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Investigating University Students' Preferences to Science Communication Skills: A Case of Prospective Science Teacher in Indonesia

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Abstract

The purpose of this study was to investigate Indonesian university students' preferences to science communication skills. Data collected from 251 students who were majoring in science education program. The Learning Preferences to Science Communication (LPSC) questionnaire was developed with Indonesian language and validated through an exploratory factor analysis (EFA) of participants' responses. The differences between student levels were also explored for their significance using ANOVA test in order to draw a clear line among different learning preferences. The results indicated that, *first*, the instrument used in this study had satisfactory in validity and reliability. The construct validities of the LPSC were vary from .48 and .83 and explained 64.54% of the variance. Overall, the Cronbach alpha coefficient of the instrument was .91. *Second*, university students as prospective teacher in junior and freshman level performed higher preference in visual (V) and aural (A) than others. Moreover, senior student depicted higher confident in read or write (R/W) than junior and sophomore level. However, university student in sophomore level performed less confident in both visual and aural. *Third*, the results also showed the significant intra-relationships among dimensions of learning preferences. The implications delineated contribute to the improvement of science teacher education program in Indonesia.

Keywords: learning preferences, science communication skills, university student

1. Introduction

Becoming a good scientist and a good communicator are the two esential things in science education. Taking for example, students in high school feel boring if the subject matter taught without a good communication skill. Whenever the teacher still gives many terms or terminologies, but the most important thing is how the science communication process run. In other words, how the teacher or prospective teacher creates a simple communication and explanation about science content to their students is very important. As Albert Einstein expressed that "if you can't explain it simply, you don't understand it well enough" and "You do not really understand something unless you can explain it to your grandmother" (Brainyquote, 2015).

Many scholars began to make a relationship between a good scientist and a good communicator by expanding the paradigm of the traditional-formal to informal science education. Specifically, Ogawa (2011) gave an illustration and emphasized that the probable relationship between formal and informal science education can be likened to that between the two paddlers (one is a veteran and the other is a novice) in a Canadian canoe. The new area of science communication was successful depends upon the kind of cooperation and collaboration between the formal science education research group and the science communication research group.

In the same way that science societies and organisations have had a major influence on science communication with the public, they have also had a similar influence upon science taught in schools. In other words, the synergies between science communication with the public and science in schools were indispensable. Through science education program graduates will be generated several potential expertise ranging from science teachers, science lecturers, museum experts, pure scientist, science instructors, zoo employees, policy makers, and etc. Therefore, the introduction of science communication must be started from the education in schools. In Indonesia, this effort began to be developed through professional development program of pre-service science teachers (PSTs) education.

Jenkin (2007) underlined that science curriculum should provide mental training and encourage the development of deductive and reasoning skills; form part of a well-rounded education for all students; provide a knowledge of science that is important for all citizens as well as for society; ensure learning science is pleasurable and useful. The hope would be entrenched scientific literacy and science communication from an early age in school, both for students and prospective science teachers. Indeed, Bowater and Yeoman (2013) emphasized the importance of extra-curricular science to achievement and for getting started with science communication in schools. There were some activities that train science literacy skills: science exhibitions; science conferences and debates; science festival; science communication and media plan; training explainers; visitor needs analysis; communication with visitors; hands-on exhibit based on local cultures; science theatre; science demos, and etc. For achieving these skills can be done early by starting from science teacher (in-service professional development program) (Perera & Stocklmayer, 2013) or prospective science teacher. Science teachers or prospective science teachers can teach the basic skills toward science literacy and science communication early to learners.

Bowater and Yeoman (2013) argued that constructivism must be applied to science communication in both formal (e.g. in school) and informal situations (e.g. science centres and museums). In order to apply the ideas behind constructivism to the design of science communication activity, we need to think about relevance and participant learning and interaction. In terms of participatory learning and interaction, learning styles and /or learning preferences must become one of the considerations to learning outcome. Ganesh (2014) argued that learning outcome can be effective if the students practice study habits according to their learning styles. Students can also learn best when teaching methods match their learning style. Moreover, Fleming and Bonwell (2009) divided learning preferences regarding the science communication into five categories: Visual (V), Aural (A), Read/Write (R-W), Kinesthetic (K), and Multimodal (M). In addition, Bell, Koch, & Green (2014) also used VARK Questionnaire to categorize an individual's learning strategy using four different categories: visual, auditory, reading/writing, and kinesthesia. Recently, research with the VARK Questionnaire is being utilized in classroom and employment settings.

