Enhancing Student’s Problem-Solving Ability Through Collaborative Problem Solving (CPS) on Simple Harmonic Motion Concept

Adam Malik\(^\ast\), Muhammad Minan Chusni and Yanti
Program Studi Pendidikan Fisika, UIN Sunan Gunung Jati Bandung, Bandung, Indonesia

\*adammalik@uinsgd.ac.id

Abstract. Learning in the 21st century requires students to be more active in the learning and skills of the 21st century, one of which is the ability to solve problems. However, the study carried out in class X MIA 1 SMAN 27 Bandung is still a student center and problem-solving skills students have not been explored. This study aims to determine the increase in the problem-solving ability of students to the concept of simple harmonic motion after the implementation of the learning model Collaborative Problem Solving (CPS). The method used in this study is a pre-experiment with the design of the study one group pretest-posttest design. Sampling is done through simple random sampling technique. The sample of this study was 30 students in class X MIA 1 SMAN 27 Bandung. Instruments used to measure students' problem-solving ability is a test essay and student worksheet. Based on normalized gain \(g\) results showed that increasing students' problem-solving abilities of 0.65 with the medium category. Based on the hypothesis test obtained \(T_{\text{count}}\) is greater than \(T_{\text{table}}\) (108.71 > 2.045) it can be concluded that there is the significant implementation of learning models CPS to increase the problem-solving ability of students to the concept of simple harmonic motion.

1. Introduction
21st century-skills is a high-level skill that must be possessed by human beings to be able to work in the real world and be able to face the challenges of the 21st century [1]-[3]. One of the high-level skills is the ability to problem-solving [4]. Trilling and Fadel [5] stated that the ability to be possessed in the 21st century consists of three capabilities, namely: 1) the ability to learn and innovate (learning and innovation skills), 2) the ability of information, media, and technology (information, media, and technology skills), 3) the life and career (life and career).

One of the abilities to learn and innovate to be possessed by the student is problem-solving skills. Problem-solving skills is the ability of a person or a student to find a solution through a process which involves obtaining and organizing information [6]. Problem-solving skills is one of the activities that use the thought process that can be taught to pay attention to the type of problem to be solved, advice and programs that are prepared to teach [7], [8].
Based on the study of literature, the problem-solving skills of students in the learning of physics is still relatively low, the students in working on the problems of physics given teachers tend to use mathematical equations without performing analytical [6]. In addition, the study also conducted by Mustofa and Rusdiana demonstrate problem-solving skills of students is still low [9]. This is confirmed by a study carried out by Amanah [10] stated that the problem-solving skills of students is still lacking. Further research conducted by Datur [11] stated that the problem-solving skills of students is still low this results indicated that students can not accurately describe the problem and do not use physics approach due to the mastery of concepts is lacking.

One model of learning that can enhance problem-solving skills learning model Collaborative Problem Solving (CPS). CPS is a learning activity that involves students in a problem-solving project, resolve these problems together and exchange ideas with one another, and suitable for heuristic tasks that require knowledge and capability of high order [12]-[14]. CPS has six stages of learning, namely: 1) share perspective; 2) define the issues; 3) identify the interests; and 4) generate options, 5) decide on objective criteria, 6) Evaluate options and reach the agreement [15].

Based on research conducted by previous researchers, learning CPS can increase the ability of the mathematical representation of students, building readiness itself in participating in learning activities and improve the quality of learning outcomes, increase team spirit in learning activities, improve understanding of concepts, problem solving, interaction with other students, and trust the students to express their ideas and opinions, can enhance students' active and creative thinking abilities of students [16]-[18]. The difference in this study with previous research, the framework syntax learning CPS used in this study is the syntax of the learning model proposed by Windle & Warne [15] with the integration of laboratory activities and discusses the student activity sheet analysis of the results of final test problem-solving skills.

2. Methods
The method used is pre-experiment with the design of the study one group pretest-posttest. The population to be studied is the entire class X MIA at SMAN 27 Bandung. The sample in this research is class X MIA 1 with the number of students 30 people. The sampling technique in this study using simple random sampling technique.

Instruments used in this research of problem-solving skills test consists of four questions essay and student activity sheet. Each question contains five aspects of problem-solving skills. Aspects of problem solving skills in this study is a useful description, approach to physics, physics specific application, use appropriate mathematical procedures, and the logical progression [19].

