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Differences between Indonesia and Singapore based on PISA 2015: Five-factor students' perception in science education

Janu Arlinwibowo [1] *, Hanif Cahyo Adi Kistoro [2], Heri Retnawati [3], Gulzhaina Kuralbayevna Kassymova [4], Bagdaulet Kenzhalyevich Kenzhaliyev [4]

[1] Universitas Muhammadiyah Kudus. Jalan Ganesha I Purwosari Kudus 59316, Jawa Tengah, Indonesia
[2] Universitas Ahmad Dahlan. Jalan Kapas 9, Semaki, Umbulharjo, Yogyakarta 55166, Indonesia
[3] Universitas Negeri Yogyakarta. Jalan Colombo No. 1, Yogyakarta 55281, Indonesia
[4] Satbayev University. 22a Satpaev str. 050013, Almaty, The Republic of Kazakhstan
* Corresponding Author. Email: janu@umkudus.ac.id

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Abstract: As a neighbouring country whose location is very close, there is a unique fact where the results of the PISA study show very different results between Indonesia and Singapore. Students' perceptions of learning have an important role to detect the quality of learning. Thus, this study aims to determine the factors of student perception of natural science learning and the differences between the two countries based on these factors. The sample in this study were 5870 Indonesian students and 5272 Singaporean stu-dents who took the 2015 PISA survey. The research data were the results of the PISA survey (codes ST098, ST100, ST103, and ST104) regarding student perception of natural science learning. The data analysis technique used is Principal Component Analysis to detect factors and Discriminant Analysis to show diffe-rences between the two countries. Students' perceptions of science learning in Singapore and Indonesia can be classified into five factors: Practicum, Assistant, Explorative, Counseling, and Collaborative. Based on these factors, there are differences in the perception of the implementation of science learning between Indonesian and Singaporean students. Indonesian students tend to be stronger in defining that science learn-ing is full of exploration, collaboration, and teachers play the role of counsellor very well, while Singapore students feel more than practical learning based on science and teachers provide student assistance in dealing with difficulties in the learning process.
Keywords: PISA 2015, Students' Perception, Science Education, Different, Indonesia and Singapore.

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INTRODUCTION

International surveys of PISA (Program for International Student Assessment), international studies such as TIMSS (Trends in Mathematics and Science Study) and PIRLS (Progress in International Reading Literacy Study) have been conducted by researchers in the world. The purpose of the surveys is to measure students' abilities and skills, especially related to solving everyday problems (Ceylan & Abacı, 2013). Thus there will be a clear world map related to education which can then be used as a means for self reflexes.

PISA is an international survey that has a mission to evaluate the process and educational achievements in each country (Fenanlampir et al., 2019). Mathematics, literacy, science, and problem-solving are the focus of the 2015 PISA Survey. In addition, the 2015 PISA survey also added an assessment of financial literacy which is an option. The PISA 2015 survey participants were around 540,000 who were representatives of around 29 million children aged 15 years (students) from 72 participating countries (Organisation for Economic Co-Operation and Development, 2015).

Indonesia and Singapore are neighbours. Although the location is very close, there are a lot of differences between the two countries, for example from the size of the country, population, to social aspects. From the aspect of education, both of them can be compared through the results of PISA 2015 because they both are members of the OECD. Differences in the results of international surveys between Indonesia and Singapore are very different (Yang & Sianturi, 2020). Singapore is the best (the first rank

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in PISA 2015) with an average score of 556 while Indonesia is ranked 62 with a score of 403 (Organization for Economic Co-operation and Development, 2016a). The difference in PISA results becomes a big question that must be studied by the Indonesian people (Suprapto, 2016)

In PISA 2015, opinions related to learning are asked of teachers and students. The strategy is used so that the data obtained is valid (Lau & Lam, 2017). One of the results of the service data from PISA is students' perceptions of science learning. This perception of data is interesting because it shows that there is a positive relationship between perception and learning achievement (Ahmed et al., 2018; Mayya & Roff, 2004). Even Ganeb and Montebon (2018) stated that it gives an influence on students' ability in mastering material. Understanding students' aspirations for learning and working in science continues to be a major concern for science educators (Sheldrake et al., 2017). Students' perceptions of a lesson can be used as an overview of the educational situation and also as a benchmark of quality. Besides, perceptions describe the experiences of students which influence their attitude towards learning (Wang, 2012).

