The role of science project based peer interaction on improving collaborative skills and physical problem solving: a mini review

I Setyowidodo1,2*, B Jatmiko1, E Susantini1, A D Handayani2 and Y S Pramesti2

1Pascasarjana, Universitas Negeri Surabaya, Jl. Ketintang 30, Surabaya 60231, Indonesia
2Universitas Nusantara PGRI Kediri, Jl. KH. Ahmad Dahlan 76, Kediri 64112, Indonesia
*corresponding author’s email: irwansetyowidodo@mhs.unesa.ac.id

Abstract. Problem solving and collaborative skills are part of the 21st century skills that students need to have. So it is necessary to develop a model of learning that can enhance those abilities. The methods of this study is literatur review. The literature about Problem Based Learning and the weakness of Problem Based Learning are discussed to find the Science Project Based Peer Interaction (SPBPI). This research technique uses a literature analysis. This study aims at efforts to improve student’s collaborative skills and problem solving through the learning of Science Project Based Peer Interaction (SPBPI). The results of this study will later be implemented in learning to improve collaborative skills and student problem solving through learning Science Project-Based Peer Interaction (SPBPI). By the implementation of this Science Project ScienceProject-Based Peer Interaction (SPBPI), student’s collaborative skill and problem solving ability will enhance.

1. Introduction

Physics education research is more focused on problem solving, because in the 21st century, problem solving capabilities are necessary to create creative and innovative solutions to current world problems [1]. Problem solving ability is the ability to plan, organize, take action, evaluate, adopt and conclude. In addition to problem solving, 21st century learning has a basic principle that learning must be student-centered, collaborative, contextual, and integrated with the community. At present we are in a time and situation where people cannot work alone, therefore the ability to collaborate and communicate is very important. The collaborative learning environment challenges students to express and maintain their position, and produce their own ideas based on reflection. They can discuss conveying ideas to friends, exchange opinions with different perspectives, seek clarification, and participate with a high level of thinking such as managing, organizing, critically analyzing, solving problems, and creating new learning and understanding more deep. This gives students the opportunity to learn from each other to monitor one another, detect mistakes and learn how to correct their mistakes. Learning based on collaborative inquiry is useful in developing individual and group knowledge.

Problem Based Learning (PBL) is a learning model that is designed to solve problems. According to Arends [2]. PBL is a learning model that presents a variety of authentic and meaningful problem situations to students, which can serve as a springboard for investigation. Another learning model that
can also be used to train problem solving skills is Project Based Learning (PjBL). In PjBL, students are actively involved in solving problems assigned by the lecturer/teacher in the form of a project. Students actively manage their learning by working in tangible ways that produce real products [3].

The application of project based learning (PjBL) in science learning shows an increase in cognitive learning outcomes, forming caring attitudes and behaviors towards the environment, science process skills. Project-based learning naturally involves many different academic skills, such as reading, writing, and mathematics and is suitable for building conceptual understanding through assimilation of knowledge. Likewise PBL can be used in learning physics problem solving. However, PBL is not designed to assist teachers in conveying knowledge in large numbers, but is designed to assist in developing thinking skills in solving problems, skills in organizing groups to solve problems, and fostering individual independence [4]. In the PjBL there are weaknesses, where knowledge is not obtained sequentially; if the project is not well planned and implemented properly, the task will not be completed on time. If project learning is well planned and successfully implemented, then many of the benefits obtained include being able to foster collaboration (collaborative); arouse interest; and develop a scientific attitude.

Given the strengths and weaknesses of the teaching model reviewed, there are two main things needed by students in the 21st century, namely: problem solving and collaborative abilities. Therefore, a strategy that is more centered on students is needed to improve these abilities. Peer Instruction is a collaborative learning technique that trains critical thinking, problem solving, and joint decision-making skills. Peer Instruction provides a structured environment for students to voice their ideas and solve problems collaboratively by sharing information/knowledge with their friends [5]. The novelty of Science Project Based Peer Interaction is the student will more active in the process study because they will more interaction with their peers. And also the use of task in the form of science project is expected to make student more active to improve their problem solving abilities.

Based on the learning characteristics of Physics, the importance of problem solving skills and collaborative abilities and to complement the shortcomings found in the two PBL and PjBL models that have been described previously, it is necessary to develop a model of learning that can improve problem solving and collaborative abilities. Therefore, it is necessary to do a research with the title "Project Based Peer Interaction Science Learning Model to Improve Collaborative Capabilities and Solve Physics Problems".

