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Problem-Based Learning-Based E-Module to Enhance Problem-Solving Skills about Pressure Topics: A Preliminary Development

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ABSTRACT

This study aims to develop an e-module based on problem-based learning to increase students' problem-solving skills regarding material pressure and its application in everyday life. The subject of this research is an 8th-grade student at a junior high school in Bojonegoro. As for the research, the R&D process is 4-D. This is limited only to the 3D phase, namely, until the module's validity. The e-module was validated by four validators: one expert in learning, one in language, one in materials, and one in media. Results validation will be analyzed using a presentation of the results of 4 expert validators. The results from validation by the four validators conclude that the e-module developed its own score (89.4%), which is included in the very valid category. Shows e-module-based problem-based learning on material pressure and its application in daily life. An e-module can be used in science instruction to improve students' problem-solving skills.

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INTRODUCTION

Knowledge of natural sciences is a body of knowledge closely connected to the natural universe (Lestari et al., 2021). In the learning process, science involves observation, followed by scientific discussion until a conclusion is reached (Ramadhani, 2020). Through observation, science learning is expected to enhance students' problem-solving skills. Because the process involves observing and analyzing a phenomenon or problem (Oktaviani & Tari, 2018). In addition, science learning has several objectives, including increasing students' skills in critical thinking, creativity, and problem-solving. However, the reality of science learning often falls short of expected goals. Based on that. The results of the 2018 PISA (Program for International Student Assessment) for students in Indonesia showed that, on average, they only understood explanations, recognized phenomena, and sought the truth about phenomena. This condition is consistent with the explanation by Oktadaviani and Tari (2018), who state that science learning has not achieved the goal of increasing problem-solving skills because this student is still focused on values rather than the learning process (Trihastuti et al., 2019).

Problem-solving skills are one of the soft skills students must possess to compete in the digital era (Rocha et al., 2023). The problem-solving skills that students possess are useful for their daily lives, such as critical, logical, analytical, and creative thinking to face all forms of problems that they will face in the future (Bag & Gürsoy, 2021). Even based on the World Economic Forum (WEF) 2020 report, problem-solving skills become the first order of competencies that must be owned to compete in the future world of work.

However, the reality is skills solution problems with students in Indonesia still exist, including in the low category. This is proven in the report Programme for International Student Assessment (PISA), which states students in Indonesia have skills solution problems that are classified as low compared to other member countries; that is, they are 64th out of 72 countries, which is the result. This is still below the average of the Organization for Economic Co-operation and Development (OECD), namely 493 (OECD, 2019). The Trends in International Mathematics and Science Study (TIMSS) states that students in Indonesia have low ability in reasoning, analysis, and problem-solving skills (Sucipto, 2017). The second results report provides evidence that the implementation of innovative strategies must continue to be developed to increase students' problem-solving skills, especially in science. The level of problem-solving skills among students in Indonesia is still low: students already understand the problems provided, but when solving them, they still have difficulty and need further guidance (Kurniawan et al., 2025).

The problem-solving skills can be trained by applying the appropriate learning model that is appropriate for the indicator solution problem so that this allows students, in a way, to actively train their skills and achieve their learning goals (Nurhidayati et al., 2018). Problem-based learning (PBL) is a learning model whose characteristics have been proven to train problem-solving skills in students (Suharlan et al., 2023). In general, specific PBL models provide a framework that effectively trains problem-solving skills, which are essential for students to succeed in science learning (Yuliani et al., 2025). Integration of the PBL model for training skills: problem-solving; students are expected to be able to guide students in the process of skill improvement, especially in science learning.

The scientific concept that often leads to misconceptions among students is pressure and its application in everyday life (Idayanti et al., 2019). The results of the study and other studies show that students are only capable of answering questions related to pressure substances, liquids, or hydrostatics not enough (50%), and understanding of student-related main discussion static fluid is still classified as low, and in some part there is an error draft or misconceptions about the material pressure (Adisna et al., 2020; Prastiwi & Nurita, 2018). The learning process is also one of the reasons for students' limited understanding of the material, as a teacher-centered, material-focused approach dominates it. Most of the theories and formulas are solely focused, so most students are passive, and there is no activity-based discussion that can train problem-solving skills (Anggreiny & Ramadhani, 2025). Interactive election teaching materials can be the solution to overcoming the problem of material pressure in the learning process. Application development technology in the world of learning moments. This has already become a required thing for supporting educational progress. One of the technologies in ongoing education that is developing rapidly is the presentation of teaching materials digitally, namely e-modules.

