

## Cognitive of Pre-service Teachers in Designing STEM-based Learning Using CODE-PLAN Model

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### **Abstract**

STEM-based learning implementation plan aims to integrate aspects of natural science, technology, engineering, and mathematics in a holistic learning activity. In the educational context, pre-service teachers have an important role in developing effective learning implementation plans to achieve learning goals and facilitate the student learning process. This study aimed to explore the cognitive abilities of prospective teachers in designing STEM-based learning implementation plans using the CODE-Plan model. This research was conducted using qualitative research methods involving several pre-service chemistry teachers as participants. Pre-service chemistry teachers design lesson plans based on the CATUR STEM guidebook (how to organize STEM Learning). This guidebook is a product developed by researchers. Data was collected through interviews, observations and analysis of documents related to learning implementation plans that pre-service chemistry teachers had made. The cognitive abilities of pre-service chemistry teachers in designing STEM-based learning implementation plans are assessed through several indicators, including clarity in formulating objectives, accuracy of integration of context and content, accuracy of a series of STEM-based learning activities, and completeness of the assessment. The results of the research show that most pre-service chemistry teachers have been able to make plans for implementing STEM-based learning by adapting the methods in the CATUR STEM guidebook. Some of the pre-service chemistry teachers have been able to formulate learning objectives in accordance with the chemistry curriculum, design STEM-based learning activities that are oriented towards learning objectives, and plan evaluations. Various chemistry issues in everyday life are correlated with chemistry material and presented in STEM-based learning activity plans by pre-service chemistry teacher students. However, pre-service chemistry teacher students still need to improve in planning the total lesson hours needed for each meeting, and some of the chemical issues used in these learning activities are difficult to implement in the classroom

**Keywords:** CATUR STEM, CODE-PLAN Model, STEM Guidebook, STEM-based Learning

## INTRODUCTION

Current world developments require educators to be able to adapt to changes, namely not only as teachers but as designers to facilitate learning environments (Norton & Hathaway, 2015). Science and technology learning, or integrated Science, Technology, Engineering, and Mathematics (STEM) learning, currently, is currently directed toward problem-solving (Mart'in-Páez et al., 2019; Permanasari, 2016). Thus, the demands of understanding science direct learning toward solving problems in the surrounding environment. Over time, the demands of teachers in teaching students not only involve psychological knowledge about how information can be stored in long-term memory and learning concepts but also on how teachers can invite students to complete ill-defined problems. Teachers in schools are required to teach how to think and solve problems rather than just teaching science so that their role is not replaced by machines (Robinson et al., 2013). Teachers are also expected to be able to design innovative learning experiences that empower the context, and they must be able to adapt to utilize technology that is continuously developing (Chai et al., 2019; González-Pérez & Ram'irez-Montoya, 2022).

There are several problems in the implementation of student-centered

Learning, namely the ability *scaffolding* to support students' active learning, not utilizing interdisciplinary collaborative Learning, lacking the ability to utilize technological devices, not yet reaching out to stakeholders from outside the school to support students' scaffolding process, not having the courage to take risks from outside things (Avsec, 2022; Márquez-Garc'ia et al., 2020; Richmond et al., 2021). So that pre-service teachers are better prepared to face challenges in the world of work when they graduate, learning design skills are required *to customize* and adapt to technological advances, one of which is STEM learning.

Learning objectives are formulated by referring to the applicable curriculum. These learning objectives are achieved by implementing innovative learning models in learning activities. One of these innovative learning models is STEM learning (Afriana et al., 2016; Farwati, Metafisika, Sari, Sitinjak, Solikha, & Solfarina, 2021).

Learning characteristics of *Science, Technology, Engineering, and Mathematics* (STEM) are very in line with the characteristics of the education curriculum in Indonesia and are written explicitly in the latest curriculum in Indonesia. STEM learning has been proven to have a significant effect on

improving 21st-century skills (Baihaqi et al., 2020; Farwati, Metafisika, Sari, Sitinjak, Solikha, & Putra, 2021; Lestari, Tri Puji and Sarwi, Sarwi and Sumarti, 2018; Nurhayati et al., 2020). However, the knowledge factor in implementing STEM learning influences teachers' self-efficacy and attitudes toward teaching STEM learning in the classroom (Kelley et al., 2020; Parmin et al., 2020; Wahono et al., 2022; Wahono & Chang, 2019). Knowledge about STEM can be improved through training (Gardner et al., 2019; Lee et al., 2019).

