

# The Development of Mobile Learning-Assisted Local Culture-Based Subject-Specific Pedagogy in Realizing the Learning Outcomes of Physics Subject

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**Abstract**—Education plays an important role in developing human resource skills in order to compete in the world of work. To support the role of education, it is necessary to develop skills through learning activities, one of them is through learning in the form of *subject specific pedagogy* (SSP) based on local culture with *mobile learning* assistance. The purpose of this study was to develop the SSP that can be used to measure learning outcomes of Senior High School students in physics subject that meet valid and reliable requirements and also to determine the effectiveness of the developed SSP so that the learning outcomes of students could be known. Learning outcomes measured are problem solving skills in physics. Problem solving skills are important in learning physics at school and are also useful for adapting to the surrounding environment. This study used a *Research and Development* research design with a 4D model. The results obtained the valid and reliable as well as effective mobile learning-assisted local culture-based SSP device for realizing learning outcomes of students in physics subject.

**Keywords:** *SSP, local culture, mobile learning, problem-solving skills*

## I. INTRODUCTION

The 21st century is full of competition between human resources (HR), especially in getting jobs. Education plays an important role in developing human resource skills in order to compete in the world of work. The Government through the Ministry of Education and Culture seeks to enter the 21st century skills by making some revision to the applied educational curriculum

from the School-Based Curriculum (KTSP) to the 2013 curriculum. The 2013 curriculum has used a *scientific approach* to keep up with the development of the XXI century education using an integrated approach to *Science, Technology, Engineering, and Mathematics* (STEM).

The learning tools that use the STEM approach are needed to keep up with the the educational trends in the XXI century. The learning tools are arranged in the form of *Subject Specific Pedagogy* (SSP) that adjusts to the standard competence of graduates, content standard, and standard of process that apply to the 2013 curriculum. The developed content standard determines the criteria for scope and level of competence in accordance with the formulation of standard competence of graduates including attitude, knowledge, and skills. The developed SSP is in the form of syllabuses, lesson plans (RPP), student worksheets (LKPD) and assessment instruments, which are suited to the needs, competencies in each subject material and expected competencies. Based on the current educational curriculum in Indonesia, the 2013 Curriculum, one of the learning models that applies the STEM approach. according to the Regulation of the Minister of Education and Culture No. 22 of 2016, is a *problem-based learning* (PBL) model[1].

Problem-based learning comes from the contextual problems that exist in the surrounding environment to stimulate students to be active in learning [2]. Problem-based learning that is equipped with virtual media has a

significant effect on students' learning activities and outcomes [3]. The steps of the PBL model used in this study are based on the opinion by Arends [4], as follows: (i) orienting students to the problem, (ii) organizing students to learn, (iii) guiding individual/group inquiries, (iv) developing and presenting results, and (v) analyzing and evaluating results. Thus, this PBL model can make students active in learning coupled with the use of virtual or learning media that utilize technology or the surrounding environment.

The developed SSP to fit the expected competence is associated with local culture in Indonesia. This is in accordance with the STEM approach where science is not only delivered through existing technology, engineering, and mathematical formulations but can also be delivered by utilizing the environment as a learning resource. Local culture in each region in Indonesia is part of the environment as a source of learning. The local culture can be in the form of traditional games in the community. Culture is introduced to students as a method for learning concepts in physics learning [5], but local culture-based learning is not much done by teachers [6]. Therefore, the local culture used here was the *pletokan* (bamboo gun) to improve learning outcomes of students in learning physics.

The local culture-based SSP is assisted using technology around us, so that students can actively learn whenever and wherever and the learning outcomes can reach the maximum. Mobile technology is often used by students to help learn physics in and outside the classroom [7]. This technology is also flexible because it can be accessed anywhere and anytime [8]. The use of mobile devices in learning supports students' higher-order thinking skills [9]. One of the kinds of mobile technology used is the android applications, as well as Edmodo application that can be operated using the smartphone. Edmodo is a free and safe educational learning network to use and provides a simple way for teachers to create and manage online classroom communities and allows students to connect and work with their class teachers anywhere and anytime [10]. Thus, Edmodo can be used to facilitate students learning both in the classroom and outside the classroom.