Analysis of problem-solving skills test instruments, beginning with 1) determining the value the test scoring of problem solving skills, 2) calculate the increase in students' problem-solving skills by using normalized gain $<g>$, 3) interpret $<g>$ value obtained used categories Hake [20] stating that $<g> < 0.3$ low category, $0.3 \leq <g> \leq 0.7$ category medium and high category $<g> > 0.7$. Analysis of student activity sheet with 1) correct of workmanship student activity sheet, 2) calculate the total score obtained by the students, 3) interpret the scores into five categories: categorized excellent (score 80-100), good (score of 66-79), pretty good (score 56-65), less well (40-55) and failed (score 30-39) [21]. Hypothesis testing is done using parametric statistics are paired samples t-test for normality test after two normally distributed data. Before the test the hypothesis, the normality test in advance using Lilliefors test.

3. Results and Discussion
The link between an activity worksheet of students with posttest results problem-solving skills shown by Table 1.
Table 1. Score worksheet of students (WoS) and posttest of problem-solving skills

| Aspects of problem-solving ability | WoS I | WoS II | WoS III | Average score | Posttest scores |
|----------------------------------|-------|--------|---------|---------------|-----------------|
| A useful description             | 64    | 67     | 81      | 71            | 83              |
| Physics approach                 | 64    | 67     | 81      | 71            | 78              |
| Application-specific physics     | 63    | 65     | 76      | 68            | 74              |
| Precise mathematical procedures  | 63    | 71     | 71      | 69            | 67              |
| Logical progression              | 57    | 64     | 68      | 63            | 59              |
| Average                          | 62    | 67     | 76      | 68            | 72              |

The average score worksheet of students every aspect of students' problem-solving skill affects the final test scores (posttest) students. The higher the score worksheet of students obtained by the student, the greater the posttest score obtained by the student. This means worksheet of students help train students in improving its problem-solving ability. Student activity sheet to guide student learning allows students and teachers to conduct learning activities that can help students understand the concepts being taught, increases the activity of learning activities, learning outcomes of knowledge, attitudes, and skills development and student achievement [22]-[26].

The average score of the pretest, posttest, and normalized gain <g> for each aspect of the problem-solving ability of students can be seen in Table 2.

Table 2. Score normalized gain each aspect of problem solving skills students

| Aspects of problem-solving skills | Average Pretest | Posttest | <g> | Interpretation |
|----------------------------------|----------------|---------|-----|----------------|
| A useful description             | 43             | 83      | 0.70| Medium         |
| Physical approach                | 32             | 78      | 0.67| Medium         |
| Application-specific physics     | 28             | 74      | 0.64| Medium         |
| Precise mathematical procedures  | 2              | 67      | 0.66| Medium         |
| Logical progression              | 1              | 59      | 0.59| Medium         |
| Average                          | 21             | 72      | 0.65| Medium         |

The normalized gain score for each aspect of the problem-solving skills is different and all aspects are of medium category. The normalized gain score is highest in the aspect of a useful description with <g> of 0.70 including medium category. Problem-solving can help students to develop their intellectual abilities and teach solve the problem using the troubleshooting steps [7]. While the lowest normalized gain score is the logical progression aspect has N-Gain value is equal to 0.59 with medium category. This is because students do not make conclusions consistent with the predictions. Problem-solving skills is the ability to find a solution through a process that involves the acquisition and organizing information [27] besides the problem solving skills and requires a special ability to be possessed by each student [28].

The average score of the pretest, posttest, and normalized gain <g> problem solving skills of students to each sub-concept shown in Table 3.
Table 3. Score normalized gain each sub concepts simple harmonic motion

| Sub concept                              | Number problem | Average | Interpretation |
|------------------------------------------|----------------|---------|----------------|
| Spring                                   | 1, 2           | 25      | 80             | 0.73 High    |
| Spring series-parallel arrangement       | 3              | 21      | 66             | 0.57 Medium  |
| Simple pendulum                          | 4              | 13      | 64             | 0.59 Medium  |
| Average                                  |                | 20      | 70             | 0.63 Medium  |

The improved student’s problem-solving skills on each sub concept including high and medium category. The improved problem-solving skills of student on the highest spring sub concepts including height (0.73). This is because problem-solving on the spring sub-concept is easier than the other sub-concept. In addition, problems in the sub-concept of spring is also found in many students in everyday life. A student will be able to communicate a thing well, of course if she/he master the content well, understand cause-effect relation contained in that content and has good reasoning [29].

