25 (3), 2024, 1397-1409

Jurnal Pendidikan MIPA

e-ISSN: 2685-5488 | p-ISSN: 1411-2531

http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

Analyzing Written Communication Skills in Pre-service Science Teachers: A Gender Perspective

Aris Singgih Budiarso[1,*], Supeno Supeno[1], I Ketut Mahardika[1], Bevo Wahono[1], & Ana Yuniasti Retno Wulandari[2]

[1]Study Program of Science Education, University of Jember, Indonesia

[2]Study Program of Science Education, University of Trunojoyo Madura, Indonesia

Abstract: This study explores the characteristics of Written Communication Skills (WCS) of pre-service science teachers from a gender perspective. WCS is a skill related to the ability to convey ideas in writing so that they can express their ideas, information, and arguments. WCS is important for pre-service science teachers to succeed in their studies and the workplace, especially when they teach in the classroom. This research is based on the differences in communication characteristics of female and male pre-service science teachers that have the potential to influence the way they write on the blackboard media. However, until now, references related to the characteristics of WCS, especially pre-service science teachers and their gender roles, have not been explored. To explore in depth the WCS of both gender groups with more flexibility, explorative is the method used in this study. This study involved 101 pre-service science teachers from three universities with similar regional characteristics. The data collection methods used included written tests. Exploratory results illustrate that pre-service science teachers covering the components of organization, development, expression, and content are at moderate and very good WCS levels. Mann-Whitney analysis showed that gender had no significant effect on WCS. However, the mean review illustrates that in the organization and development components, the mean of female is higher than male. In contrast, male have a higher mean than female in the expression and content components. Thus, there is no need for special treatment by considering gender differences when honing WCS. To increase the level of WCS of pre-service science teachers, educators in universities are seen as only needing to provide opportunities for pre-service science teachers to carry out problem formulation and self-group reflection.

Keywords: pre-service science teachers, written communication skills, and gender roles.

▪ INTRODUCTION

Written Communication Skills (WCS) is fundamental in the 21st century for students (Chalkiadaki, 2018; González-salamanca et al., 2020; Kemendikbud, 2020). It helps students to express thoughts and ideas in written mode so that they can improve their ability to reason, understand, and construct the natural phenomena around them (Cardetti & LeMay, 2019; Syamsuddin et al., 2021). WCS can encourage individuals' ability to manage information, allowing them to connect ideas, make decisions about the information used, and organize the entire writing (Graham et al., 2020).

Humans require WCS in communication by making use of relevant vocabulary, grammar, and semantics. Good writing is characterized by accurate sentence structure, paragraphs, accuracy in punctuation, spelling, and organization between sentences (Anjum, 2021; Asemanyi, 2015). WCS is also crucial for scientists to communicate their findings to readers and contribute to the development of their field (Mercer-Mapstone & Matthews, 2017; Mercer-Mapstone & Kuchel, 2015).

Aris Singgih Budiarso
*Email: singgiharis.fkip@unej.ac.id

DOI: http://dx.doi.org/10.23960/jpmipa/v25i3.pp1397-1409
Received: 09 December 2024
Accepted: 19 December 2024
Published: 24 December 2024

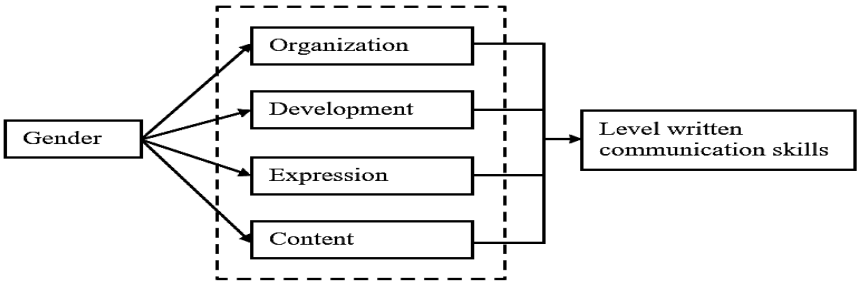

Figure 1. Theoretical framework of WCS

WCS is a communication modality students can use to disseminate ideas, data, and findings (Shivni et al., 2021). These processes require careful focus on the content and communication context by considering who, why, what, and how (Wack et al., 2021). Who is identified by analysing the target audience, particularly by examining their level of initial knowledge. Why is explored by identifying the goals and desired communication results. What is interpreted by making sense of factual content relevant to the communication goal and the social context. Finally, How is related to the audience's involvement during communication by crafting the language style appropriately (Shivni et al., 2021). When writing, students must also focus on the substance they aim to send across, especially the extent to which the message is fully and clearly delivered (Diana, 2020; Langan, 2016). WCS encompasses organization, development, expression, and content (Holmes et al., 2019), as shown in Figure 1.