Based on the observations conducted at several high schools in Yogyakarta, it was known that teachers still used lecture, discussion and *ideal problem solving* learning models in implementing physics learning. The teacher also still used conventional SSP that is existing and has not been linked to local culture and the use of technology to help learning. Then, the teachers were still limited to use low-level thinking skills in assessing

learning outcomes. Therefore, the the researchers developed a local culture-based SSP based on mobile-learning to realize the learning outcomes of students, one of which is problem solving skills in physics.

Problem-solving skills are seen as a fundamental part of learning science in schools [11]. Problem solving skills are not only important at school and work, but also to adapt to the environment [12]. Problem solving skills in Physics can provide an effective understanding of physics by linking various ideas and concepts in various situations encountered in solving a problem [13]. Thus, problem solving skills are one of the skills needed to be able to compete in this highly developed world.

According to experts, problem solving skills have several indicators, so in developing instruments to measure problem solving skills also follow the indicators that have been mentioned by the experts. According to Ruseffendi [14], the indicators of problem solving skills are presenting problems more clearly, stating the problem in an operational form, compiling alternative hypotheses and using work procedures, testing hypotheses, and doing some work to get results, as well as performing double check. Then, Polya [15] mentions indicators of problem solving skills, among others, understanding the problem, planning a solution, solving a problem, and re-checking. Furthermore, according to Gunawan [16], there are five steps in solving problems in physics, namely identifying and defining problems; determining goals and objectives; generating a solution; making an action plan; following the action plan. This stage is called the implementation of the solution. The test instrument developed in this study used indicators of problem solving skills according to Polya.

## II. MATERIAL & METHODS

### A. Development Model

This research and development used the 4D Research and Development model by Thiagarajan and Semmel which consists of *Define*, *Design*, *Develop*, and *Disseminate* [17].

### B. Development Procedures

The development procedures conducted can be seen in the following flowchart.

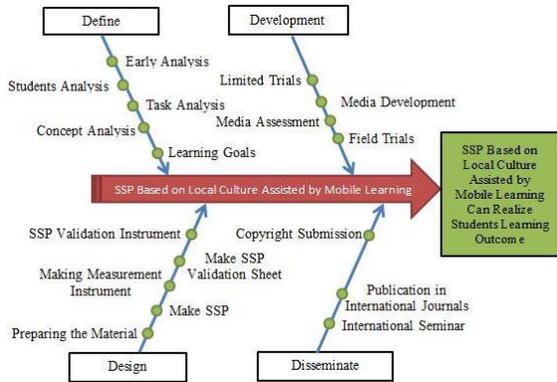


Fig. 1. Research Flowchart

C. Product Testing Design

The product test design included three stages, namely expert validation, consisting of expert lecturers, practitioner teachers and peers; empirical validation, a validation of the test instrument with the items being tested limited to students. After obtaining a valid and reliable SSP and test instruments through the analysis of test items, a field test was conducted to determine the learning outcomes profile of students.

D. Test Subject

The subjects of the research were the students of Class X MIPA in Muhammadiyah 1 Senior High School of Yogyakarta. Then, the limited test subjects test instruments included 332 students in high schools in Yogyakarta with high, medium and low categories.

E. Data Collection Technique

The data obtained were in the form of expert validation data consisting of SSP eligibility data, media feasibility, initial and final profile of learning outcomes of students. Therefore, the instruments used include: SSP study and validation sheets, media assessment sheets, test instruments for the *pretest* and *posttest*.

F. Data Analysis Technique

The data analysis technique used was based on the type of data obtained from the research, as follows:

1) Instrument Validity

a) Quantitative

The validity of the contents of items on the instrument was calculated using the Aiken's V formulation to find out the value of the content validity coefficient based on the results of assessments by a number of experts as many people as to the extent to which an item could represent the measured construct [18]. Aiken's V statistics are formulated as:

$$V = \frac{\sum s}{n(c-1)}$$

Information:

$$s = r - lo$$

lo = the lowest value of validity assessment

c = the highest value of validity assessment

r = the value given by an assessor

Then, the determination of the instrument validity category referred to the category proposed by Azwar as shown in the following Table 1 [19].