Thus it is interesting to compare the perceptions of students in Indonesia and Singapore towards science lessons. It is important to know whether there are significant differences in students' perceptions of science lessons in Indonesia and Singapore so that policymaking can be done as a basis for developing the learning process and learning environment.

METHOD

This research is survey research. The survey process was not carried out independently by researchers but researchers took data from the 2015 PISA survey. Survey data were selected and grouped for later data to be taken by the research objectives.

Sample

Around 540,000 students were involved in the PISA survey in 2015, representing around 29 million children aged 15 years in schools from 72 participating countries. Indonesia and Singapore participated in the PISA survey in 2015. This study involved data on 6513 Indonesian students and 6115 Singaporean students participating in PISA 2015. However, not all students had sufficient data to be analyzed. Thus the election was carried out so that 5870 Indonesian students and 5272 Singapore students were selected.

Instrument

The instrument used in this study was a student instrument in the form of a questionnaire to assess natural science learning. Taken 23 items related to students' perceptions of science learning in their schools (ST098, ST100, ST103, and ST104). All items have the same format, which is a questionnaire with 4 graded answer choices.

Data Analysis

Differences will be made between the situation in Indonesia and Singapore. For this reason, the first analysis is to reduce and classify the data with the principal component of the analysis so that through the MSA assessment it can be identified which items are issued and grouped. Then in distinguishing the two groups done by discriminant function analysis (DFA) which is usually used to classify individuals based on one or more actions or to realize group differences (Green et al., 2000) conducted in this study. DFA is done to distinguish low-performing countries (Indonesia) and high-performance countries (Singapore) with respect to students' perceptions of natural science education in the 2015 PISA survey.

RESULTS AND DISCUSSION

Results

23 items in the 2015 PISA survey measure students' perceptions related to learning science in the classroom. The results of the survey conducted in Indonesia and Singapore were conducted in 6513 and 6115. However, the selection of complete data was carried out so that what was included in the analysis were 5870 Indonesian students and 5272 Singapore students. The first stage of the analysis is a partial

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component analysis to group 23 items into the main factors. The results of the PCA are as follows (Table 1).

Table 1. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.896
Bartlett's Test of Sphericity	Approx. Chi-Square	93460.161
	df	253
	Sig.	0.000

The results of the KMO analysis and Bartlett's Test (Table 1) show that the Kaiser-Meyer-Olkin Measure of Sampling Adequacy yields a value of 0.896 which is > 0.5 so that there is sufficient sample in performing PCA. Furthermore, the significance of Bartlett's Test of Sphericity shows a value of 0,000 < 0.05, so it can be concluded that there is a relationship between factors. Thus, the second prerequisite test has been fulfilled so that further analysis can be done.

Table 2. Eigenvalues

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	6.477	28.161	28.161
2	2.345	10.194	38.355
3	1.956	8.505	46.860
4	1.616	7.026	53.886
5	1.190	5.172	59.058
6	.857	3.726	62.784

Table 3. Rotated Component Matrix

Item	Component				
	1	2	3	4	5
Students are allowed to explain their opinions	.444				
Students practice experiments in the laboratory					.699
Students are expected to state the reasons for the question about science	.735				
Students are asked to make conclusions from the experiments they have done	.517				
The teacher explains how an idea in science can be applied to some different phenomena (for example, the movement of objects, materials with similar properties)	.555				
Students are allowed to plan their experiments	.670				
There is a debate class regarding investigations.	.597				
The teacher explains well the relationship between science concepts and our lives	.649				
Students are asked to investigate to test the idea	.663				
The teacher is interested in each student's learning activities			.596		
The teacher provides additional assistance for students who need it			.744		
The teacher helps students in learning			.785		
The teacher continues to teach until students understand			.722		
The teacher allows students to express their opinions			.663		
The teacher explains scientific ideas				.716	
There was a discussion of all students in the class with the teacher.				.703	
The teacher discusses our questions				.790	
The teacher demonstrates an idea				.763	
The teacher told me about my achievements in science lessons		.690			
My teacher gave me input about my strengths in science subjects		.763			
The teacher told me what material I could still improve		.813			
The teacher told me how to improve my performance		.807			
The teacher advised me how to achieve my learning goals		.758			

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 9 iterations.