E-module is something structured with teaching materials in a systematic way that can be used for learning in an independent, complete, and easy-to-use way, as well as containing material that is easy to learn and understand (Herzegovina et al., 2023). Characteristics of interactive and communicative e-modules have proven capable of helping students in the learning process (Prastyaningrum & Handhika, 2017); if the e-module is equipped with various features like images, animations, and videos, it will increase motivation in students (Kimianti & Prasetyo, 2019; Pramana et al., 2020). Problem-based learning implemented in e-module teaching materials has been proven to improve students' problem-solving skills by 0.63, from the low to the high category (Asih et al., 2022).

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However, the use of e-modules in learning is still not evenly distributed across schools, especially at the junior high school level. Al-Fatimah Plus Junior High School, Bojonegoro, is one of the schools that has not applied a full e-module in learning. Based on the analysis, the initial implementation will focus on teaching materials that are still widely used, such as module printouts, book packages, and a teacher-compiled summary. This impact on skills that students do not have can be distributed effectively. Jack Ma (Dewi, 2019) states that if education only emphasizes results and overlooks skills, the generation produced is not capable of competing with machines or technology at this moment. Even now, this innovative technology continues to develop rapidly across various fields, including education.

Based on the problem and the description above, the objectives of the research are to increase problem-solving skills among junior high school students by implementing e-modules based on material pressure and its application in everyday life. Benefits obtained from the implementation of this PBL e-module: besides training students in problem-solving skills, this PBL e-module can also become a reference as a source of additional teaching materials for students and teachers, as well as provide material evaluation for schools with knowledge of the problem-solving skills of participants. His students will use PBL e-modules on material pressure and its application in daily life. This own characteristic is typical, including the e-module interactive activities inside it arranged in a special way. For training skills in problem-solving for students, and this PBL e-module. Applicable because it is designed in a way that is interesting and easy for users. This study aims to determine the level of validation of e-modules based on problem-based learning on the concept of pressure and its application in everyday life.

RESEARCH METHOD

Study this applied type of research and development approach. For the design research, 3D was used, adapted from 4D design research, as shown in the flowchart below. The following is a 4D research flowchart.

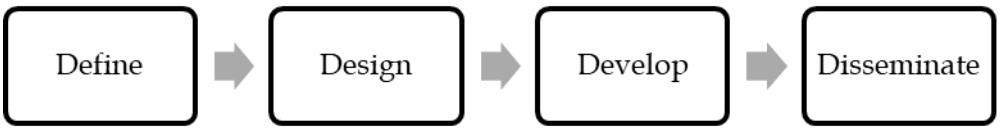

Figure 1. 4D Research Flowchart (Thiagaraja, 1974).

Participants used for analysis were students in Class VIII of Junior High School in Bojonegoro, with a sample of 64 students. During e-module development, data were collected quantitatively using the e-module validation method. Quantitative data obtained from the results assessment of 4 lecturers, experts consisting of expert learning, expert language, expert material, and media experts. Meanwhile, applied data analysis in the study. This is the presentation of the results from the validity of 4 expert validators in each field that applies the Likert scale. The results were further calculated and interpreted according to the criteria listed below.

Table 1. Criteria determination of validity level (Hikmah et al., 2021)

Range (%) 0-20	Criteria Invalid
20-40	Less valid
40-60	Quite valid
60-80	Valid
80-100	Very valid

RESULTS AND DISCUSSION

Define

Stage definition: This started with analyzing the related 2013 curriculum, material pressure, and its application in basic competency. 3.8: Explaining the pressure of substances and its application in everyday life, including blood pressure, osmosis, and capillary transport in plants. and basic competency 4.8. Presenting experimental data to investigate the pressure of liquids at a certain depth, buoyancy, and capillarity, for example, in plant stems, which explains how pressure is applied daily in life, such as blood pressure, osmosis, and the transport system in plants. Concept pressure and its application in daily life are one of the integrated science concepts that connect draft physics to draft biology. Next is the definition process, to be continued with analysis of beginning-level skills, solution problems, and student pressure on the material.

