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Applying The Problem-Solving Method to Improve Student Learning Achievement in the Concrete Construction 1 Course

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***Abstract*— This classroom action research aimed to improve the quality of student achievement and instructional process in the Concrete Construction 1 course by implementing the problem-solving method. This study was done through four steps namely planning, implementing, observing, and reflecting. The research participants were thirty Civil Engineering students at Universitas Negeri Malang who were taking the Concrete Construction 1 course. Two lecturers from the study programme of Building Construction Education were involved in this study, one of whom was a lecturer of Concrete Construction 1. The findings of this research indicated that the implementation of the problem-solving method in the Concrete Construction 1 course could (a) significantly improve the student learning achievement and (b) vastly increase the quality of instructional process.**

Keywords—problem solving, learning achievement, instructional process, concrete construction

I. INTRODUCTION

Research shows that most higher education institutions in Indonesia produce graduates with a low level of cognitive, affective and psychomotor skills. Mulkhan stated that a professor from State Islamic University (UIN) of Sunan Kalijaga Yogyakarta coneyed that the quality of higher education in Indonesia is inferior compared to the neighbouring countries, such as Malaysia and Brunei Darussalam [1]. Sardjoko, the Director of Education in the National Development Planning Agency (Bappenas), further pointed out that Indonesian higher education index is considered low, namely 14.6 %, in contrast to Singapore and Malaysia which have already had a better education index, 28 % and 33 % respectively [2]. On top of that, there is no balance between the courses on technical skills and character building as working beings, resulting in students with low life skills.

To improve the quality of education in Indonesia, increasing student learning achievement in the vocational education is the main agenda. In fact, the learning achievement of students in various levels of education is still far lower compared to the one of students from other developing and developed countries. At the level of higher education, the quality of student learning achievement, especially in the field of technology, is still very much a subject for educational research and seminars. Students' lack of mastery of the subject matter shows their lack of success in learning.

Based on the researchers' experiences and observations in the Building Construction Education at Universitas Negeri Malang, the students in that study programme had relatively low learning achievement. The main reasons behind this situation were the problems coming from lecturers and students. The problems coming from lecturers were lecturers' (l) limited pedagogical knowledge, (2) inadequate skills in applying problem-solving methods, (3) overuse of textbook driven approach, (4) low ability in delivering lessons in accordance with the appropriate teaching principles. The existence of these fundamental problems affects the instructional process and student learning achievement.

Judging from the student learning achievement of in the Concrete Construction 1 course, there were many students who could not satisfy the minimum pass criteria. The data on students' final exam scores showed that the percentage of students reaching the passing grade in 2012, 2013, 2014, and 2015 was only 40%, 35%, 40%, and 45% respectively. Due to the low number of students able to pass the course, the passing grade was lowered.

Besides, students were mostly passive in the instructional process, lacking interaction among students and having low learning motivation. Most students could not perform tasks properly; they did not know where to start, could not identify the problem or the correct formula to solve the problem. Students who were completely clueless simply waited to be spoon-fed.

Some students attempted to work on the problem but were unable to solve it, while others answered the question but the answer was wrong. Many students also committed different types of plagiarism or academic cheating, such as copying the work of others and cheating on exams. Some students could not perform well due to lack of confidence.

The difficulties encountered by students in Concrete Construction 1 were caused by students' lack of ability in understanding tasks, connecting concepts, creating visual aids, and applying mathematical concepts or rules for solving problems. Consequently, the operational objectives of the course, i.e. the ability to (1) apply formulas, (2) reason, (3)

work hard and independently, and (4) solve problems, could not be achieved optimally.

Based on the above descriptions, it is necessary to put in the right effort to improve student achievement in Concrete Construction 1. The solution should be able to overcome the problems related to the development of students' problem-solving skills and the delivery of instruction. The chosen method should be in accordance with the characteristics of the course so that the instructional problems can be completely solved.

There are actually many kinds of problem-solving models, but the most suitable model should be chosen based on the characteristics of students' and the Concrete Construction 1 course. After reviewing the literature, the researchers considered the model proposed by Wankat and Oreovicz, called Problem Solving of Engineering, as the most suitable solution [3].

Problem solving is a part of contextual teaching and learning. Basically, a contextual approach is a learning concept that links learning materials with real-world situations and encourages students to make connections between their knowledge and its application in real life. With the implementation of this contextual concept, the learning achievement is expected to be more meaningful for students.

Problem solving is a learning process whereby the real-world situations are used to provide context for students to learn [4]. The problem-solving learning initially began in Canada, precisely at McMaster in Hamilton, Ontario; it was applied for the development of a medical school [5,6]. Then, experts developed various types of problem-solving methods in accordance with the characteristics of each academic discipline. For example, there are problem-solving strategies for social science, biological science, engineering, and so on.