Based on the initial eigenvalue (Table 2) shows that 5 components have an eigenvalue of more than 1, it can be concluded that there are 23 items collected into 5 factors. Table 3 is a grouping of items in each factor.

Grouping is indicated by a loading factor above 0.4 or the highest among others. The data above shows a grouping that can be summarized in Table 4.

Table 4. Grouping and Naming Factors

Item	Factor
Students are allowed to explain their opinions	Explorative
Students are expected to state the reasons for the question about science	
Students are asked to make conclusions from the experiments they have done	
The teacher explains how an idea in science can be applied to some different phenomena (for example, the movement of objects, materials with similar properties)	
Students are allowed to plan their experiments	
There is a debate class regarding investigations.	
The teacher explains well the relationship between science concepts and our lives	
Students are asked to investigate to test the idea	
The teacher told me about my achievements in science lessons	Counselling
My teacher gave me input about my strengths in science subjects	
The teacher told me what material I could still improve	
The teacher told me how to improve my performance	
The teacher advised me how to achieve my learning goals	
The teacher is interested in each student's learning activities	Assistant
The teacher provides additional assistance for students who need it	
The teacher helps students in learning	
The teacher continues to teach until students understand	
The teacher allows students to express their opinions	
The teacher explains scientific ideas	Collaborative
There was a discussion of all students in the class with the teacher.	
The teacher discusses our questions	
The teacher demonstrates an idea	
Students practice experiments in the laboratory	Practicum

Table 4 shows that 23 items are divided into 5 major factors, namely exploratory, counselling, assistive, collaborative, and practicum. Explorative is a teacher activity that aims to explore and develop students' abilities. Counselling is the teacher's role in providing various suggestions regarding problem-solving strategies and techniques to students. Assistive is the teacher's role in assisting students technically against student learning difficulties. The collaborative is the ability of the teacher to manage the class so that the nuances of learning become two-way. Whereas practicum is the implementation of practicum in laboratories.

General characteristics of items loaded on the same factor are considered and these eight factors are named accordingly. Table 5 shows the name of the factor, eigenvalue, and total variance.

Table 5. Factor Name, Abbreviation, Eigenvalues, and % Variance

Factor Name	Abbreviation	Eigenvalues	% Variance
Exploratory	F1	6.477	28.161
Counselling	F2	2.345	10.194
Assistive	F3	1.956	8.505
Collaborative	F4	1.616	7.026
Practicum	F5	1.190	5.172

The next step is discriminant analysis (DFA) using average data from each factor. DFA is run based on factor scores extracted from factor analysis. The DFA dependent variable is the countries that are Indonesia and Singapore. The independent variables, on the other hand, are named based on factor analysis, namely exploratory, counselling, assistive, collaborative, and practicum. DFA analysis begins by analyzing the covariance matrix data presented in Table 6.

According to Table 6, the M Box test is significant, because the p-value is less than the 5% significance level (p-value = 0.00 < 0.05), therefore the results of the analysis reject the homogeneous matrix hypothesis at the 95% confidence interval. However, the absolute value of the Log Determi-nants does

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not differ significantly and the sample size for each level of the dependent group is more than five times the number of independent variables.

Table 6. Covariance matrix

Test Results		
	Box's M	667.936
F	Approx.	44.508
	df1	15
	df2	487577423.996
	Sig.	.000

Log Determinants		
Classification	Rank	Log Determinant
.00	5	-5.395
1.00	5	-4.954
Pooled within-groups	5	-5.126

Eigenvalues and canonical correlations from the second discriminant analysis were found 0.34 and 0.504, respectively. Based on the results in Table 7, Eigenvalue is 0.341**[a]** and Canonical Correlation is 0.504 in the sense that 50.4% of the Discriminant model can be explained by explorative, counselling, assistive, collaborative, and practicum variables, the remaining 49.6% is explained by other variables. The significance value is 0.000, indicating that there is a significant difference between the response patterns of Indonesian and Singaporean students to the composite variable at a significance level of 0.05. Table 7 is a summary of the various data above.