Linking learning preference to the design and delivery of a science communication activity, especially for basic skills toward science communication can be mapped from visual, aural, read/write, and kinesthetic skill (Bowater & Yeoman, 2013). For making learning in science communication easier, Gilbert (2013) suggested several ways: dealing with familiar and important situation, the language used must be meaningful, improving the visualisation of ideas, the use of the verbal mode, using the concrete/material mode, using the visual mode, using the gestural mode, using the symbolic mode, and clarity in explanations. All of these ways in lined with the five categories of learning preferences as discussion above. The present study tries to investigate learning preferences of the students through the application of VARK inventory and is also interested in finding out whether the students carry out study habits as per their learning preferences. Therefore, this paper investigated University students' preferences to science communication skills as a contribution to the development of science literacy and science communication itself especially in Indonesia.

1.1 Learning Preferences to Science Communication Skills

Regarding learning preferences or learning styles, Klement (2014) stated that learning styles is characterized by taking into account the type of sense which is preferred by students in the process of learning: (1) V means Visual, thus visually nonverbal. Student with this preference can learn best when the curriculum is prepared in visual forms such as pictures, graphs, charts, diagrams, maps and photographs; (2) A, means Aural, an auditory learning style. Student with this learning style prefers to listen and speak before reading or writing; (3) R, means Read/Write, a visually verbal learning style. Student with this preference can best learn by reading textbooks; and (4) K, means Kinesthetic learning style. Student with this learning style prefers to learn by doing something with the teaching materials or manipulating with them. We do not speak about students of physical education here, but the students who want to manipulate, even internally with objects or with symbols.

Considering the science communication processes, various categorisations have been developed to distinguish between different types of public engagement can be applied to them (see for example, Rowe & Frewer, 2005; Bucchi, 2008; McCallie et al., 2009). The fundamental concept shared by all the models was the distinction between 'deficit' and 'dialogue' approaches. In the former, the assumption can be proposed that the audience members lack necessary knowledge about scientific concepts, and therefore communication *from* scientists *to* a public audience is required (Gross, 1994). In formal science, Fleming and Bonwell (2009) introduced five categories learning preferences to science communication (VARK system) as shown as Table 1:

Table 1. Learning preferences (adapted from Fleming & Bonwell, 2009)

Learning preferences	Definition
Visual	Preference for information presented (e.g. as charts, graphs, flow charts and other devices to represent what might have been presented as words)
Aural	Preference for information which is spoken or heard
Read/write	Preference for information displayed as words either read or written
Kinesthetic	Preference related to the use of experience and practice (learning by doing)
Multimodal	A mix of the above learning styles, can be a combination of two, three or all preferences

The VARK consists of 16 questions and can be completed online and an immediate analysis of the data sent to our email address (http://vark-learn.com/the-vark-questionnaire/). VARK is a very active topic for researchers and the statement is an attempt to assist researchers from following unhelpful pathways. VARK is only part of a learning style. A complete learning style should have information on all the preferences that would affect learning. This includes such things as preferences for learning at different times in the day. It would be a complex amalgam of questions and analysis. Bowater and Yeoman (2013) also developed the activities of each preference in VARK more completely. In this research, the item of each learning preference adopted with some modifications from the list of activity designs as depicted by Bowater and Yeoman (2013, p. 80).

1.2 Research Purpose

Based on the introduction and the aforecited theoretical foundations, the purpose of the current study is to investigate the Indonesian university students' preferences to science communication skills. To this end, the aims of this study are twofold:

1) To compare the learning preferences to science communication skills among university student majoring in science education in different level.

2) To examine the intra-relationship among dimensions of learning preferences to science communication.

2. Method

2.1 Participants

As described as the introduction, this research focuses on the fields of science education. The subjects were 251 university students (aged 18–22 years) enrolled in prospective science teacher program at public universities which have pre-service teachers (PSTs) program in Indonesia. In this study, the participants consisted mostly of females (15.1% male and 84.5% female) as well as the population. The sample varied of demographic factors, as shown in Table 2.

