# Erawan Handhika

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**Submission date:** 03-Mar-2023 12:43PM (UTC+0700)
**Submission ID:** 2027741653
**File name:** Handhika_2018_J._Phys.__Conf._Ser._1013_012028.pdf (433.41K)
**Word count:** 3954
**Character count:** 22634

Journal of Physics: Conference Series



# The influence of project-based learning on the student conception about kinematics and critical thinking skills



# The influence of project-based learning on the student conception about kinematics and critical thinking skills

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**Abstract**. This research revealed the influence of project-based learning (PjBL) to increasing the level of the conception. The research method used the pre-experimental design with one group pre-test post-test. PjBL applied to students of physics education program of IKIP PGRI Madiun (23 Students). The test used to determine the level of conception is multiple choice tests and index of certainty. Activities on PjBL described. Obtained that the PjBL model can increase the level of conception and Critical thinking skills with the average normalized gain 0.49 and 0.57 (Medium category). It can be concluded that the PjBL could improve the level of conception and critical thinking ability of the students. Implementation of each model phase following learning objectives and needs analysis is the key to improve both.

## 1. Introduction

Project-based learning (PjBL) is a student-centered model integrated with real-world issues and activities [1]. This model also uses the project/activity [2] as the core of learning. In addition to the project/activity, the emphasis on problem finding is also an orientation of the PjBL model [3]. Projects in the PjBL model can be products, publications, or presentations [4]. The PjBL model can enhance abstract thinking and gain understanding. In PjBL, make judgments, interpret, and synthesize information in meaningful ways [1]. This process is a representation of adult learning system. PjBL also put forward the inquiry consisting of authentic questions and carefully designed products and tasks [5]. PjBL oriented to the problems in the form of questions that serve to guide learning activities.

The implementation of PjBL has made learning more enjoyable [6]. Through PjBL, students are not only more confident with their understanding of the material but also gain experience in the process of designing and manufacturing innovative activities [6]. The PjBL model has student-oriented activity characteristics and the opportunity to solve interdisciplinary problems. The PjBL model allows activities performed outside the classroom. The work done leads to teamwork, students learn to work as researchers, with tools, technologies, and materials. The student group has an opportunity to present the work [7]. PjBL can develop student thinking, to create solutions, to develop cooperation, to find available sources of reference, present findings and conduct evaluations of findings independently or in groups [8].

PjBL is concerned with the interest and motivation of learning [9]. Project tasks arise from questions that are sometimes unrelated verable by memorization, thus requiring active student involvement [9]. Through PjBL, students have a cl understanding of the concepts of physics and can indirectly change their perceptions of physics to be more positive and able to connect the concepts of physics into real life situations.

The core of PjBL is the project and some included in other activities. In addition to the project, the orientation of questions in the PjBL model is presented in various forms. [10], using case studies in directing learning activities, [11] using needs analysis before asking questions. The PjBL model has advantages and disadvantages. The advantages of the PjBL model according to [5, 12] are: (1) improving learning motivation, (2) improving problem-solving skills, (3) enhancing learning activities (4) enhancing collaboration (5) for developing and training communication skills, 6) Improve resource management and re ence skills, (7) provide experience in organizing projects, (8) engage students in learning to retrie information and demonstrate their knowledge, then implemented with the real world. The weaknesses of the PjBL model include: (1) It takes a lot of time, (2) requires considerable cost, (3) the amount of equipment to be supplied [13].

Conceptions and misconceptions are problems because students do not understand the concept well. It has been extensively researched by physics and physics education researchers [14 - 17]. The representation of graphic and visual concepts into verbal / text becomes one of the emerging problems [16, 18,19]. A solution is needed to solve this problem. Mathematical language in physics learning needs to be introduced, both in learning the concept of demonstration and experimental activities. The PjBL model enables the students to design experimental activities and simulations that may involve the language of mathematics. Critical thinking skills are one of the key elements in PjBL [20]. PjBL learning is effective for improving students' critical thinking skills [21]. Students are encouraged to become self-employed, critical thinkers, and lifelong learning [1]. The PjBL model can improve critical thinking skills only if the project Tasks structured by demanding thoughtful, reflective thinking, students should be shown critical examples of thought, and given feedback on group discussions.

## 2. Methods

The PjBL model applied on the exper ent class. The PjBL ph e adapted from [22]. Conception test and critical thinking provided through pre-test and post-test. The method used the pre-experimental with one group of pre-tes post-test [23-25]. Samples used are 23 students who take the basic physics education courses at physics education program of IKIP PGRI Madiun. Data analysis of conception level using qualitative descriptive analysis. The conception test instrument is a multiple choice with five choices for each question equipped with a level of certainty with seven choices. This instrument measures the level of student conception. A critical thinking test is also given. The qualitative analysis uses conception level categories [26] to classify student conceptions. The case, Level 3* is discussed in this research.