There is various STEM learning training for teachers in Indonesia (Nurtanto et al., 2021; Suebsing & Nuangchalem, 2021; Sulaeman et al., 2022; Wahono et al., 2022). However, there is no description of the characteristics of STEM learning, so teachers cannot differentiate STEM learning from other learning models. Apart from that, there are findings that teachers in Indonesia have difficulty choosing learning models and writing them into learning implementation plans (Adha et al., 2023; Jannah et al., 2021; Ernawati & Safitri, 2017). Thus, the CATUR STEM guidebook could be a solution to overcome this problem.

CATUR STEM is an abbreviation for "How to Organize STEM-Based Learning" (Isnaini et al., 2023). Teachers can use the CATUR STEM

guidebook to design learning activities by integrating STEM learning stages with teaching materials. This manual is very practical to use. The CATUR STEM guidebook provides information about curriculum policies, knowledge about STEM, and plans for implementing STEM-based Learning.

In the sub-chapter, the STEM-Based Learning Implementation Plan explains in detail the pattern of learning activities in one complete material. The teaching material exemplified in the CATUR STEM guidebook is Colligative Properties of Solutions in chemistry subjects. This guidebook teaches how to formulate learning objectives to suit the learning model used and accommodate learning outcomes.

Learning activities are designed according to the breadth and depth of teaching material. The concept of colligative properties of solutions is taught first. After that, the application of the concept of Colligative Properties of Solutions is packaged with STEM learning model activities. In the learning activities, the learning stages that follow are emphasized *Engineering Design Process* consists of problem identification, problem analysis, designing ideas and problem-solving designs, testing, and communicating (Farwati et al., 2018).

The CATUR STEM guidebook exemplifies an assessment design consisting of an initial assessment and a final assessment. This assessment measures students' knowledge, skills and attitudes related to the material studied. So, in this assessment design, students' initial and final conditions after Learning can be recorded. Apart from that, students also provide feedback on the Learning that the teacher has carried out at the end of the material.

This book has the potential to be used by teachers or pre-service teachers to design innovative learning implementation plans that comply with learning management standards with a validation result of 3.74 out of 4.00, which indicates that this book is suitable for use (Isnaini et al., 2023). Thus, this article aims to analyze the effectiveness of using this guidebook in terms of the suitability of the description of the learning implementation plan made by pre-service teachers.

The lesson plan instrument is a tool used to assess and evaluate the effectiveness of the lesson plan. This instrument is designed to measure various aspects of learning planning, such as construct validity, reliability, practicality, and skill development in inquiry-based teaching. Several studies have been carried out to develop and validate these instruments using

different research methods and models. For example, a study developed a lesson plan instrument using the POGIL model and assessed its validity and practicality (Anggraini et al., 2018; Otaya et al., 2020). Other research developed and validated instruments to measure understanding in daily lesson plans, using the Madeline Hunter Model and The ASSURE Model (Ghazali et al., 2018). Apart from that, there are instruments specifically for analyzing inquiry-based lesson plans (Goldston et al., 2013). However, there is no instrument specifically designed to analyze STEM-based lesson plans, so an instrument is needed that can accommodate the characteristics of STEM learning.

This time, the instrument used to analyze STEM-based lesson plans is *the Cognitive Demands of Lesson planning (CODE-PLAN) Model* developed by König et al., (2021). The advantage of CODE-PLAN is that it is very detailed so that researchers can take points that are in accordance with the lesson plan guidebook that has been developed. Thus, this research aims to analyze the accuracy of developing STEM-based lesson plans referring to the CATUR STEM guidebook.

## **METHOD**

This research was conducted using qualitative content analysis with a direct

approach. Direct or deductive content analysis is carried out by reading textual data and paying attention to parts of the text that, in the initial analysis, appear to be related to theory. Next, the highlighted text will be coded using predetermined codes (Assarroudi et al., 2018; Hsieh & Shannon, 2005). Qualitative content analysis aims to classify large amounts of text into several efficient categories that represent similar explicit and implicit meanings (Prasad, 2008). In content analysis, criteria are needed to identify themes or patterns from text or data (Hsieh & Shannon, 2005).

The criteria used refer to the criteria for an ideal learning plan using CODE-PLAN (König et al., 2021). The content analysis steps carried out are (1) data preparation, (2) definition of units of analysis, (3) development of categories and coding schemes, (4) testing of coding schemes in text samples, (5) coding of the entire text, (6) assessment coding consistency, (7) drawing conclusions from coded data, and (8) reporting methods and findings (Assarroudi et al., 2018; Zhang & Wildemuth, 2009).