TABLE I. CRITERIA OF SCORE V CATEGORY

V Value	Categorization
> 0,35	Very Useful
0,21 – 0,35	Useful
0,11 – 0,20	Depends of Condition
< 0,11	Useless

b) Empirical

The empirical evidence of the score validity of the test results was then analyzed using the *partial credit model* (PCM) which is the development of the IRT 1 *parameter logistics* (1-PL) model. Data analysis included the goodness of fit items with the PCM model, establishing a test reliability index, estimating item difficulty levels, estimating ability parameters, and delineating total information function curves and *standard error measurement* (SEM) [20]. The test data were analyzed using the QUEST program to find out the items developed if they were fit for the PCM model. The rules of Adam and Khoo state that an item is fit for the PCM model if the mean value of INFIT MNSQ and its standard deviation and the value of INFIT t and its standard deviation meet the criteria in Table 2 below [21].

TABLE II. FIT ITEM CATEGORIES WITH PCM MODELS

No	Parameter	Limit
1	INFIT MNSQ	0,77 – 1,30
2	INFIT t	-2,0 – 2,0

The MNSQ INFIT value limits the distribution of calibrated scores and is still on the *Leptokurtic* curve which reflects that it is still in a state of *unity*.

The QUEST program can also be used to determine the reliability of test instrument reliability. The requirement for a good reliability estimate follows the opinion of Sumadi Suryabrata, where the test instrument that can be used has at least a reliability coefficient of 0.90 [22]. George and Mallery categorize the value of reliability as shown in Table 3 below [23].

(1)

TABLE III. RELIABILITY SCORE CATEGORY

Score Range	Category
$X \geq 0,9$	Excellent
$0,9 > X \geq 0,8$	Good
$0,8 > X \geq 0,7$	Acceptable
$0,7 > X \geq 0,6$	Questionable
$0,6 > X \geq 0,5$	Poor
$\leq 0,5$	Unacceptable

The reliability score can also be obtained from the analysis using Parscale program, seen from the graphic of total information.

c) *Descriptive*

The assessment of the developed SSP was analyzed using descriptive analysis with the following steps:

- a. Change the scale of the statement to a scale value of 0 and 1; No = 0 and YES = 1.
- b. Calculate the mean score of assessment using the following equation [24]:

$$\bar{X} = \frac{\sum x_i}{n}$$

(2) Information:

- $\bar{X}$  = Mean
- $\sum x_i$  = Total value X from  $i^{th}$  to n
- n = Total Individuals

The obtained mean value was then converted into 4 scales with the following procedures

- 1) Finding the ideal mean ( $\bar{X}_i$ ) and ideal standard deviation ( $SB_i$ ) with the following formulations:

$$\bar{X}_i = \frac{1}{2}(X_{maximum} + X_{minimum})$$

$$SB_i = \frac{1}{6}(X_{maximum} - X_{minimum})$$

- 2) Converting score into value with the criteria shown in Table 4 below [25]:

TABLE IV. THE 4-SCALE ASSESSMENT CRITERIA

Respondent Score	Category
$X \geq \bar{X} + 1.0 SBx$	Very High
$\bar{X} + 1.0 SBx > X \geq \bar{X}$	High
$\bar{X} > X \geq \bar{X} - 1.0 SBx$	Low
$X < \bar{X} - 1.0 SBx$	Very Low

2) *The Analysis of Media Assessment and Learning Outcomes Profile of Students*

The data of the results of media assessment and learning outcome profile of students were analyzed using descriptive analysis by calculating the mean assessment score, then the mean score was categorized according to the criteria in Table 4.

The effectiveness test was carried out using the *General Linear Model* (GLM). The improvement on learning outcomes of students can be seen in the *Mean Difference* section of the *GLM* output [26]. Then, to

find out the contribution of the developed SSP in improving learning outcomes can be seen in the *Partial Eta Square* of GLM output.

III. RESULTS AND DISCUSSION

A. *Define Stage*

In this stage, there was an initial diagnosis of physics learning carried out at Muhammadiyah 1 Senior High School of Yogyakarta. Based on the results of interviews with teachers, in learning physics, teachers have used the conventional SSP from the MGMP and also lectures and ideal problem solving as learning methods. Therefore, it is necessary to develop a local culture-based SSP of physics using edmodo applications, so that students can better understand the concepts of physics through the local culture used, so as to increase effectiveness in learning. The results of observation also show that students have a balanced/even ability to understand physics. Students also have a smartphone and can operate it well.