**Table 1.** Category of Student Conception Level 1

| **Category** | **Level 1** | **low degree of certainty ($K \leq 2$)** |
|---|---|---|
| Not knowledgeable about concepts | Level 1a | The correct answer, low degree of certainty, the students guess the answer |
| | Level 1b | Incorrect answer, low degree of certainty, the students have no knowledge of concepts |

**Table 2.** Category of Student Conception Level 2

| Category | Level 2 | Medium degree of certainty 2 <K < 5 |
|---|---|---|
| Little knowledge about concept | Level 2a | The correct answer, medium degree of certainty, the students have a chance to guess the answer or have little knowledge about the concept |
| | Level 2b | Incorrect answers, medium degree of certainty, the students have a chance to guess the answer or have little knowledge of the concept |

**Table 3.** Category of Student Conception Level 3

| Category | Level 3 | High degree of certainty K ≥5 |
|---|---|---|
| Misconception | Level 3* | Incorrect answer, high degree of certainty, Student experience misconception (Special Case) |
| Students understand the Concept | Level 3 | The correct answer, high degree of certainty, Students understand the concept |

To know the increasing of conception to know the increasing of conception level and Critical thinking skill, an analysis of pre-test and post-test score conception test and Critical thinking skill was performed. Used normal gain scores to determine the improvement of critical thinking skills following equations [27].

$$\langle g \rangle = (\%\langle Sf \rangle - \%\langle Si \rangle)(100\% - \%\langle Si \rangle)^{-1} \quad (1)$$

where %<Sf> and %<Si> are the percentage finals (post) and initial (pre) class averages.

## 3. Results and Discussion

Concept test results that the student (level 3) has increased, while the other level has decreased (Figure 1).

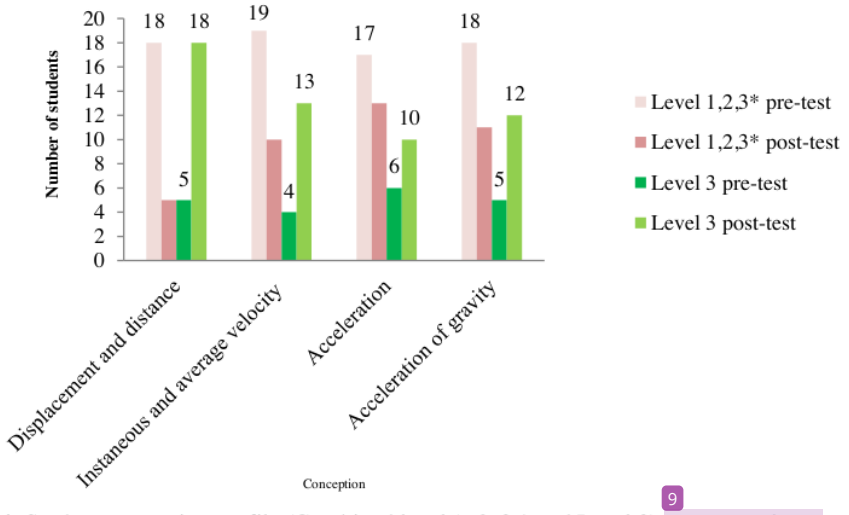


**Figure 1**. Student conception profile (Combined level 1, 2, 3 * and Level 3) pre-test and post-test

Based on Figure 1 it shows that students at level 3 increase in all components of conception, whereas students at the level of 1, 2, 3 * decrease at all levels of conception. This decrease in the level of 1, 2, 3 * gives information that there is a change of conception from students who are not and have little knowledge about the concept of being understanding the concept. Concept level-specific profiles (Figure 2.) provide information that level 3 * was informed.

