

# Development of a Cultural-based Physics Learning Module for Teacher Education and Training Program to Enhance Teacher Pedagogical Content Knowledge

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**Abstract.** The teachers' education and training model conducted by central government agencies often do not answer the basic needs of teachers. Local governments through relevant institutions should open up opportunities as possible to the changing of the needs of their region oriented (bottom up); it is a cultural-based teachers' education and training program. This R&D study undertakes the development of a cultural-based education and training module of high school physics teachers. The cultural module was built following the systematic instructional design process of ADDIE model. The module validity aspects meet the validity of substance, language, and design. The module effectiveness aspect is the ability to improve teachers' content (PCK-CK) and pedagogical knowledge (PCK-PK). This study involved 20 in-service physics teachers. Data were collected using content and pedagogical knowledge test, guidelines on validation of module substance, language, and design advisability. The research findings showed that (1) the developed module conform the validity criterion (excellent category), (2) there was an increasing of teachers' content and pedagogical knowledge, and (3) hypothesis testing using one sample t-test proved that there is significant increase of teachers' content and pedagogical knowledge. This module has certain essential characteristics: (1) the module was developed based on the principles of andragogy learning and meet the learning needs of teachers as adult learners, (2) the module contains learning units that clearly and contextually conform need assessment, (3) the module established perspectives, customs, beliefs, and values that are firmly held by people of East Nusa Tenggara, (4) the module discusses the concepts related to the development of cultural-based physics learning activities, such as nature of science, ethnoscience, and physics learning models, and (5) the module equip teachers the abilities to develop their own observational and exploratory skills of balancing local science with modern science. These findings suggest that the module can be useful tool for high school physics teacher to develop cultural physics learning and their content and pedagogical knowledge as well.

## INTRODUCTION

Teacher education and training is a continuous program that is related to the development of teacher competence and proficiency that would help and empower the teacher to qualify them to assume responsibilities of educational profession more effectively and face the challenges therein. Education and training is the process of organizing learning in order to improve the ability of civil servant to carry out his post [1]. Education and training is process pursued by teacher of their profession to improve competence, skill, attitude, intellect abilities, and personality need to be managed by teacher [2]. Professional teacher and educators undergo the continuously professional learning and development. Teacher education and training program should include all the competencies that must be mastered by the in-service and pre-service teacher on a variety of skills that are really needed in learning process and also teaches how one should be able to manage the classroom so that learning can take place effectively and enjoyable.

In recent years, Indonesian government through The Ministry of Education and Culture continually work to improve the teacher quality for better education, through teachers' education and training. But based on the results of senior high school teacher competency test in 2015, pedagogical and professional competencies scores are generally still below the standard minimum passing criterion which is 55. Only seven provinces earned teacher competency test score above the average. East Nusa Tenggara is in 30th place with the average score 41,05. The results showed how competent the teachers in East Nusa Tenggara. This failure is contrary to the

diversity of East Nusa Tenggara as the wealth of this province. There is also challenge in improving teaching learning quality in East Nusa Tenggara, especially physics, as lowest score of National Exam in 2016.

There are institutions with important role in nurturing and enhancing teachers' professionalism in Indonesia, such as the central government through The Centre for the Development and Empowerment of Educators and Educational Personnel or PPPPTK, the provincial government through Institute for Assuring the Quality of Educational Personnel or LPMP, and local government. But still, there was an overlapping role of the central government, provincial government and local governments, and there has been no systematically coordination support cooperation towards improving the professionalism of teachers [3]. Autonomy and decentralization of education to local governments open up opportunities as possible to the changing of the needs of each region oriented (bottom up). Local governments through relevant institutions need to organize activities that support the development and improvement of teachers' competences.

