

Problem Solving Skills Analysis of Vocational Engineering Teacher Candidates in Term of Several Variables [Analysis of Problem-Solving Skills of Vocational Teacher Candidates in Terms of Several Variables]

Muhammad Anwar

Faculty of Engineering, Universitas Negeri Padang, Padang, Indonesia
e-mail: muh_anwar@ft.unp.ac.id

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ABSTRAK

Strategi pembelajaran yang diterapkan selama ini masih belum optimal mengembangkan kemampuan berpikir mahasiswa. Pembelajaran yang membekalkan *problem solving skills* kepada mahasiswa sebagai calon guru belum secara nyata dilaksanakan. Penelitian ini bertujuan untuk menemukan metode pembelajaran yang dapat meningkatkan keterampilan berpikir mahasiswa sebagai calon guru, khususnya keterampilan *problem solving*. Penelitian ini dilaksanakan dengan menggunakan metode survei umum tipe deskriptif. Dengan menggunakan formula Slovin dan kesalahan 5%, maka dipilih sampel 340 mahasiswa secara proporsional bertingkat dari 2289 mahasiswa sebagai populasi. Pengumpulan data menggunakan kuesioner keterampilan pemecahan masalah yang disusun ulang berdasarkan konsep *the simplicity thinking process* Basadur. Bagaimanapun, penelitian ini menunjukkan bahwa terdapat perbedaan yang signifikan ($p < 0.05$) dari keterampilan memecahkan masalah berdasarkan tingkat kepuasan calon guru terhadap metode pembelajaran yang dilaksanakan dosen. Namun, tidak ada perbedaan yang signifikan keterampilan pemecahan masalah berdasarkan program studi, jenis kelamin, latar belakang sekolah menengah, dan tahun masuk ($p > 0.05$) setelah dianalisis dengan one-way ANOVA. Penelitian ini menunjukkan bahwa kepuasan terhadap pembelajaran, sejalan dengan keterampilan pemecahan masalah calon guru.

Untuk itu, penting bagi institusi penghasil calon guru kejuruan untuk mengajarkan keterampilan pemecahan masalah dan menjaga tingkat kepuasan mereka dalam proses pembelajaran.

ABSTRACT

The learning strategy applied so far is still not optimal to develop students' thinking skills. Learning that includes problem solving skills to students as teacher candidates have not yet substantially implemented. This research aims to find learning methods that can improve students' thinking skills as teacher candidates, especially problem solving skills. This research was conducted using a descriptive type of general survey method. Using Slovin formula and 5% error, a sample of 340 students was proportionally selected from 2289 students as a population. Data collection using a problem solving skills questionnaire that rearranged based on the concept of the simplicity thinking process Basadur. However, this study shows that there are significant differences ($p < 0.05$) from problem solving skills based on the level of satisfaction of teacher candidates to the learning methods implemented by lecturers. However, there were no significant differences in problem-solving skills based on course, gender, middle school background, and year of admission ($p > 0.05$) after analyzed with one-way ANOVA. This study shows that satisfaction with learning is in line with the problem-solving skills of teacher candidates. Therefore, it is important for institutions that produce vocational teacher candidates to teach problem solving skills and maintain their level of satisfaction in the learning process.

Introduction

The 21st century, also known as information/knowledge age, has successfully shifted needs of world of work, society, economy for skill structure of workforce. It presents a more dominant role and position of brainpower and even replaces brawnpower. In other words, critical thinking skills of workforce are needed more than merely hard skills. Beers (2012) cited results of 2011 National Science Teacher Association Conference in the United States stating "*Exemplary science education can offer a rich context for developing many 21st-century skills, such as critical thinking, problem solving, and information literacy. These skills not only contribute to a well-prepared workforce of the future but also give all individuals life skills that help them succeed*". Critical thinking and problem-solving skills are not only assets for workforce but also determine success, career and level of community acceptance.

Furthermore, problem solving is basically a higher-order thinking skill that is essential for work, business and survival (Mayer, 2013). Problem solving often involves making decisions that are crucial to management and leadership. Binkley et al., (2012) classified critical thinking, problem solving and decision making as 1 of 3 ways of thinking needed in the 21st century. Today's students are leaders of tomorrow and leaders who should be successful (Moorthi, 2018). Results of study showed that level of problem-solving skills of students was relatively high and there was no significant difference between male and female students in terms of decision-making skills (Moorthi, 2018).