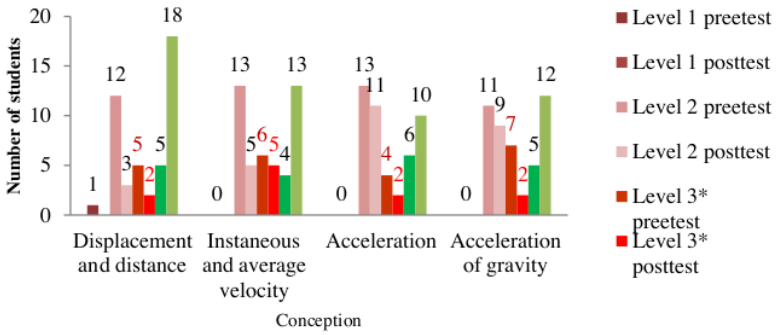


**Figure 2.** Student conception level profiles (Level 1, 2, 3 * and 3) pre-test and post-test.

Base on Figure 2, the students, experienced a misconception the concept of displacement and distance, six students, the concept of average velocity and instantaneous velocity, four students experiencing zero acceleration misconception and constant acceleration, and seven students experiencing misconceptions about the concept of gravitational acceleration (Figure 2). Misconceptions about the concept of displacement and distance arise because the students have a conception that distance and displacement are the same. This result is similar to the studies undertaken by [28 - 30]. The student's experience in doing physics affects the student's conception. The distance magnitude can be equal to the displacement, but only under certain conditions. The same misconception also arises in the concept of instantaneous velocity and average velocity. This result is the same as the research done by [29]. Knowing mathematical equations without knowing their physical meaning can lead to misconceptions. Misconceptions will be more difficult to eliminate when every matter of physics is done with the same equation without knowing their physical meaning, and the result is right or declared true by the person assumed by the student as an expert.

In the concept of zero acceleration and constant acceleration, students have difficulty in distinguishing the two terms. The results of extracting information through questions and answers with students provide information that they recognize the term constant as “no change”; Zero is also interpreted equally so that constant and zero are equal. Intuitive zero appears in this issue. Other research results provide information that students do not understand that zero acceleration is generated by a constant velocity [29]. The next misconception about the acceleration of gravity influenced by mass. This conception arises because students have the experience Student dropped objects on his body, bigger masses are more painful than lesser mass. The feeling that produces a non-scientific analogy and leads to misconceptions. Through student project activities both experiment and simulation can reduce this misconception. Activities in the PjBL phase are used to reduce misconceptions (Table 4).

**Table 4.** Example Activities in the PjBL phase in reducing misconceptions and increasing critical thinking skills

| PjBL Phases | Examples of activities for: | |
|---|---|---|
| Relating problems with everyday life | Reduce Misconceptions by connecting the concept of moving house or moving boarding | Identify issues independently of the concept of displacement and distance based on experience |
| Plan the project | Planning the project used to prove the mass affects the magnitude of gravitational acceleration through group discussion | Analyze the design arguments presented by students in group |
| Discuss and gather information | Gathering information about the design of projects, the amount of physics that will be made variable in the experimental and simulation activities, indirectly students discuss mathematical equations | Evaluate the credibility of the literature review information |
| Discuss criteria and evaluation | Determining indicators of project success, one of which is conformity with the concept of physics | Evaluate the credibility of the literature review information |
| Collect materials needed | - | - |
| Create project | - | - |
| Preparing project presentations | Verbal presentation, including verbal presentation of concepts | Evaluating presentations submitted by students (other groups) |
| Reflection and evaluation | Reflect and evaluate the project, the results of experiments and project concepts are used and evaluate them | Evaluate the overall activities carried out comprehensively, and submit conclusions based on the scientific information of the results of reflection and evaluation. |

In addition to the level of conception, critical thinking skills are also trained in the PjBL model. To find the conclusions of increasing the level of conception and critical skills N-Gain scores are calculated, by scoring at the conception level with the score criteria (Table 5).

**Table 5.** Conception Score Criteria

| Answer Options | Level of Certainty | Score |
|---|---|---|
| Inappropriate with the concept agreed by scientists | Certainly | 6 |
| Inappropriate with the concept agreed by scientists | Almost certainly | 5 |
| Inappropriate with the concept agreed by scientists | Partly certain | 4 |
| Inappropriate with the concept agreed by scientists | A small part is certain | 3 |
| Inappropriate with the concept agreed by scientists | not sure | 2 |
| Inappropriate with the concept agreed by scientists | Most guess the answer | 1 |
| Inappropriate with the concept agreed by scientists | Overall guess the answer | 0 |
| Not inappropriate the concept agreed by scientists | certainly | 0 |
| Not inappropriate with the concept agreed by scientists | Almost certainly | 0 |
| Not inappropriate with the concept agreed by scientists | Partly certain | 0 |
| Not inappropriate with the concept agreed by scientists | A small part is certain | 0 |
| Not inappropriate with the concept agreed by scientists | not sure | 0 |
| Not inappropriate with the concept agreed by scientists | Most guess the answer | 0 |
| Not inappropriate with the concept agreed by scientists | Overall guess the answer | 0 |

The N-Gain score for students' conception scores (Table 6), N-Gain Score Critical thinking skills presented.

