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The Identification of Factors of Mentoring In the Context of Science Project Competition

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Abstract : Science project competition is a platform for students to expose their scientific work. In completing their science project, school provides them with mentors. Mentoring has many factors involved which can be implemented in different contexts. It is important to identify the factors of mentoring which influence the success in science project competition. In this study, a survey design of research was conducted to identify factors of mentoring in the context of science project competition. The survey involved 250 students as participant of science project competitions in ten different areas in Indonesia. The result of the study demonstrates two out of six factors of mentoring were the most influencing factors toward success in science project competitions. The two factors are communication between the students and their respective mentors, and coaching on science project during the mentoring process. By putting the two factors into consideration of school management in assigning teachers as mentors to the students, it is expected that the students' achieve their success in science project competitions.

Keywords –Mentoring, science project, science project competition, communication, coaching

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I. INTRODUCTION

Science project competition is a platform of students which exposes research projects in the form of competition. Reis, Trudel, Guilet, Kleine & Hancianu [1], and Abernathy & Vineyard [2] reported that science fairs or science project competitions, are refer to a team project developed according to a proposed challenge and topic. This research is focus on science project competition because it is open to wider audience. According to MIT former President, Charles M. Vest [3], the challenge of the future will be to create new ideas and to make innovation. Directorate General of Secondary Education Indonesia [4] stated in the 2014 report that Indonesia is training its youngsters to be creative, innovative, and entrepreneurial Moreover, Handayana [5] reported in 2010 that Indonesia is rigorously sending its youngsters to compete in science competitions locally and internationally, some of them awarded as champions.

Nevertheless, the result of study conducted by Permanasari [6] in 2010 mentioned that science project in the form of research is not a common practice in secondary schools in Indonesia, it is being practiced separately as laboratory activities. Small numbers of school in Indonesia, which are mostly international schools, have included research in their curriculum. In public, students experience conventional style of learning, which is more teacher centered, as reported by Bahri [7]. Students who have interest in doing research are expected to join out of school activities, or chose science club as extra curriculum activity. The National Curriculum 2013 with an encouragement on more creativity in learning has been failed in the first year of implementation and withdrawn by the government. Teachers were not prepared for a student centered and active learning. Hassan, Mustapha, Yusuff & Mansor [8] stated in their report that teacher need guidance on higher-order thinking skills in teaching. The needs of mentoring system to be established to nurture young scientists was reported by Wahab, Mustapha, Ahmad & Jelas [9].

Mentoring has been studied by many researchers in wide variation of context. In this study, mentoring in the context of science project competition constructed of six factors. According to McSheck [10], Effron [11], Chou [12], Hill [13], Armani [14], Wilkins [15], Henley [16], and Nakkula [17], the factors were relationship, supervision, communication, role model, research skill, and coaching. The success of mentoring was measured through students' achievement in science project competitions.

This study proposes a new strategy to achieve students' success in participation in science project competition. The preparation of science project, involving teacher as the mentor in the mentoring process. A survey design was constructed in this study and 250 students as participant of science project competition in ten different areas in Indonesia were involved.

II. METHODOLOGY

The aim of the study was to determine factors of mentoring in the context of science project competition. Research objectives of this study were, to identify the effectiveness of mentoring in science project competition as perceived by the respondents, and to determine the factors of mentoring in the context of science project competition as perceived by the respondents. The respondents in this study were secondary school students in Indonesia, who participates in science project competitions. To achieve the first objective of this study, five null hypotheses were constructed and tested using inferential statistics, and one null hypothesis was constructed to achieve the second objective of the study. Quantitative data was collected from the respondent using a set of questionnaire developed by Raharti, and qualitative data collected from the respondents by interview. The construct reliability of the questionnaire was tested using Cronbach Alpha to examine the internal consistency of relationship, supervision, communication, role model, research skill, and coaching as the factors of mentoring. The questionnaire was validated by three experts in order to make sure that the items in the questionnaire measured the factors of mentoring. Quantitative data was analyzed utilizing SPSS version 18.0 to examine the Pearson correlation coefficients and regression, while qualitative data was analyzed by semi-structured data analysis.