In fact, thinking skills, especially problem solving, do not grow by themselves in students, but they must be taught systemically. Rossman (1993) explained that students' roles change from passive recipients of information to participants in understanding creation when they use problem-solving skills. Accordingly, a problem must captivate students' attention, be meaningful, and allow for a variety of individual responses. Mills and Kim (2017) also affirmed *“In the real world, students encounter problems that are complex, not well defined, and lack a clear solution and approach. They need to be able to identify and apply different strategies to solve these problems. However, problem solving skills do not necessarily develop naturally; they need to be explicitly taught in a way that can be transferred across multiple settings and contexts”*. Thus, it is necessary to develop learning strategies or classrooms that are able to provide provisions and practice problem-solving skills to students.

Unfortunately, some of learning strategies applied so far in classrooms are still not optimal in developing students' thinking skills. In theory course, there have not been many innovations or attempts to carry out learning, such as brainstorming, problem-based, inquiry-based learning or other scientific-activity-based learning optimally. This also occurs in practicum courses where learning takes place according to the work instructions in lab/job-sheet. This study aims at finding learning methods that encourage thinking skills of students as teacher candidates, especially problem-solving skills. For this reason, a complete description by paying attention to various aspects related to problem-solving skills of students needs to be obtained first. It then can provide direction for selection of various suitable methods for improving thinking skills.

Moreover, this study aims to measure problem-solving skills of vocational teacher candidates at Faculty of Engineering, UNP using simplicity thinking process concept developed by Basadur. Implementation of this model can approach process in a systematic manner, including identifying problems, creating a sense of comfort in making solid decisions, ideas and action plans for implementing solutions (Basadur, 2020).

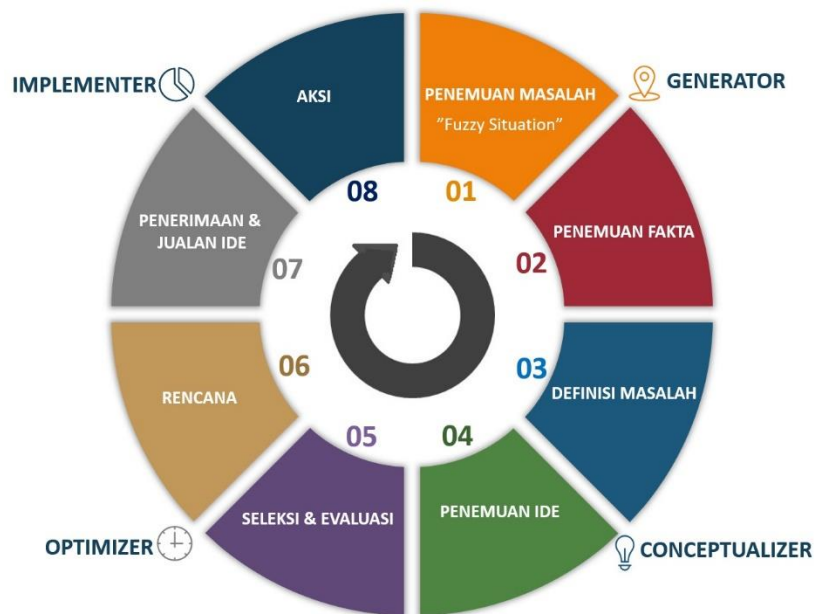


Figure 1. Simplicity Thinking Process

Simplicity Thinking Process fulfills 8 steps or problem-solving elements following a circular pattern as a continuous process (Basadur, 2020), which includes: *Find the Problem (FP)*: ability to find problem, *Find the Facts (FF)*: ability to find supporting facts, *Define the Problem (DP)*: ability to interpret and determine problems, *Find the Idea (FI)*: ability to find ideas (as a solution to a problem), *Select and Evaluate (SE)*: ability to evaluate

and select most appropriate solution, *Plan*: ability to plan problem solving/solution implementation, *Sell the Idea* (SI): ability to offer ideas for selected solution, and *Act*: ability to implement solutions appropriately. Researcher argues that those 8 elements used to measure problem-solving skills are relatively comprehensive and represent all thought processes in problem solving.