#### *Data Preparation*

A total of 5 pre-service chemistry teacher students were involved in this research. They are 5th-semester students from an Islamic University in Palembang. Pre-service chemistry teachers were given the CATUR STEM

Handbook in e-book form which has been tested for validity (Isnaini et al., 2023). Pre-service chemistry teachers read this book for approximately 30 minutes. Then, they design a learning implementation plan using SMA/MA chemistry teaching materials. The LESSON PLAN developed refers to the guidebook. During the preparation of the learning implementation plan, pre-service chemistry teacher students are allowed to re-read the CATUR STEM guidebook. Next, the learning implementation plans that have been made by the pre-service chemistry teacher students are analyzed.

This learning implementation plan is the main data in the research. This data was then analyzed using the criteria from CODE-PLAN in accordance with the directions of the CATUR STEM guidebook, so it was necessary to redefine CODE-PLAN in STEM learning according to the directions of the CATUR STEM book.

#### *Definition of Units of Analysis and Category Development*

In principle, those stated in the CODE-PLAN criteria are suitable for developing teaching modules, while the LESSON PLAN directions from the CATUR STEM guidebook refer to simple LESSON PLAN criteria. Thus, the criteria for CODE-PLAN were redefined in accordance with the

directions of the CATUR STEM guidebook. Several criteria have been removed, but more is needed to eliminate the essence of an ideal LESSON PLAN. Table 1 shows the CODE-PLAN criteria adapted to the CATUR STEM guidebook (Isnaini et al., 2023).

*Development of schemes on text samples*

In this section, three researchers analyzed the text sample being analyzed, namely lesson plan 1, until all researchers agreed on categorization and how to assess the lesson plans based on categories.

*Full-text coding and coding consistency*

At this stage, each researcher analyzes the entire lesson plan and repeats the analysis at three-day intervals

three times to maintain consistency in the assessment together.

*You are drawing conclusions and reporting.*

The report of coding results is not only in quantitative form but is described in qualitative form.

Then, the researchers came together and compared the themes, categories, and codes they created and determined the compliance rate. Miles et al. (2020) proposed a reliability formula to calculate this compliance rate. The study determined the consistency reliability coefficient among the coders to be 85%. This calculated value shows that the coding made in qualitative studies is reliable.

Table 1. CODE-PLAN Criteria for STEM Learning.

Aspect	Indicator (Code)
Content Transformation	Inappropriate use of STEM themes/topics seen from the integration of science, technology, engineering and mathematics (0); Appropriate use of STEM themes/topics seen from the integration of science, technology, engineering and mathematics (1) accompanied by appropriate reasons (2)
	The selected STEM learning content is not adapted to the national curriculum (0); the selected STEM learning content is adapted to the national curriculum (1)
	Steps that do not match EDP-STEM syntax (0) Explain STEM learning steps according to EDP-STEM syntax that are linked to science content (1)
Evaluation Development	Did not write formative evaluation (0) wrote formative evaluation used (1) evaluation of knowledge (test), attitude (character survey to assess the learning process), and skills (students) (2)
Clarity of Learning Objectives	Does not explain problem identification and analysis or is wrong in identifying problems and analyzing problems (0) Problem identification and analysis explained (1) and

Aspect	Indicator (Code)
	reflected on the learning objectives (2).
Clarity of Learning Objectives	Mistakes in developing the core stages of learning (designing, designing, and testing) in the learning hat phase are explained (0). Topics and methods/activities related to the core stages of Learning (designing, designing, and testing) in the lesson topic phase are explained (1) and reflected on the learning objectives (2) Wrong in developing the inspection/feedback phase (0), Topics and methods/activities related to the inspection/feedback (communicating) phase of the lesson are explained (1) and reflected on the learning objectives (2).
Unit Contextualization	There needs to be references in the lesson plan for the unit. (0) There is a reference in the lesson plan for the unit. (1) There needs to be more differentiation in the focus of learning content (0). In the lesson plan, differentiation is made according to the focus of lesson content (1)
Creation of Phases in Learning	At least a 3-phase structure in the LESSON PLAN: 1. Introduction (P1) (1), 2. Working on the topic (P2) (1), 3. Checking the results, and 4. Providing feedback (P3) (1)

## RESULTS AND DISCUSSION

Based on the CODE-PLAN criteria in the lesson plan for STEM Learning, researchers found several interesting facts from the results of the LESSON PLAN analysis for pre-service chemistry teachers. The following is the

average value of the coding results of the three researchers:

### *Aspects of Content Transformation*

Table 2 shows the results of the researcher's analysis of the lesson plan in the content transformation aspect.

