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Physics Learning Tools of Inquiry-Creative-Process Integrated Ethnoscience: Its Validity to Train Prospective Teachers' Critical Thinking Ability

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Abstract. This study aims to develop physics learning tools of an inquiry-creative-process (ICP) model integrated with ethnoscience and to find its validity in training prospective teachers' critical thinking skills. This study's learning tools developed and tested for validity comprise lesson plans (RPS) and learning scenarios, learning materials or modules, and test instruments. The validation of learning tools employs three validators. The instrument for collecting validation data uses a validation sheet. The validity of the learning tools refers to the aspects of content and construct validity. The quantitative validation score of each item uses a stratified scale, where the maximum score is 5 (validation statement items are very consistent with the measured aspect) and a minimum of 1 (validation statement item does not correspond to the measured aspect). Furthermore, the data of the validation results are analyzed descriptively by computing the mean scores of each validation aspect from each validator. The validation results show that the learning tools on the content and construct validity aspects are valid criteria, except for the lesson plans (RPS) and learning scenarios categorized as very valid in the construct validity. This finding shows the learning tools to be implemented in the classroom are feasible to train the prospective teachers' critical thinking skills. The researchers' future tasks are to test the practicality and effectiveness of the developed learning tools.

Keywords: Physics Learning Tools · Inquiry-Creative-Process · Ethnoscience · validity · Critical Thinking

1 Introduction

Most intervention done by educators in the learning and education system at higher education leads to the achievement of learning competencies towards critical thinking [1]. Recently, the determination to achieve critical thinking competence has been emphasized for prospective teachers, considering their increasingly crucial role, especially in training

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students' critical thinking in the future [2]. It aligns with the role of future teachers as the backbone of the progress of a better learning and education system in terms of providing learners with critical thinking skills [3]. The willingness to achieve critical thinking competence in prospective teachers still seems problematic [4]. Previous studies claimed that prospective teachers' critical thinking skills were unsatisfactory [5]. The lecturers' existing teaching methods that do not sharpen the perspective teachers' critical thinking are assumed as its cause [6].

Many researchers, in their studies, offer various innovations to train learners' critical thinking skills. Some of them are by implementing student-centered interactive multi-mode learning [7], exploring through inquiry activities [8], authentic problem solving [9], exploring by utilizing sources of technological power [10–12], and through self-evaluative processes in learning [13]. Recently, the intervention of scientific creativity in inquiry can be a way to train students' critical thinking [14]. However, these pedagogies focus on attaining critical thinking through material interconnection with learning models and are not diversified in broader sociocultural aspects. Students experience difficulty in solving their learning problems when learning activities are directed to a more authentic context in everyday life, especially regarding sociocultural aspects. It has an impact on students' thinking skills that do not develop. It should be remembered that students spend more time interacting with the environment and the wider community in which they live rather than interacting with learning materials in the classroom. Due to this, the interconnection of the learning process should pay attention to sociocultural issues. Therefore, cultural diversity, social values and local wisdom of a nation should be a bridge to train students' critical thinking. Thus, this becomes a current learning trend where the characteristics of the learning system applied are focused on internalizing cultural diversity, social values and local wisdom [15]. The integration of science with cultural values and local wisdom is called ethnoscience [15].

Knowledge of the enculturation of science that grows and develops in society (ethnoscience) can be investigated in today's modern scientific knowledge. The inquiry process is one way to attain the goals of science teaching [16, 17]. In ethnoscience, cultural traditions and local wisdom cannot be separated from knowledge [18]. The phenomenon of ethnoscience as indigenous knowledge of the community needs to be investigated through inquiry processes, and the tendency to achieve critical thinking in inquiry learning activities is achieved through scientific creativity. Through ethnoscience learning, students' scientific literacy develops [19], positively impacting the development of scientific thinking logic [20]. Recently, an inquiry learning model that emphasizes scientific creativity has been developed; this is called the Inquiry-Creative-Process (ICP) learning model [14, 21]. Previous studies have shown that aspects of students' thinking can be optimized with creativity reflected in learning activities [22]. Finally, a new framework emphasizing creativity in scientific inquiry integrated with ethnoscience must be developed to train prospective teachers' critical thinking. This framework in the learning process is actualized or operationalized in learning tools. Learning tools are a buffer for the learning process to achieve learning objectives [23].