WCS plays an important role in communication regarding academics and administration between school members (Khasawneh, 2021), which explains that this skill determines one's academic and occupational success (Rios et al., 2017; Sparks et al., 2014; Syamsuddin et al., 2021). This also applies to science teachers as part of the school community and WCS as part of communication occupy an important position in every training programme (Viršulienė, 2016). They have gone through a series of education at bachelor's education and professional training. However, empirical evidence measuring their WCS is still scarce. Furthermore, Alpusari et al., (2019) stated that students' WCS is still low compared to their ability to represent information and present their knowledge. The other research also underlines that WCS is generally still low compared to other required competencies, leading to students' low confidence (Fouché, 2013; Irafahmi et al., 2021; Riley & Simons, 2016). Likewise, studies in this area hardly delve into science teachers.

Gender and Written Communication Skills

Gender denotes individual biological characteristics based on sex. It is represented by responses from men and women (Lindqvist et al., 2021). It also manifests a social construction (Cameron & Stinson, 2019). Gender in the classroom involves male and female. Gender is seen to bear a crucial role in the development of WCS (Bahtiar et al., 2023; Shubina & Kulakli, 2019; Tzu-Ling, 2019). This role is found in attitudes during communication (Davis & Bahuleyan, 2024). However, the measurement of WCS among genders is limited (Dielissen et al., 2011). Furthermore, findings in this area are somewhat inconsistent, noting different findings and implications on the roles of gender on WCS (Anggraini, 2016; Winggowati et al., 2023).

The present study underlines the need for investigating pre-service science teachers, involving both genders, to close the gaping void while extending the border of science learning strategies in higher education. Following this rationale, this study aims to address the following questions: (1) what are the characteristics of the WCS level of pre-service science teachers? and (2) do their genders play a role in the WCS characteristics?

▪ METHOD

Research Design and Procedures

This exploratory research examined the WCS of pre-service science teachers and the roles of their gender. The exploratory method was chosen to extract information from the research sample and perceive meaning accurately (Creswell, 2014). This research was conducted in 6 (six) stages. This research started from the first stage, namely problem identification, focusing on the WCS of prospective science teachers and how gender influences WCS. A theoretical review was conducted in the second stage involving literature studies related to WCS and previous research. The third stage is determining the sample by considering regional characteristics. The fourth stage was data collection through writing tests. The fifth stage was data analysis. Data analysis was conducted by categorizing the WCS level and inferential statistical tests to determine the significance of gender differences in WCS. The sixth stage drew conclusions that were used as a basis for providing recommendations to improve the WCS of prospective science teachers by considering gender aspects.

Participants

This study recruited students of the Science Education study program who had attended at least 1 semester, totaling 101 students from 3 state universities in Indonesia. The universities were chosen by pondering the goal of representing the population of Indonesian students, the proximity of campuses for practicality concerns, and a substantial number of potential participants. Detailed sample characteristics are shown in Table 1.

Table 1. The characteristics of research samples

Gender	Sample	Frequency	Percentage (%)
Male	University 1	7	7
	University 2	4	4
	University 3	3	3
Female	University 1	27	27
	University 2	28	28
	University 3	32	32

Data Collection and Instruments

WCS was examined using a test. To ensure that participants took the test voluntarily and had a clear understanding of the research, they were allowed to fill out informed consent. In the test, they had to analyze and demonstrate their ability to solve a problem in the form of a text related to daily science phenomena, which had been validated by experts through a focus group discussion. They were allowed to answer the phenomena on the WCS test sheet. They had to formulate the solution to a problem formulation involving the rationales for the alternatives they offered in at least 2 paragraphs, each of

which contained 75 words.

The participants' writing was assessed based on the WCS rubric, encompassing organization, development, expression, and content as adopted from (Holmes et al., 2019). Each component has 4 indicators, showing the extent to which they meet the criteria of each indicator. A score of 4 indicates that they satisfy all the four indicators in a component. The WCS rubric used to take measurements has been declared valid with the results of validity testing using Aiken's V having an average score of 0.970 with an interpretation of high validity and reliability testing using Kendall's W having an average score of 0.632 with an interpretation of a substantial level of agreement.