Method

This study was carried out using descriptive type general survey method. Population of this study was 2,289 students of Faculty of Engineering, Universitas Negeri Padang. By using Slovin formula and margin of error of 5%, 340 students from 6 undergraduate educational study programs (vocational teacher candidates) were selected as samples using proportionate stratified sampling. Sample consisted of 223 male students (65.59%) and 117 female students (34.41%) from 2016 to 2019 class, with different high school backgrounds: Senior High School/SMU (41.18%), Vocational High School/SMK (46.47%), Islamic Senior High School/MA (9.7%) and others (2.65%). Data were collected using a problem-solving skills questionnaire that was rearranged based on Basadur's concept of simplicity thinking, with 3 criteria for final skill score: 1) good (score more than 58); 2) fair (score between 37 to 58); and 3) poor (score 36 and below). Data analysis was done utilizing inferential statistics using one-way ANOVA test to see difference in mean of each sample based on specified criteria, and the independent samples t-test specifically to see differences in problem-solving abilities based on gender.

Result and Discussion

This research was conducted to see the problem-solving skills of vocational teacher candidates at Faculty of Engineering, UNP. Based on study programs including Building Engineering Education (PTB), Electrical Engineering Education (PTE), Electronics Engineering Education (PTElka), Informatics Engineering Education (PTI), Mechanical Engineering Education (PTM), and Automotive Engineering Education (PTO), most of accumulative scores of problem-solving skills of vocational teacher candidates were in a fair category (between 37 – 58).

Table 1. Distribution of Problem-Solving Skills Scores

Study Program	Problem-Solving Skills Score						Mean Score	Total
	Poor	%	Fair	%	Good	%		
PTB	0	0.00	42	91.30	4	8.70	50.11	46
PTE	0	0.00	50	94.34	3	5.66	49.74	53
PTElka	0	0.00	48	94.12	3	5.88	49.69	51
PTI	1	1.52	57	86.36	8	12.12	50.21	66
PTM	1	1.67	56	93.33	3	5.00	49.67	60
PTO	2	3.13	60	93.75	2	3.13	49.56	64
Total	4	1.18	313	92.06	23	6.76		340

However, there were still 1.18% of teacher candidates who had scores less than 37 and only 6.76% who had “good” scores. It indicates that teacher candidates’ approach to problem solving is somewhat “chancy”, in which solutions sometimes worked very well, and sometimes they did not. Teacher candidates basically understood what needed to be done and realized importance of having a structured problem-solving process. Unfortunately, they did not always follow that process. Here, consistency and commitment to process is required for teacher candidates to see significant improvements in these skills.

Importantly, results of statistical testing with one-way Anova showed that there was no significant difference in students’ problem-solving abilities based on their study program. There was no significant difference in terms of overall aspects or based on 8 elements of problem solving. Referring to Table 1, mean score of students’ problem-solving skills in all study programs was in range of 50 without any significant differences. This study also revealed that there was no significant difference in problem-solving skills in terms of gender, as in following table.

Table 2. Comparison of Gender-Based Problem-Solving Skills

Group	n	Mean Score	SD	t	Sig.
Male Students	223	49.68161	4.550218	-0.815	0.415
Female Students	117	50.10256	4.467092		

Independent samples t-test obtained level of significance of 0.415 or it did not meet $p < 0.05$. However, it can be seen that mean score of female students was slightly higher than mean score of male students. It is in line with a study conducted by Yenice et al., (2012), except for one approach, Hasty Approach.

Based on high school backgrounds, there was statistically no significant difference, especially in problem-solving skills. Data of this study demonstrated that SMU graduates obtained mean score of 50.29, SMK graduates obtained mean score of 49.48, MA graduates obtained mean score of 49.52 and other high school graduates obtained mean score of 49.89. Although difference was not significant, mean score of SMU graduates was slightly higher than mean score of other high school graduates. One-way Anova showed that based on 8 elements measured in detail, high school background was significantly different ($p < 0.05$) in element of select and evaluate (SE). It indicates that SMU graduates who were accepted had ability to determine criteria for a good solution, decide what elements needed for a realistic and practical solution, and think about criteria used to select among potential solutions.

In line with above findings, this study also explained that there was no significant difference in problem-solving skills based on class or year of entry. Data demonstrated that 2016 class of teacher candidates had the highest mean score of 50.21. Besides, 2017 class of teacher candidates had mean score of 49.88, 2018 class had mean score of 49.31, and 2019 class had mean score of 49.96. In addition to insignificant difference in mean scores, data trend also did not show that class of teacher candidates determine whether their problem-solving skills were good. One-way Anova test is presented as follows.