Education and training are an inseparable unity [4]. From the viewpoint of cultural anthropology, to learn science is to acquire the culture of science; students must travel from their everyday life-world to the world of science found in their science classroom. Education with the cultural approach is ideal for environments such as cultured plural Indonesia, then education should be rooted in the nation's cultural values were significantly able to comprehend the harmony and peaceful life in a pluralistic state. Physics learning should be allied with students' prior knowledge in order to harmonize the new concepts with students' prior knowledge. The knowledge, skills and abilities to organize physics learning is known as the Pedagogical Content Knowledge (PCK). A professional teacher should have the decent knowledge and ability of PCK [5]. An outlook of PCK as dynamic and affected by changes in multiple social systems suggests three driving reasons for taking an explicitly cultural-based and place-based approach to professional development in science.

There are challenges and shortcomings in teaching physics suggest that PCK is far from being achieved. Generally, one of the difficulties that confronted by the pre-service teachers or even in-service teachers is how to modify a theoretic physics material into an easy to understand, valuable, and properly fit the students daily experience material. Concept understanding and the ability of Senior High School students in Kupang in analyzing tables, figures, and graphs related to physical phenomena is low [6]. Based on pre-study interview with one of the physics teachers in Kupang, physics instruction is done by utilize various teaching and learning strategies, but still the students find it difficult to understand the physics concept. Various studies suggest designing contextual learning by illustrating some problems faced in the students' daily experiences [7,8,9,10].

In order to develop a cultural-based physics learning activities, teachers need to be equipped with knowledge and skills, relevant knowledge of physics, knowledge of the local culture, and the ability to combine local cultural knowledge on the concepts of physics involved in learning activities. Some countries are already implementing the program of professional development of teachers to develop learning cultural learning activities, which is SUAVE, in California, USA [11]. Ethnomathematics in the Philippines has been pioneered by the University of the Philippines College of Baguio, discipline of Mathematics since 1996.

Given the importance of conducting cultural-based teacher education and training, there is also a need to prepare and establish as best the module as learning material. The module has to be a packet of learning materials consisting of behavioral objectives, a sequence of learning activities, and provisions for evaluation. Module as a handbook for trainers and participants should arrange systematically, including the purpose and description of training material, exercises and evaluation of the participants. The ideal cultural teacher education and training module would make each course or program of a collection of concepts to be internalized through performance or competency-based activities by learners. Responsibility for achievement of preset goals is placed on the teachers, as adult learner. This module development has a very important role because the resulting module provides an overview of physics concepts that can be found in local culture. As a further implication, the module provides new experience for teacher in integrating culture in physics learning activities.

Overall, the literature review suggests that advisedly designed cultural module for physics teacher education and training, in order to equip teachers with information, knowledge, skills and abilities to help students harmonize school science with their local culture as their prior knowledge, and empowered teachers to contextualize physics instruction and to teach in ways that support diverse learners.

## **METHODS**

### **Research Method**

The module was developed by referring to ADDIE model [12]. This ADDIE provides a framework to ensure that the module developed is valid and effective.