As for the results of the analysis, the first is that the student still has low problem-solving skills, especially under material pressure. Based on interviews with science teachers and students involved, the cause is a lack of motivation for student study, as well as a lack of source materials in the form of book texts and physical materials on theory, without any training activities, skills, solutions, or problems for students. This is in accordance with the study, which shows that students of Buduran 2 Junior High School have low problem-solving skills involving the concept of pressure, as evidenced by test question solutions that yield still low scores. A monotonous text without activities is one of the problems identified; technology, as a means of implementation, is expected to be capable of overcoming these problems in schools.

The implementation of technology for source Study in line with 21st-century learning must optimize technology across all aspects of life, including education. One of the integration technologies in education is to integrate it into later modules, as interactive e-modules are created (Puspitasari, 2019). The e-modules developed in research will include features such as images, videos, animations, and interactive activities to train students' problem-solving skills. E- modules that will be developed, integrated with learning models based on the problem-based learning (PBL) model. This specifically in learning physics can increase skills solution problem, from the problem scenario presented during learning capable of motivating student for discuss, analyze problem as well as bring up hypothesis in finish the problems provided (Putra & Y., 2021; Savery, 2006).

Design

The design stage begins with compiling e-modules, that is, their contents. Overall, it began with activities and tasks, and the e-module's activities were tailored to the PBL learning model's syntax. The integration of e-modules and PBL models can train students to solve problems. Research shows that PBL e-module results contribute to increased student motivation and the development of students' problem-solving skills (Hadi & Novaliyosi, 2019; Riau, 2022).

In a way, the general e-module consists of three components: an introduction, which includes a cover, and a central section, which contains an e-module title and short icons to help students use the e-module, as shown in the figure below (figures 2 and 3). Instructions for operating the e-module are also included. This is what is arranged: use an image for users. Good, is it a teacher or a student, it's easy to understand. Basic competency and indicators, as well as map concepts, are also available in the e-module. Things. It is hoped that users, that is, specifically students, can more easily understand the objective learning from draft pressure.

Part two is the core, comprising a come-on study with four subchapters, a draft deep-pressure presentation, and material customized using PBL syntax. The integration of PBL and modules is straightforward in the section, which begins every introductory activity with a problem presented as a picture or a short video, as expected, thereby motivating students to study. At every activity, learning provides feature activities in the form of practical work lights that can become receptacles for students to train skills and solve problems. The final core part is

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the grain question evaluation for each activity. Part three of the e-module is a part-cover containing a brief biography of the author, a glossary, and a bibliography.

Figure 2. Cover of the e-module

Figure 3. Main icon of the e-module

Figure 4. Activities learning e-module

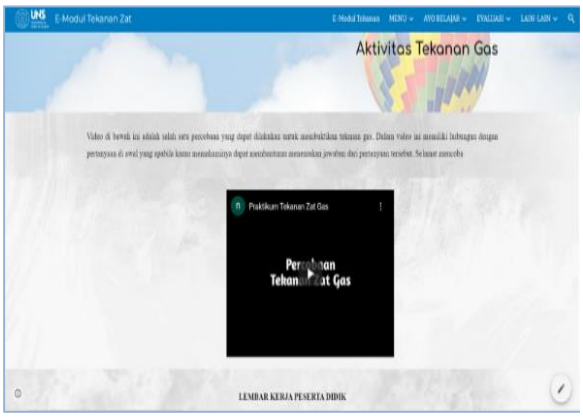

Figure 5. Video in e-module

As for the characteristics that distinguish this PBL e-module from other e-modules, the other is that this e-module contains interactive content with activities and in-depth questions. Its composition customized with indicator skills problem according to Polya (1957) which consists of from define problem, planning settlement problem, execute problems, and evaluate problem (Herak, 2010). Training skills solution problem provided by students in the e-module. This is done in two ways: implementing PBL syntax in every e-module learning activity, and preparing activities and questions in accordance with the indicator in the training skills solution problems for students. Every syntax of problem-based learning is designed to help and develop critical analysis and problem-solving skills in students (Rehman et al., 2024)

Developmen

Study development: this teaching material produces e-modules based on problem-based learning on material pressure and its application in daily life, which are valid and applicable. As for the results, their validity has been demonstrated through analyses by several expert lecturers in both qualitative and quantitative research.