The materials used in this study were momentum and impulse, as in accordance with the basic competencies (KD), namely KD 3.10 and 4.10 and adjusting to the local culture used, namely pletokan (bamboo gun). The basic competencies were translated into ten indicators of learning achievement. Then, from the subject materials, it was determined for the existing concepts and planned for steps to deliver the concept through the developed SSP.

B. *Design Stage*

At this stage, a draft SSP was made which was developed in the form of syllabuses, lesson plans, LKPD, and assessment instruments in the form of items about problem solving skills tests and a learning independence questionnaire. Then, the measurement instruments were also made in the form of media assessment sheets and response questionnaires to the use of media by students and teachers, and also the SSP study sheets and validation sheets of measurement instruments. The SSP and measurement instruments were validated by expert lecturers, supervisors (practitioners), and peers so as to obtain the appropriate SSP and measurement instruments to use. If there are suggestions and input on the SSP and measurement instruments, revisions will be made immediately.

At this stage, there were also online learning activities made using the edmodo application. The material that contains the concepts was made in the form of Power Point (PPT) slides, word files and video learning, and was then uploaded to Edmodo. This application can be used anytime and anywhere as long as connected to the internet and mobile phone/smartphone, or can also be used using a PC or laptop.

C. Develop Stage

The draft SSP has been developed, reviewed and validated by seven experts, consisting of three expert lecturers, two practitioners/teachers, and two students of physics education. The study was conducted on the syllabuses, lesson plans, and LKPD that were developed. The aspects that have been carried out included: aspects of format, content, assessment, and language and writing, as well as the aspects of benefits. Validation was carried out on the instrument of problem solving skills tests and student learning independence questionnaire.

The results of the study on the syllabuses showed that the syllabuses had a mean score of 19 from the range of 0 to 20 which refers to Table 4, categorized as very high. The results of the study on the lesson plans showed that the lesson plan developed had a mean score of 33 from the range of 0 to 35 which refers to Table 4, categorized as very high. The results of the study on LKPD showed a mean score of 18 from the range of 0 to 20 which refers to Table 4, categorized as very high. Thus, the learning tools from the developed SSP are appropriate to be used as guidelines for the implementation of learning activities.

The items on problem solving skills and the learning independence questionnaire were also validated by seven experts before being used to take measurements. The validation results were analyzed quantitatively using equation (1). The results of the analysis of problem solving skills items had an Aiken's coefficient value ranged from 0.76 to 0.95, so that all items were declared valid and very useful as referring to Table 1.

The items which had been validated by experts, were then tested on 332 respondents from 4 Senior High Schools in Yogyakarta Special Region (DIY). The test results in the form of dichotomous data in 2 categories were analyzed according to the Rasch's model. The results of the test suitability analysis seen through the INFIT parameters for Mean Square (MNSQ) and INFIT t indicate that the physical problem solving skills test instrument meets the statistical fit criteria according to the Rasch model which is fully presented in Table 5. The results of the analysis of 25 test items developed had an INFIT MNSQ value ranging between 0.77 and 1.30, so that all test items were declared fit or match the Rasch's model.

TABLE V. THE PARAMETER OF TEST STATISTICS FIT AT THE LEVEL OF CHANCE OF 0.5

No	Test Parameter	Estimated Items	Estimated Case
1	INFIT MNSQ	1,00 ± 0,04	1,00 ± 0,16
2	OUTFIT MNSQ	0,99 ± 0,17	0,99 ± 0,37
3	INFIT t	0,00 ± 0,78	0,10 ± 0,51
4	OUTFIT t	0,00 ± 1,04	0,12 ± 0,60
5	Mean Difficulty	0,00 ± 0,81	
6	Estimate Reliability	0,95	

The reliability values of the items were analyzed using the *Classical Test Theory* (CTT) theory and the modern *Item Response Theory* (IRT). The reliability value, according to classical test theory, can be seen in the reliability estimate of 0.95. This shows that the items are reliable. The reliability value according to IRT can be seen through the *Total Information Curve* (TIC) graph as shown in Figure 2, which shows that the items are reliable if used for students with abilities of -1.2 to 3.8 on the logit scale. Items that have been declared valid and reliable were then uploaded to the Edmodo application to be used as materials for *pretest* and *posttest*.