Table 7. Summary of tests of significance and statistical relationships for DFA

Function	Eigenvalue	% of Variance	Canonical Correlation	Wilks' Lambda	Chi-square	df	Sig.
1	.341[a]	100.0	.504	.746	3266.854	5	0.000

All factors have been shown to have a significant effect. This is indicated by all the significance of each variable 0,000 < 0.05 so that it shows that H_0: the variable does not affect is rejected. So empirically all factors have a significant influence on the differences between the two groups. A summary of the significance tests for each variable is summarized in Table 8.

Table 8. Variables Entered/Removed [a, b, c, d]

Step	Entered	Min. D Squared					
		Stat	Between Groups	Exact F			
				Stat	df1	df2	Sig.
1	Practicum (F5)	.257	IND & SGP	713.984	1	11140.000	0.000
2	Explorative (F1)	.797	IND & SGP	1107.037	2	11139.000	0.000
3	Collaborative (F4)	1.281	IND & SGP	1185.618	3	11138.000	0.000
4	Assistive (F3)	1.364	IND & SGP	946.783	4	11137.000	0.000
5	Counseling (F2)	1.367	IND & SGP	759.190	5	11136.000	0.000

The discriminant function (DF) which shows which structure of factors is significantly different in distinguishing the two groups of countries is listed in Table 9.

Table 9. Standardized Canonical Discriminant Function Coefficients

	Function
	1
Practicum (F5)	1.048
Explorative (F1)	-.768
Collaborative (F4)	-.298
Assistive (F3)	.581
Counseling (F2)	-.056

Table 9 produces a discriminant function as follows:
DF = 1.048 F5 – 0,768 F1 – 0,298 F4 + 0,581 F3 – 0,056 F2

The discriminant function for each group is also partially analyzed to produce an equation to predict the value of each group. Table 10 summarizes the discriminant functions of each group partially.

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Table 10. Classification Function Coefficients

	Classification	
	IND	SGP
Practicum (F5)	8.607	6.485
Explorative (F1)	1.472	2.740
Collaborative (F4)	10.788	11.338
Assistive (F3)	8.964	7.975
Counseling (F2)	8.024	8.118
(Constant)	-51.931	-49.056

Fisher's linear discriminant functions

Based on the analysis results summarized in table 10, the following is the DFA equation for each group:
IND: -51,931 + 8.607 F5 + 1.472 F1 + 10.788 F4 + 8.964 F3 + 8.024 F2
SGP: -49.056+ 6.485 F5 + 2.740 F1 + 11.338 F4 + 7.975 F3 + 8.118 F2

The centroid group (Table 11) shows the relative position of the two countries according to DF. This centroid shows, in its function, that the independent variable which is positive is for Indonesia and the negative one is for Singapore. Also, group centroids show average discriminant scores for students' perceptions of natural science learning in Indonesia and Singapore (George & Mallery, 2006). The results of the Functions at Group Centroids analysis are summarized in Table 11.

Table 11. Functions at Group Centroids

Classification	Function
	1
IND (low-perform)	.553
SGP (high-perform)	-.616

The factor structure of Singapore students who have high perception scores lies in the factors:
1. Practicum (F5)
2. Assistive (F3)

On the other hand, the composite variable of Indonesian students has a high score on factors:
1. Explorative (F1)
2. Counselling (F2)
3. Collaborative (F4)

The data above appears in the mean score presented in Table 12.

Table 11. Mean scores of factor structures

Country	Factor				
	Explorative	Practicum	Assistive	Collaborative	Counselling
IND	2.4729	1.7901	3.1087	2.5747	2.7343
SGP	2.2278	2.1491	3.2314	2.2427	2.6938

The DFA results reveal that students who have good perceptions of science learning related to exploration-based learning, collaboration, and the ability of teachers to play the role of the counsellor are very likely to come from Indonesia, while students who strongly feel that the science learning process in their country is based on practicum and teachers assist in the process learning is most likely to come from Singapore.

Discussion

Broadly speaking, there are differences in the curriculum in Indonesia and Singapore (Lisarani et al., 2018; Yang & Sianturi, 2017). The Singapore Science Curriculum Framework is centred on the spirit of scientific inquiry and is based on three domains that are important for scientific practice: knowledge, understanding and application; skills and processes; and ethics and attitudes (Ministry of Education, 2013b, 2013a). The curriculum aims to help students appreciate the pursuit of science and appreciate the important role it plays in everyday life and society. According to the research results of Lisarani et al. (2018) learning in Singapore reflected in the textbook tends to emphasize tasks with verbal representations and closed assignments are the most common types, while application and non-

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application tasks are divided exactly into two. Whereas in Indonesia, tasks with a combination of representations, non-application tasks, and open-middle tasks are the types that most often appear. While research from Yang and Sianturi (2017) shows that education in Singapore requires higher cognitive abilities than Indonesia.