The objectives of this study is to examine the literature related to problem based learning and its weaknesses and the advantages of providing projects to improve students' problem solving and collaborative abilities. By reviewing various sources about PBL and their weaknesses and strengths, it is hoped that a SCBPI learning model will be created that can improve students' collaborative and problem solving abilities.

2. Methods
Based on the learning characteristics of Physics, the importance of problem solving skills and collaborative abilities and to complement the shortcomings found in the two PBL and PjBL models that have been described previously, it is necessary to develop a model of learning that can improve problem solving and collaborative abilities. The references used in this study were forty articles consisting of books and journals related to Problem based Learning, peer interaction and problem solving abilities. By reviewing the weaknesses and strengths of PBL, it developed the Science Project Based Peer Interaction developed to improve students' problem solving and collaborative abilities. Therefore, it is necessary to do a research with the title "Project Based Peer Interaction Science Learning Model to Improve Collaborative Capabilities and Solve Physics Problems".
3. Result and Discussion

3.1. strengths and weaknesses of the problem based learning and project based learning learning models

The essence of the PBL model is the development of student skills in groups to solve problems. PBL is an effective learning alternative to explore students' abilities, challenge students' interests, and condition students to learn actively. Teachers design PBL model learning by bringing up problematic situations for students and preparing students to investigate and find their own solutions. However, PBL still has several obstacles during the learning process. For example, the period of school standard learning is 45 minutes of lessons and the diversity of students' abilities greatly influences the process and results of implementing PBL. The 45-minute meeting hours are very lacking if in one period the students must complete all PBL stages with the assumption that students have mastered the material discussed [6].

In addition to PBL, the problem solving learning is PjBL, the PjBL approach refers to teaching strategies that allow instructors to guide students through in-depth study of real-world topics. In PjBL, students learn to be responsible for their learning, this learning helps students to form a solid foundation on which they can work with others around them. Project learning is considered as a means used by students to: (a) develop independence and responsibility, and (b) practice social behavior and democracy. PjBL aims to help students learn at school, work independently and combine theory with practice. Some of the benefits of PjBL include: a) Increased motivation. PjBL is proven to increase motivation to learn through their involvement in their own chosen projects. b) Increased problem solving ability. PjBL can improve the ability to solve problems that are complex and make students more active. c) Improved library research skills. PjBL requires students to be able to quickly obtain information, thus increasing students' ability to find and obtain information. d) Increased collaboration. PjBL requires group work in implementing the project. Group work really needs communication, information exchange, evaluation and good cooperation, so PjBL will improve the ability of students to work. e) Increased resource management skills. Students must design and compile the project they choose according to a predetermined time allocation.

3.2. learning models developed to improve collaborative capability and problem solving with peer instruction

Project Based Learning model components with Peer Instruction include the objectives of development, theoretical and empirical foundations, planning and implementation of learning, learning environment, assessment and evaluation. The main purpose of developing Project Based Learning learning models with Peer Instruction is to improve collaborative skills and student problem solving. One learning that has the potential to develop the activity of students in learning is Peer instruction. In the peer instruction interspersed with concept questions [7] and involves the activeness of students in learning [8]. Students are given the opportunity to think in completing concept questions given by the instructor then discuss with their peers. In addition, in learning PI students are expected to be able to optimize the mastery of the concept of problem solving through thinking and discussing with colleagues. Peer instruction learning is more effective than class discussion learning [9].

The study shows that there is a difference in mastery of concepts and the ability to solve student physics problems that use peer instruction integration guided inquiry learning. Furthermore, mastery of concepts and problem solving of students who study with peer instruction integration guided inquiry learning is higher than students who learn with guided learning and conventional learning. Finally, the problem solving ability of students who study with peer instruction integration guided inquiry learning is higher than students who learn with guided learning and conventional learning.

In peer Instruction, students can increase their involvement in discussion among peers, they can solve problems with Group Problem Solving Activities. Hybrid Peer Instruction Model (HPI) increases understanding, learning, interest, motivation, and attitude; encourage students to think about challenging basic concepts; help improve critical thinking skills and better metacognitive skills.
The application of Peer instruction can be explained in four stages. The first stage is presentation, the second stage is discussion, the third stage is explanation, and the last stage is evaluation. Explanation of this stage is given as follows respectively.

3.2.1. **the first stage is the presentation.**
Educators make a few brief presentations about the concepts to be learned. Educators propose a concept understanding test to students. Students are expected to read the required knowledge about subjects before coming to class at this stage. This stage presents a strong interaction between peer instruction and timely teaching.