In general, the problem-solving learning aims to develop critical-thinking, problem-solving, and intellectual skills, as well as to facilitate students to learn various roles of adults through hands-on experience [7]. The elements an individual should have in order to solve a problem are knowledge, experience, learning skills, motivation, communication skills, and various learning strategies. In the discipline of engineering, a number of problem-solving methods have been developed, one of which is the problem-solving strategy developed by Wankat and Oreovicz [3]. The procedure of Wankat and Oreovicz's method consists of (a) I can: teachers boost students' motivation and self-confidence; (b) Define: students make a list of the things they know and do not know about a topic/problem—the use of mind mapping is recommended; (c) Explore: teachers stimulate students to ask questions and guide them to analyse the dimensions of the problem encountered; (d) Plan: teachers guide students to develop their logical-thinking skills to analyse the problem and use flowcharts to illustrate the problem; (e) Do: students estimate the possible answers to solve the problem; (f) Check: teachers guide students to recheck the answers made to detect any possible mistakes; (g) Generelise: Students are encouraged to ask the questions of "what have I learnt in this subject? How can the solutions be done more efficiently? If the solution is not correct, what should I do?" as well as to reflect and correct any errors.

Compelled by the aforementioned problems, this classroom action research attempted to improve the quality of student achievement and instructional process in the Concrete Construction 1 course in the Department of Civil Engineering UM by implementing the problem-solving method.

II. METHOD

A. Research Design

The design of this study was classroom action research. The study was done through a four-step process: (1) planning, (2) implementing, (3) observing, and (4) reflecting.

B. Study Participants

This study involved thirty Civil Engineering students at Universitas Negeri Malang who were taking the Concrete Construction 1. In addition, two lecturers from the study programme of Building Construction Education participated in this study, one of whom was a lecturer of Concrete Construction 1. The study was conducted for four months, from March to June 2016.

C. Planning

The planning process covered several activities, namely (a) designing an instructional scenario consisting the procedure of problem-solving method—the scenario was designed to provide guidance for achieving the learning objectives, (b) preparing supporting facilities i.e. learning media, student worksheets, etc, (c) preparing research instruments used to observe the instructional activities in class, (d) conducting a simulation of the implementation, and (e) establishing the criteria of success.

D. Implementing and Observing

After planning the action, the instructional scenario was implemented in class. The process of implementation was carried out simultaneously with observation, interpretation, and reflection.

Observation is an action to note the instructional process. Therefore, an easy and quick procedure was developed. The instruments used in the observation were (a) instruments for observing lecturers, (b) instruments for observing classroom, and (c) instruments for observing students [8].

Anecdotal observation was done to observe the lecturers' performance in applying the problem-solving method in class. The instructional process was recorded informally in the form of narative. The condition of the learning environment was also observed including the physical condition, arrangement, and management of the classroom.

The anecdotal observation technique was also done to record any interesting things from students as an individual or a group in the pre-, whilst-, and post-learning. In addition, questionnaires were used to identify the improvement of student learning motivation and knowledge. To measure

student achievement, a series of tests was administered at the end of each meeting. By doing so, the progress of student learning in each meeting can be tracked.

E. Analysing and Interpreting Data

The research data were collected from the results of observation of the instructional process i.e. the results of questionnaire and test in each cycle. The Problem-Solving method was implemented by the lecturer and this process was observed by the researchers. Data analysis was done using the descriptive technique, both qualitative and quantitative methods. The data which can be numerically described were analysed using the descriptive quantitative technique. The data obtained from observation was analysed qualitatively covering the process of data reduction, identification, and conclusion [9].

The hypothesis proposed in this study was validated to empirically test whether or not it was accepted. The validation employed the triangulation technique. This technique was used to check the validity of data by comparing data from different sources, methods, and researchers.

Data interpretation was performed in accordance with the relevant theory, compared with peers' experiences, judgments, and suggestions. The validated hypothesis was matched against the criteria, norms, and values accepted by lecturers and students.

F. Evaluating and Reflecting

The evaluation step was done to compare the results of analysis with the criteria of success. By doing so, the existing student achievement could be determined. The results of the evaluation were used to reflect the action done.

The reflection step was done to review the things had been done, the results, the contributing factors, and the future plan. The results of the reflection were used to decide what should be revised before performing the next cycle.

III. RESULT

A. Student Learning Achievement

The results of data analysis from cycle I to III indicate that the implementation of the problem-solving method in the Concrete Construction 1 course can significantly improve student achievement. The percentage of students who met the requirements to pass the course is presented in Table I.