Table 2. Analysis of Content Transformation Aspects.

Criteria	Code on Analysis Objects (lesson plan)				
	1	2	3	4	5
Inappropriate use of STEM themes/topics seen from the integration of science, technology, engineering and mathematics (0); Appropriate use of STEM themes/topics seen from the integration of science, technology, engineering and mathematics (1) accompanied by appropriate reasons (2)	0	0	2	2	2
The selected STEM learning content is not adapted to the national curriculum (0); the selected STEM learning content is adapted to the national curriculum (1)	1	1	1	1	1

Criteria	Code on Analysis Objects (lesson plan)				
	1	2	3	4	5
Steps that do not match EDP-STEM syntax (0) Explain STEM learning steps according to EDP-STEM syntax that are linked to science content (1)	0	0	1	1	1

In this section, there are interesting findings that can be noted in developing STEM learning lesson plans. lesson plan1 and lesson plan2 get zero marks in determining theme and content. In lesson plan1, the chemical content used as a reference is a discussion of hydrocarbons and petroleum, while in lesson plan1 the context taken is used cooking oil.

Used cooking oil is used cooking oil from olive oil, palm oil, sunflower oil or coconut oil, and the whole thing does not consist of hydrocarbon chains but fat. Thus, lesson plan1 shows inaccuracy in determining context.

In the lesson plan 2, the chemical concepts taken are atomic structure and the periodic table. In the STEM learning steps, the author invites students to study atomic structure using the applications *mobile* Avogadro. A glance at lesson plan 2 shows the use of technology in understanding science, but this does not mean that the Learning is STEM learning.

Lesson plan 3 takes the context of using acids and bases to remove pesticides from food, lesson plan4 is about how to avoid corrosion through painting for electrochemical content, and

lesson plan5 is about using nail polish remover to explain the concept of chemical bonds. The context taken is in accordance with the chemical content taken as a reference.

Lesson plan 1 and lesson plan 2 show that STEM learning requires pre-service teachers to understand how to connect context with content. In lesson plan 1, errors in taking context will result in errors in chemical concepts that are studied and used in solving problems. However, in the CATUR STEM guidebook, directions have been given to deepen understanding of chemistry first at the introductory stage of Learning, then go into its application in STEM learning. The possibility of errors occurs due to the need for more analytical skills of pre-service teachers in understanding chemical concepts through macroscopic, submicroscopic, and symbolic abstractions (Kapici, 2023). Even though in Indonesian, petroleum and cooking oil begins with the word oil, physically and chemically, the characteristics of these two substances are very different even though they are both nonpolar. Macroscopically, the author of lesson plan1 still needs to understand the



physical and chemical characteristics of the substances taken as context.

Petroleum is part of the hydrocarbons in the subfield of organic chemistry which are usually found associated with gasoline and lubricants. Gasoline has a hydrocarbon chain that tends to be short, so it evaporates easily, while lubricants are thick because they have a higher hydrocarbon chain. Meanwhile, the study of the context of cooking oil is part of the field of biochemistry, namely fats with physicochemical properties that are different from gasoline. In integrated STEM learning, teachers must be scientifically literate first before developing ideas from real problems to be solved using science (Akerson & Bartels, 2023; Shaffer et al., 2019).

Lesson plan 2 shows pre-service chemistry teachers' mistakes in understanding the definition of science in STEM learning and starting from the definition of STEM, namely combining science, technology, engineering and mathematics to solve real problems, not just combining several scientific disciplines (Breiner et al., 2012; Bryan et al., 2015; English, 2016). Moreover, science in STEM learning is a tool to explain phenomena or solve real-world problems (Wahono et al., 2022; Wahono & Chang, 2019).

The author of lesson plan 2 developed STEM learning objectives for understanding concepts using information technology. At first glance, if pre-service teachers understand the definition of STEM only from its abbreviation without examining the philosophy and learning objectives of STEM-EDP, then this mistake can occur because, basically, the use of technology to understand the concept of atomic structure is not integrated Learning but uses media in chemistry learning.