The respondents of the study were 250 students from selected area (province/municipal) in Indonesia: Sumatera Utara, Sumatera Selatan, Jawa Barat, DKI Jakarta, Jawa Tengah, Jawa Timur, Kota Surabaya, DI Yogyakarta, Bali, Kalimantan Tengah. A set of questionnaire was distributed to the respondents during their participation in science project competitions in 2017 in their area, and jury scores in the competitions represented their achievement. The instruments in this study were survey questionnaire and interview protocol. The structure of the questionnaire illustrated in Table 1. Part A of the questionnaire was demographic information of the respondents such as gender, school level, school type, age groups, and their achievement in science project competitions. Part B comprised of seven items on relationship, nine items on supervision, ten items on communication, nine items on role model, four items on research skills, and eight items on. Part C of the questionnaire consisted of three open-ended items on mentoring in general regarding students' participation in science project competitions. The interview protocols comprised of three questions regarding mentoring on science project competition.

Table 1.The structure of the questionnaire

Items	Description	Evaluation
Part A	Background information of the respondents	Demographic Data
Part B		
1 - 6	Relationship between the respondents and their mentor	Relationship
7 - 15	Supervision on science project by the mentors	Supervision
16 - 25	Communication between the students and the mentors	Communication
26 - 34	Role model on mentor	Role Model
35 - 38	Research skills of the mentors	Research Skills
39 - 46	Coaching regarding science project competition	Coaching
Part C	Open-ended questions on mentoring	Mentoring

III. FINDINGS AND DISCUSSION

The findings of this study is presented in three parts. The first part illustrates demographic information of the respondents. The second part reports data on mentoring which presented its six factors, followed by the result of independent sample t-test on null hypothesis 1, null hypothesis 2, null hypothesis 3, null hypothesis 4, and null hypothesis 5. The third part consists of the result of correlational test on mentoring perceived by the students, continue by regression result on mentoring toward success in science project competition.

The questionnaires were 100% returned from the respondents. Demographic data of the respondents is presented in Table 2. The respondents in this study were 250 students comprised of 44% male and 56% female. The respondents were students in junior high school (47%) and senior high school (53%). Majority of the students were going to public school (74%), while only 26% going to private school. Out of 250 students, 56% of them were 13 to 15 years old, and 44% were 16 to 18 years old. Regarding their success science project competition, 60% of the respondent won, while 40% of them did not win in the competition.

Table 2. Demographic information of the respondents

Item	n	(%)
Gender:		
Male	110	44.00
Female	140	56.00
Total	250	100.00
Level of schools:		
Junior High School	117	46.80
Senior High School	133	53.20
Total	250	100.00
Type of Schools:		
Public School	186	74.40
Private School	74	29.60
Total	250	100.00
Age groups:		
13-15 years-old	141	56.40
16-18 years-old	109	43.60
Total	250	100.00
Achievements:		
Medalist	150	60.00
Non-medalist	100	40.00
Total	250	100.00

To identify the mentoring perceived by the students, a set of questionnaire was distributed to the students. In the questionnaire, the five-points Likert scale provided the options of strongly agree (5), agree (4), not sure (3), disagree (2), and strongly disagree (1). Six items on relationship between the students and their mentors were posed to the students and the result showed that, in general, the students strongly believed (M = 4.40; SD = 0.52) that they had positive relationship with their mentor. The positive relationship between the students and their mentors shown through students' comfortable feeling when discussing with their mentors (M = 4.50; SD = 0.62), the mentors' honesty to the students (M = 4.44; SD = 0.66), the mentors' care about the students' emotion (M = 4.43; SD = 0.72), the safe feeling of the students when being together with their mentors (M = 4.42; SD = 0.66), the ability of the mentors to reduce the student's stress M = 4.39, SD = 0.69), and the willing of the mentor to spend their time with the students in completing the science projects (M = 4.22; SD = 0.88).

Regarding the supervision in the preparation to participate in science project competition, the students strongly believed (M = 4.49; SD = 0.41) that they experienced supervision from the mentors regarding science project competition. Most of the students strongly agreed (M = 4.66; SD = 0.51) that the mentors cared of the students' emotion. Moreover, the students strongly agreed (M = 4.61; SD = 0.50) that the mentors appreciated the students' contributions in their science project. Nevertheless, the students agreed (M = 4.33; SD = 0.75) that their mentors never made fun of them if they made mistake. The students strongly agreed (M = 4.41; SD = 0.67) that their mentors tried not to make the students felt ridicule when they committed a mistake. The students also strongly agreed (M = 4.55; SD 0.56) that their mentors showed appreciation to to the students in front of other students. However, the students agreed (M = 4.13; SD = 0.95) that their mentors did not show their expression when they were not happy in front of the students. The students agreed (M = 4.34; SD = 0.77) that their mentors avoided to be rude to them. Furthermore, the students strongly convinced (M = 4.52; SD = 0.67) that their mentors never told the students that the students were incompetent. Finally, the students strongly agreed (M = 4.60; SD = 0.58) that their mentors encouraged them to interact with other people with respect.