Science is a concept for understanding natural phenomena (U.S. Department of Education, 2018). At the upper secondary level, students begin to specialize in science subjects such as biology, chemistry, and physics, or combination (Organization for Economic Co-operation and Development, 2016a). Science learning requires teachers who can encourage and model scientific inquiry skills, as well as curiosity, openness to new ideas (Kelley & Knowles, 2016), and discovery-based (Retnawati et al., 2018). Various enrichment programs complement the formal curriculum at school and national. Science exhibitions, competitions, learning pathways, camps, workshops, and attachments to research institutions function to engage and inspire students at all levels of learning (Organization for Economic Co-operation and Development, 2016a).

The purpose of education in Indonesia is to encourage students to develop their scientific potential (Elvanisi et al., 2018) with the concept of student-centred learning (Retnawati et al., 2017). To realize this, teachers are needed to master theory and practice (Putri & Jumadi, 2017). Science education in Indonesia has undergone an extraordinary transformation to create a foundation for prosperity and sustainable development. Between 2012 and 2015 alone, science performance among 15-year-old students rose 21 score points. This makes Indonesia the fifth-fastest increasing education system among the 72 who took part in this comparison. Education in Indonesia, including science, is starting to be directed towards materials that are closely related to real phenomena. PISA 2015 also asks students about their beliefs about the nature of scientific knowledge and methods of inquiry (Organization for Economic Co-operation and Development, 2016b).

Based on the above reference support, it can be concluded that the two countries have the same relative view, that is, basing learning on the philosophy of constructivism which is always associated with context-based learning and student-centred. Active learning is put forward so that there is an active relationship between the teacher and students, the teacher with the environment, and students with the environment. Thus, it is not uncommon if students' perception questionnaire on learning science is grouped into Practicum, Assistant, Explorative, Counseling, and Collaborative.

Students' perceptions of science learning can be used as indicators related to the real situation (Bernardo et al., 2008). According to the DFA analysis, there is an indication that Indonesian students are higher in terms of exploratory, counselling, and collaborative, while Singaporean students feel the learning of science in their schools is close to practicum and teachers show assistive nature. Thus, although there are similarities related to the foundation of the implementation of science education, namely student-centred and contextual, in practice there are inequalities so that differences in student perceptions are found.

Based on the 2015 PISA ranking where Singapore has a very high ranking while Indonesia is low, then the portrait of students' perceptions of science learning cannot yet describe a causal phenomenon in a straightforward manner. However, based on the reference it can be identified the relationship of student perception with the results of the 2015 PISA survey. Practicum is a learning strategy that can have a positive impact on learning outcomes (Solikhin et al., 2019). Specifically, practicum can have an influence on students' science process skills (Duda et al., 2019; Kurniawan et al., 2019), increase motivation, curiosity, and self-confidence (Arlianty et al., 2017). Facts show that cognitive demands in Singapore are higher (Yang & Sianturi, 2017). The high standard of positive achievement coupled with the strong elements of practicum in learning is a factor that might make Singaporean students successful, especially in the PISA survey.

However, the complexity of cases in education makes the conclusion process more complicated (Jacobson et al., 2019). Each country has its educational characteristics (Istiningsih, 2016). The standard of perception of Indonesian and Singaporean students may be different because of various aspects such as the variance of students' cognition. Therefore, it is necessary to conduct a deeper search related to related aspects to complete an objective view to conclude why there are different perceptions between Indonesia and Singapore and their effects on the quality of education.

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CONCLUSION

Students' perceptions of science learning in Singapore and Indonesia can be classified into five factors, namely Practicum, Assistant, Explorative, Counseling, and Collaborative. Based on these factors, there are differences in the perception of the organization of science learning between Indonesian and Singaporean students. Indonesian students tend to be stronger in defining that science learning is full of exploration, collaboration, and teachers play the role of counsellor very well, while Singapore students feel more than practical learning based on science and teachers provide student assistance in dealing with difficulties in the learning process.

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