The recent study aims to develop physics learning tools of an inquiry-creative-process (ICP) model integrated with ethnoscience and determine its validity in training prospective teachers' critical thinking skills. Learning tools are plans to carry out the learning process for certain expected goals [24]. Learning tools generally include a syllabus, lesson plans, worksheets, test instruments [25], handouts, or learning modules [26]. This study's learning tools developed consisted of lesson plans (RPS) and learning scenarios, learning materials or modules, and test instruments.

2 Method

This development study produces physics learning tools of the inquiry-creative-process (ICP) model integrated with ethnoscience phenomena to train students' critical thinking skills. A qualified product should meet the element of validity with the expected goals [27]. This study aims to train prospective teachers' critical thinking skills. This study is limited to the development of prototype tools and their validity. Therefore, the development research framework, according to Gall et al. [28], was adapted and modified. The development steps are a) preliminary study and information collection, b) tools development planning, c) preparation of learning tools, d) validation of learning tools, and e) revision of learning tools based on validation results.

The learning tools developed and tested for validity covered lesson plans (RPS), learning scenarios, learning materials or modules, and test instruments. The validation of learning tools employs three validators. The instrument for collecting validation data is a validation sheet. The validity of the learning tools refers to the aspects of content and construct validity. Content validity is aimed at all components of learning tools based on needs and state of art of reciprocity or novelty, and construct validity is aimed at components of learning tools that must be consistently linked to one another [27]. It is clarified that construct validity refers to the extent to which the operationalization of a construct or concept is defined by a theory [29]. From a more specific perspective, it is identified with a conceptual framework built on a theory [30]. Specifically for the test instrument, content validity refers to three content domains whose validity is measured (domain definition, domain representation, and domain relevance) [31].

The quantitative validation score of each item uses a stratified scale, where the maximum score is 5 (validation items are very consistent with the measured aspect) and a minimum of 1 (validation item does not correspond to the measured aspect). Furthermore, the data from the validation results are analyzed descriptively by computing the mean scores of each validation aspect from each validator. In the end, the conclusion, the validity of the learning tools was obtained by the range of scores according to the criteria: very valid ($x > 4.21$), valid ($3.40 < x < 4.21$), quite valid ($2.60 < x < 3.40$), less valid ($1.79 < x < 2.60$), and invalid ($x < 1.79$) [14]. Qualitative data of the validation results are in the form of suggestions for improvement from the validators of the developed learning tools. Suggestions and validator inputs are accommodated as considerations for improving the learning tools.

3 Results and Discussion

The initial stage of developing learning tools is started with preliminary studies and information collection. It is the basis for planning the development of learning tools. Based on the elaboration of the preliminary study results and the collection of information that researchers have carried out, it is important to develop learning tools to train prospective teachers' critical thinking skills. To train critical thinking, a learning model intervention that combines scientific creativity with inquiry is needed, and the intended criteria are met in the Inquiry-Creative-Process learning model [14, 21].

Furthermore, so that learning is holistic and authentic, especially regarding socio-cultural aspects, ethnoscience becomes a study of knowledge that can encourage prospective teachers' critical thinking. Ethnoscience is a system of knowledge about nature owned by a particular indigenous or traditional culture. This knowledge includes ecology and the reciprocal relationship between humans and nature [32, 33]. Ethnoscience is also called by other names, such as "indigenous science," traditional ecological knowledge, or traditional indigenous knowledge [34]. Several ethnoscience phenomena in Indonesia that can be used as teaching materials to train critical thinking are shown in Fig. 1.

The values of local wisdom in Indonesian cultural traditions -as indigenous science-can be studied further to discover the science concepts within them. It has the potential to become an ethnoscience study and learning resource. Referring to the preliminary studies that have been carried out, a prototype of the learning tools of the ICP model, which is taught through the phenomenon of ethnoscience, is prepared to train prospective teachers' critical thinking skills.