1. Validity of Learning Expert

   The preparation of PBL e-modules is not to be left to device learning. In conclusion, device learning must still consider integration between 4C capabilities, one of which is solving skills problems (Kemendikbud, 2017). One of them is a type of device; his learning is a lesson plan with results validation presented in the table below.

Table 2. Results of e-module validations based on aspect learning

Aspect	Indicator Evaluation	Item Evaluation	Evaluation (1-5)
A. Learning content	Learning methods	Selected indicators in accordance with KI and KD	5
		Presentation material and questions evaluation explained from the substances contained in KI and KD	5
	Learning objectives	Compliance indicator with the level of development of the student	5
	Steps learning	Presentation material-based *PBL* can increase the ability of students to solve problems student	5
		Composition activities in *PBL* direct students to increase their problem-solving ability and solve problems	5
	Compliance learning	Clarity of objective in learning	4
B. Learning strategies	Convenience learning	Compliance with the *PBL* of the material studied	5
	Accuracy learning	The material presented is easy to understand	4
		Material presented in accordance with the development of science and technology	5
		Use of the *PBL* model makes students more independent	4
		Tasks/activities exercise students in accordance with the formulation indicator	5
		Tasks/activities exercise students in accordance with the material presented	5
		The composition sentence from the tasks/activities exercise makes it easy for the students to understand	4
		Increase the knowledge of students about the material presented	5
C. Evaluation	Effectiveness learning	Availability module-based *PBL* can increase the ability of students to solve problems student	5
		Average value (%)	**94.67**

As for the learning planner that has been developed, the details used as references in the e-module have validity tests, and the expert learning was conducted based on the table above, which shows an average value of 94.67%, which falls within the very valid criteria. Plan learning that has been developed using the format in the 2013 curriculum and adapted with step-by-step learning-based problems. The learning planner was created during 4 appropriate meetings, with extensive material and existing pressure in the e-module. Implementation learning consists of three stages: introduction, core activities, and closing. In this section, the activity introduction presents an issue or phenomenon related to material pressure, which students find lighter. Later, students are expected to submit questions about this phenomenon. Some existing phenomena in every activity introduction to the e-module are characteristics of the learning model based on the problem, constructivism, in which students are, in a way, active and independent in building their knowledge alone during the

learning process, which can train problem-solving skills in students (Wahyudiana et al., 2021).

According to (Misbah et al., 2018) learning physics can be accepted by students when the material to be discussed is directly related to a frequent phenomenon they encounter in their daily lives. In a way, no direct phenomena are presented. Good in form: picture or video in every activity introduction. Make students who have no direct, own-related experiences with the material active subjects in the learning process, which will be studied in e-modules for further analysis and discussion in the following activities.

2. Validity of Linguists Expert

Development of e-modules that contain materials, activities, and some tasks, which students cannot separate from the role of the language used. Therefore, the existing languages in the e-module must be appropriate languages and have been tested by a language validation expert.

Table 3. Results of e-module validation on aspect linguists

Indicator Evaluation	Item Evaluation	Evaluation (1-5)
A. Straightforward	Accuracy structure sentence	5
	Effectiveness sentence	4
	Standardization term	5
B. Communicative	Understanding the message or information	5
C. Dialogic and Interactive	Ability to motivate participants to educate	5
D. Compliance with Development Learners	Compliance with the development of intellectual participants educates	5
	Compliance with the level of development of emotionally intelligent participants educates	5
E. Compliance with Language Rules	Grammatical correctness	4
	Accuracy spelling	4
	Average value (%)	**93,3**

Aspect Language in e-module. This covers some rules: proper grammar and spelling, with correct rules; the language used must be easy to understand, with no multiple interpretations; and terms, signs, and formulas must be proper physics. Based on the table above, it can be known that the language used in the e-module is very valid with the criteria value reached (93.33%).