In relation to communication between the students and their mentors, in overall, the students strongly believed (M = 4.40; SD = 0.37) that they have good communication with their mentors during the mentoring process. The students strongly agreed (M = 4.38; SD = 0.65) that their mentors praised them after they have done a good job that requires substantial effort. The students strongly agreed (M = 4.34; SD = 0.72) that their mentors avoided making negative comments about them to others. The students also strongly agreed (M = 4.28; SD = 0.62) that in discussion with the students, the mentors focused on the students' needs. In relation to discussion on the science project, the students strongly agreed (M = 4.43; SD = 0.55) that their mentors welcomed inputs from the students when discussing about the students' science project. Moreover, the students agreed (M = 4.33; SD = 0.62) that in facing new problem, their mentors would rather listen to the students' opinion first. The students also strongly agreed (M = 4.46; SD = 0.55) that their mentors listened patiently to the students' thoughts. Next, the students strongly convinced (M = 4.49; SD = 0.54) that their mentors welcomed feedback from them. Nevertheless, the students strongly agreed (M = 4.44; SD = 0.63) that their mentors used

positive gestures and facial expressions when talking with them. The students strongly agreed (M = 4.47; SD = 0.62) that their mentors explained using simple analogy when the students did not understand a concept. Finally, the students strongly agreed (M = 4.36; SD = 0.61) that their mentors asked the students' suggestions on how to solve the problem in their science project.

The students were posed to eight items regarding role model to reflect mentoring process. In general, the students strongly agreed (M= 4.44; SD = 0.39) the mentors as their role model. The students strongly agreed (M = 4.50; SD = 0.62) that their mentors proofread the students' writing before submission. The students also strongly agreed (M = 4.49: SD = 0.56) that their mentors provided them with feedback on their work. Regarding conducting research, the students convinced (M = 4.44; SD = 0.72) that their mentors have conducted several science projects. The students strongly agreed (M = 4.49; SD = 0.70) that their mentors provided extra time (for example after school) for them for consultation. The students also strongly agreed (M = 4.43; SD = 0.62) that their mentors' attitude becomes a role model for the students. Nevertheless, the students strongly agreed (M = 4.31; SD = 0.69) that their mentors were not angry when they made a mistake in doing science project. The students strongly agreed (M = 4.44; SD = 0.57) that their mentors patiently guided the students' science project. Finally, the students strongly agreed (M = 4.39; SD = 0.70) that their mentors were enthusiastic when guiding the students' science project.

Findings on the part of questionnaire about role model, in general, the students strongly believed (M = 4.38; SD = 0.50) that their mentors' research skills were supporting to the process of mentoring regarding science project competition. Most of the students strongly agreed (M = 4.46; SD = 0.63) that their mentors guided them to find relevant information to support their science projects. The students strongly agreed (M = 4.36; SD = 0.73) that their mentors suggested relevant resources to them. The students convinced (M = 4.18; SD = 0.74) that their mentors guided them to create a time line for their science project. Finally, the students strongly agreed (M = 4.50; SD = 0.67) that their mentors reminded them the importance of completing their science project on time.

The students were posed to eight items on coaching. In general, the students strongly believe (M = 4.46; SD = 0.40) that they were supported by coaching from their mentors, regarding science project competition. The students strongly agreed (M = 4.34; SD = 0.59) that their mentors were accessible to them to discuss about their science project. Majority of the students strongly agreed (M = 4.55; SD = 0.55) that their mentors supported and encouraged them in completing their science project. The students also strongly agreed (M = 4.42; SD = 0.58) that their mentors provided proper guidance to them on the science project design. Moreover, the students strongly agreed (M = 4.57; SD = 0.55) that their mentors provided them with suggestions to improve their science project. In relation to the role of the mentors as advisors, the students strongly agreed (M = 4.54; SD = 0.53) that the mentors gave advice to them in appropriate way. Furthermore, the students strongly agreed (M = 4.38; SD = 0.62) that their mentors showed appreciation when they told their thoughts or feelings. Regarding sharing experiences, the students strongly convinced (M = 4.48; SD = 0.60) that the mentors liked to use their positive experiences in discussion. Finally, majority of the students agreed (M =4.37; SD 0.61) that after discussion, the mentors preferred to have group consensus.