This inaccuracy has an impact on how pre-service teachers analyze STEM learning steps and the formulation of learning objectives. For example, as follows in lesson plan 2 in identifying problems:

#### *"IDENTIFICATION OF PROBLEMS*

- 1. Identify molecules to create 3D atomic structures in the Avogadro app*
- 2. Identify how to use the Avogadro application."*

The definition of problem identification in the CATUR STEM book is identifying real problems that exist in the environment to be solved using the chemical concepts studied (Isnaini et al., 2023), while in this section, pre-service teachers have formulated the Designing Ideas and Designs section.

Based on the explanation of Cheng & So (2020), STEM learning should integrate not only knowledge content but

also pedagogical integration and integration of students from various fields to solve real, complex problems. However, the learning paradigm, especially in high school, is still sealed (Suebsing & Nuangchalerm, 2021); integration must be carried out in stages, starting from content knowledge based on one field of science with a more complex pedagogical approach to strengthen understanding of science, only then can it be integrated into a broader spectrum. It is what is socialized in the CATUR STEM book, namely focusing first on learning chemistry to support understanding chemical concepts and how to apply them in STEM learning related to the concepts discussed.

Developing a lesson plan is a challenging thing for beginners to do. There are different cognitive structures between beginners and experts.

#### *Evaluation Development*

Table 3 contains the analysis in the evaluation development section.

Table 3. Analysis of lesson plan regarding Evaluation Development.

Criteria	Code on Analysis Objects				
	1	2	3	4	5
Not writing formative evaluations (0) writing down formative evaluations used (1) evaluating knowledge (tests), attitudes (character surveys to assess the learning process), and skills (students) (2)	2	2	2	2	2

Table 4 is an analysis of the clarity of learning objectives.

Table 4. lesson plan analysis regarding clarity of learning objectives.

Criteria	Code on Analysis Objects				
	1	2	3	4	5
It does not explain problem identification and analysis or needs to be corrected in identifying problems and analyzing problems (0). Problem identification and analysis are explained (1) and reflected in learning objectives (2).	0	0	2	1	2
Mistakes in developing the core stages of Learning (designing, designing, and testing) in the learning hat phase are explained (0). Topics and methods/activities related to the core stages of Learning (designing, designing and testing) in the lesson topic phase are explained (1) and reflected on the learning objectives (2)	0	0	2	1	2
Wrong in developing the inspection/feedback phase (0), Topics and methods/activities related to the inspection/feedback (communicating) phase of the lesson are explained (1) and reflected on the learning objectives (2).	0	0	2	1	2

In the CATUR STEM book it refers to simple lesson plans with the aim of seeing continuity between objectives, learning steps and evaluation. In this

section, pre-service teachers are not required to describe the instruments given to students but only show the forms of instruments used for formative

evaluation of students' knowledge, attitudes, and skills. Skills are required in applying various forms of instruments according to the knowledge domain to know the form of instrument to be applied. In the evaluation aspect, pre-service teachers can label formative instruments in the knowledge, affective and psychomotor domains according to the learning objectives.

*Clarity of Learning Objectives*

The aspect of formulating learning steps and objectives is very influential on pre-service teachers' understanding of connecting concepts with the context raised in STEM learning. Because in lesson plan1, there is an error in the relationship between concepts and context, and lesson plan2 needs to be corrected in the application of STEM-EDP learning, automatically, the learning objectives formulated are wrong.

Apart from that, in the book CATUR STEM, the author provides steps to formulate learning objectives, which include *Audience, Behavior, Condition, and Degree* (ABCD) elements (Chairani, 2019; Kiliçkaya, 2016; Kilickaya & Ersoy, 2016). Based on the findings, lesson plan1 is complete in formulating learning objectives according to the ABCD model and each learning step is reflected in the learning objectives. It is just that because there was an error in connecting content with

context, the code for each learning step is 0. Meanwhile, for lesson plan2, it is good. The learning objectives do not follow the ABCD model, and the implementation of the learning steps is not appropriate.

In lesson plan 4, the author needs to explain the concept of electrochemistry at the stage of understanding the concept to be applied in STEM learning regarding corrosion, so the code given is 1. Meanwhile, for lesson plan3 and lesson plan5, the author can explain the relationship between concepts that need to be understood at the beginning before entering STEM learning, so the author gives code 2.

*Unit Contextualization*

Table 5 contains unit contextualization analysis.