TABLE I. PASS RATE OF STUDENTS IN CYCLE I

Cycle	Pass Percentage of Students (Score ≥ 75)
I	59.4% (18 students)
II	73.6% (22 students)
II	85.8% (26 students)

Only a total of 59.4% of students (18 students) passed the course in cycle I. Then, from cycle 2 to 3, the pass rate increased by 11.9% from 73.6% to 85.8%. This indicates a significant improvement of student achievement from cycle to cycle.

The average test score from the cycle I to III is shown in Table II.

TABLE II. AVERAGE TEST SCORE IN CONCRETE CONSTRUCTION 1

Cycle	I	II	III
Mean	73.2143	75.1786	79.2857
Median	75.0000	75.0000	z80.0000
Mode	75.00[a]	75.00[a]	75.00

Table II shows that there is a moderate increase of average score from cycle to cycle. The average score from cycle I to III was 73.21, 75.17, and 79.28 respectively.

The individual students' test scores also increased from cycle I to III. (See table 3 for full data results.)

TABLE III. STUDENTS' TEST SCORE IN EACH CYCLE

Test Score	Cycle I		Cycle II		Cycle III	
	Frequency	*Percentage*	*Frequency*	*Percentage*	*Frequency*	*Percentage*
50	2	7.1	0	0	0	0
55	0	0	1	3.6	0	0
60	2	7.1	2	7.1	2	7.1
65	1	3.6	1	3.6	0	0
70	5	17.9	2	7.1	0	0
75	8	28.6	10	35.7	11	39.3
80	8	28.6	10	35.7	7	25.0
85	1	3.6	1	3.6	2	7.1
90	1	3.6	1	3.6	5	17.9
95	0	0	0	0	1	3.6
100	0	0	0	0	0	0
∑	28	100	28	100	28	100

Table III shows that there is a fairly significant increase in students' test scores from cycle I to III. In cycle I, there were several students who failed to meet the pass criteria; one student got 60 and 5 students got 70. In cycle III, there were no students who got a test score of 60 or 70.

Based on the findings presented in Table I-III, the researchers suggest that the problem-solving method applied in the Concrete Construction 1 course can improve student achievement.

B. Implementation of the Problem-Solving Method

The success of implementing the problem-solving method in the instructional process depends on 2 aspects namely (l) lecturer's ability in implementing the method and (2) student engagement in the learning process.

1) Lecturer's Ability in Implementing the Problem-Solving Method

The lecturer implemented the problem-solving method in 7 stages, namely (1) motivate students, (2) identify the problem (3) explore, (4) plan the solution, (5) solve the problem, (6) evaluate, and (7) generalise. The results of analysis on the lecturer's performance in applying of the method are presented in table 4.

TABLE IV. LECTURER'S ABILITY IN IMPLEMENTING THE PROBLEM-SOLVING METHOD

Component of the Problem-Solving Method	Cycle I	Cycle II	Cycle II
Motivating Students	Poor	Fair	Good
Identifying the Problem	Poor	Fair	Good
Exploring	Poor	Fair	Good
Planning the Solution	Fair	Fair	Good
Solving the Problem	Fair	Good	Good
Evaluating	Fair	Good	Good
Generalising	Fair	Good	Good

The data presented in table III shows that there is a significant increase from cycle to cycle in the lecturer's ability to apply the problem-solving method in Concrete Construction 1.

In cycle I, all stages of the method were not implemented successfully by the lecturer. In cycle II, the lecturer could satisfy the criteria of good performance only in three stages. In cycle III, all stages of the problem-solving method could be well-implemented. These results indicate that the application of problem-solving learning method in the Concrete Construction 1 can significantly improve the quality of the instructional process.

2) *Student Engagement in the Instructional Process*

There were five components of student involvement observed during the instructional process: questioning skills, learning motivation, participation in discussion, presentation skills, and teamwork. The results of student engagement in the instructional process are presented in Table 5.

TABLE V. STUDENT ENGAGEMENT IN THE INSTRUCTIONAL PROCESS

No	Component of Student Engagement	Cycle I	Cycle II	Cycle II
1	Questioning Skills	Poor	Fair	Good
2	Learning Motivation	Poor	Fair	Good
3	Participation in Discussion	Fair	Fair	Good
4	Presentation Skills	Fair	Good	Good
5	Teamwork	Fair	Good	Good

Table 5 shows that, in cycle I, students did not perform well in all components indicating student engagement in the instructional process. In cycle II, among all components, students only showed a good performance in presentation and teamwork. In cycle III, students were fully engaged in the instructional process by performing well in all components. These results indicate that the application of problem-solving method can increase student engagement in the teaching and learning process.