Data Analysis

To answer research questions, the researchers calculated the WCS scores for each participant in each component, along with the mean value (μ) and standard deviation (σ). The WCS was classified based on Table 2.

Table 2. The classification of WCS

WCS scores	Category
86 – 100	Excellent
76 – 85	Good
60 – 75	Moderate
55 – 59	Fair
< 55	Poor

Adapted from Alpusari et al., (2019)

The classification above helped to determine pre-service teachers WCS. The second research question regarding the role of gender on the WCS characteristics of pre-service science teachers was addressed statistically with the aid of SPSS 23. Statistical analysis was completed using a normality test by using Kolmogorov-Smirnov, involving more than 50 participants (Mishra et al., 2019). The test of gender roles was carried out using the Mann-Whitney Test considering that the data was not normally distributed (Ai, Huang, & Zhang, 2020; Orcan, 2020).

▪ RESULT AND DISSCUSSION

The results of this exploratory research produced two major findings. The first finding shows that the majority of pre-service science teachers can organize their writing quite well. The second finding demonstrated that gender does not have a significant influence on their WCS. Further details are presented below.

The Levels of WCS among Pre-service Science Teachers

The WCS levels were determined by calculating the percentage of achievement in each component, as displayed in Figure 2. Figure 2 demonstrates that more than half of pre-service science teachers achieve moderate and excellent levels in organization, development, expression, and content. This illustrates that pre-service science teachers are capable of demonstrating decent WCS. Notwithstanding, the findings imply the potential development of WCS through a structured pedagogical method.

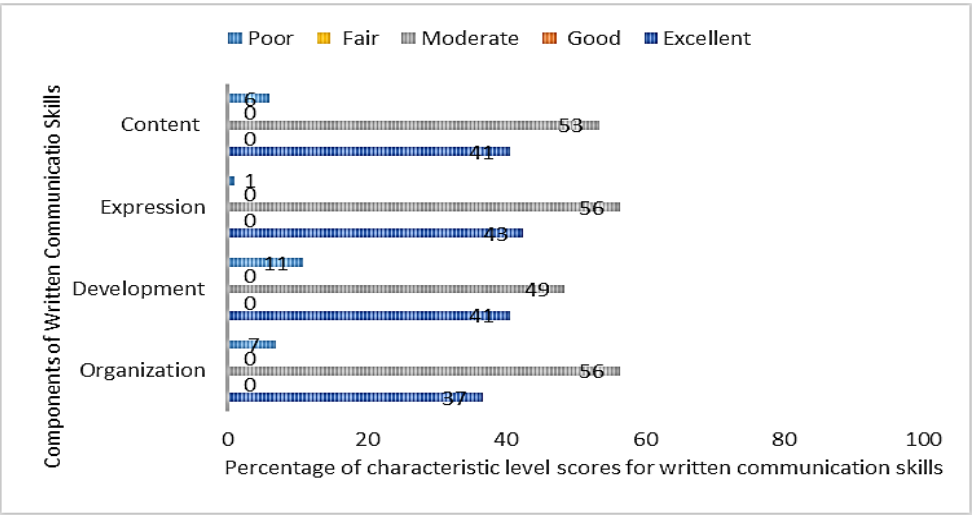

Figure 2. The characteristics of WCS among pre-service science teachers

The Roles of Gender in Pre-service Science Teachers WCS

The roles of gender on WCS were examined through a normality test using Kolmogorov-Smirnov. The normality test results for both genders in all components demonstrated $p < 0.05$, implying that the data was not normally distributed. The next test was carried out using the Mann-Whitney Test. The test results are presented in Table 3.

Table 3. Analysis results on the roles of gender in WCS

Genders		**Components of WCS**			
		Organization	**Development**	**Expression**	**Content**
Male	Mean (n=14)	3.07	3.29	3.64	3.50
	Median	3.00	3.00	4.00	4.00
	Variance	.379	.220	.247	.423
	Standard Deviation	.616	.469	.497	.650
Female	Mean (n=87)	3.33	3.33	3.38	3.32
	Median	3.00	3.00	3.00	3.00
	Variance	.341	.550	.261	.337
	Standard Deviation	.584	.742	.511	.581
Analysis of Variance	Mann-Whitney U	476.000	573.000	453.000	504.000
	Z	-1.489	-.388	-1.778	-1.168
	Asymp. Sig. (2-tailed)	.137	.698	.075	.243

The data above demonstrates $p > 0.05$ on all WCS components of pre-service science teachers. The analysis results acknowledge that there is no significant difference in WCS between male and female science teachers. However, the mean score shows that

male have a higher mean on the expression and content components, with a more diverse distribution on the organization and content, than female. Female attain a higher mean on the organization and development components with a varied distribution on the development and expression components.