The total average of factors of mentoring was illustrated in Table 3. In general, the students convinced (M = 4.43; SD = 0.32) that they experienced positive mentoring from their mentors. Regarding effectiveness mentoring from the students' perspective, majority of the students strongly agreed (M = 4.49; SD = 0.41) that their mentors provided supervision to them, as well as coaching (M = 4.46; SD = 0.40). The students strongly agreed that their mentors built positive relationship (M = 4.40; SD = 0.52) and communication (M = 4.40; SD = 0.37) with them. Nevertheless, the students strongly agreed (M = 4.38; SD = 0.50) that their mentors possessed research skills.

Table 3. The total average of mean and standard deviation of mentoring from the students' perspective.

Factors of Mentoring	M	SD
1. Relationship	4.40	.52
2. Supervision	4.49	.41
3. Communication	4.40	.37
4. Role Model	4.44	.39
5. Research Skills	4.38	.50
6. Coaching	4.46	.40
Total Mentoring	**4.43**	**.32**

Five independent sample t-tests were conducted to compare the mentoring perceived by male and female students, the students in junior and senior high-schools, the students in public and private schools, the students in the group age of 13 to 15 years-old and 16 to 18 years-old, and medalist and non-medalist students.

The result indicated that there was no significant difference on mentoring as perceived by the male and female students [t(248) = -0.935, p = 0.351], with the mean of mentoring perceived by the male students was 4.41 (SD = 0.32) the female students was 4.45 (SD = 0.31). Regarding the school level, the result indicated that there was no significant difference on mentoring as perceived by the the students in junior and senior high schools [t(248) = -1.447, p = 0.149], with the mean of mentoring perceived by the students in junior high school was 4.39 (SD = 0.31) and the students in senior high school was 4.45 (SD = 0.32). More over, the independent sample t-test indicated that there was no significant difference on mentoring as perceived by the the students in public and private schools [t(248) = -0.414, p = 0.679], with the mean of mentoring perceived by the students in public school was 4.43 (SD = 0.32) and the students in private school was 4.44 (SD = 0.33). The result of the fourth independent sample test indicated that there was no significant difference on mentoring as perceived by the the students in the group age of 13 to 15 years-old and 16 to 18 years-old [t(248) = -0.766, p = 0.445], with the mean of mentoring perceived by the students the group age of 13 to 15 years-old was 4.41 (SD = 0.29) and the students in the group age of 16 to 18 years-old was 4.44 (SD = 0.34). Finally, the last independent t-test indicated that there was no significant difference on mentoring as perceived by the the medalist and non-medalist students [t(248) = 0.799, p = 0.425], with the mean of mentoring perceived by the medalist students was 4.45 (SD = 0.35) and the non-medalist students was 4.41 (SD = 0.25).

An open-ended question was posed to the students about their mentors regarding mentoring process on the preparation to science project competition. The answers from the students were presented in Table 5. The students listed three traits of their mentor's good mentoring, the first one was the mentors' role as advisor (58.0%), second was their mentors' encouragement to the students (33.6%), and third was the the fact that their mentors were accessible (24.0%).

Table 5. Characteristics of good mentor from the students' perspectives.

Rank	Factors	%
1	Advisor	58.4
2	Encouraging	33.6
3	Accessible	24.0

Correlational test was conducted to examine the relationships among the six factors of mentoring, and the result presented in Table 6. The Pearson coefficients for all correlations among the six factors of mentoring were statistically significant at the level of $\alpha = 0.01$. Out of sixteen correlations, there was one weak correlation [r(248) = 0.246; p = 0.000] between research skills of the mentors and relationship between the students and the mentors from the students' perspective. Nevertheless, there were fifteen moderate relationships varied from [r(248) = 0.325; p = 0.000] to [r(248) = 0.623; p = 0.000]. The weak and moderate relationships among the factors are showing the independency of the factors. Regarding relationship between the factors and the total mentoring, it can be seen from Table 6 that there were moderate relationships between the total mentoring and relationship [r(248) = 0.680; p = 0.000] and between the total mentoring and research skills of the mentors [r(248) = 0.621; p = 0.000]. Furthermore, there were strong relationships between the total mentoring and communication [r(248) = 0.812; p = 0.000], the total mentoring and supervision [r(248) = 0.810; p = 0.000] and between the total mentoring and role model [r(248) = 0.810; p = 0.000]. Therefore, relationship, supervision communication, role model, research skills, and coaching, were positively representing mentoring from the students' perspective in the context of science project competition.

Table 6. Pearson coefficients of correlations amongst mentoring factors from the students' perspective.