IV. DISCUSSION

A. Student Learning Achievement

A significant increase in students' pass percentage and average test score from cycle to cycle indicates that the implementation of the problem-solving method in the Concrete Construction 1 course can significantly improve student achievement. This is in line with Suharmanto, stating that the implementation of the problem-solving method could increase the learning achievement of vocational high school students in Engineering Mechanics [10]. Wena, Sugandi, & Sugiyanto also suggested that there was a significant difference in learning achievement between students taught using the problem-solving method and those taught using the conventional method [11]. Widarta, Wena, & Priyono further pointed out that the implementation of the problem-solving method could vastly improve student achievement [12]. Moreover, Sugiyanto and Pranoto concluded that the use of the problem-solving method in the Steel Structure course was able to significantly improve student learning achievement [13].

There are several factors contributing to the improvement of student achievement resulting from the use of the problem-solving method. According to Felder and Bren, the implementation of problem-solving methods can encourage students to use deep approach to learning [14]. As a result, students will view learning as a process of giving meaning to the concepts being learnt (meaning orientation).

In the implementation of the problem-solving method, students were guided step by step to seek solutions of the problem faced. If students regularly practice using the problem-solving method in learning, they will eventually have good problem-solving skills and life skills. According to Lowman, in the constructivist learning process, lecturers should be able to cultivate students' habits of problem solving, such as (l) stimulating the ability to think and learn regularly and independently, (2) fostering critical attitude in thinking and learning (3) boosting creativity in thinking and learning [15].

B. Implementation of Method

The results of this study show that the implementation of the problem-solving method in the Concrete Construction 1 course can vastly enhance the quality of instruction. This concurs well with Sugiyanto, pointing out that the implementation of the problem-solving method could improve the quality of instructional process of the Building Construction course in vocational high schools [16].

The procedure of problem-solving method consists of seven stages, namely (l) motivate students, (2) identify the problem (3) explore, (4) plan the solution, (5) solve the problem, (6) evaluate, and (7) generalise.

The first step of the problem-solving method is to cultivate student learning motivation. Without an optimal learning motivation, lecturers will find difficulties in engaging students in learning. As suggested by Wena, Sugandi, and Sugiyanto, learning motivation is one of the main factors that should exist in the learning process [11]. After the motivation grows and develops, students are more likely ready to be faced with problems. Problems given should be able to challenge students' curiosity. With a great curiosity, students will be motivated to explore various alternatives to solve problems [17].

The results of exploration will be the source of information to determine appropriate solutions for the problem. After discovering the most suitable solution, students can try to

solve the problem. The problem-solving process needs to be evaluated to see whether or not the procedure done is theoretically and empirically correct. By doing so, any remaining errors or drawbacks can be detected and fixed. The final stage of the problem-solving learning method is generalisation in which students are encouraged to reflect, give feedback, and correct possible errors, and will eventually find the most effective and efficient solution [7].

C. Student Engagement in the Instructional Process

The results of this study show that the implementation of the problem-solving method in the Concrete Construction 1 course can foster student participation in class. This corroborates with Sugiyanto and Pranoto, stating that the use of the problem-solving method could improve student involvement in the Steel Structure course [13]. Widarta, Wena and Priyono also suggested that the application of problem-solving method could increase student participant and creativity in learning [12]. The improvement of student participation was inseparable from the systematic learning stages of the problem-solving method which was able to develop and encourage students to actively participate in learning and independently solving problems [3]. According to Gosling, to optimally promote student involvement in learning, students should be faced with problems related to the learning materials discussed [18].

Neale stated that the improvement of student creativity can be done by (1) stimulating students to be creative, (2) teaching students some methods to be creative, and (3) welcoming creative ideas proposed by students [19]. The strategies to stimulate students to be creative are: (1) developing some creative methods for problem solving, (2) providing several alternatives to solve a problem, and (3) listing some possible solutions to overcome a problem. The steps are actually an integral part of the problem-solving strategy [19].

V. CONCLUSIONS

The findings of the study have led us to conclude that the implementation of the problem-solving method in the Concrete Construction 1 course in the Department of Civil Engineering at Universitas Negeri Malang can (1) significantly improve the student learning achievement and (b) vastly increase the quality of instructional process i.e. shifting from teacher-centred to student-centred.