3.2.2. **the second stage is discussion.**
Initially, students answer and choose test concepts that are submitted individually without being influenced by the responses of other students. Students can record responses individually if needed. Students begin to discuss to find the right answer among peers after the student answers the response. The essence of the peer instruction is the discussion stage. Discussions among friends enhance deeper thinking and complex reasoning skills on concept tests, providing for sharing and growing alternative ideas and ideas, and finding solutions from sharing different ways.

3.2.3. **the third stage is explanation.**
Student answers are discussed in an interactive classroom environment. Class participation at this stage is important enough to share student ideas, views and thoughts. Students can make connections and connections between new and existing knowledge. In addition, educators provide students with important and critical explanations about subjects or questions about concepts that have been studied.

3.2.4. **The last step is evaluation.**
Educators make formative assessments at this stage. They evaluate students' responses and then explain the correct responses from the concept test questions submitted. Real-time feedback on student evaluation is very important to provide meaningful learning. Educators complete the process by explaining the correct responses from concept test questions and then the educator continues the test questions of other concepts or other subjects.

The importance of Peer Instruction in science learning is that most schools do not provide an authentic learning experience. Most students learn by memorizing and remembering, while when they are faced with problems their daily life is difficult. Learning in the meaning of action, students become active because they really are learning while doing. In the peer instruction, students are actively involved in learning.

In peer learning and teaching, two or more people learn and teach each other in groups. One view is that peer learning occurs when peer tutors, who are more knowledgeable, teach, and others listen and learn. Another view, which is increasingly gaining acceptance in higher education, is a view that recognizes that in peer-to-peer learning and teaching situations, groups can go beyond mastering content to produce new knowledge together. The generation of new group knowledge occurs when the group shares information, discusses, challenges, clarifies and confirms learning from each other.

In line with that, Piaget views social relations as cooperation with others, in the form of discussion, collaboration in work, exchange of ideas and mutual control, which are the basis for the development of logic. He believes that discussions with other people lead to internalized discussions or deliberations, and reflections. The development of critical thinking, objectivity and discursive reflection is enhanced through cooperative interaction with peers. Slavin explained this further with the claim that: interactions between students about the task of learning will lead to increased achievement students. Students will learn from each other because in their discussion of content, cognitive conflict will arise, inadequate reasoning will be exposed, and understanding of higher quality will emerge. According to Falchikov and Slavin, it appears that cognitive conflict can also occur when students learn on their own and are actively involved with their own material, and that may be more easily stimulated and made harder through interactive interactions with peers.
When students learn from each other, it is inevitable that cognitive and social conflicts and challenges arise during the process. The ability to handle their own feelings and attitudes, as well as to deal with potential conflicts, becomes an important skill. Students need to be trained in interpersonal skills in such a way that their learning is not hindered by negative feelings, interpersonal fields and small group processing skills as determinants of success in the context of peer learning [10]. Learning environments that are rich in peer discussions can develop critical thinking skills and mastery of concepts deeply in students [11].

Peer Instruction (PI) is an interactive teaching method, which is widely used in learner-centered learning. The basic purpose of Peer Instruction is to exploit student interactions during college and focus students' attention on basic concepts. In Peer Instruction, the lecture consists of a number of brief presentations about the main points, each followed by a short conceptual question about the problem being discussed. After each conceptual question is submitted, students are given one or two minutes to form individual answers and then discuss their answers with each other. During the discussion, students try to convince each other about the truth of their own answers by explaining the underlying reasons.

The novelty in this study is classified as an intervention. Interventions are prioritized on learning models for problem solving and collaborative abilities. The results of this intervention are based on studies and literature studies on the Problem Based Learning (PBL) and Project Based Learning (PjBL) and Peer Interaction (PI) models. The results of the study found several weaknesses that need to be improved to improve problem solving skills and collaborative abilities. The SCBPI design is an improvement in the PBL, PjBL, and PI models in the Basic Physics course, especially in phases 2, 3, and 4 models. Phase 2 is not in PBL and PjBL, but is in the PI, where the lecturer guides students to understand the sub-topics that will be studied as a basis for completing the project to be done. Discussions among friends enhance deeper thinking and complex reasoning skills on concept tests, providing for sharing and fostering alternative ideas and ideas, and finding ways of solving differences. In contrast, phase 3 is present in PBL and PjBL but is not in the PI; where students make plans and make a schedule of activities to be carried out collaboratively between teachers and students to complete project tasks according to the chosen topic. Likewise in phase 4 this also exists in PBL and PjBL but is not in the PI; where after students make plans and schedule activities to be carried out. They collaboratively complete project tasks according to the chosen topic and their respective assignments, then group consultation and discussion returns to produce creative products. The syntax of the SCBPI model is complementary between the syntax of PBL and PjBL models, as well as PIs in Basic Physics courses.