The lowest student problem-solving skills were found in sub-concepts of spring series-parallel arrangement including medium category (0.59). This is because the concept of sub parallel arrangement of spring series for students requires the application of various mathematical formulas to solve problems. The era of the global community has forced each individual to have not only knowledge but also skills in order to compete in the 21st century [30].

Problem-solving skills by encouraging students to be active in practical activities and capable of solving problems given. CPS learning model emphasizes the students to share ideas about issues that are given so that students can exchange ideas and find answers to the problems given. Griffin [31] states that CPS is a problem-solving approach is responsive to cooperate and exchange ideas, and are very useful when dealing with complex problems.

Based on the results of the hypothesis test results showed that Tcount (108.71) is larger than Ttable (2.045) this indicates that the learning model can improve students' problem-solving skills. CPS facilitate student learning models to solve problems related to the concepts of physics in group discussions and practical activities. Based on previous research Ningrum [32] CPS instructional model can enhance the activity and the ability of students creative thinking. Problem-solving skills can be developed using a collaborative learning model that integration with problem-based learning [33], [34]. Based on the analysis and the above discussion, it can be concluded that the application of learning models CPS can enhance problem solving skills of students to the concept of simple harmonic motion.

4. Conclusion
In general, we have successfully tested the use of Collaborative Problem-Solving models in improving student problem-solving skills. The improved student problem-solving skills including medium category. Therefore, the use of collaborative problem-solving models is worth considering to apply in physics learning on other topics.

Acknowledgments
The authors thank the students of class X MIA 1 and teachers SMAN 27 Bandung, the homeroom teacher of writing and head of Research and Publishing Center UIN Sunan Gunung Djati Bandung.
References

[1] E. Y. Wijaya, D. A. Sudjimat, and A. Nyoto, “Transformasi pendidikan abad 21 sebagai tuntutan pengembangan sumber daya manusia di era global,” Pros. Semin. Nas. Pendidik. Mat. 2016, vol. 1, p. 264, 2016.

[2] W. S. Wibowo, “Implementasi Model Project-Based Learning (Pjbl) dalam Pembelajaran Sains untuk Membangun 4Cs Skills Peserta Didik sebagai Bekal dalam Menghadapi Tantangan Abad 21,” Semin. Nas. IPA V, pp. 276–286, 2014.

[3] A. Setiawan, A. Malik, A. Suhardi, and A. Permanasari, “Effect of Higher Order Thinking Laboratory on the Improvement of Critical and Creative Thinking Skills,” IOP Conf. Ser. Mater. Sci. Eng., vol. 306, no. 1, p. 012008, 2018.

[4] Fianti, F. Najwa, and S. Linuwih, “Morphological effect of the type, concentration and etching time of acid solutions on enamel and dentin surfaces,” Braz. Dent. J., vol. 9, no. 1, pp. 3–10, 2017.

[5] B. Trilling and C. Fadel, “21st Century Skills: Learning for Life in Our Times.” San Francisco: John Wiley & Sons, Inc., 2009.

[6] M. H. Mustofa and D. Rusdiana, “Profil Kemampuan Pemecahan Masalah Siswa pada Pembelajaran Gerak Lurus,” Jurnal Penelitian & Pengembangan Pendidikan Fisika, vol. 2, no. 2, pp. 15-22, 2016.

[7] I. S. Datur, L. Yuliati, and N. Mufti, “Eksplorasi Kemampuan Pemecahan Masalah Siswa Fisika pada Materi Fluida Statis,” Pros. Semnas Pend. IPA Pascasarjana UM, vol. 1, no. 1, p. 294-300, 2016.
[19] J. Docktor and K. Heller, “Assessment of Student Problem Solving Processes,” Minnesoeta: University of Minnesoeta, 2008.

[20] R. R. Hake, “Interactive-engagement versus traditional methods: A six thousand-student survey of mechanics test data for introductory physics courses,” Am. J. Phys., vol. 66, pp. 64–74, 1998.

