





An analysis of the characteristics of Indonesian pre-service science teachers' compassion skills and gender roles

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ABSTRACT

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This research aims to analyze pre-service science teachers' generosity, friendliness, wisdom, sensitivity, and tolerance as indicators of compassion skills, and explore gender roles on the characteristics of these skills. As 21st-century skills, compassion skills need to be conveyed through teachers' attention, affection, kindness, and gentleness toward their students. These skills are fundamental for pre-service science teachers' personality competence in supporting their role as future professional teachers. These skills also play an important role when there is interaction between teachers and students or among students during the learning process which affects learning outcomes. However, references concerning the characteristics of pre-service teachers' compassion skills and the role of gender in these skills are underexplored. To address this gap, this research employed an exploratory method involving 107 pre-service science teachers at several state universities in Indonesia. Data was collected using a questionnaire that met validity and reliability criteria. The research results show that the teachers generally demonstrate a high/very high extent of compassion skills. The results also point to the fact that gender differences pose no significant influence on compassion skills. The implication highlights the necessity to focus on training pre-service science teachers' compassion skills, while undermining any anxiety due to gender differences.

Contribution/Originality: Compassion skills are essential for pre-service science teachers to form bonds with students. This study contributes by providing an overview of the characteristics of pre-service science teachers' compassion skills and exploring their gender roles as well as providing strategies for improving compassion skills through the learning process.

1. INTRODUCTION

Recent trends in relation to the education of pre-service science teachers underscore the need to improve their 6C skills, which are: (1) communication; (2) collaboration; (3) critical thinking; (4) creative thinking; (5) computational logic; and (6) compassion (Kemendikbud, 2020). Compassion skills are manifested in how teachers demonstrate care for other people. They include the ability to demonstrate kindness and take responsibility for committing mistakes and facing despair (Ferrari et al., 2019; Gilbert, 2017). Furthermore, compassion skills involve cognitive, affective, and behavioral processes toward oneself and others (Strauss et al., 2016). Initially, the term

compassion was related to spiritual philosophical traditions and behavior that can direct attention, generate reason, and prevent suffering (Gilbert et al., 2017).

In the field of education, compassion skills relate to teachers' personalities expressed through their attention, affection, kindness, and gentleness toward their students, making it a fundamental component of their profession (Eldor & Shoshani, 2016; Willis, 2021). Compassion skills can be built through teacher and student interactions. The interpersonal communication relationship between teachers and students is very important in fostering compassion skills. Compassion skills emerge when teachers educate, guide, and direct students through a series of learning processes (Kelana, Kelana, & Pratama, 2019; Kurniawan, Astalini, Darmaji, & Melsayanti, 2019). These skills also play an important role in helping teachers recognize the level of needs, questions, and ambiguity that students encounter when learning new information and building a strong rapport with students so that they feel safe to voice their learning challenges (Xue, 2023). Compassion skills are part of the art of teaching that show the ideal quality of a teacher.

In Indonesian education, compassion skills are part of the personality explicitly stated in the formulation of learning outcomes for graduates of the Teacher Professional Development. These skills are defined as "the ability to carry out professional duties as educators in a charming, authoritative, firm, and disciplined manner, full of soul calling, vigilant, love for the nation, wholeheartedness, and generosity" (GTK, 2020). Professional science teachers need to go through a series of educational processes as pre-service teachers as part of the teacher education program in the science education study program. However, the general trends of compassion skills among pre-service science teachers along with gender are hardly understood. Measures to close this gap in the literature can help to determine appropriate and effective learning strategies aimed at the compassion skills of pre-service science teachers and encourage the sustainable professional development of science teachers. In this scenario, this study attempts to address the following inquiries: (1) What are the characteristics of pre-service science teachers' compassion skills? and (2) Does the teachers' gender play a role in compassion skills?