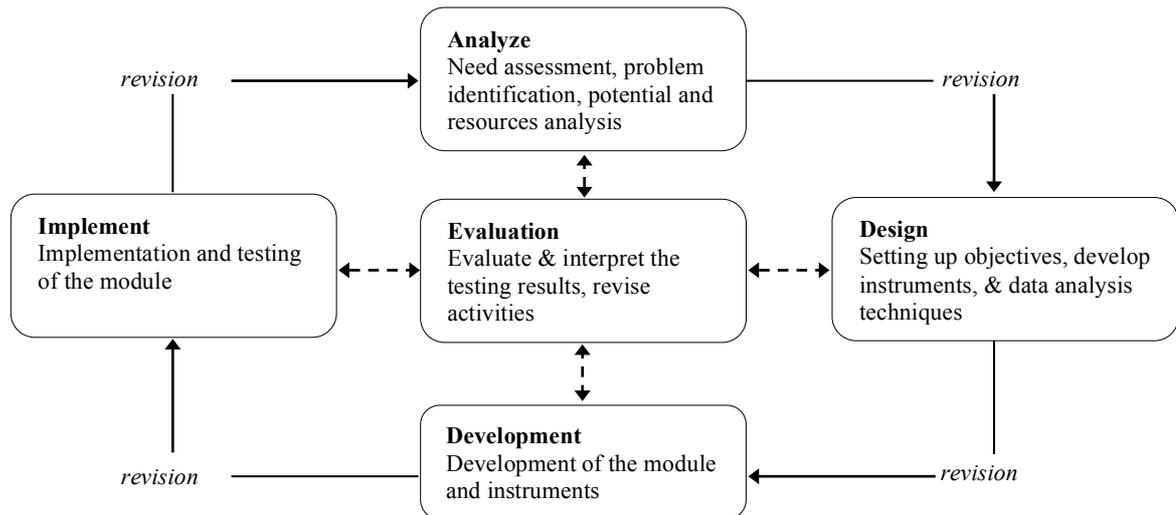


FIGURE 1. ADDIE framework of module development [12]

## Participants

Twenty physics teachers from several senior high schools in one of the districts in East Nusa Tenggara participated in this study. First, the teachers responded to a questionnaire that aimed at identifying need assessment, the PCK-CK and PCK-PK pretest. Second, they were invited to learn the developed module and do the posttest PCK-CK and PCK-PK. Through a factor analysis there was a proof of PCK as consisting of two related constructs (PCK-CK and PCK-PK) [13]. Three experts were involved to judge the validity of substance, language, and design of the module.

## Instruments and Data Analysis

Data were collected using content and pedagogical knowledge test, guidelines on validation of module substance, language, and design advisability. The content knowledge test consists of 48 test of (1) Units, standards, and measurements, (2) Newton's law and its applications, (3) Temperature, heat, and heat transfer, and (4) Sound waves. The pedagogical knowledge test consists of 78 item test. The content and pedagogical knowledge test are multiple choice test. The results of content and pedagogical knowledge test are analyzed by N-gain. Education and training module quality is analyzed by conclusion drawing and verification of expert judgment. The module evaluation are analyzed by conclusion drawing based on teachers and experts responses.

## RESULTS AND DISCUSSION

### Local Physics Learning Resources for Developing Cultural-based Module

This phase included need assessment and problem identification, potential, and resources analysis. Need assessment process tried to find out teachers opinion, teaching experiences and their necessity of achieving professional teacher. In this phase, we also identified the teachers' profile (see Table 1). The results suggested containing cultural contextual teaching-learning in to module. In order to adjust this, we need to identify the culture aspects relevant to physics. This is also the potential and resources analysis. Here are the identification results:

- Units, standards, and measurements  
The traditional units, standards, and measurements of length, mass and time (traditional calendar).
- Newton's law and its applications
  - (1) *Pasola*, a thanksgiving ceremony to ancestral spirit of people from West Sumba. The Alornese still use bows and arrows for hunting tools and war.
  - (2) *Kela Koti* or traditional spinning top of Endenese. The traditional umbrella dance *Enene*.
  - (3) The timber panels of traditional house *Ammu Hawu* (traditional house of Sabunese).
  - (4) *Etu*, a traditional boxing ceremonial of traditional people of Nagekeo.
- Temperature, heat, and heat transfer

- (1) *Tatobi* is a series of activities aimed to warm postpartum mother in rooms where there is a fireplace.
  - (2) *Mbaru Niang* is a traditional house of Wae Rebo village, located within the Rainforest Mountains of Flores.
  - (3) During the water boiling, the mother often adding a spoon or other small-sized iron made into a container of cooking water to faster boiling process.
  - (4) *Moke* is a traditional beverage, symbol of brotherhood and unity of Ngadanese.
- Sound waves
    - (1) *Sasando* is a traditional music string instrument from Rote Island.
    - (2) Traditional music instrument *Foy Pay* comes from Ngada, it is a double flute of small bamboo.