REFERENCES

[1] Mulkhan, A.M. (2015). Mutu Pendidikan Tinggi Indonesaia Tertinggal jauh dengan Negera Tetangga. ***Jawa Post National Network.Com.*** 21 Pebruari 2015

[2] Sardjoko, S (2015). ***Kualitas Pendidikan di Indonesia Masih Rendah.*** http://www.beritasatu.com/pendidikan/ 144143-kualitas-pendidikan-di-indonesia-masih-rendah.html. 21/2/2015.

[3] Wankat, P.C. & Oreovics, F.S. (1995). *Teaching Engineering*. New York: McGraw-Hill, Inc

[4] Nurhadi, dkk.(2003). *Pembelajaran Kontektual dan Penerapannya Dalam KBK*. Malang: Universitas Negeri Malang

[5] Baptiste, S.E. (2003). *Problem –Based Learning*. America:Slac Incorpotared.

[6] Setjo, S. (2004). *Implementasi Problem Based Learning Dalam Penyiapan Mahasiswa Calon Dosen Biologi*. Makalah disampaikan dalam seminar Exchange Exprience Kegiatan Piloting JICA-IMSTEP Penigkatan Pembelajaran MIPA Konstruktivistik di FPMIPA Universitas Negeri Malang, Malang 28 Januari 2004

[7] Wilson C. H. (2006). *Engineering Instruction*. Tersedia pada http://www.cs.utah. edu/~wilson/papers/derive-usenix01.html. Diakses tanggal 6 Agustus 2007.

[8] Tantra, D.K. (2006). *Konsep Dasar dan Karakteristik Penelitian Tindakan Kelas*. Makalah Disampaikan dalam Pelatihan Metodologi Penelitian Untuk Peningkatan Kualitas Pembelajaran (PPKP) dan Penelitian Tindakan Kelas (PTK) bagi Dosen-Dosen LPTK se-Indonesia pada tanggal 17-21 April 2006 di Makasar dan Surabaya

[9] Susilo, H., Laksono dan Ibnu, S. (2006). *Prosedur Penelitian Tindakan*. Makalah Disampaikan dalam Pelatihan Metodologi Penelitian Untuk Peningkatan Kualitas Pembelajaran (PPKP) dan Penelitian Tindakan Kelas (PTK) bagi Dosen-Dosen LPTK se- Indonesia pada tanggal 17-21 April 2006 di Makasar dan Surabaya.

[10] Suharmanto, Priyanto dan Sujono, A. 2007. Penerapan Strategi *Problem Solving Of Engineering* dan Teori Elaborasi Untuk Meningkatkan Hasil Belajar PDTM SMK. Malang: Lemlit Universitas Negeri Malang.

[11] Wena, M. Sugandi, R.M. dan Sugiyanto. 2013. Efektivitas Penggunaan Model Pembelajaran Peningkatan dan Pengembangan Intelektual Untuk Meningkatkan Hasil Belajar Siswa SMK.

[12] Widarta, B., Wena, M dan Priyono. 2010. Pengembangan Bahan Ajar Matadiklat Pengetahuan Dasar Teknik Bangunan (PDTB) Pada Sekolah Menengah Kejuruan Dengan Pendekatan Setrategi Penyampaian Pemecahan Masalah. Malang: LP2M Universitas Negeri Malang

[13] Sugiyanto dan Pranoto. 2008. Penerapan Metode Pemecahan Masalah dan Motivasional ARCS Untuk Meningkatkan Kualitas Pembelajaran Struktur Baja Prodi PTB. Malang: LP2M Universitas Negeri Malang

[14] Felder, R.M. & Brent, R. 2004. The Intelectual Development of Science and Engineering Student. *Journal of Engineering Education*, 93 (4) 279-291.

[15] Lowman, J. (2008). *Mastering the Techniques of Teaching*. San Fransisco: Josse-Bass.

[16] Sugiyanto. 2012. Pengembangan Pembelajaran Teknik Konstruksi Bangunan Dengan Metode Pemecahan Masalah *Ideal* Berbasis *Paikem* Guna Meningkatkan Hasil dan Motivasi Belajar Siswa SMK.

[17] Keller, J,.M. and Kopp,T.W. 1987. *An Aplication of The ARCS Model of Motivational*. In C.M. Reigeluth (Ed). Instruc tional theories in action: Lesson llustrating selected theories and models. New Jersey: Lawrence Erlbaum Associated Publsher

[18] Gosling, D. 2009. *Supporting Student Learning* . In AHandbook for Teaching and Learning in Higher Education. 3th Edited by Heather Fry, Steve Ketteridge, Stephanie Marshall. New York : Routledge.

[19] Neale, A. .2003. *10 reasons for you to make students an offer they can't refuse*! Adapted from the poster presentation given by Andrew.Neale at the 2001 CAOT Conference in Calgary, Alberta.