

2. Prosiding Seminar Internasional ICST 2018 (18-19 Oktober 2018) *by* Martini Martini

Submission date: 07-Nov-2020 12:01PM (UTC+0700)

Submission ID: 1438779975

File name: rosidng_Seminar_Internasional_ICST_2018_18-19_Oktober_2018.doc (218K)

Word count: 3278

Character count: 17607

Exploring Pre-service Science Teachers' Capabilities in Competing for National Scientific Fair through SETS Learning

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Abstract—To participate in the National Scientific Fair, pre-service science teachers (PSTs) need to prepare their capabilities in the competition. This study used survey to explore the capabilities of PSTs in terms of preparing scientific proposal, assessing proposal format and surveying PSTs perception. Rubric and questionnaire were used in the exploration process. A 10 item questionnaire was administered after SETS learning, whereas the rubric was implemented to measure the quality of the proposal. The result showed that mostly PSTs are capable of competing in National Scientific Fair due to their motivation, effort, and step-by-step mentoring in SETS learning. The shortcomings of processing to make proposal include formatting, referencing, and determining the budget. The positive responses outperform the negative responses to indicate that PSTs are doing best when they are asked for creative ideas.

Keywords—PST, National Scientific Fair, SETS, Capabilities

I. INTRODUCTION

Scientific competition has grown very rapidly to become more popular among educational institutions, especially for higher education. It functions to strengthen both educational institution position and student awareness of competitiveness in science. Take any example of this, students who participate in Student Creativity Program on a five different scientific based scheme, influence the national rank of their university and their motivation to inquire science in a deeper way. In 2017, for instance, National Scientific Fair held in Makassar, Indonesia, categorized universities into top ten which was mainly based on how many medals the students won during competition. The other, Meydan [1] found that after competition students achieve socio-academic values including the way they interact to school and friends, widen academic perspective and motivate themselves to

engage in science confidently. In such a case, competition itself then gains more attention year by year.

To compete with other participants, there are three requirements for participants to be acceptable in the competition. First, students have to deal with creativity to achieve a first-time deal of theoretical and practical works [2] which provide solution to solve societal problems. In doing so, students may search hundreds of article and discuss with their lecturers to seek out ideas for scientific accomplishment; and this refers to the domain of intellectual creativity [3]. Second, it is mandatory for participants to write proposal for the selection process. In such a case, they have to follow the proposal format of the scientific fair, unless their proposal becomes rejected. Third, in case of preparing proposal students are under several discussion and mentoring, and therefore they must have mental strength to refine the work so as to produce readable proposal to get financial support [4].

When asked to begin starting project for scientific fair, the most challenging part is writing proposal. Previous research found that problems with ideas are at first. Students are always not sure whether their ideas are novel and innovative to be so called as creative. They perceive that ideas are brilliant enough if they are found in the first place; no single expert have implemented those. Wood and Bilsborow [5] stated that in producing creative ideas students need to explore multiple sources through multiple methods. In doing so, they can search for information from *google scholar*, read articles from online and offline journals, and become aware to the potential of particular things that seem to be not valuable. In accordance to this, students pursuing science teacher profession called as Pre-Service Science Teachers (PSTs) from Surabaya State University suffer from the same problem. Among 1500 proposals, only one-third are acceptable in university level. The weakness of their proposal is

regarded to low creativity because the topics of the proposals are not unique since many previous projects in various scientific fair already unveil the same topics. Another, the formatting of the proposals do not fit to the official style. The mistakes are about cover, margin, spaces and financial planning. Doing refinement for those mistakes or errors needs mental efforts which are sometimes unstable in terms of motivation, and therefore making the proposals are not accurate and well-formatted.

Through SETS (Science, Environment, Technology and Society), PSTs are offered with a multidisciplinary approaches. They can access biology, physics, chemistry, humanities and informatics. Therefore, the ideas from multiple perspectives are acceptable to produce; and these are unleashed as the creative ideas through multi-steps mentoring. It then makes sense that in SETS learning, PSTs will undergo several student-student and student-teacher discussion.

Based on the explanation above, this article tries to explore the capabilities of PSTs following the National Scientific Fair. It is unique because those are perceived to have limited access to science, instead of both pedagogical and scientific concepts. The observation then relies on the writing of scientific proposals and their perceptions to do scientific information related to hard sciences.

II. RESEARCH METHOD

This study involved 78 PSTs from three different coeducational classes who took course on SETS (Science, Environment, Technology and Society). Five among them have been participant in National Scientific Fair.

In SETS, they are determined to think science in an integrative way from multiple disciplines such as hard sciences, social studies and humanities. The final product of the course was research proposals which have to be submitted in the competition of national scientific fair. While doing so, a survey was conducted to measure the dimension creativity of their work.