Use language in the e-module. This, besides, must be language customized with the rules, and it must also be communicative. The meaning of 'communicative' here is the use of appropriate language with the function of communication so that e-module expectations are easy for students to understand (Yastini et al., 2018). In addition, use communicative language, expect the student to be capable, and invite the student as if you were currently communicating with the compiler so that the student becomes more enthusiastic in the learning process (Turnbull et al., 2009).

3. Validity of Material Expert

An e-module is one of the learning media that applies digitalization in education. In the development of learning media, it must be in accordance with the competence base as well as the intended learning objectives (Asri & Kusumawati, 2022). This aims to ensure that learning is meaningful and valuable for students (Siagian & Yasthophi, 2021). As for the competency-based and objectives-based learning in the e-module, the material to be tested and its validity will be assessed by the validator.

Table 4. Results of e-module validation on material expert

Indicator Evaluation	Item Evaluation	Evaluation (1-5)
Aspect Introduction	Explicit instruction on the use of the e-module learning	4
	Clarity steps in preparation for learning	5
	The accurate application of learning strategies	4
	Completeness component introduction	4
Aspect Learning	Compliance competence basis and indicators	5
	Compliance competence based on material	5
	Compliance standard competence graduate with competence base	4
	Clarity title from e-module	4
	Clarity target users	5
	Variation delivery type information	4
	Accuracy in the theoretical explanation material	4
	Accuracy in the explanation of the material, practical	4
	Engaging and motivating material users	4
Content Aspect	Scope (breadth and depth) of content material	4
	Collapse material	5
	Factualization content material	4
	Actualization content material	4
	Accuracy examples are included in the material	5
	Attraction motivating material users	4
Aspect Evaluation or Evaluation	Clarity instruction	4
	Sequence questions presented quality evaluation	4
	Difficulty level question	4
	Compliance evaluation with competence-based	5
	Balance proportion evaluation with content material	5
	Clarity evaluation of the given problem	4
Summary Aspects	Clarity summary module	4
	Accuracy reflection module as material repetition	4
	Benefits of a summary as a material understanding draft	4
	Glossary/list of terms	5
	Bibliography	4
	Average value (%)	**86**

On eligibility material covering introduction, competency basis and indicators, content/coverage material, evaluation, and end-of-semester instrumental meetings in honing skills to solve problem students. Based on the table above, the material in the e-module is highly valid, with a mark of 86%. This proves that the e-module material, PBL-based, has met the standard eligibility criteria for content/material.

As for suitability, the material in the e-module aligns with the competency basics according to the curriculum, includes variations in subtopics, provides suitability descriptions, and features good examples of real material (Ummah, 2021). In addition, suitability: the material is also based on competencies and learning objectives in every meeting, material pressure, and its application in daily life.

4. Validity of Media Expert

Attractive design in e-module development is a critical consideration. This is because an appealing design can motivate students in the learning process (Nurdiana et al., 2021). E-module development: This uses Google Sites, which offers various interesting features that can motivate students during the learning activity. Media validation is necessary to ensure the e-module has an attractive design and appropriate content. As for the recapitulation results, media validation is stated in the table below.

Table 5. Results of e-module validations based on media aspects

Aspect	Indicator Evaluation	Item Evaluation	Evaluation (1-5)
E-Module View	Cover	Appearance layout elements on the cover in a way harmonious with its own rhythm and unity, as well as consistent	4
		The letters are in an engaging and easy-to-read	4
		Illustration cover module describes content/teaching materials and expresses a character object	4
	List of contents	The list of contents loads the module outline in a complete way	4
	Glossary	A glossary explains the meaning of every difficult term	4
Introduction	Competencies and competency-based	There are core competencies and competencies based on the e-module	4
	Indicator achievement competence	There is an indicator of achievement competence in the e-module	5
	Motivation/apperception	There is apperception in the e-module	4
	Instruction on the use of e-modules	Instruction in the e-module is easily understood	4
	Learning objectives	There is objective learning in the module	4
Activity Learning Material Description	Fonts and layout title chapter	There are fonts and layouts for the title chapter in the module	4
	Subtitle font and layout of the chapter	There are fonts and subtitle layouts in the chapter in the e-module	4
	Font and text layout in a paragraph	There are fonts and text layouts inside a paragraph in the module	5
	Layout text special / symbol	There is a layout text special / symbol in the e-module	4
	Layout and quality of the picture	There is a layout and quality picture in the e-module	5
	Video layout and quality	There is a layout and quality video in the module	4
	Collapse material learning	There is a collapse of material learning in e-modules	4
	Depth content learning	There is in-depth content learning in e-modules	4
	Layout knob navigation	There is a layout knob navigation in e-modules	4
	Summary	There is a summary in the e-module	4
	Assignments and sheets for the work student	There are assignments and sheets for work in e-modules	4
Evaluation	Exercises	There is an exercise question in the e-module	5
		Average value (%)	**94.67**