Traditional teaching methods are not effective enough on student problem solving performance, conceptual understanding, self-efficacy, confidence, and motivation. The results of other studies indicate that many students have difficulty learning and understanding the basic concepts of physics [12]. One of these approaches is peer instruction. One approach that makes students more central to what happens in class, involves them individually and in peer groups to encourage individual construction of understanding. The description of peer instruction is "students individually respond to questions, discuss with peers, and respond to the same questions again. Peer instruction changes the traditional lecture format to include questions designed to involve students and reveal difficulties with the material [13] Peer instructions (PI) is a learning strategy that is centered on interactive learners to involve students in the class through a structured question and answer process that enhances learning the basic concepts of science.

The roles and responsibilities of instructors and students must also be determined in peer instruction. The task of the instructor is to model appropriate social skills such as listening and giving constructive feedback in greater depth. They must also strengthen positive behavior by discussing the responses given. Students can interpret and form correlations between new building information and existing knowledge [14]. Peer instruction is effective in decision making skills, meaningful learning, conceptual learning, quantitative / qualitative problem solving, and critical thinking. peer instruction reduces the number of students who cancel physics subjects [15].
4. Conclusion
Problem based learning that is applied in science learning not facilitating students in improving collaborative skills so that a project activity is needed to work together in order to increase interaction between students and improve problem solving abilities. So it expected through the development of learning models Science Project Based Peer Interaction can improve collaborative skills and student problem solving. Through this learning can increase conceptual understanding, problem solving performance, critical thinking, decision making procedures and students' scientific reasoning abilities from the point of view of the cognitive domain. Peer Interaction increases interaction between students and educators, develops student concentration, and increases student retention. Peer Interaction also increases the satisfaction and presence of students towards lectures from an affective point of view.

5. References
[1] The Partnership for 21st Century Skills 2009 The MILE Guide: Milestones for Improving Learning and Education
[2] Arends R I 2012 Learning to Teach; 9th Edition New York: McGraw-Hill Companies, Inc
[3] Fathurrohman M 2015 Model-model Pembelajaran Inovatif Yogyakarta: Ar-Ruzz Media
[4] Baer J and Kaufman J C 2005 Bridging Generality and Specificity: The Amusement Park Theoretical (APT) Model of Creativity Roeper Review 27 3158-162
[5] Gok T 2012 The Impact of peer instruction on college student’s beliefs about physics and conceptual understanding of electricity and magnetism International Journal of Science and Mathematics Education 10 2 417-436
[6] Reyendra 2012 Pengaruh PBL Terhadap Prestasi Belajar Fisika Ditinjau dari Kemampuan Penalaran Ilmiah Siswa SMAN 5 Malang Tesis Malang: Program Pascasarjana Universitas Negeri Malang, Malang
[7] Crouch C H and Mazur E 2001 Peer Instruction: Ten years of experience and results. Department of Physics, Harvard University, Cambridge. American Journal of Physics 69 9 970–977
[8] Fagen A P, Crouch C H and Mazur E 2002 Peer Instruction: Results from a Range of Classrooms Cambridge: Harvard University
[9] Nicol D J and James T B 2003 Peer instruction versus class-wide discussion in large classes: a comparison of two interaction methods in the wired classroom centre for academic practice, University of Strathclyde Studies in Higher Education 28 4 457-473
[10] Slavin R E 2009 Educational Psychology: Theory and Practice 9th Edition New Jersey: Pearson Educational
[11] Anderson T, Howe C, Soden R, Halliday J and Low J 2001 Peer interaction and the learning of critical thinking skills in further education students Instructional Science Journal 29 1–32
[12] Mazur E 1997 Peer instruction: A user’s manual Upper Saddle River NJ: Prentice Hall
[13] Crouch C H and Mazur E 2001 Peer Instruction: Ten years of experience and results. Department of Physics, Harvard University, Cambridge American Journal of Physics 69 9 970–977
[14] Cortright R N, Collins H L and Carlo S E 2005 Peer instruction enhanced meaningful learning: ability to solve novel problems Adv Physiol Educ. 29 2 107-11
[15] Lasry N and Mazur E 2008 Peer instruction: From Harvard to the two-year college American Journal of Physics 76 11