Total Percentage	99.44
Response Criteria	Very good

Small group trials were carried out on 20 students on the e-module which contained 15 statements with 3 aspects consisting of 8 indicators. Based on data processing from the student response questionnaire, the average student response score for all aspects was 99.44%. Referring to the validation criteria in table 5 with a P score > 84% with very good criteria.

Discussion

Based on the research results, it is known that the e-module based on phenomenon based learning using the articulate storyline application on the material on the colligative properties of solutions for class XII SMA/MA equivalent is suitable for use as teaching material. E-modules have been developed and can be accessed by teachers and students via links developed by the developer. The use of e-modules can be done outside school hours using a smartphone or laptop.

Material expert validation consists of 5 aspects, namely content appropriateness, PhBL characteristics, presentation, grammar and graphics. After going through the first validation stage, then revise it until you reach the second validation. Aspects of the material in this e-module have entered the very valid category and can be continued at the next stage. Meanwhile, media validation consists of 2 aspects, namely display and use of software. In the validation results, especially in the appearance aspect, there was a significant improvement due to the revisions that had been carried out. Revisions related to videos, font use, and even buttons on the e-module have been carried out and resulted in getting a better score.

A development product is said to be valid if the product has been validated and received a very valid category. Direktorat Pembinaan SMA (2017) explains that the criteria assessed by experts in developing teaching materials include the components of appropriateness of content, presentation and language which must be valid before being used in the next test. This is in accordance with the opinion of Akbar (2013) and Widyaningsih (2014) who state that validation testing is an effort to produce good and relevant teaching materials based on the theoretical basis of development and ensure whether or not the teaching materials are suitable for use in the learning process.

The feasibility aspect of the e-module content has 100% validity with a very valid category. This means that the e-module material is in accordance with the applicable curriculum and in accordance with the demands of Core Competencies (KI) and Basic Competencies (KD) which are described as learning indicators. Suitability of teaching materials with the curriculum will make it easier for students to learn (Weng et al., 2019). Valid criteria for the suitability of content in e-modules also indicate the correctness of the substance in good e-modules (Aprilia & Suryadarma, 2020). Substantial truth is needed so that there are no misconceptions and understanding errors for students (Buchori & Rahmawati, 2017). The e-module also has topics that are in accordance with the curriculum, the e-module is also supported by learning videos that can help students in learning. The suitability of the learning topics presented has a big impact on students' knowledge. If the topic presented is appropriate, students can avoid misconceptions (Pratiwi et al., 2023).

The characteristic aspects of the PhBL e-module have a validity of 90% with a very valid category. This means that the e-module material is in accordance with the syntax of Phenomenon Based Learning. Valid criteria for this aspect also show that this e-module is able to make students active in developing new concepts, understanding and insight based on the facts obtained. The implication of increasing these skills is that the process of changing students' concepts from wrong to right becomes smooth. This is in line with David Ausubel's theory that learning will occur effectively through real experiences related to everyday life phenomena (Bektiarso et al., 2023).

The presentation aspect has a validity of 100% with a very valid category. This means that the e-module material is in accordance with the characteristics of the e-module itself, namely self-instruction and also means that the e-module presentation components contain clear indicators and learning objectives. The material in the e-module is also presented in full according to the sequence of indicators developed. Clarity of indicators and learning objectives will help students so that

students' learning becomes focused (Imansari & Sunaryantiningsih, 2017).

The grammatical aspect has a validity of 100% with a very valid category. The linguistic aspect is related to the use of clear sentences so that they do not cause confusion and are easy for students to understand (Ningsih & Mahyuddin, 2021). Based on the validity value from the linguistic aspect, it shows that this e-module uses good and correct Indonesian. Good and correct language presented in the E-module will make it easier for students to learn (Afriyanti et al., 2021). Based on the validity questionnaire regarding the presentation aspect, it was revealed that the e-module met valid criteria.

The graphic aspect has a validity of 100% with a very valid category. This shows that the design of the e-module that has been developed is good and attractive, including the type and size of letters used, a layout that attracts students' attention to use it, providing picture illustrations that match the material and the material is presented in clear writing and letters. (Astra et al., 2020). Giving various colors to e-modules aims to increase students' attention, motivation and interest in learning (Lestari & Parmiti, 2020).

The display aspect has a validity of 91.67% with a very valid category. This shows that the e-module is easy to access and has good quality images, videos and animations. This ease of access will help students use e-modules during learning. Each explanation of the material in the e-module has been given an image to clarify the material discussed, apart from that, this easy access can make it easier for students to use the e-module anywhere and anytime (Istyadji et al., 2022).

The software utilization aspect has a validity of 95% with a very valid category. This shows that the e-module has a good response to users and makes it easy to find information in the e-module. This will help students use e-modules during learning.

A development product is said to be practical if the product is easy for students or educators to carry out and is richer than textbooks. Practical testing focuses on data about students' abilities to confirm the success of improving product results before field testing. This was confirmed by Ibrahim & Subali (2017) that the practicality of development products can be obtained by observing whether the book users experience difficulties in using the product. To find out the practicality of this, one-on-one trials and user response tests were carried out.

The teacher's response contains 23 statements with 5 aspects consisting of 16 indicators. These indicators include, suitability of material to basic competencies (KD), learning objectives, competency achievement indicators, application of PhBL, ease of use, practicality, increasing knowledge, motivation, clarity, attractiveness, accuracy, and communicativeness. The teacher comments on adding concentration questions to the evaluation section and adding motivational words to the phenomenon orientation section. The results of the teacher response test were very positive and in line with the validation results in the aspects of appropriateness of content, PhBL characteristics, presentation, grammar and graphics. According to the teacher at SMAN 1 Pekanbaru, the e-module developed has fulfilled all aspects and is proven by the response results of 97.188%. Respondents also thought that this e-module would help students and teachers during learning.