The learning tools developed and tested for validity are lesson plans (RPS), learning scenarios, learning materials or modules, and test instruments. The validation of learning tools employs three validators. The results of the validation on the aspects of content and construct validity are summarized in Table 1.

Lesson plans (RPS) and learning scenarios are assessed for validity in the aspects of content and construct validity. In content validity, the validity of the lesson plans and learning scenarios are assessed based on indicators reflecting the framework of a learning plan with an ethnoscience-integrated ICP model to support the performance of students' critical thinking skills. In the context of planning, the learning outcomes of the

Horse carriage transportation related to the concept of kinematics and dynamics of motion

The traditional art of *Gendang Beleq* related to the concept of sound waves

The clay '*bong*' as a place for ablution related to the concept of fluid

The floating village of the Bajo tribe related to the concept of fluid

Floating market related to fluid mechanics concepts

The tradition of worshiping '*menyunggi*' is related to the concept of object balance

Fig. 1. Some ethnoscience phenomena in Indonesia and the scientific concepts that underlie it

Table 1. Validation results of learning tools

Learning Tools	Content Validity				Construct Validity			
	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
Lesson plans & learning scenarios	4.33	4.17	4.00	4.17	4.38	4.25	4.13	4.25
Learning materials	4.14	4.00	4.29	4.14	4.00	4.13	4.00	4.04
Test instrument	3.75	4.00	3.75	3.83	3.67	3.67	3.67	3.67
Mean scores	4.08	4.06	4.01	4.05	4.01	4.01	3.93	3.99

subjects contained in the lesson plans and learning scenarios have reflected the competence of the need for critical thinking achievement in the ethnoscience phenomenon of physics. Likewise, the expected final abilities in the lesson plans (RPS) document and learning scenarios have reflected the expected (required) knowledge mastery competencies through ethnoscience phenomena. In addition, lesson plans and learning scenarios reflect an innovative (state-of-the-art) framework based on an ethnoscience-integrated ICP model as a bridging practice for students' critical thinking performance.

Regarding content validity, the average validity score given by the three validators is 4.17 with valid criteria (valid if: $3.40 < x < 4.21$). The validity of lesson plans and learning scenarios becomes the initial standard of learning planning to achieve the expected goals [35]. To train critical thinking, lesson plans, and learning scenarios must be prepared as well as possible and valid so that they become the basis for their implementation in the classroom [13].

Construct validity of lesson plans (RPS) and learning scenarios was a very valid criterion on aspects of the correct and appropriate planning framework based on concepts or theories in training critical thinking through the ethnoscience-integrated ICP model. The lesson plans developed are consistently linked to the framework of learning scenarios to underpin critical thinking and vice versa. The main components in the lesson plans and learning scenarios (learning outcomes, final abilities, study materials, and indicators) are consistently linked. The learning phases of the ICP model have been logical and consistent with the ethnoscience phenomenon to support the purpose of critical thinking. The arrangement of information in the lesson plans and learning scenarios is clear and coherent, using specialist vocabulary (on certain words) to clarify the meaning of sentences. In construct validity, the average validity score given by the three validators is 4.25 with very valid criteria (very valid if: $x > 4.21$). Construct validity in the learning planning system is needed, related to the lesson plan developed. Without a good quality and valid lesson plan from the constructed aspect, the direction of learning by the teacher can be biased [36].