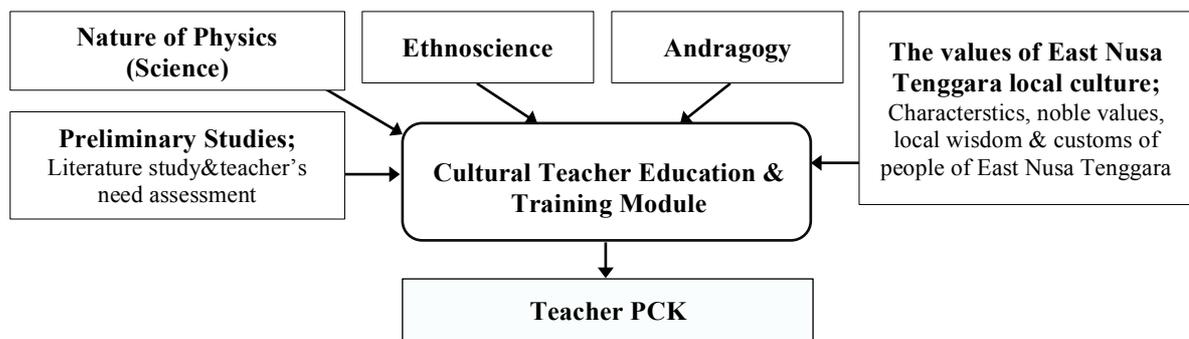
Indigenous cultures of East Nusa Tenggara have educational values that can be integrated into learning activities. The integration of indigenous science concepts into physics instruction helps teachers and students to learn better. This finding is in accordance with [14] who stated teaching methods which incorporate indigenous scientific knowledge as the tool for providing experiential bases for formal science learning can be beneficial for reinforcing learning. The literature also recognizes the beneficial effect of the learner's socio-cultural background in the teaching and learning of science for a strong foundation and effective learning outcomes [15]. If students' views and beliefs are in accordance with the concept of physics, there will be interference mutually reinforcing.

**TABLE 1.** Distribution of teachers by experience and education

Category	Number of teachers
1. Years of teaching	
< 5 years	3
6 – 10 years	10
> 10 years	7
Total	<b>20</b>
2. Academic degree	
S1	16
S2	4
Total	<b>20</b>

### The Development of a Cultural-based Learning Module

The design phase involved using the outputs from analyze phase to plan strategies for developing module. During this phase, we determined the components and elements of the module (see Figure 3).



**FIGURE 3.** The components of cultural-based teacher education and training module.

The components of cultural teacher education and training module planned in the design phase were developed in this phase. Prepared content, layout, text, and graphs were put together in a balanced way [16]. In addition, the development level of the teachers as adult learner was taken into consideration. Concerning the PCK, the tests instruments of PCK-CK and PCK-PK were developed and guided by the indicators of physics teachers' competences and description of physics PCK [18].

### Cultural-based Module Implementation and Evaluation Results

During the implementation phase, the pre-test was given to teachers then they passed to implementation process. The post-test was applied in the end of implementation process. N-gain analysis shows the improvement of teachers PCK-CK and PCK-PK (see Table 2).

**TABLE 2.** N-Gain analysis results

Knowledge	Average of N-Gain	Gain Ranges
Content	0,54	medium
Pedagogical	0,62	medium

Cultural education and training module provided information, knowledge, and approach for the teachers. The module united teachers' experiences and number of knowledge that emphasize real situation and focused on achieving knowledge and skills which is PCK. Physics teachers should socio-culturally contextualize PCK in order to effectively develop learning strategies that meet the diverse needs of students and society. Comparatively, [17] argues for an increase in educational research on teacher education programs for developing "place-based and culture-based PCK". Science teachers and students differ significantly in language, culture, and values, place-based programs incorporate an explicitly culture-based perspective in order to situate teachers' learning in meaningful contexts focused on underrepresented learners' knowledge and experiences. The validation results are shown in Table 3.