**Table 6.** Score Conception Increase and Critical thinking skill

| Test | Percentage Score (%) | | N Gain | Category |
|---|---|---|---|---|
| | Pretest | Postest | | |
| **Conception** | 25.36 | 61.95 | 0.49 | Medium |
| **Critical Thinking** | 49.73 | 78.53 | 0.57 | Medium |

The PjBL application can improve the level of conception and critical thinking of students with N Gain values of 0.49 and 0.57 (medium category). The increase has not reached the high category because, in the implementation, the students concentrated on doing the project. The project-making stage seen as an activity that supports the level of conception because students spend more time at home. There are no activities that invite students to investigate their conceptions. The students' critical thinking skills are also increasing, as are conceptions, enhancement of critical thinking skills ensured by the PjBL model that traces this ability in several stages.

In the planning phase of the project, two groups of students are still having difficulty determining and planning the project. This difficulty arises because in one group has a different conception the basic concepts that will be developed to make the project. This problems also found in the implementation of teaching and learning process. The main factor that causes the information collected from the source students are invalid, thus impacting on the strengthening of conception that is not appropriate for students. Student conceptions that are inconsistent with the agreement of scientists are reinforced by references from sources that are inconsistent with the agreement of scientists quite complicate the process of conceptual change. The information is false, but in accordance with the conception that students have right into long-term memory [31], this condition causes the concept representation to be the misconception.

PjBL has the same N gain score category [21] in the medium category. PjBL can significantly improve critical thinking skills [32], with (high) N-Gain value categories [33] because of time constraints in the application of phases and non-fulfillment of activities that increase critical thinking skills in each phase. Because the results obtained are not maximal. Based on the results described there are some disadvantages of applying the PjBL model, among others (1) takes a long time, especially

project-making, (2) students are more project-oriented, and less ignoring conceptual learning, (3). In addition to its weaknesses, the PjBL model also has advantages such as (1) students interested in the PjBL learning model (78.26), and students' ability to be assessed, including cooperation and presentation.

## 3. Conclusion

It can be concluded that the PjBL model can improve the level of conception and students' critical thinking skills. Every phase in PjBL supports both upgrades. The development of the PjBL model is following the recommended learning objectives by strengthening the appropriate activities at each stage. On increasing the level of conception, based on the N gain (medium) category, this result certainly needs to be improved. The phase in the inquiry model recommended as a modified model material in PjBL. For example, before entering into the manufacture of experimental kinematics products, students must understand the basic concepts of kinematics and identify the concepts to be used and proven. Costs that become problems in PjBL can reduce because students know the working principles of the tool to be made. Critical thinking ability trained in every phase of PjBL. Cooperation, leadership, and argumentation ability are some factors that emerged but not yet revealed in this research.

## 5. References

[1] ETDME Malaysia 2006 *Project-Based Learning Handbook "Educating the Millennial Learner"* (Malaysia: Educational Technology Division Ministry of Education)
[2] Morgan A 1983 Theoretical Aspects of Project- Based Learning in Higher Education *British Journal of Educational Technology* **14** 1 66-78
[3] Laffey J, Tupper T, Musser D and Wedman J 1998 A computer-mediated support system for project-based learning. *Educational Technology Research and Development* **46** 1 73-86
[4] Patton A 2012 *Work that matters The teacher's guide to project-based learning* Paul Hamlyn Foundation
[5] Kramer B S, Walker A E and Brill J M. 2007 The underutilization of information and communication technology-assisted collaborative project-based learning among international educators: A Delphi study *Educational Technology Research and Development* **55** 5 527-43
[6] Liu S 2014 Implementing Project-Based Learning in Physics and Statics Courses *In121st ASEE Annual Conference & Exposion*
[7] Holubova R 2008Effective Teaching Methods--Project-based Learning in Physics Online *Submission* **5** 12 27-36
[8] Kubiatko M and Vaculová I 2011 Project-based learning: characteristic and the experiences with application in the science subjects. *Energy Education Science and Technology Part B: Social and Educational Studies* **3** 1 65-74
[9] Juan Rosales J and Sulaiman F 2016 Correlation of Students' Perception after Project – Based Learning (Egg Drop Project) Intervention towards learning Physics IOSR *J. Humanit. Soc. Sci.* **21** 56–60
[10] Mitchell S, Foulger T S, Wetzel K and Rathkey C 2009 The negotiated project approach: Project-based learning without leaving the standards behind *Early Childhood Education Journal* **36** 4 339
[11] Mettas A C and Constantinou C C 2008 The technology fair: a project-based learning approach for enhancing problem solving skills and interest in design and technology education *International Journal of Technology and Design Education* **18** 1 79-100
[12] Neo M and Neo T K 2007 Engaging students in multimedia-mediated Constructivist learning – Students ' perceptions *Educ. Technol. Soc.* **10** 133–46
[13] Handhika J 2010 Upaya Peningkatan Aktivitas Belajar dan Pembentukan Kaarakter Mahasiswa Melalui Pembelajaran Berbasis Proyek *Prosidng Seminar Nasional LS* **4** 73–7
[14] Trowbridge D E and McDermott L C 1980 Investigation of student understanding of the concept of velocity in one dimension *American journal of Physics* **48** 12 1020-8