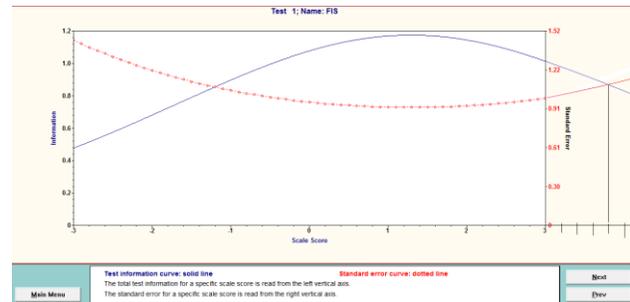


Fig. 2. Total Information Curve (TIC) of Test Instrument

Items that have been declared valid and reliable were then uploaded to the Edmodo application to be used as materials for *pretest* and *posttest*. Edmodo application that has been completed with additional valid and reliable test questions, was then assessed to determine the feasibility of instructional media. The results of the media assessment were then analyzed using a standardized mean equation, obtained an average value of 118 from a range of 35 to 140, and referred to Table 4, categorized as very high. Thus, it can be concluded that the Edmodo media is feasible to support learning activities.

The validated SSP was then used for field test at Muhammadiyah 1 Senior High School of Yogyakarta, in which the test subjects were the students of Class X MIPA 1, X MIPA 2, and X MIPA 3. The results of the field test obtained the scores of pretest and posttest on problem solving skills. Then the results were analyzed to determine the effectiveness of the SSP that has been used.

The effectiveness of the use of edmodo-assisted local culture-based SSP was tested using *One-way Multivariate Analysis of Variance* (one-way MANOVA) test that was preceded by normality and homogeneity tests as prerequisite tests. Normality test can be seen from the relationship between

Class			Mahalanobis Distance	Chi
Experiment	Mahalanobis Distance	Pearson Correlation	1	,996**
		Sig. (2-tailed)		,000
		N	31	22
	Chi	Pearson Correlation	,996**	1
		Sig. (2-tailed)	,000	
		N	22	22
Contrast 1	Mahalanobis Distance	Pearson Correlation	1	1,000**
		Sig. (2-tailed)		,000
		N	31	27
	Chi	Pearson Correlation	1,000**	1
		Sig. (2-tailed)	,000	
		N	27	27
Contrast 2	Mahalanobis Distance	Pearson Correlation	1	,999**
		Sig. (2-tailed)		,000
		N	31	20
	Chi	Pearson Correlation	,999**	1
		Sig. (2-tailed)	,000	
		N	20	20

mahalanobis distance and chi square with posttest data for each class. The normality test results of the experiment, contrast 1 and contrast 2 classes can be seen in Table 6,

TABLE VI. RESULTS OF NORMALITY TEST

Based on Table 6, the significance value of two tailed is  $0,000 < 0,05$ . The significance value is in the starting region  $H_0$  so that it can be concluded that the data from the experimental class and contrast class 1 and 2 come from normally distributed samples.

The next prerequisite test was the homogeneity test. Homogeneity test is used to determine the homogeneity of data. The data used to test the variance homogeneity were the pretest data. The analysis of the homogeneity test results is shown in Table 7.

TABLE VII. THE RESULTS OF HOMOGENEITY TEST

	F	df1	df2	Sig.
KMPPretest	1,125	2	90	,329

The homogeneity test used was *Levene's test*. Based on Table 7, the significance value of problem solving skills is 0.329. The significance value obtained is greater than 0.05, so it is in the  $H_0$  reception area so that variations in the value of problem solving skills and learning independence for the experimental and contrast classes are homogeneous.

After all the prerequisite tests were met, the data of problem solving skills and students' learning independence were analyzed by using MANOVA. The first hypothesis was to determine whether there is an interaction between the *pretest-posttest* scores in the experiment, contrast 1, and contrast 2 classes using *general linear model* (GLM) analysis in the *Test of Within-Subject Effect* as shown in Table 8.