Additionally, a review of problem-solving skills in terms of student or teacher candidate satisfaction with learning methods used by lecturers showed different results. In general, there was a significant difference ($p < 0.05$) between students who stated that they were very satisfied with learning method compared to those who stated that they were quite satisfied, less satisfied or dissatisfied. By using multiple comparisons of Bonferroni's method, level of significance of each level of satisfaction is shown in following figure.

Table 3. Comparison Matrix of Level of Significance of Satisfaction towards Method

Group	Comparison of Level of Significance					Mean Score
	VS	S	QS	LS	D	
Very Satisfied (VS)		0.056	0.001	0.016	0.49	53.78571
Satisfied (S)	0.056		0.078	1	1	50.35152
Quite Satisfied (QS)	0.001	0.078		1	1	48.99248
Less Satisfied (LS)	0.016	1	1		1	48.70588
Dissatisfied (D)	0.049	1	1	1		48.72727

Based on mean score of problem-solving skills, there was quite a significant difference between Very Satisfied group and the other groups. There was a difference of 3.43 points between Very Satisfied and Satisfied groups. Focusing in detail on 8 elements, there were significant differences ($p < 0.05$) in DP, SE, Plan, and SI elements. It indicates that students who were very satisfied with learning method were better able to understand problem, focused on main problem, had ability to determine criteria for a good solution, decided what elements were needed for a realistic and practical solution, and thought about criteria that would be used among potential solutions.

More importantly, these students also had ability to implement solutions based on problem experienced. They were able to make plans depending on implementation project that needed to be prepared. Minor projects/issues required an action plan outlining who would do what, when and how. For major projects, students had ability to plan a more sophisticated and systematic approach. When communicating plans, students were able to face challenges, listen to what others have to say, and make changes as needed. The better the offer of an overall solution (sell the idea) that meets everyone's needs, the greater the positive impact. Therefore, besides an ability to make plans, survey results also showed the ability of students who expressed 'very satisfied' with learning method by lecturer to sell good ideas or solution plans.

Conclusion

It is necessary for vocational teacher candidates to have higher order thinking skills, especially problem-solving skills. These skills are not only taught to students but are also needed by teachers to carry out 21st Century learning. Results of this study indicate that there is a significant difference ($p < 0.05$) in problem-solving skills based on level of satisfaction of teacher candidates with learning methods implemented by lecturers. However, after analysis using one-way ANOVA, there is no significant difference in problem-solving skills based on study program, gender, high school background, and year of entry ($p > 0.05$). These findings prove that

satisfaction with learning is in line with problem-solving skills of teacher candidates. This study recommends that lecturers should be able to apply problem-solving learning clearly and need to study in detail steps of problem-solving learning activities as well as aspects observed at each of these stages to teacher candidates.

References

- Anwar, M., Jalinus, N., dan Pardjono. (2017). The learning model development of higher order thinking on electronics system subject. *Regionalization and Harmonization in TVET – Abdullah et al. (Eds).* Taylor & Francis Group, London, ISBN 978-1-138-05419-6.
- Demirel, M., Askin, İ., dan Yağcı, Esed. (2014). An investigation of teacher candidates' metacognitive skills. *Procedia - Social and Behavioral Sciences* 174, 1521 – 1528.
- Doyle, Alison. (2019). Problem Solving Skills: Definition, Steps, and Examples. Diambil dari <https://www.thebalancecareers.com/problem-solving-skills-with-examples-2063764>.
- M. Binkley, O. Erstad, J. Herman, S. Raizen, M. Ripley, M. Miller-Ricci, M. Rumble, (2012). Defining Twenty-First Century Skills. In P. Griffin, B. McGaw, & E. Care (Eds.), *Assessment and Teaching of 21st Century Skills*, Springer Netherlands, 17-66.
- Mayer, R. E. (2010). Problem Solving and Reasoning. *International Encyclopedia of Education*, 273–278.
- Mayer, R.E. (2013). Problem Solving, *The Oxford Handbook of Cognitive Psychology*, Oxford University Press, UK.
- Mills, Kate & Kim, Helyn. (2017). Teaching problem solving: let students get “stuck” and “unstuck”. Diambil dari <https://www.brookings.edu/blog/education-plus-development/2017/10/31/teaching-problem-solving-let-students-get-stuck-and-unstuck/>.
- Yenice, N., Ozden, B., & Evren, B. (2012). Examining of problem solving skills according to different variables for science teachers candidates. *Procedia - Social and Behavioral Sciences* 46, 3880 – 3884.