2. LITERATURE REVIEW

2.1. Compassion Skills for Pre-Service Science Teachers

Compassion skills encourage individuals to help and support one another. According to Atkins and Parker (2012), compassion skills involve not only one's feelings but also a real action as a response. This response is important because it can improve leadership and productivity (Paakkanen, Martela, Hakanen, Uusitalo, & Pessi, 2021). Furthermore, Eldor and Shoshani (2016) stated that compassion skills are related to attitudes toward other people, despite the level of intimacy. These skills emerge in human interactions and are mediated by various feelings, cognition, and behaviors that are focused on understanding, supporting, and caring for one another.

Compassion skills are social skills that enable students to build a positive learning environment and thus drive effective learning (Louis, Murphy, & Smylie, 2016). The skills connect awareness, feelings, understanding, and action aimed at reducing the suffering of others (Xue, 2023). People with good compassion skills will experience three things within themselves: (1) an instilled awareness of doing what is good and necessary, rather than blaming other people; (2) the ability to differentiate between thoughts and emotions, which enables one to finely perceive fear, sadness, doubt and loneliness; and (3) the awareness to grow universally with the ability to understand every problem that others grapple with (Feldman & Kuyken, 2011).

Compassion skills aid in building strong bonds between teachers and students. Teachers who have exemplary compassion skills tend to demonstrate emotional closeness with students (Virat, 2022), which is essential to minimize fatigue when teaching and interacting within the school environment (Christian-Brandt, Santacrose, & Barnett, 2020). Teachers who are emotionally close to students can have positive impacts on the learning climate, which, in turn, encourages their learning achievements and reduces the school dropout rate (Tarrasch, Berger, & Grossman, 2020).

To measure compassion skills, several indicators come into play. These indicators include generosity, friendliness, wisdom, sensitivity, and tolerance (Feldman & Kuyken, 2011; Gilbert, 2009; Goetz, Keltner, & Simon-Thomas, 2010; Lama, 1995; Martins, Nicholas, Shaheen, Jones, & Norris, 2013). Generosity is the willingness to assist others sincerely (Heiphetz & Young, 2019; Rao, 2019). Friendliness is defined as familiarity in establishing relationships with others (Amin, Ahmad, & Sang Choi, 2019). Friendliness is a positive response to a message received from another person (Fong et al., 2021). Wisdom is an attitude that arises from the integration of the ability to control emotions, social behavior, self-reflection, and balance in demonstrating firmness and sincerity in embracing diversity (Jeste et al., 2020; Jeste et al., 2019). Sensitivity is one's ability to react to a situation (Kron, Sommerhoff, Achnert, & Ufer, 2021). Tolerance is a person's attitude to understanding, respecting, and accepting differences (Adelman, Verkuyten, & Yogeeswaran, 2022; Damirovich, Ilhom Ibragimovich, & Ulugbek Sattarovich, 2022).

2.2. Gender and Compassion Skills

Everyone has distinctive compassion skills due to several factors, including gender, education, culture, and age (Neff & Germer, 2017; Strauss et al., 2016). Chen and Phillips (2018) stated that teachers' gender, ethnicity, age, emotionality, experience, and educational qualifications influence their compassion skills. López, Sanderman, Ranchor, and Schroevers (2018) contend that women have higher compassion skills than men because they tend to maintain their femininity, while men are inclined to maintain their masculinity.

In contrast, other studies revealed that compassion skills are not completely influenced by gender. Levenson (2009) stated that compassion skills are an intersection of wisdom and ethics, so these skills are not influenced by gender. This integration encompasses masculine and feminine aspects and involves cognitive, affective, conative, and reflective constructions. Prabha and Mittal (2019) stated that compassion skills are determined by age rather than gender, and adults have more developed compassion skills, implying a positive correlation between age and compassion skills. These competing views on gender inspired the present study to further probe the role of pre-service science teachers' gender on their compassion skills, particularly given the fact that both genders have equal opportunity to take part in education.

