Journal of Physical Education and Sport ® (JPES), Vol. 22 (issue 12), Art 385, pp. 3044-3050, December 2022
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

The development of scientific methods for teaching elementary physical education

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Published online: December 25, 2022
(Accepted for publication December 15, 2022)
DOI:10.7752/jpes.2022.12385

Abstract:
This study aimed to develop and test a learning model relevant to the needs and characteristics of physical education teachers. The study method was based on the model developed by Borg and Gall. Data were collected via observations, interviews, and questionnaires. The research subjects were 24 physical education teachers in elementary schools located in East Java Province, namely Blitar Regency, Nganjuk Regency, and Pasuruan Regency. The selection of this location was based on two aspects. First, in this area, there is a continuous program for the development of physical education teachers to carry out learning. Second, the needs analysis results show the urgency of implementing a scientific method-based learning model, and the competence of teachers for this purpose is still inadequate. The results of the study indicate that the appropriate learning models with scientific method teaching include project-based learning, problem-based learning, and discovery learning. The learning model in this study showed significant increases in the large group trials of the three learning models at percentages of 76.59% for discovery learning, 78.68% for project-based learning, and 75.55% for problem-based learning. The analysis of these learning tools at the elementary school level showed that the models are feasible for use in the learning process. However, for their implementation, they should be adjusted to the conditions and situations of each school. This learning product can be further developed by adjusting the format of the learning device with the applicable regulation. This research can be continued at a higher level, such as in junior high school or high school, according to the needs.
Key Words*:* **physical education, learning models, project-based learning, problem-based learning, discovery learning**

Introduction

Scientific methods have been introduced in Indonesian education through the 2013 curriculum policy (Kemdikbud, 2014). Scientific methods are believed to improve student's critical thinking skills (Lieung et al., 2020) and problem solving in the real world (Lieung et al., 2019). This is based on the many studies in Indonesia that have focused on using this method in several subjects, including biology (Hasanah & Suyanto, 2021), physics (Arini, 2020), mathematics (Marlissa & Untayana, 2018), history (Ratnasari et al., 2020), and english (Sarwanti, 2016). Several studies have also proven that scientific methods can improve learning outcomes (Firman et al., 2018), interest in learning (Yusup et al., 2021), analysis skills (Yuniarti et al., 2018), problem-solving abilities (Roheni et al., 2017), critical thinking, and understanding of concepts in science (Syarifuddin, 2018).

Although many studies have identified the benefits of the scientific method, physical education, which is learning through motion, has not explored many guidelines for implementing the scientific method for teachers (Myroslava, Olha, Iryna, & Victoria, 2017). Research related to physical education learning that uses scientific methods is still limited to experimental research that has examined the positive effect of its application on student development (Sinulingga et al., 2020; Tarigan et al., 2017). However, no studies have specifically provided lesson plan guidelines for physical education teachers from recommended learning models via scientific methods, such as project-based learning (PjBL), problem-based learning (PBL), and discovery learning (DL).

The current condition is that many teachers still have difficulty using scientific methods in their classrooms (Murni et al., 2019; Nenotaek et al., 2019; Biletska, 2018). This is even though the teacher's implementation of education plays an important role (Kaur, 2019). The teacher's role in learning is a key factor for student development (Blazar & Kraft, 2017). The role of physical education teachers in the learning process is to motivate children to have a healthy lifestyle (Norboev, 2021). The movement activities provided in physical education can be used as a strategic center to promote motor development in children (da Silva et al., 2022). Several research results indicate that physical education teacher performance still needs improvement. Wang & Ha (2009) concluded that the productivity and quality of the work of physical education teachers is still lacking. The scientific method introduces several learning models that support students learning to solve problems: project-based learning, problem-based learning, and discovery learning. Indahwati, Tuasikal, & Ardha (2019)

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showed that the project-based learning model can encourage students to recognize ways of learning and collaborate in groups to find solutions to problems in the real world, can make learning situations more interesting, and can train students by designing skills learning. Other research shows that the problem-based learning model in physical education could improve the learning outcomes of class VII C students of SMP Negeri 4 Abiansemal. Students positively responded to the model's implementation because student participation appeared to be active, and a pleasant learning atmosphere was realized (Sukarini, 2020). Other studies showed that the discovery learning model can improve creative thinking skills through physical education learning in schools (Dupri et al., 2021).