There are three aspects to measure, namely, the way PSTs write the proposal, the proposal itself, and the PSTs' perception towards what is so called as creativity. *The process of writing proposal* was descriptively analyzed by which the main focuses were the novelty of ideas and how PSTs arrange creative ideas in written form. This study used interview to obtain the result in depth. *Assessment of the proposal* deals with the formatting process and how each individual idea was converted into coherent paragraph. Rubric for assessing this was adapted from national scientific fair rubric. Lastly, *PSTs' perception* was measured using a questionnaire containing 20 items adapted from Kumar & Holman [6] which were in

accordance with *self-perceived creativity*. The scales to be used was Likert Scale, ranging from absolutely *disagree* to *absolutely agree*. Semi-structured interview was also conducted to strengthen the result of this study.

To address the research question in depth, those mixed data were analyzed in descriptive manner by which at first those were classified into the same theme. Interview data were transcribed to support the quantitative data. Second, the images of the analysis was then described using information from other research articles where relevant.

III. RESULTS AND

DISCUSSION A. Process of writing proposal

Starting to write involves both mental and cognitive processes. Each of which functions to support information delivery including information arrangement, words use, and style until finishing the writing.

Processing to writing proposal include two aspects, namely, novelty of ideas and the way PSTs convert their mind into written form. In terms of novelty, PSTs use multiple strategies to obtain ideas. First, by means of internet connection they search for information in *Android* application such as *Line*, *Jakarta Post*, and *VivaNews*. The reason is that the applications are easy to handle and display updated information related to problematic phenomena which need immediate problem solving. It then gives opportunities to PSTs to dig down their thinking for finding alternative. Second, in each scientific competition there are a large number of issues presented by the participants. Using a thorough checking, PSTs can look at the titles which previously become award-winning trend. The last, experiencing science from the surrounding provides better connection between what to think and what to write. In such a way, the PSTs can easily determine creative ideas in accordance with the potential of nature as shown in the Figure 1.

The poster exhibition is part of the National Scientific Fair. The title of the poster is the same with the title of the proposal, that is, "The Effect of LoFaGo Juwet Extract on Histopathological Images of Pancreas Structure of Mice Suffering from Diabetes Mellitus".

From the title, the PSTs use the potential of nature of Juwet because one of the member of the group knew that one of the villages in East Java, Lamongan, is known as the village of juwet. Many students from faculty of medicine usually visit the village to observe about the use of juwet.

In terms of scientific observation, the member then relate her existing experience to the area of scientific discovery, so called as Nature of Science (NOS). Then creative ideas are generated. In such a situation, SETS

plays an important role in facilitating students' thinking to realize their creative ideas. The emphasis is through combining disciplines and step-by-step mentoring.



Fig 1. Example of poster in National Scientific Fair 2017 presented by PSTs

B. Proposal Formatting and Content

To make the proposal acceptable for financial support, the formatting should meet the requirements that are already mentioned in the rule of writing for National Scientific Fair. Sampling towards several proposal showed that at first stage, the PSTs do not aware that the formatting process is rigid and determines the final decision for the implementation of the proposal. The table below displays some mistakes about proposal formatting.

TABLE I. PROPOSAL FORMATTING MISTAKES

No.	Formatting errors
1	The margin is not fit to the rule, i.e. margin is 3 cm, but in fact, is 2.5 cm.
2	The way the chapter is written is not appropriate.
3	The numbering is inconsistent.
4	The cover color is not correct for particular scheme, i.e. logo is placed in below the name of the group.
5	The subsections are not in well-ordered.

After looking at the format, the content of the proposals are then assessed using rubric. The rubric contains idea of the proposal, coherence, method, and references.

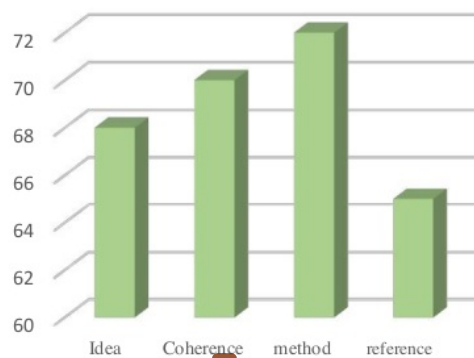


Fig 2. Assessment results of the proposal content

Figure 2 displays the score of individual assessment of each aspect in the rubric. The score of those aspects are not quietly different. The idea is at 68 score which means that the idea itself is gained through modification; and if the google search is used to find the idea, it displays more than five articles. It indicates that the use of idea is frequent in different context. However, there is no redundancy for it. Coherence among background, literature review, method, and finance is at 70 which means there is a gap between those. The most challenging part for PSTs is determining the expenditure because it is not usual for them to deal with the cost of laboratory equipment use.

Method generally is modified from articles. In such a case, there are some errors to implement that. The PSTs usually revise the errors after having discussion with mentor in SETS. They can discuss about the materials, the procedure, and the use of formula (if possible). The lowest score is for reference. There are two shortcomings in the use of reference. The first is they cite the article from the year 1993 which is not updated. The second, they also put sources from Wikipedia that sometimes are not credible because those can be written by people who are not professional in their field. However, there are a few articles that can fit to the theme.

C. PSTs' Perception

Perception refers to the awareness of cognitive function related to what people have done [7]. In this study, perception is limited to self-perceived creativity. It is in accordance with the extent to which the PSTs value themselves to be creative enough for writing proposal. According to Dilliello [8], it also belongs to the creativity of an individual which is influenced by supportive environment. The responses towards self-perceived questionnaire are presented in the Table 2.