3. METHODOLOGY

3.1. Research Design

This exploratory research analyzed the levels of generosity, friendliness, wisdom, sensitivity, and tolerance as indicators of the compassion skills of pre-service science teachers and explored the roles of their gender on these indicators. An exploratory method is used to navigate and negotiate the meaning of an issue (Creswell, 2014). The overall research procedure is presented in Figure 1.

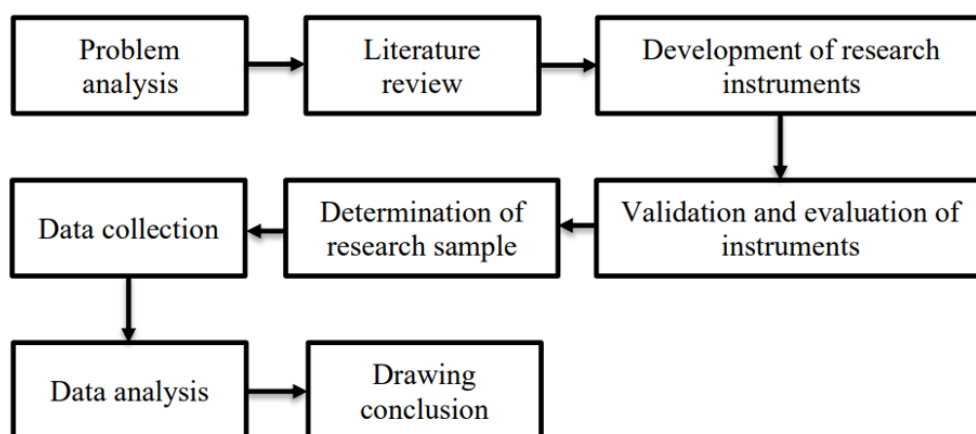


Figure 1. Research procedure.

3.2. Sample and Data Collection

The study sample consisted of students enrolled in science education programs at three state universities in Indonesia: State University of Malang (University 1), University of Trunojoyo Madura (University 2), and University of Jember (University 3). They attended lectures for at least one semester. Several of these universities have students who come from regions with common features, and these universities are the largest producers of pre-service teachers in each region. The students' demographic information is displayed in Table 1.

Table 1. The demography of pre-service science teachers.

Sample	Gender	Age	Frequency	Percentage (%)
University 1	Male	18	5	4.67
		19	2	1.87
	Female	18	21	19.63
		19	5	4.67
University 2	Male	18	3	2.80
		19	1	0.93
	Female	18	20	18.69
		19	9	8.41
University 3	Male	18	3	2.80
		19	1	0.93
	Female	18	28	26.17
		19	9	8.41

The 107 respondents involved had different characteristics in terms of age, gender, and ethnicity. To collect the data, the researchers distributed an online survey through Google Forms due to its flexibility. While the data collection aimed to address the research inquiries, it also enabled further exploration of the characteristics of pre-service science teachers.

Table 2. Validity and reliability of the questionnaire items.

Indicators of compassion skills	Question code	Validity test through product moment test				Reliability test through Cronbach's alpha	
		Sig. (2-tailed)	Calculated <i>r</i>	Interpretation	Variance	Cronbach's alpha of each item	Cronbach's alpha
Generosity	Gen1	0.000	0.519**	Valid	0.443	0.874	0.877
	Gen2	0.000	0.563**	Valid	0.494	0.872	
	Gen3	0.000	0.595**	Valid	0.512	0.871	
Friendliness	Fri1	0.000	0.663**	Valid	0.599	0.867	
	Fri2	0.000	0.702**	Valid	0.647	0.865	
	Fri3	0.000	0.540**	Valid	0.439	0.875	
Wisdom	Wis1	0.000	0.440**	Valid	0.323	0.882	
	Wis2	0.000	0.543**	Valid	0.467	0.873	
	Wis3	0.000	0.542**	Valid	0.477	0.872	
Sensitivity	Sen1	0.000	0.723**	Valid	0.675	0.865	
	Sen2	0.000	0.733**	Valid	0.670	0.863	
	Sen3	0.000	0.637**	Valid	0.555	0.869	
Tolerance	Tol1	0.000	0.624**	Valid	0.537	0.870	
	Tol2	0.000	0.758**	Valid	0.705	0.862	
	Tol3	0.000	0.624**	Valid	0.550	0.869	