Based on the problems above, it is necessary to develop a physical education learning model based on scientific methods, which include PjBL, PBL, and DL models. This model can later be used as a guide for teachers to carry out quality physical education learning. The learning guide developed is in the form of a learning implementation plan.

Materials & methods

The procedure used in this study is based on ten steps developed previously (Gall et al., 2003). Based on the characteristics of the problem, local context, and research objectives, the procedure was modified into seven steps: (1) needs analysis, (2) initial product development/prototype, (3) expert test, (4) revision and confirmation by experts, (5) small-group trial, (6) large-group trial, and (7) reporting and dissemination.

The research subjects were 24 physical education teachers in elementary schools located in East Java Province, namely Blitar Regency, Nganjuk Regency, and Pasuruan Regency. The selection of this location was based on two aspects. First, in this area, there is a continuous program for the development of physical education teachers to carry out learning. Second, the needs analysis results show the urgency of implementing a scientific method-based learning model, and the competence of teachers for this purpose is still inadequate. To validate the initial model, four experts were involved, namely, lecturers who are curriculum and learning technology experts, physical education learning experts, and two physical education practitioners/teachers who have met academic qualifications and who have a reputation, achievements, and teaching experience.

The selection of teachers involved in this study was done via the simple random sampling technique. This technique was used because the population studied are teachers who have undergone continuous pedagogical development, so they have relatively homogeneous competencies in teaching. Data were collected via interviews, observations, and questionnaires. Interviews were used during needs analysis to identify and formulate the problems. Interviews were also used to explore the teacher opinions about the development and application of the model, while observation was used to collect data about teacher performance when practicing the learning model that had been developed (lesson study). Questionnaires were used during the needs analysis and during the assessment of the developed model.

The data analysis technique for this study involved quantitative and qualitative analysis. To analyze quantitative data, descriptive statistics, namely percentage analysis, was implemented via the following formula.

$$P = \frac{f}{N} x100\%$$

To determine the significance of the score from the percentage analysis, a conversion was made to the standard developed by Akbar & Sriwiyana (2011).

Table 1. Score Significance Norms

Percentage	Category	Meaning
75.01–100%	Sangat Valid	Digunakan Tanpa Revisi
50.01–75.00%	Cukup Valid	Digunakan Dengan Revisi Kecil
25.01–50.00%	Tidak Valid	Tidak Layak Digunakan
00.00–25.00%	Sangat Tidak Valid	Terlarang Digunakan

Qualitative data analysis includes three activities: (1) data condensation, (2) data display, and (3) conclusion drawing/verification (Miles and Huberman, 2014). Data condensation involves selecting, focusing, simplifying, abstracting, and converting/compiling data from interviews into complete sentences to make the data more meaningful. Data display is an activity of organizing and compiling data so that it is easy to understand and make conclusions about. Conclusion drawing/verification is the concluding activity of formulating findings in accordance with the research problem.

Results and Discussion

The first activity in this study was a needs analysis. The results obtained indicate that: (1) all teachers in this research area already have an educator certificate, (2) the 2013 curriculum (K13) is used as a reference in learning, (3) the RPP for physical education is compiled and refers to the classroom teacher so that the characteristics of physical education are not reflected properly, (4) learning models of discovery learning, problem-based learning, and project-based learning have not been understood, so in practice, learning does not refer to these three models, and (5) all respondents need coaching to improve their ability to organize learning in accordance with K13. In general, physical education teachers need practical examples for applying scientific

methods-based physical education learning as stated in the K13 curriculum.

Initial product development was based on a study of related theories and considered the aspirations of physical education teachers. This was done so that the product fits the needs of teachers, can be a solution to existing problems, and can be practiced in schools. The product developed was in the form of lesson plans, which include teaching materials and monitoring, and evaluation guides. The RPP developed was in the format stated in Permendikbud No. 22 of 2016. The learning lesson plans based on the project-based learning, problem-based learning, and discovery learning models have differences from the previous lesson plans, namely the learning steps section must bring up the syntax (the entire flow of learning activities that reflect the teacher's actions and student tasks in achieving goals). Teaching materials are descriptions that are more than learning materials. The components of teaching materials in this product include titles, descriptions of materials containing general explanations, and special descriptions in sub-chapters, which are equipped with pictures or illustrations to help understand the material, and guidelines for monitoring and evaluation. This monitoring and evaluation guide contains the instruments used to implement learning. The M&E guide that has been developed has three instruments: monitoring instruments for learning devices, implementing learning, and evaluating learning models for project-based learning, problem-based learning, and discovery learning in physical education subjects. Expert assessment of the initial product resulted in the following data.