Table 2. Summary of sample demographics (N= 251)

Background	Subtotal	
	n	%
Gender		
Male	38	15.1
Female	212	84.5
Missing	1	.4
Level		
Freshman	83	33.1
Sophomore	45	17.9
Junior	89	35.5
Senior	34	13.5
Missing	0	0

High School background		
Natural Sciences	240	95.6
Social Sciences	1	.4
Linguistic	1	.4
Others	8	3.2
Missing	1	.4
Total	251	100.0

2.2 Science Teacher Education Program in Indonesia

In Indonesia, PSTs is placed in undergraduate teacher education programs through a nationwide university entrance examination after graduating from high schools. Most of the candidates for science teacher education programs have passed from science programs in Indonesian high schools. These students take more science courses and more advanced science courses at the high school level than other students. There are currently about 20 public universities that have middle school science teacher preparation programs in Indonesia. Specifically, the middle school science teacher education program is a four-year program (eight semesters) in science faculties. The PSTs' sole responsibility is to teach science to their students from Grades 7 to 9 after graduating from the faculty. In this program, the PSTs needed to complete at least 144 credits of course work distributed in six areas: general science and laboratory courses; more specific science courses, such as analytical chemistry; mathematics courses; general culture and language courses; general education courses, such as Educational Psychology; and science methods courses (Dirjen Dikti, 2012).

2.3 Instrumentation

The instrument used in this study was the Learning Preferences to Science Communication (LPSC) questionnaire developed from Bowater and Yeoman (2013, p. 80). Originally, the instrument consisted of 24 items for LPSC which used English version (see Appendix A). The instrument distributed into four crucial conceptions of learning preferences to science communication skills, including Visual (V), Aural (A), Read/Write (R/W) and Kinesthetic (K). The items were coded on a nine-point-Likert scale. The higher scores indicated the greater learning preferences to science communication. By translating process into Indonesian language and checking the content validity, the instrument feasible to Indonesian university students. Finally, the LPSC consisted of 17 item as shown as Table 3. The information of validity and reliability for the scale also shown in Table 3.

The LPSC items were efforted to accommodate the university students' preferences to science communication skills as a contribution to the development of science literacy and science communication. The detailed descriptions and sample items of the four dimensions are presented as follows:

1) Visual (V, four items): assessing the university students' confidence in their ability to use fundamental visual skills such as poster, images, key words, and flow charts.
2) Aural (A, four items): assessing the university students' confidence in their ability to organize oral skills including individual and social relation such as debate, ask question, visual information, and group discussion.
3) Read/Write (RW, four items): assessing the university students' confidence in their related capabilities to read and write such as online material, printed information, powerpoint, and glossary.
4) Kinesthetic (K, five items): measuring the university students' confidence in their capability to utilize hands-on activity in science.

Table 3. The construct validities and reliabilities of the LPSC questionnaire

Factor/ Dimension	Item	λ	%	α
Visual (V)	*V1: Use a colorful poster or other written material for convey information.*	.72	14.03	.76
	V2: Make good use of images in the activity.	.74		
	V3: Highlight or underline key words.	.65		
	V4: Use flow charts to explain concept.	.54		
Aural (A)	*A1: Allow opportunity for individual or group discussion.*	.61	14.45	.76
	A3: Point out and describe visual information.	.48		
	A4: Try using a debate.	.76		
	A5: Ask question about prior knowledge.	.77		
Read/Write (RW)	*RW1: Use PowerPoint for presentations.*	.72	16.71	.79
	RW2: Give out printed information.	.77		
	RW3: Use definitions in printed information, such as a glossary.	.73		
	RW4: Use online material.	.72		
Kinesthetic (K)	*K1: Design a hands-on activity or experiment to demonstrate concepts.*	.64	19.35	.88
	K2: Use video material to help explain concepts.	.67		
	K3: Go outside and collect or make observations.	.83		
	K4: Measure things.	.58		
	K5: Use games to demonstrate principles.	.78		
Overall			64.54	.91

λ, factor loading; α, reliability coefficient

2.4 Data Collection

The data collection of this study was accomplished with printed surveys. Invitations were first distributed to the potential participants (i.e. university students as prospective science teachers in East Java Indonesia) through email and face to face requests. This made sure that all the participants volunteered to take part in and to respond to the questionnaires. At the beginning of the surveys, the students were informed of the aim of this study and the purposes of the questionnaires. In the questionnaires, we only addressed the intention to investigate university students' perspectives and confidence about science communication skills.