The teaching materials developed in terms of content validity cannot be separated from the ways of presenting material related to the ethnoscience context to support students' critical thinking skills. In more detail, the teaching materials describe the learning competencies that are achieved through the ethnoscience-integrated ICP model and, in each meeting, reflect the ethnoscience content that provides students with ethnoscience knowledge and its relation to the context of the material being studied to stimulate students' critical thinking. The teaching materials also contain an activity framework (student worksheets) to explore ethnoscience phenomena according to the ICP model. The state-of-the-art teaching materials have shown an innovative framework (state-of-the-art) integrating ethnoscience concepts, contexts, and their relation to the material being studied. The features of ethnoscience in teaching materials are under the context of new ways to support critical thinking, efforts to grow productivity insights, stimulate curiosity, motivate, and develop contextual insights that lead to critical thinking. In the content validity aspect of teaching materials, the average validity score given by the three validators is 4.14 with valid criteria (valid if: $3.40 < x < 4.21$). One of the serious efforts to build critical thinking is the readiness of teaching materials [9]. The readiness of learning materials in terms of content lies in their validity, so each teaching material presented must have valid criteria [37].

Regarding construct validity, teaching materials consistently describe ethnoscience phenomena related to sub-teaching materials and show consistency in the accuracy of facts, concepts, principles, and theories. The presentation of features and material is interrelated and shows a logical and coherent order (between chapters, between chapters and subchapters, between sub-chapters within chapters, and between paragraphs within sub-chapters). The writing of symbols and units used in teaching materials is consistent with the International System of Units (SI) rules. Organizing information in teaching materials clearly and coherently, using specialist vocabulary (on certain words) to clarify the meaning of sentences. In the aspect of construct validity, the average score of the validity of teaching materials given by the three validators is 4.04 with valid criteria (valid if: $3.40 < x < 4.21$). Teaching materials are part of learning tools that form the foundation of knowledge acquisition [38]. Therefore, teaching materials must meet the validity of the construct in order to be implemented. The construct validity of teaching materials shows the accuracy of facts based on theory so that the material is worth learning [39]. The results of previous studies show that valid learning materials or modules impact their effectiveness in training students' critical thinking [40].

In measuring critical thinking performance, a test instrument should be developed [14]. The validity of the test instruments has been tested in content validity. They have been declared valid with a validity score of 3.83 (valid if: $3.40 < x < 4.21$). The validity of the test instrument refers to three content domains whose validity is measured (domain definition, domain representation, and domain relevance) [31]. The test instrument has reflected several contexts, namely: the content domain of the test instrument by the operational definition of critical thinking (domain definition), the suitability of the content with cognitive specifications in critical thinking (domain representation), the relevance of each item to the content domain contained in the teaching materials (domain relevance), and the content domain reflects a new framework that represents critical ways of thinking. The test instrument has been declared valid in construct validity with a validity score of 3.67 (valid if: $3.40 < x < 4.21$). The test instrument consistently measures critical thinking according to the material being taught, and the test instrument reflects consistency in the accuracy aspects of facts, concepts, principles, and theories in it. The most important thing is that the test instrument shows a consistent effort to achieve competence and learning indicators toward critical thinking. In addition, the writing of symbols and units used in the test instrument is consistent with the rules in the International System of Units (SI). The arrangement of information in the test instrument is clear and coherent, using specialist vocabulary (on certain words) to clarify the meaning of sentences. These aspects then become aspects of measuring the validity of the test instrument in terms of the construct. The results of previous studies show that the validity of the test instrument is a measure of the accuracy of students' critical thinking skills [2].

In general, the average level of learning tools validity in the aspect of content and constructs is 4.05 and 3.99, both of which are valid categories. Finally, based on the findings in this study, the physics learning tool of the ethnoscience-integrated inquiry-creative-process (ICP) model developed is feasible to be implemented in the classroom to train prospective teachers' critical thinking skills.

4 Conclusion

Physics learning tools have been developed with an ethnoscience-integrated inquiry-creative-process (ICP) model that aims to train prospective teachers' critical thinking skills, and their validity has been assessed through a validation process. The learning tools developed and tested for validity cover lesson plans (RPS) and learning scenarios, learning materials or modules, and test instruments. The average validation results from learning tools in content and construct validity are valid criteria, except for the lesson plans (RPS) and learning scenarios with a very valid level in the construct validity aspect. This finding shows that learning tools can be implemented in the classroom to train critical thinking skills. Researchers' future work must be paid attention to test the practicality and effectiveness of the developed learning tools.

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