Table 2. Feedback from Validators

No.	Subject	Rating and Feedback
1	Curriculum Expert	1. 1. Learning resources are sought in electronic form, such as media-based, video, ppt files, and e-books. 2. 2. The learning method is adapted to the learning objectives. 3. 3. Learning to use technology that makes it easier for students to understand and practice movement tasks 4. 4. Basic competencies are used as the main reference, as described in the learning objectives with steps adapted to the developed model's characteristics. 5. 5. This research needs to be rushed because it is very urgent, and physical education teachers can use the results.
2	Physical Education Learning Expert	Learning implementation plan for problem-based learning 1. 1. Learning implementation plan so that 5M appears in the learning step 2. 2. Basic techniques in learning are adapted to KD. 3. 3. The assessment is adjusted to the assessment standard of Permendikbud number 28. 4. 4. Application in games to achieve competence at the end of learning 5. 5. Assessment of the classified attitude aspects related to the material 6. 6. The use of tools is adjusted to the class level and the conditions of the facilities and infrastructure. Learning implementation plan for discovery learning 1. 1. Learning implementation plan so that 5M appears in the learning step 2. 2. More specific basic competency indicators 3. 3. Attitude assessment is indicated by every aspect, such as honesty and cooperation 4. 4. Material in syntax to be clarified 5. 5. Activities in learning to be clarified 6. 6. Learning steps to provide a picture of each activity Learning implementation plan of project-based learning 1. 1. Learning implementation plan so that 5M appears in the learning step 2. 2. Formulation of goals is adjusted to four benchmarks. 3. 3. The project is described in the teaching materials. 4. 4. Lower grade class to be reproduced as a game for learning 5. 5. Innovation in modifying the game
3	National Instructor Expert	1. 1. Basic Competence assessment is adjusted to Permendikbud. 2. 2. Assessment of knowledge aspects can use a multiple-choice form with minimum questions at the C4 level, namely analyzing 3. 3. Criteria in each assessment to be explained clearly 4. 4. The formulation of learning objectives must contain the principles of ABCD (audience, behavior, condition, and degree). 5. 5. Teaching materials are arranged according to the competency achievement indicator material.

Based on the experts assessment and input (Table 2), product revision was then carried out, and the revised results were returned to the expert to confirm or approve the product revision according to the expert's assessment. Small-group trials assessed product readiness before they were tested on larger groups. The following shows the results of the small-group trials.

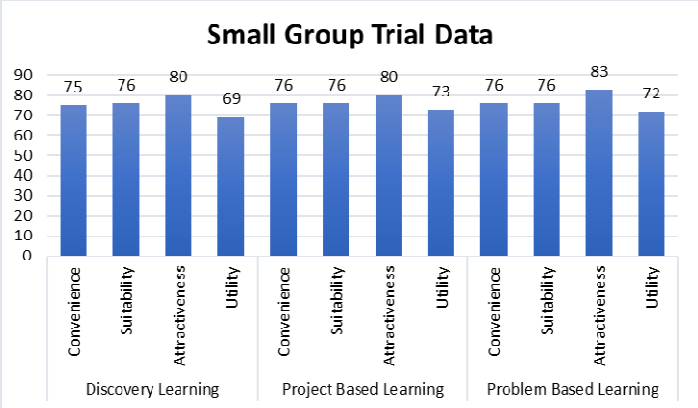

Figure 1. Small-group Trial Data

As shown in Figure 1, in general, the level of attractiveness of this model was ranked first. This shows that the model developed is very interesting for further study. Meanwhile, the usefulness of the model was ranked the lowest, meaning that physical education teachers did not fully understand or feel the usefulness of the developed model. Aspects of the ease and suitability of the model were ranked second and third. Three aspects could be categorized as very well, namely convenience, suitability, and attractiveness, while the usability aspect was in the good category. The data from the large-group trial is presented in Figure 2.