TABLE II. PSTs RESPONSES TOWARDS SELF-PERCEIVED CREATIVITY QUESTIONNAIRE ITEMS

No	Statement	Preference Scales				
		(-)			(+)	
		AD	D	N	A	AA
1	I think I am a creative person.	2	10	0	40	26
2	I can easily transfer my thinking into creative ideas.	32	25	18	2	1
3	Creativity is designed in non-ordered structure.	8	12	8	25	25
4	Supportive environment gives help to building creativity.	0	1	5	46	26
5	I have to increase my motivation when dealing with creativity.	0	0	2	26	50
6	Creative ideas needs more efforts to be produced.	1	0	1	20	56
7	Creativity is the coincidence when I think more often.	10	2	2	17	47
8	Creative ideas can attract my attention, thus make me working until those are implemented.	2	1	1	50	24
9	Creative ideas are well produced when I focus on what I do.	2	2	0	35	39
10	I often think creative when I engage to the problem outside my field.	18	15	3	35	7

AD: Absolutely Disagree
 D: Disagree
 N: Neutral
 A: Agree
 AA: Absolutely Agree
 (+): positive response (-): negative response

According to the results above, the PSTs generally feels that they are creative person (item 1) by which the environment gives the aid to strengthen their motivation to produce creative ideas (item 4 and 5). The supportive environment refers to the group in which they are belong to. When one the motivation of a single person decreases, the remaining members will encourage him to stay on the right track so as to keep the motivation alive. It benefits to the accomplishment over their task. However, the results also record interesting phenomena. Making creative ideas seems to be difficult without more endeavors (item 6). The PSTs need to focus on what they do (item 9). In such a case, finding relevant information and also step-by-step mentoring require mental strength which then lead to the personal and group success.

In terms of SETS, PSTs feel that the course gives opportunities to them to widen their thinking through its multidisciplinary approach. In other words, they can think globally in the borderless area as shown in the interview below:

Interviewer: "How can SETS learning provide you support for making scientific proposal?"
 PST : "It provides me step-by-step discussion to reach my goal, especially when making proposal. I can think physics, biology, and

chemistry at the same time. It is interesting for me because pursuing the scientific nature is just like uncovering the hidden mystery of science".

Interviewer: "Why do you feel interested in following scientific inquiry?"

PST : "It is because we can do experiment and use various equipment in a laboratory. Also, I have a chance to deepen my knowledge. For instance, in my previous research which was presented in national Scientific Fair in Makassar 2017, I had to do collaborative research with a lecturer from Airlangga University who has expertise in diabetes research and there I operated new laboratory apparatus. It was challenging for me as pre-service science teachers dealing with such a new stuff".

Interviewer: "According to your experience, do PSTs still need a scheme for pure science to follow as implemented in SETS?"

PST : "I think that PSTs need that because they do not have access to do research in hard science, other than research in education which really different. In such, if they do follow inquiry in hard/pure science, they can strengthen their scientific knowledge when someday they teach. Also, they can guide their students in school if there is national competition of science. This will lead to strengthen their position in school and professionalism".

Interviewer: "Okay, it seems that you are more confident now from SETS and scientific competition after all. Now, how about SETS related the creativity?"

PST : "SETS offers freedom to think of what I am interested in. Besides, it also introduces me what is classified as creative idea and how I can generate that. I then begin with searching much information from google and many android news apps such as VivaNews, Jakartapost, and Detik to get the latest info. Afterwards, I discuss the idea to meet solution over the problems found".

Interviewer: "How about creative ideas in National scientific Fair?"

PST : "In National Scientific Fair, creative ideas I think are limited to the solution of global issues that needs to be implemented in the near future. Thus, student-teacher and student-student tutoring can make creative ideas even clearer to produce".

Based on the transcription above, PSTs needs chances to pursue their scientific inquiry although it is quite challenging for them such not having enough knowledge to do experiment in the laboratory related to hard science. In their learning, they do laboratory working related to knowing concepts rather than experiment. The other is learning about pedagogical knowledge. This makes them difficult to compete in National Scientific Fair. SETS, however, provides opportunity to PSTs in developing their thinking and skills related to other area which is in the scope of National Scientific Fair. In such, PSTs believe that experience in SETS learning can strengthen their competencies in science. Therefore when one day they teach their students in school, they believe that they are capable of mentoring the process of making scientific proposal so as to support their position in the institution. In such, it will give them confidence. Due to such benefits, PSTs finally are successful to make and compete scientific project in National Scientific Fair.

5 IV. CONCLUSION

Based on the results of it is concluded that mostly PSTs are capable of competing in National Scientific Fair due to their motivation, effort, and step-by-step mentoring in SETS learning. The shortcomings of processing to make proposal include formatting, referencing, and determining the budget. The positive responses outperform the negative responses to indicate that PSTs are doing best when they are asked for creative ideas. Interview data reveal that PSTs believe what they experience in SETS learning make them capable of generating creative ideas and developing their competencies related to science, not only pedagogy.

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