Table 5. Lesson plan analysis of unit contextualization

Criteria	Code on Analysis Objects				
	1	2	3	4	5
There needs to be references in the lesson plan for the unit. (0) There is a reference in the lesson plan for the unit. (1)	0	0	0	0	0
There is no distinction in the focus of learning content (0). In the lesson plan, differentiation is made according to the focus of the lesson content. (1)	1	1	1	1	1

In this section, the CATUR STEM book only provides input regarding the relevance of the theme to the concepts

discussed. Thus, the existence of references is really needed as a tool to determine the validity of the references used by pre-service teachers to use them in Learning. References can come from journal articles or scientific reference books.

Meanwhile, for the second criterion, in the contextualization aspect of the unit, all pre-service teachers have developed it in accordance with the directions of the CATUR STEM book. The STEM learning stages are carried out in steps *engineering design process*. Meanwhile, the concept understanding stage is carried out with other strategies according to the objectives.

#### *Making Phases in Learning*

Table 6 is an analysis of making phases in Learning.

Table 6 Lesson plan analysis regarding making phases in Learning.

Criteria	Code on Analysis Objects				
	1	2	3	4	5
No phase division (0); At least a 3-phase structure in the lesson plan: 1) Introduction (P1) (1), 2) Core activities (P2) (1), 3) Checking results and providing feedback (P3) (1).	3	3	3	3	3

In this section, all lesson plans contain an introduction in the form of understanding concepts before entering the STEM learning stage and an initial test, core activities, namely STEM

learning, and closing activities in the form of formative evaluation, as exemplified in the CATUR STEM book.

Different from professional teachers. Pre-service teachers have limited knowledge, so that if they are not trained simultaneously, they will have difficulty adapting to the ability to design lesson plans. The earliest mistakes can occur due to a lack of understanding or mastery of the material, which has an impact on the overall lesson plan design. Teachers need to analyze the material to fully understand the content and learning objectives, resulting in effective teaching (Beghetto, 2017). In addition, not analyzing the material can result in a lack of harmony between the lesson plans and the curriculum, resulting in student confusion. Analyzing materials allows teachers to identify potential challenges or gaps in content and make necessary adjustments to ensure effective teaching (Raval, 2013). Therefore, it is important for teachers to analyze the material thoroughly before creating a lesson plan to ensure a meaningful and productive teaching and learning experience.

Beginning teachers face challenges in creating effective lesson

plans. Beginning teachers may need help managing their time effectively during instructional steps, resulting in a lack of adequate activities and adequate assessment (Bailey, 2015). Beginning teachers also need help in preparing lesson plans, including unclear teaching objectives, minimal warm-up activities, inadequate activities to achieve objectives, and a lack of time set for each learning and assessment step (Knotts, 2016).

The skills needed to create lesson plans include developing an understanding of the learning process in the classroom (Rusznyak & Walton, 2011). (Fujii, 2019) explains that teachers must also design lesson plans that are oriented towards higher-order thinking Skills (HOTS). In addition, teachers must be able to confidently teach a lesson and create a clear "road map" that guides the lesson and documents what is taught. Furthermore, teachers should be trained in designing lesson plans that focus on developing student qualities and competencies. Some of the specific skills involved in creating a lesson plan include writing appropriate learning objectives and outcomes, designing engaging

teaching activities and lesson resources, assessing student learning, implementing strategies for differentiated Learning, and evaluating lessons.

Thus, the skills of pre-service teachers cannot only be directly seen from the effectiveness of using guidebooks because many variables influence the success or difficulty of developing STEM-based lesson plans.

#### **SUGGESTION**

CODE-PLAN can be a summative analysis tool for simple format lesson plans for STEM learning as well as formatively analyzing the effectiveness of the CATUR STEM guidebook. It can be seen from the five lesson plans analyzed; it is known that lesson plan1 and lesson plan2 are different from the lesson plan for STEM learning because, in lesson plan1, there are errors in connecting context with concepts, while in lesson plan2, there are errors in implementing STEM learning. Errors in determining learning content affect the objectives and steps of STEM learning even though they are formulated ideally, as seen in lesson plan1.

Even though lesson plan4 is correct, there needs to be an explanation regarding deepening concepts in explaining phenomena before entering

the STEM learning steps. Moreover, finally, lesson plans 3 and 5 show how to write an ideal learning lesson plan. The implications of this research can be applied to assess how pre-service teachers can understand and develop STEM learning.

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