The student response test was carried out on 20 students from class XII of SMAN 1 Pekanbaru. The student response questionnaire contains 15 statements with 3 aspects composed of 8 indicators. These indicators include, making it easier for users, practicality, helping the learning process, motivating, clarity, attractiveness, communicativeness, and accuracy. The results of the student response test were very positive and in line with the validation results on the appearance and use of the software. According to respondents who are students of SMAN 1 Pekanbaru, the e-module developed is very easy to use and also very interesting. The color display and use of images, videos and animations are very good and attract students' attention. This is supported by the student response value of 99.44%.

The average user response to using the e-module is very high, illustrating that the e-module on colligative properties of solutions is very practical to use as teaching material in class. Apart from that, this shows that students are able to learn to use e-modules independently without supervision from teachers or developers.

The validity and practicality of this e-module product is important before the product is used to measure its effectiveness. Research is limited to the small group trial stage. This is because the aim of this research is only to develop and determine user responses to e-modules based on phenomenon based learning using the articulate storyline application on the topic of colligative properties of valid solutions. The final product can be continued to be implemented on a wider scale with further research.

Based on the research results, it can be said that e-modules are learning resources in the form of teaching materials and learning media that are effectively used in various learning processes because they have a positive impact on students' learning outcomes in improving mastery of 21st century skills. The integration of phenomena in the modules developed is able to improve skills. 21st century that students have. 4C skills can be

improved through each syntax in the pheno bl learning model . The improved skills can be described in table 10.

Table 10. 21st century skills that can be improved from each Phenobl syntax

Phenobl syntax and activities	Developed 21st Century Skills
Orienting students to a real phenomenon related to the subject matter	Improve critical and creative thinking skills
Organizing student learning	Improve critical thinking skills
group investigation	Improve collaboration and communicative skills
Presenting the results of investigating phenomena	Improve collaboration and communicative skills
Analyze and evaluate phenomena	Improve critical and creative thinking skills
Evaluate questions	Improve critical thinking skills

Phenomenon based learning is transdisciplinary, collaborative, exploratory and student-centered, giving rise to a learning environment based on problem solving, where the teacher will pose a phenomenon-based problem and ask students to find answers to this phenomenon. Phenomenon-based learning supports learning according to several advanced and innovative educational ideas, such as projects and portfolios. This will encourage student interest and motivation because learning is created using the inquiry process to improve students' 21st century skills. PhenoBL is designed to ensure that students are not only the center of the learning process, but also that students have a sense of responsibility for the learning they receive (Adipat, 2023). Phenomenon-based learning also encourages independent learning. Effective independent learning will enable students to acquire new skills that can be used in real world situations (van Laar et al., 2019).

Phenomenon-based learning is proven to improve 21st century abilities, in accordance with findings made by (De Klerk et al., 2022) which states that by having a discussion phase to find answers to these phenomena, students will consciously create a scope for them to discuss and collaborate in accordance with socio-constructivist and sociocultural learning theories.

The use of electronic-based teaching materials has been proven to be able to improve 21st century skills, especially critical thinking skills. The learning model used must support and integrate artificial intelligence and technology to reduce the negative impacts of online learning (González-pérez & Ramírez-montoya, 2022). This is supported by the results of research by (Taqiyyah et al., 2023) which states that students are more interested in learning using electronic-based teaching materials so that they have the potential to increase students' motivation and interest. Apart from that, the application of the phenomenon based learning model in learning also provides opportunities for students to experience more active learning and be directly involved in the process of understanding the material (Kadarisman et al., 2023). Learning that is created actively and interactively will increase students' motivation and involvement in the learning process (Daryanes et al., 2023).

The use of interactive multimedia also helps meet learning standards. Where the learning objective is to train students to think creatively and critically, while improving metacognitive and collaboration skills in solving given problems (Addriani et al., 2023). This is in accordance with research conducted by (Lestarani et al., 2023) which states that the use of learning media developed with an articulate storyline has a positive and good impact on learning.

The use of learning media based on phenomenon based learning is supported by research by (Bachri et al., 2023) who suggests that the use of this model is able to involve students in learning because in its application it is able to attract students' attention in solving problems. Apart from that, the application of learning concepts, especially science learning, can improve critical thinking skills because in-depth thinking is required in solving the problems given. Using interactive learning media can help students develop independence within themselves.

Conclusion

The E-Module developed has been declared valid by material expert validators and media experts with a presentation of 96.667% with very valid criteria. The results of the one-on-one trial activity showed that using this e-module was very easy and also contained complete material on the colligative properties of solutions. In this test, students gave the opinion that this e-module was able to make learning easier for students because it contained complete material and added videos and animations. The small group trial is intended to determine the responses of teachers and participants in terms of the appropriateness of the content, characteristics of Phenomenon Based Learning, ease of use, benefits of use, and attractiveness of presentation. This is supported by students' responses that phenomenon-based learning e-modules are considered very good in terms of ease of use, benefits of use and attractiveness of presentation.

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Conceptualization: Abdullah and Herdini, data curation: Tiara Swastika Putri, funding acquisition: Herdini, methodology: Abdullah, Herdini, Tiara Swastika Putri, writing–original draft: Tiara Swastika Putri, writing–review & editing: Tiara Swastika Putri

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Conflict of Interests
The authors declare no conflict of interest.

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