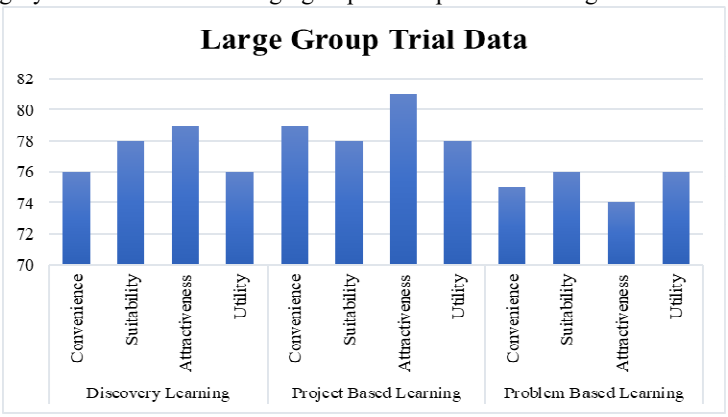

Figure 2. Large-group Trial Data

The level of attractiveness was the highest for DL and PJBL, while in the PBL model, the highest ranking was for the suitability and usability aspects. In the DL model, the suitability aspect was ranked second, while in the PJBL model, the second rank was occupied by the convenience aspect. These data show that the attitude of physical education teachers to the developed model varies widely.

Difficult Syntax

In the implementation of the product in the form of guidelines for learning devices based on these three models, there was a syntax for each learning model. The syntax was translated into a form of learning activity (Table 3).

Table 3. Learning Model Syntax

Discovery Learning	*Problem-based Learning*	*Project-based Learning*
Giving Stimulus	Student Orientation on Problems	Determination of a Project
Problem Statement	Organizing Students	Project Completion Steps Planning
Data Collection	Guiding Observation	Preparation of Project Completion Schedule
Data Analysis	Developing and Delivering Results	Project Work
Validation	Analyzing and Evaluating the Problem-solving Process	Report Preparation and Project Presentation
Conclusion		Activity Evaluation

Data data in the form of a syntax were difficult to develop, namely from the distribution of questionnaires after the product was tested on large groups. Then, the data were processed using the percentage analysis formula and shown in Figure 3.

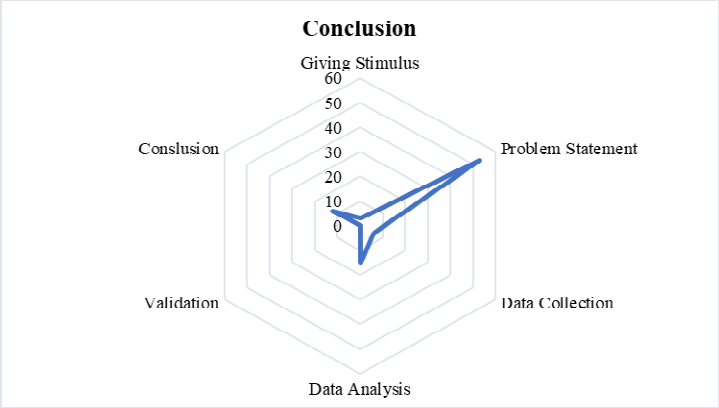

Figure 3. Difficult Syntax for Discovery Learning

One obstacle faced by educators when teaching using this model was the tendency to bring up problems that should be solved when students are taught via the discovery learning model, and this is based on the data presented in the Figure 3 of the highest percentage of difficulty being 53% for problem statement syntax. Other syntax difficulties experienced by educators were the syntax of giving stimulus at 3%, collecting data at 6%, processing data at 15%, and drawing conclusions at 12%. On the other hand, one syntax could be performed by educators without difficulty, namely the syntax of validation at 0%.

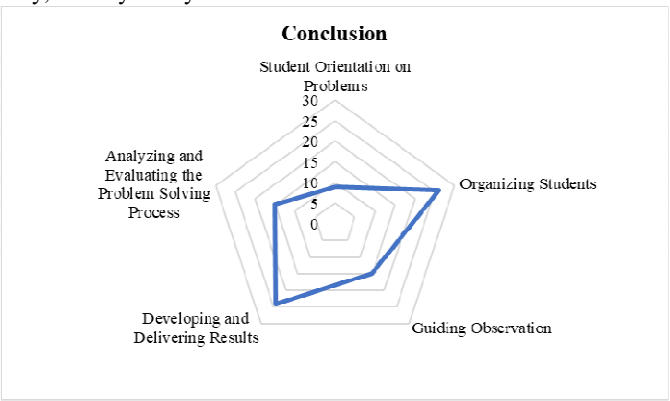

Figure 4. Difficult Syntax for Problem-based Learning

Based on the data in the Figure 4, all the syntax of the problem-based learning model show the level of difficulty experienced by educators when teaching. The highest difficulty experienced by educators was in organizing students with a percentage of 26%. Other syntax difficulties experienced by educators included orientation of students to problems at 9%, guiding investigations at 15%, developing and presenting results at 24%, and analyzing and evaluating problem-solving processes at 15%.