2.5 Data Analysis

The LPSC questionnaire was developed with Indonesian language and validated through an exploratory factor analysis (EFA) of participants' responses. Hereafter, analysis of data used SPSS's software for checking the validity and the reliability of instrument. The LPSC scale was used belong to interval data so this situation fullfilled the Brace et al. (2006) who noticed that for using factor analysis at least the variables should be ordinal level of measurement. According to the validation criteria of exploratory factor analysis suggested by Stevens (2002), the retained items should preferably be weighted greater than .4. In other words, the items with a factor loading of less than .4 were deleted. The principal component extraction with a varimax rotation was conducted to estimate the number of factors proposed in this study, which contributed to the construct validity of each instrument. Furthermore, the Cronbach's alpha coefficient for each scale of the LPSC instrument was calculated to ensure the reliability of each factor as well as the overall alpha coefficients of the instrument. In addition, the differences between student levels were also explored for their significance using ANOVA test in order to draw a clear line among different learning preferences in terms of student level and gender. Subsequently, the Pearson product moment was used to measure the correlation among four dimensions of LPSC.

3. Results and Discussion

3.1 Exploratory Factor Analysis of LPSC

To validate the LPSC instrument, an exploratory factor analysis with a varimax rotation was performed to clarify its structure. Based on the results, shown in Table 3, the participants' responses were grouped into the following four proposed factors—(1) visual, (2) aural, (3) read/write, and (4) kinesthetic—and a total of 17 items were retained in the LPSC instrument. The eigenvalues of the four proposed factors from the principal component analysis were all larger than one, and the total variance explained was 64.54%, which was validated to clarify the structure of the instrument. In addition, the reliability in terms of Cronbach's alpha coefficients for these factors were .76, .76, .79, and .88, respectively, and the overall alpha value was .91, suggesting that these factors had high internal consistency for assessing the participants' four dimensions of learning preferences to science communication.

Table 3 also shows factor loading of learning preferences to science communication designed to measure each factor were between .48 and .83, so that it meets the criteria of Stevens (2002). Nevertheless, there were some items were deleted because the items with a factor loading of less than .4 (e.g. V5: use gestures when explaining; V6: replace words with pictures or symbols; A2: use sound recordings; A6: describe what has been learnt; RW5: use quotes in posters or other written material; RW6: if doing a class activity get others to write down what they did and what they learnt; and K6: use real life examples of how concepts are applied).

3.2 The Comparisons of LPSC Skills

Table 4 depicts the comparison of learning preferences to science communication skills among different levels in university. Based on ANOVA test, there were any significantly different among levels in terms of visual, aural, and read/write. In contrast, there was no significantly different among university student in different levels in kinesthetic dimension. Subsequently, from post hoc test (Scheffé test) indicated that university students as prospective teacher in junior and freshman level performed higher preference in visual (V) and aural (A) than others. This result may be a concern early in the learning level of students in a class more than the upper-level students. It is also associated with the level of compliance among students beginning of the year and towards the end of the year of graduation. In other words, the student performed confidently in their ability to use fundamental visual skills such as poster, images, key words, and flow charts and their ability to organize oral skills including individual and social relation such as debate, ask question, visual information, and group discussion. Cheng, Wong, Lee, and Mok (2013) also emphasized this quantitative literacy in science communication as well as other skills, such as representing incidence rate vs number of cases, communicating uncertainty and risks, and understanding of simple statistical graphs.

Moreover, senior student depicted higher confident in read or write (R/W) than junior and sophomore level. A possible reason given is senior student has used many scientific references and writing skill activities including minipaper, proposals, or papers. However, university student in sophomore level performed less confident in both visual and aural. This situation might be posed flexibility in the choice of subjects made sophomore students less in visual and aural skills.

Table 4. The comparisons of learning preferences to science communication among different levels in university

Level	Gender	V	A	RW	K
Freshman (1)	Male (*N*=14), mean/SD	7.07 (1.41)	7.04 (1.34)	6.64 (1.17)	6.82 (1.49)
	Female (*N*=68)	7.43 (1.15)	7.21 (1.13)	6.49 (1.49)	7.22 (1.17)
Sophomore (2)	Male (*N*=7)	7.07 (.73)	6.79 (1.11)	7.21 (1.32)	7.21 (.95)
	Female (*N*=38)	6.55 (1.17)	6.70 (1.36)	6.88 (1.19)	6.68 (1.21)
Junior	Male (*N*=11)	6.45 (1.40)	7.04 (1.46)	7.09 (1.39)	6.45 (1.42)
(3)	Female (*N*=78)	7.47 (1.19)	7.39 (1.15)	7.14 (1.05)	7.22 (1.35)
Senior	Male (*N*=6)	7.50 (.45)	6.83 (.82)	7.58 (.58)	6.92 (.86)
(4)	Female (*N*=28)	7.05 (1.36)	6.89 (1.08)	7.36 (1.16)	7.18 (1.32)
ANOVA		4.252**	3.256*	5.830**	1.007
Post hoc test		1>4>2	3>4>2	4>3>2>1	-
		3>4>2	1>4>2		

*p < .05, **p < .01.