[21] S. Arikunto, “Dasar-dasar Evaluasi Pendahuluan”. Jakarta: PT Bumi Aksara, 2012.

[22] R. Noor, “Penyusunan Lembar Kerja Peserta Didik (LKPD) Biologi SMA Melalui Inventarisasi Tumbuhan yang Berpotensi atau Sebagai Pewarna Alami di Kota Metro,” vol. 5, no. 2, pp. 94–104, 2014.

[23] N. Annafi, Ashadi, and S. Mulyani, “Pengembangan Lembar Kegiatan Peserta Didik Berbasis Inkuiri Terbimbing pada Konsep Termokimia Kelas XI SMA/MA,” J. Inkuiri, vol. 4 (3), pp. 21–28, 2015.

[24] Fitriani, M. Hasan, and Musri, “Pengembangan Lembar Kegiatan Peserta Didik (LKPD) Berbasis Masalah untuk Meningkatkan Pemahaman Konsep dan Aktivitas Belajar Peserta Didik pada Materi Larutan Penyangga,” J. Pendidik. Sains Indonesia, vol. 4, no. 2, pp. 24–35, 2016.

[25] F. Karsli and C. Şahin, “Developing Worksheet Based on Science Process Skills: Factors Affecting Solubility,” Asia-Pacific Forum Sci. Learn. Teach., vol. 10, no. 1, pp. 1–12, 2009.

[26] Y.-T. Chen, T.-J. Chen, and L.-Y. Tsai, “Development and Evaluation of Multimedia Reciprocal Representation Instructional Materials,” Int. J. Phys. Sci., vol. 6, no. 6, pp. 1431–1439, 2011.

[27] E. Sujarwanto, A. Hidayat, and Wartono, “Kemampuan Pemecahan Masalah Fisika pada Modelling Instruction pada Siswa SMA Kelas XI,” Jurnal Pendidikan IPA Indonesia, vol. 3, no. 1, pp. 65–78, 2014.

[28] M. Rahmat, Muhardjito, and S. Zulaikah, “Kemampuan Pemecahan Masalah melalui Strategi Pembelajaran Thinking Aloud Pair Problem Solving Siswa Kelas X SMA,” Jurnal Fisika Indonesia, vol. 54, no. XVIII, pp. 108–112, 2014.

[29] Sapriadil, A. Setiawan, A. Malik, D. Safitri, S. A. S. Lisdiani, and N. Hermita, “Optimizing Students’ Scientific Communication Skills through Higher Order Thinking Virtual Laboratory (HOTVL),” J. Phys.: Conf. Ser. vol. 1013, no. 1, p. 012050, 2018.

[30] A. Malik, A. Setiawan, A. Suhandi, A. Permansari, A. Samsudin, D. Safitri, S. A. S. Lisdiani, Sapriadil, and N. Hermita, “Using HOT Lab to Increase Pre-Service Physics Teacher’s Critical Thinking Skills Related to the Topic of RLC circuit,” J. Phys. Conf. Ser., vol. 1013, no. 1, p. 012023, 2018.

[31] P. Griffin, B. McGaw, and E. Care, Defining Twenty-First Century Skills. New York: Springer, 2012.

[32] P. Ningrum, “Meningkatkan Keaktifan dan Kemampuan Pemecahan Berpikir Kreatif melalui Pembelajaran Kolaboratif Berbasis Masalah Materi Kelarutan dan Hasil Kali Kelarutan (KSP) Siswa Kelas XI SMA Negeri Semarang,” Jurnal Pendidikan Sains, vol. 4, no.1, pp. 17–28, 2016.

[33] N. Dewi, I. M. Suarsana, and I. P. P. Suryawan, “Pengaruh Model Pembelajaran Kolaboratif Berbantuan Masalah Autentik terhadap Kemampuan Pemecahan Masalah Matematika,” Wahana Mat. dan Sains Jurnal Mat. Sains, dan Pembelajarannya, vol. 12, no. 1, pp. 26–41, 2018.

[34] S. Jaisook, S. Chidmongkol, and S. Thongthew, “The Development of Instructional Model by Integrating Problem-Based Learning and Collaborative Learning Approach to Enhance Mathematical Problem Solving, Communication and Connection Abilities,” 7th Int. Technol. Educ. Dev. Conf., vol. 13, no. 2, pp. 3196–3204, 2013.