[15] Professer A, Ali A, Mahdi S, Elwan A and Zaman A 2015 Student's Alternative Conceptions of Free-Fall , Speed , Velocity and Acceleration, In High School in Tripoli Libya **5** 322–38
[16] Shaffer P S and McDermott L C 2005 A research-based approach to improving student understanding of the vector nature of kinematical concepts *American journal of physics* **73** 10 921-31
[17] Handhika J, Kurniadi E and Muda I 2014 Pengembangan Media Pembelajaran Bermuatan Konflik Kognitif Untuk Mengurangi Dugaan Miskonsepsi Pada Matakuliah Fisika Dasar. *Jurnal Materi dan Pembelajaran Fisika* N **4** 2
[18] Hale P 2000 Kinematics and graphs: Students' difficulties and cbls. *The Mathematics Teacher* **93** 5 414
[19] Kariz M V, Planinsic G and Cepic M 2009 Sketching graphs---an efficient way of probing students' conceptions. European Journal of Physics **30** 163-75
[20] Harper A 2014 *Teacher Guide: Using Project-Based Learning to Develop Students' Key Competences* (Brussels: European Schoolnet)
[21] Saripudin A, Haryani S and Wardani S 2014 *Characterized Project Based Learning To Improve Critical Thinking Skill* https://icmseunnes.com
[22] Stix A and Hrbek F 2006 Teachers as classroom coaches. Association for Supervision & Curriculum *Deve*
[23] Sherrod S E and Wilhelm J A 2009 Study of how classroom dialogue facilitates the development of geometric spatial concepts related to understanding the cause of moon phases. *International Journal of Science Education* **31** 7 873-94
[24] Kaniawati I, Samsudin A, Hasopa Y, Sutrisno AD and Suhendi E 2016 The Influence of Using Momentum and Impulse Computer Simulation to Senior High School Students' Concept Mastery. *InJournal of Physics: Conference Series* **739** 1 012060
[25] Horner R H, Carr E G, Halle J, McGee G, Odom S and Wolery M 2005 The use of single-subject research to identify evidence-based practice in special education *Exceptional children* **71** 2 165-79
[26] Handhika J, Cari C, Suparmi A and Sunarno W 2017 Development of Diagnostic Test Instruments to Reveal Level Student Conception In Kinematic and Dynamics. ICSME UNNES
[27] Hake R R 1999 Analyzing change/gain scores Dept. Physics, *Indiana Univ* **16** 1073–80
[28] Lemmer M 2013 Nature, cause and effect of students' intuitive conceptions regarding changes in velocity *International Journal of Science Education* **35** 2 239-61
[29] Antwi V, Hanson R, Savelsbergh E R, Eijkelhof H M 2011 Students' Understanding of Some Concepts in Introductory Mechanics Course: A Study in the First Year University Students UEW *International Journal of Educational Planning & Administration* **1** 1 55-80
[30] Yıldız A 2016 A discussion on velocity–speed and their instruction. *InJournal of Physics: Conference Series* **707** 1
[31] Kalyuga S 2008 *Managing cognitive load in adaptive multimedia learning*. IGI Global
[32] Masek A. The effects of problem based learning on knowledge acquisition, critical thinking, and intrinsic motivation of electrical engineering students (Malaysia: Universiti Tun Hussein Onn Malaysia)
[33] Holmes VL and Hwang Y 2016 Exploring the effects of project-based learning in secondary mathematics education *The Journal of Educational Research* **109** 5 449-63

**Acknowledgments**
This work was financially supported by "Hibah Penelitian Disertasi Doktor Dirjen Penguatan Riset dan Pengembangan Kemenristek Dikti", Contract number: 076/SP2H/K2/KM/2017

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