3.3 The Intra-Relationships among Dimensions of LPSC Skills

The intra-relationship among dimensions of learning preferences to science communication skills presented varying results (see Table 5). The coefficient of correlation range from .333 to .623 that useful for limited prediction based on the criteria of Creswell (2012). However, each dimension correlated each other at α=. 01. The result confirmed us that most participants used a mix of these different learning preference or we call "multimodal", but some participants feel they have strong tendencies toward one style (Bowater & Yeoman, 2013). A multimodal is a mix of the varians of learning preferences, can be a combination of two, three or all preferences.

Table 5. The intra-relationship among dimensions of learning preferences

Dimension	1	2	3	4
1. Visual (V)	--			
2. Aural (A)	.533**	--		
3. Read/Write (RW)	.333**	.401**	--	
4. Kinesthetic (K)	.623**	.517**	.351**	--

** p < .01.

4. Conclusion and Implication

The study was designed to investigate the Indonesian University students' preferences to science communication skills. Specifically, the study compared the learning preferences to science communication among university students majoring in science education in different levels and examined the intra-relationship among dimensions of learning preferences to science communication skills. The results indicated that, *first*, the instrument (LPSC) used in this study had satisfactory validity and reliability. The construct validities the instrument was vary from .48 and .83 and explained 64.54% of the variance. Overall, the Cronbach alpha coefficient of the instrument was .91. *Second*, university students as prospective teacher in junior and freshman level performed higher preference in visual (V) and aural (A) than others. Moreover, senior students depicted higher confident in read or write (R/W) than junior and sophomore level. However, university students in sophomore level performed less confident in both visual and aural. *Last*, the results also showed the significant intra-relationships among four dimensions of learning preferences: Visual (V), Aural (A), Read/Write (R-W), and Kinesthetic (K).

The result confirmed us that most participants used multimodal in terms of their preferences and some of them have strong tendencies toward one style (Bowater & Yeoman, 2013). As Fleming and Bonwell (2009) stated that learning preferences regarding the science communication categorized into five dimensions: "four above" plus Multimodal (M). Therefore, for further research, this dimension should be included in the exploration. In addition, it is important to notice that the distribution of participant in each level should be balanced. Impartial distribution of prospective teacher (participant) at every level will provide a higher level of accuracy in describing the learning preference. However, it is difficult for conducting this idea in this study because of the nature (the characteristics) of data which indicated that prospective science teacher in Indonesia is dominated by female in population.

This result gives implication to pre-service teachers (PSTs) in science education programs in Indonesia for promoting science communication in school to their curriculum. The PSTs' sole responsibility is preparing to teach science to their students from Grades 7 to 9 after graduating from the faculty. They also can build the constructivist approaches to teaching and learning which have transformed some classrooms by implementing several skills from each dimension contained in this study. Therefore, the implications delineated contribute to the improvement of science teacher education program in Indonesia.

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Appendix A

The LPSC Questionnaire

V1. Use a colorful poster or other written material for convey information.

V2. Make good use of images in the activity.

V3. Highlight or underline key words.

V4. Use flow charts to explain concept.

V5. Use gestures when explaining.

V6. Replace words with pictures or symbols.

A1. Allow opportunity for individual or group discussion.

A2. Use sound recordings.

A3. Point out and describe visual information.

A4. Try using a debate.

A5. Ask question about prior knowledge.

A6. Describe what has been learnt.

RW1. Use PowerPoint for presentations.

RW2. Give out printed information.

RW3. Use definitions in printed information, such as a glossary.

RW4. Use online material.

RW5. Use quotes in posters or other written material.

RW6. If doing a class activity get others to write down what they did and what they learnt.

K1. Design a hands-on activity or experiment to demonstrate concepts.

K2. Use video material to help explain concepts.

K3. Go outside and collect or make observations.

K4. Measure things.

K5. Use games to demonstrate principles.

K6. Use real life examples of how concepts are applied.