The Domination of Moderate and Excellent Levels of WCS

In the organizational component, the majority of pre-service science teachers are classified in the moderate and excellent categories. They have displayed sufficient competence in organizing writing to allow a clear flow of ideas to support critical reasoning and communication of ideas. The organization component provides an overview of sentence arrangement and cohesion (Holmes et al., 2019). The findings confirm the results of previous research (Babayiğit, 2015; Krell et al., 2020), noting that science teachers still need more explicit reinforcement to improve their reasoning, especially in preparing their writing. Furthermore, they need to improve their ability to formulate problems through proper planning and timing when structuring alternative solutions to a problem (Erenler & Cetin, 2019).

The findings on the development affirm that the majority of pre-service science teachers are in the moderate and excellent levels, although some fall in the poor category. These findings cohere with previous research (Yaman, 2020) which states that pre-service science teachers have good argumentative skills based on the knowledge they have. They also can develop alternative solutions by exploring their ideas (Krell et al., 2020). Pre-service science teachers need to engage comprehensive viewpoints to structure and refine their ideas (Batey et al., 2009). Imaginative, divergent, and lateral thinking patterns also influence in developing ideas (Syahrin et al., 2019). These acknowledge the urgency of creativity and criticality as two score elements in developing and conveying ideas as the medium to address real-life issues.

The findings of the expression component prove that pre-service science teachers can compose clear writing by using appropriate language structures, indicated by their achievement in moderate and excellent categories. This finding is in resonance with research results (Tagle et al., 2017) showing that students have mastered good knowledge and understanding of grammar and vocabulary. However, the findings of this research contradict (Alfaki, 2015) which states that students have problems in using punctuation and spelling. This expression component is measured based on writing clarity (Iksan et al., 2012).

In the content component, pre-service science teachers demonstrate moderate and excellent performances in composing writing based on scientific truth. This finding is in line with previous research (Alpusari et al., 2019) which states that pre-service science teachers are good at writing to elaborate on scientific truth. Students can develop an understanding of the content without separating their arguments and knowledge (Yaman, 2020). This research is also in line with the results of research (Seckin Kapucu & Yurtseven Avci, 2020) that pre-service science teachers have a high and moderate ability to generate content for written composition. The scientific truth showcases the ability to elaborate arguments based on individual knowledge bases (Evagorou et al., 2023). The understanding of science concepts is activated and enhanced through observations and reading graphs as well as diagrams (Fadly et al., 2021).

Gender Bears Insignificant Roles on Pre-service Science Teachers WCS

The relationship between gender and WCS is still a much-debated issue. The research findings show that gender does not have a significant effect on all WCS components of pre-service science teachers. This confirms research results (Anggraini, 2016) reporting that gender does not have a significant effect on students' writing skills. This research is also in line with that conducted by (Winggowati et al., 2023) which report that gender does not have a noteworthy influence on communication skills. Another research (Hariyanto, Yamtinah, Sukarmin, Saputro, & Mahardiani, 2019) documents no significant difference in WCS between genders. Overall, gender is seen as not influencing writing results (Cakir & Ciddi, 2023).

This research contradicts several previous research results which stated that gender influenced WCS. (Groene et al., 2022; Nurhayati & Bahtiar, 2024) said that gender is one of the driving factors to WCS apart from age, ethnicity, parental education level, mastery of the native language, and language use. Another study argues that gender is seen as having an important role in determining communication success (Bahtiar et al., 2023; Shubina & Kulakli, 2019; Tzu-Ling, 2019). (Yu, 2021) revealed that women tend to communicate better than men.

Genders do not have a significant effect on the WCS of pre-service science teachers. However, the opposite is true if viewed based on the mean of each WCS component. In the organizational component, the mean for female is higher than that for male, which means that female pre-service science teachers are more adept at conveying ideas effectively and logically. This is in line with research reporting (Babayiğit, 2015) that female can better organize writing than male. In the development component, female achieve a higher mean than male, indicating the superiority in developing comprehensive and structured ideas. The findings of the development component are in line with research (Zhang et al., 2019), showing that female are better at developing ideas than male.