**TABLE 3.** Expert judgments' validation results

Validation aspects	Result of evaluation		
	Average	Validity	Category
Substance	3,82	valid	excellent
Language	3,75	valid	excellent
Design	3,58	valid	excellent
Average score	3,71	valid	excellent

As the results of implementation phase, in order to evaluate the module, teachers and experts responses were concluded. The opinions and responses of teachers and experts are shown in Table 4.

**TABLE 4.** Teachers and expert opinion on cultural module

	Responses (%)			
	Very poor	Poor	Good	Very good
Ease of use	0	2,6	19,2	78,2
Clarity	0	0,2	18,6	81,2
Encouraging thinking	0,2	2,2	20,0	77,6
Including cultural aspects	0	0	7,6	92,4
Enjoyable	1,2	2,4	12,8	83,6
Ensuring teaching reflection	0	6,4	13,4	80,2
Ensuring the teachers can use what they have learnt	0,1	0,4	20,4	79,1

Looking at Table 4, it is clear that teachers did not face problems while using the module. There are several major rationales of explanation, which are teacher education and training module provides (1) nature of physics concepts and its implementation on teaching-learning activities, (2) ethnoscience, (3) the comparison of modern & local science, (4) the advantages of cultural physics learning, (5) physics learning models; descriptions and examples of different strategies, models, approaches, methods, and learning techniques, the characteristics of the models of 2013 curriculum; Project Based Learning, Problem Based Learning and Discovery Learning, as well as (6) principles of the integration of cultural elements in physics learning activities. There are several essential characteristics of this module: (1) developed based on the principles of andragogy learning and meet the learning needs of teachers as adult learners, (2) contains learning units that conform need assessment, (3) established perspectives, customs, beliefs, and values that are firmly held by people of East Nusa Tenggara, (4) discusses the concepts related to the development of cultural-based physics learning activities, and (5) equips teachers the abilities to develop their own observational and exploratory skills of balancing local science with modern science. These findings suggest that the module can be useful tool for high school physics teacher to develop cultural physics learning and their content and pedagogical knowledge as well.

A teacher is required to understand and have sufficient skills in developing various models of effective, creative and fun learning. If the teachers have been able to grasp the concept or the basic theory of learning which refers to the process (along with the concepts and theories) learning as described above, then the teachers can creatively develop a distinctive learning model, based on the real conditions in each workplace, which in turn will appear learning models version of the teacher concerned, which is certainly the more enriched learning models that already exist.

## CONCLUSION

The cultural teacher education and training module purposes to guide teacher to discover and construct the concepts of physics in the elements and cultural phenomena, and then integrate them into contextual physics learning activities. The teachers are expected to better understand the purpose of education and training, and be able to follow the program better. Teacher education and training strategy should involve the participants as much as possible in the whole process and to support this necessary, the module also need to develop to conform the education and training program. This module facilitates teachers to improve their content and pedagogical knowledge. The effectiveness and quality of module constructed by the real context of culture helps teachers understand better the physics and find the better strategy to teach physics. This cultural education and training module equips teachers with knowledge about the nature of teaching and learning physics and cultural-based physics learning, which is beneficial (1) for teachers' insight and knowledge about cultural values that can be integrated into physics learning activities, (2) to equip teachers the principles and knowledge in developing cultural-based physics learning activities, and (3) to give understanding of importance of culture role as students' initial experience and knowledge in teaching and learning activities. The integration of culture and science in cultural-based physics instruction which presented in module hopefully can help students understand physics as modern science through contextual learning activities and based on the culture as students prior knowledge.

Findings from this study indicate that the module was effectual in supporting teachers to have better knowledge and reflection on their instructional practices and beliefs because the module incorporated theory, demonstration, feedback and follow up, and substance was contextualized and integrated into teachers' learning areas. We can also conclude that there is a continued need to research programs built on this study provides evidence to support this claim. By providing opportunities for physics teachers' education and training as participation in cultural-based communities of learners which address meaningful and relevant physics or science issues in general, holds potential of a path toward educational equity for all learners. It is essential therefore to continue to explore, refine and develop our understanding in the design and implementation of teachers' education and training to better support the needs of teachers.

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