Validation results from media experts indicated that this PBL-integrated e-module is already highly valid, with an average validity of 83.6%. The developed e-module integrates with the indicator ability solution problem according to Polya in (Herak, 2010), which includes (1) defining the problem, (2) planning the settlement problem, (3) execution problem, and (4) evaluation problem. According to (Maulita et al., 2023) The e-module must have an attractive appearance to increase students' motivation to learn. The e-module developed this way, in addition to its gorgeous display, also features an interactive design.

The existence of interactive e-modules. This own excess can be accessed when only improving students' understanding, due to its attractive and responsive form, which automatically responds to stimuli in the form of pictures or videos given to students (Kusrini & Haryanto, 2019). Each e-module validator, in every aspect, not only provides an evaluation but also provides scoring and suggestions that can be used as references for e-module improvements to become worthy and fulfill the standard for use in learning. The validator's recommendations are summarized in the table below.

Table 6. Summary of suggestions from multiple validators

Validator	Suggestion	Repair
Learning Expert	Repair objective learning in RPP	Learning objectives are already aligned with the validator's directions.
	Verb operational on indicators and objectives learning repaired	Composing sentences in the section indicators and objectives learning is already arranged with operational sentences
	Notice the return of every component in activity learning in RPP	Reassemble the component activity lesson plan learning according to validator instructions, consisting of the above: approach scientific, syntax *PBL*, and teacher and student activities
	Pay attention to the rubric format question for evaluation, *pretest,* and posttest.	Rearrange the format in the rubric, more questions are simple and easy to understand
Linguist	Notice the return error spelling of words	Correcting repeated and spelling errors
	The notice sign read according to PUEBI and KBBI	Correcting repeated and repair error signs accordingly to the rules
Subject Matter Expert	E- module title *PBL* written its length and enlarged	E- module title on page beginning already enlarged and given abbreviation from *PBL*
	To clarify the instruction e-module operation	Instructions for the e-module operation have already become more precise and detailed.
	Make map concepts in e-modules.	Give the map a straightforward concept that is understood in the e-module
	Make a clear summary of each sub-chapter	Give a clear summary of each sub-chapter in the e-module
Media Expert	More written forms are firm, especially on the title and chapter	Change the text to clearer and firmer in the title and chapter of the e-module
	Pay attention to the return form writing in accordance with the rules, Subject, Predicate, Object, and Description (SPOD)	Correcting repeated and repairing writing sentences in the appropriate e-module rules
	Notice every letter and writing so that more focus is on the meaning of the substantive.	Correcting repeated words and repairing the sentence structure makes it easier to understand and focus on the meaning.

Some suggestions from the validator will be used in e-module repair: good from the perspective of learning, language used, materials applied, and graphics and display in the e-module. In its function as e-module teaching materials, this can help increase problem-solving skills. Because it has an integrated learning model based on proven problems, it can help improve problem-solving skills. There is PBL integration in e-modules. This is reflected

in channel learning, e-module display, compilation of material, and discussions and assignments outlined in e-modules.

CONCLUSION

This research shows that the development of an e-module-based problem-based learning module on material pressure and its application in daily life is deemed highly valid and worthwhile. As for the aspects, learning has very valid criteria (94.67%), language has very valid criteria (93.33%), material has very valid criteria (86%), and media aspects/e-module design has very valid criteria (83.6%). The overall element, including valid criteria. The results show that e-module-based problem-based learning is effective for improving problem-solving ability among junior high school students. Educators can use the implications of this research as an alternative teaching resource on pressure and its application in everyday life. Furthermore, this research can serve as a reference for developing e-modules with other science concepts. This research is still limited to the development stage, namely the validation of the e-module by four expert validators in their respective fields.

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