TABLE VIII. TEST OF WITHIN-SUBJECT EFFECT

Source		df	Mean Square	F	Sig.
time * Class	Sphericity Assumed	2	1366,903	19,463	,000
	Greenhouse-Geisser	2,000	1366,903	19,463	,000
	Huynh-Feldt	2,000	1366,903	19,463	,000
	Lower-bound	2,000	1366,903	19,463	,000

Table 8 shows the significance value lower than 0.05. This shows the significance of being in the rejection area of  $H_0$  so that there is an interaction between time (pretest-posttest) and Class (experimental, contrast 1 and contrast 2) [26]. The interaction between time and class shows that there is a significant change in the value of the pretest and posttest among the three classes.

The second hypothesis was to find out whether there is an increase in the scores of problem solving skills in the experiment, contrast 1 and contrast 2 classes using GLM by looking at the mean difference and the significance of the *pairwise comparison* output as shown in Table 9.

TABLE IX. PAIRWISE COMPARISON OF PROBLEM SOLVING SKILLS

Class	Time		Mean Difference (I-J)	Std. Error	Sig. <sup>b</sup>
	(I)	(J)			
Experiment	Pretest	Posttest	-30,871	2,129	,000
Contrast 1	Pretest	Posttest	-12,806	2,129	,000
Contrast 2	Pretest	Posttest	-17,387	2,129	,000

Table 9 shows the significance value of the three classes lower than 0.05, so it is in the rejection area of  $H_0$  which means there is an increase in the score of problem solving skills in each class. Then, the *Mean Difference* (MD) value of the experimental class has the

highest negative value (MD = -30,871). This shows that the experiment class has improved scores higher than those of contrast 1 and contrast 2 classes.

Information about effective contributions made by each class to the improvement of problem solving skills can be seen in Table 10.

TABLE X. MULTIVARIATE TEST OF PROBLEM SOLVING SKILLS

Class		F	Sig.	Partial Eta Squared
Experiment	Hotelling's trace	210,329	,000	,700
Contrast 1	Hotelling's trace	36,196	,000	,287
Contrast 2	Hotelling's trace	66,720	,000	,426

Based on Table 10, the experiment class uses the SSP with full guidance by the teacher contributed 70% to improve problem solving skills, while the contrast 1 class uses the SSP with partial guidance by the teacher and contrast class 2 uses the SSP without getting guidance by the teacher which give contributions of 28.7% and 42.6%, respectively. This shows that the experiment class gave the greatest effective contribution when compared to the contrast 1 and contrast 2 classes.

#### D. Disseminate Stage

In this stage, the results of the research were written into articles to be submitted to two international journals, one of which was JEGYS and was included in the ICRIEMS international seminar, and ICERI international seminar. Then, the developed SSP was made into a prototype and registered for its Intellectual Property Rights (IPR). persons located between 0.5m to 4.5m from the sensor (see Fig. 6). Despite some range and accuracy limitations, the Kinect Sensor has been employed in a multitude of applications in health care with notable potential in making therapy and alert systems financially accessible and medically beneficial to a large population [20]. For our purpose, its field of view of 70x 60 degrees and depth accuracy of about 1cm [19], is in theory accurate enough to compute the considered fitness test metrics.

#### IV. CONCLUSION

The Edmodo-assisted local culture-based SSP is appropriate to use based on the results of the feasibility assessment by the seven experts using the 4-scale 4 standards with very good category. The content validation of the test instruments in the developed SSP showed that the test instrument was valid with Aiken's coefficient V value ranging between 0.76 to 0.95 and all items were in accordance with the MNSQ INFIT and INFIT values in accordance with the Rasch's model. Based on the TIC graph, the test instrument is reliable if

it is used on students with abilities of 1.2 to 3.8 on the logit scale. Edmodo-assisted local culture-based SSP can improve problem solving skills in Physics at Muhammadiyah 1 Senior High School of Yogyakarta. The effective contribution of the SSP was developed to improve problem-solving skills by 70% based on *Partial Eta Squared* in *Multivariate Test* output.

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