Male pre-service science teachers demonstrate better performance in expression than female. The findings show that male can better convey information in a way that is easily comprehensible to readers without minimum interpretation errors. These confirm the results of research (Cordeiro et al., 2018) noting that female are superior in spelling. The next finding on content shows that male have a higher mean than female. Moving forward, the findings also support the idea that male understand problems more easily than female, leading to more accurate details according to scientific evidence. The findings of this content contradict research results underlining the inferiority of male to female in writing (Al-Saadi, 2020; Babayiğit, 2015).

One appealing finding is that gender does not affect WCS. However, in other countries, gender is proven to play an influence on WCS. The results showed that gender is a factor that influences the completion of writing (Abdel Latif, 2019). Female students are superior to male (Nggawu, 2024). At the beginning of writing, male produce shorter and lower quality writing than female (Adams & Simmons, 2019). Universities need to integrate WCS into the curriculum through apt learning strategies to allow equal growth for both genders (Fadli & Irwanto, 2020; Kowalewski, 2019; Saenab et al., 2018; Tagle et al., 2017; Wildan et al., 2019). One trajectory is through problem formulation in which students are allowed to explore scientific ideas (organization) and develop alternative solutions to problems (Chalkiadaki, 2018; Schwieger & Ladwig, 2018; Tang, 2020). These students are required to propose solutions to contextual problems in their

surroundings. Such a model is deemed relevant because science learning plays a vital role in solving problems in society (Bouillion & Gomez, 2001).

Escalating WCS can be actuated through self-group reflection in which pre-service science teachers gain the opportunity to develop a better understanding of the new knowledge they have acquired (Kaufman, 2019). New knowledge provides changes in a person's information structure through a reflection process (Koopman & Hakemulder, 2015). The Zone of Proximal Development (ZPD) theory is the distance between actual development in solving problems independently and potential development with the help of more mature people or more capable peers (Crompton & Ferguson, 2024; Schunk, 2014; Smagorinsky, 2018; Xi & Lantolf, 2021). The verification stage with self-reflection can be used to ensure the accuracy of an answer (Moss, 2016). Lecturers can be a medium to stimulate motivation and make explicit the importance of written communication (Sarda et al., 2021). In addition, lecturers need to provide effective feedback in oral and written form so that they can improve students' learning achievements (Getzlaf et al., 2009).

▪ CONCLUSION

The research results confirm that pre-service science teachers can develop alternative solutions to problems through a logical and structured strategy, which is indicated by informative, clear, and effective writing. They can also develop sentences in each paragraph with specific main ideas by using a nuanced selection of words and sentence structures. Their arguments are generally in coherence with scientific concepts and truths. Finally, the research has demonstrated that gender plays no bearing impact on pre-service science teachers WCS.

The study has several limitations. First, the proportion of male and female samples is not equal. Equal proportions between genders may lead to generating noteworthy data and conclusions. However, this proportion suffices to explain the impact of gender on pre-service science teachers WCS. The second limitation is the level of parental education. Parental education influences students' awareness, attention, and habituation patterns. Parents' education, to some extent, can be predicted by pre-service science education level. The third limitation is individual experience. Individuals with more extensive experience tend to have broader knowledge. At the same academic level and a similar length of study, pre-service science teachers are more likely to have the same knowledge. Future researchers are expected to investigate gender proportions, parental education level, and prior knowledge.

Given the fact that gender exerts no significant effect on WCS, innovations in pedagogical structure to develop pre-service science teachers are called forth. Teacher educators in higher education must provide opportunities for students to engage in problem-based learning and self-group reflection. Practically, problem formulation is achieved through (1) providing problems in the form of video, text, or other forms of modality; and (2) guiding students using subconscious language to formulate problems based on specific problems. Educators carry out self-group reflection by (1) providing opportunities for students in groups to exchange their works, and (2) encouraging students to make corrections, and provide comments, and suggestions on student worksheets that are obtained randomly. Problem formulation and self-group reflection can be done separately or combined in a learning model.

▪ **ACKNOWLEDGEMENTS**

This research was funded by the Institute for Research and Community Service (LP2M) Universitas Jember, Indonesia with contract number 3383/UN25.3.1/LT/2023.

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