Factors		1	2	3	4	5	6	Total Mentoring
1. Relationship	Pearson	1	.562**	.439**	.363**	.246**	.325**	.680**
	Sig (2-tailed)		.000	.000	.000	.000	.000	.000
2. Supervision	Pearson	.562**	1	.623**	.548**	.339**	.413**	.810**
	Sig (2-tailed)	.000		.000	.000	.005	.000	.000
3. Communication	Pearson	.439**	.623**	1	.589**	.375**	.501**	.812**
	Sig (2-tailed)	.000	.000		.000	.000	.000	.000

4. Role Model	Pearson	.363**	.548**	.589**	1	.488**	.604**	.800**
	Sig (2-tailed)	.000	.000	.000		.000	.000	.000
5. Research Skills	Pearson	.246**	.339**	.375**	.488**	1	.526**	.621**
	Sig (2-tailed)	.000	.000	.000	.000		.000	.000
6. Coaching	Pearson	.325**	.413**	.501**	.604**	.526**	1	.723**
	Sig (2-tailed)	.000	.000	.000	.000	.001		.000
Total Mentoring	Pearson	.680**	.810**	.812**	.800**	.621**	.723**	1
	Sig (2-tailed)	.000	.000	.000	.000	.000	.000	

** Correlation is significant at the 0.01 level (2-tailed)

To determine the significant factors of mentoring, the technique of step-wise was conducted. In order to determine the factors which influencing the success, the data used in this part was the medalist students. The result in Table 7 indicated that communication and coaching were factors which significantly influencing (5.9%) mentoring in the context of success in science project competition as perceived by the students. Table 7 presented the result of the Analysis of Variance test of communication and coaching as the predictors of achievement in science project competition. The result of the test indicated that the influence of communication and coaching toward the achievement in science project competition was significant [$F(2,147) = 4.618$; $p = 0.11$].

Table 7. The model summary of communication and coaching as factors of mentoring

	R	R^2	Adjusted R^2	Standard Error of the Estimate
Communication, Coaching	.243	.059	.046	.800

Table 8 The ANOVA test for mentoring perceived by the students.

	Sum of Squares	df	Mean Square	F	Sig.
Regression	5.911	2	2.956	4.618	.011[a]
Residual	94.089	147	.640		
Total	100.000	149			

[a]Predictors: (Constant), Coaching, Communication
[b]Dependent Variable: Achievement

The coefficients of regression of communication and coaching as predictors to the achievement in science project competition were illustrated in Table 9. The result of regression suggested that both communication ($p = 0.12$) and coaching ($p = 0.04$) were significantly contributed in the influence of mentoring toward the achievement in science project competition. This was supported by the answer of the students on the open-ended question, that they were expecting their mentor play the role as coach, such as providing advice, encouraging, and being accessible during the process of mentoring. Moreover, the interview session with students was supporting this result, as one of the student stated "When I failed to complete task from my mentor, I was expecting my mentor to give me advice in order to get better result". Another student mentioned his opinion about a good mentor as:"A good mentor should take a role as a "friend" instead of "teacher", which made me comfortable to share problems in the science project. He would never under-estimate my opinions or offend me. If he acts as teacher, I am afraid he will blame me on my mistakes. As good mentor he will provide me with advices."

Table 9. The coefficients of regression for mentoring perceived by the students.

Factors	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	3.745	.809		4.628	.000
Communication	-.551	.216	-.264	-2.546	.012
Coaching	.601	.207	.300	2.898	.004

[a]Dependent Variable: Achievement

IV. CONCLUSION

The mentoring toward science project competition was identified in this study. The findings demonstrated that there was no significant difference of mentoring perceived male and female students, junior and senior high school students, public and private school students. Regarding age groups, students aged 13 to 15 and 16 to 18 years-old had the same perception on mentoring. Moreover, the was no significant different of mentoring perceived by medalist and non-medalist students.

The factors of mentoring were determined in study: relationship, supervision, communication, role model, research skills, and coaching. In the context of science project competition, the most influencing factors of mentoring were communication and coaching. The result of this study can be implemented in school regarding research activities of the student. School management shall put the willingness of teacher to spend his/her extra time for students' project and the openness of the teachers into consideration in assigning mentors. Another strategy to win science project competition is to enhance teachers' capability in coaching their students' in the context of participation in science project competition.

This study was conducted in ten provinces/municipal in Indonesia in the science project competition setting and the result can be applied to students in other countries, or to mentoring in other setting such as mentoring in completing students' research in higher education.

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