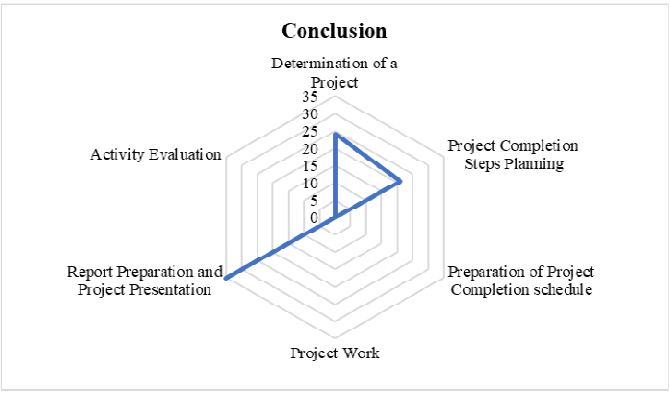

Figure 5. Difficult Syntax for Problem-based Learning

Learning with the project-based learning model was felt by some educators to improve the quality of teacher professionalism in physical education, but not all educators could implement this due to limited time, facilities and infrastructure, and different student inputs. Forms of learning innovation are needed, but not all educators can provide this via teaching materials in their teaching. Therefore, there needs to be an exchange of ideas because not all students can put their work into writing and present it. Based on the diagram above, it can be concluded that teachers experience the most serious difficulty in preparing reports and presenting projects at

35%. Other difficulties are in determining the project at 24% and planning the steps for completing the project at 21%.

The products developed are learning tools for use in lesson plans, teaching materials, and monitoring and evaluation guides. The learning implementation plan developed is in the format stated in Permendikbud No. 22 of 2016. The plan for implementing learning models based on project-based learning, problem-based learning, and discovery learning differs in the RPP section, which is in the learning steps section. This is because in the learning steps, several syntaxes for each model must be raised and described to create learning activities. Applying this lesson plan in accordance with the trial results can help teachers encourage students to be actively involved in learning. Students are enthusiastic and are encouraged to develop cognitive and psychomotor abilities via learning. Elementary school students have several characteristics, namely, the students like to play, move actively, do activities in groups, and carry out practical activities directly (Burhaein, 2017). Teaching materials that have been developed can assist teachers in implementing lesson plans via learning activities. The components of the teaching materials in this product contain the following:

- The title of this teaching material is in accordance with the material in the learning implementation plan.
- The learning objectives contain expectations for students by the teacher after delivering teaching materials.
- The content description contains an explanation of the material, sub-chapters, and content descriptions of the material in accordance with sub-chapters, pictures, or illustrations to help students understand the material.

Another product is a monitoring and evaluation guide. This guide contains the instruments used for implementation of learning. The M&E guide developed has three instruments: an instrument for monitoring learning devices, implementing learning, and evaluating the learning models of project-based learning, problem-based learning, and discovery learning in physical education subjects. However, in applying this RPP product, not all syntax in the three learning models can be implemented for learning.

Conclusions

The findings show that the product is feasible for use in the learning process in schools. Implementing the product in the form of learning tools based on the learning models in this study had a positive effect, namely, the teachers felt that they helped in making learning tools designed explicitly for physical education learning. The learning models of project-based learning, problem-based learning, and discovery learning can be used by teachers to help students in the problem-solving learning process to trains students' cognitive abilities, and this learning model can create active and fun learning. However, this study has some limitations, i.e., the product developed in this study can only be implemented in elementary schools. The application of learning tools is adapted to the conditions and situations of each school. One suggestion is that this learning product can be further developed by adjusting the format of the learning device with the applicable Permendikbud. Then, this research can be continued at a higher level, such as in junior high school or high school, according to the needs. The effectiveness and efficiency of this product can be determined by conducting further research using the ten steps from Borg and Gall.

Conflicts of interest

The authors declare that there are no conflicts of interest.

Acknowledgment

The author would like to thank the Universitas Negeri Malang for providing research grants and Falcon Scientific Editing (https://falconediting.com) for correcting the English in this paper.

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