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

Before filling out the questionnaire, the respondents filled out an informed consent form to ensure their voluntary participation and full understanding of the research objective. The researchers developed the questionnaire items by referring to the abovementioned indicators of compassion skills, i.e., generosity, friendliness, wisdom, sensitivity, and tolerance. Each indicator was measured using three questions, so there were 15 questions in total. All questions were declared valid and reliable (see Table 2). To ensure accurate completion of the survey,

the following requests and information were included in the Google Form: (1) Read each question carefully and provide candid answers; (2) Choose the number that corresponds to your opinion; and (3) The answers given will be kept confidential. Next, the respondents filled out another questionnaire to measure their life satisfaction on a scale ranging from 1 (strongly disagree) to 7 (strongly agree) to investigate their estimated life quality (Karakasidou, Raftopoulou, Pezirkianidis, & Stalikas, 2021).

Table 2 describes the validity and reliability of the research instrument. Validity was based on r , calculated using SPSS version 23, while the r -table was calculated through the product-moment correlation table with a confidence interval of 5% (critical $r = 0.1900$) and $df (n-2)$. The results proved that the 15 questions achieved positive scores above the r table. Based on the output correlations, the researchers identified $p 0.000 < 0.05$ (2-tailed), so these questions had been proven as valid measures of compassion skills. A valid instrument can warrant accurate measurement of what an item is set to gauge (Beniermann, Moormann, & Fiedler, 2023; Forzani et al., 2021; Shrotryia & Dhanda, 2019). Table 2 also reports the results of the reliability test using Cronbach's alpha, marked at $0.877 > 0.6$, implying reliability of the instrument (Amirrudin, Nasution, & Supahar, 2021; Barbera, Naibert, Komperda, & Pentecost, 2020; Burgueño & Medina-Casaubón, 2021).

3.3. Data Analysis

The data analysis was performed descriptively based on the scores assigned by the respondents to each question. The researchers then calculated the mean values (μ) and standard deviations (σ). The respondents' compassion skills were classified following the description in Table 3.

Table 3. The classification of compassion skills.

Score range	Category
$X \leq (\mu - (1,5 \sigma))$	Very low
$(\mu - (1,5 \sigma)) < X \leq (\mu - (0,5 \sigma))$	Low
$(\mu - (0,5 \sigma)) < X \leq (\mu + (0,5 \sigma))$	Fair
$(\mu + (0,5 \sigma)) < X \leq (\mu + (1,5 \sigma))$	High
$(\mu + (1,5 \sigma)) < X$	Very high

Source: Renggani and Wideasavitri (2018).

The compassion skills were classified by referring to the percentage of scores assigned. This was achieved by adding up each category in each indicator and dividing it by the total number of respondents. The resultant data is presented visually to provide an overview of the respondents' characteristics (Creswell, 2014). The same analysis tool was also used to address the second research question regarding the role of gender on the pre-service science teachers' compassion skills. Data analysis began with a normality test using the Shapiro–Wilk test due to its high sensitivity to deviations from normal distribution (González-Estrada & Cosmes, 2019; Mishra, Satpathy, Dash, & Mishra, 2022). Next, to find out the median difference between males and females based on data that was not normally distributed, the Mann–Whitney U test was employed (Ai, Huang, & Zhang, 2020; Saegusa, 2021).

4. RESULTS

The results of the data analysis classified the compassion skills of pre-service science teachers in alignment with the categories specified in Table 3. The results are displayed in Figure 2 below.

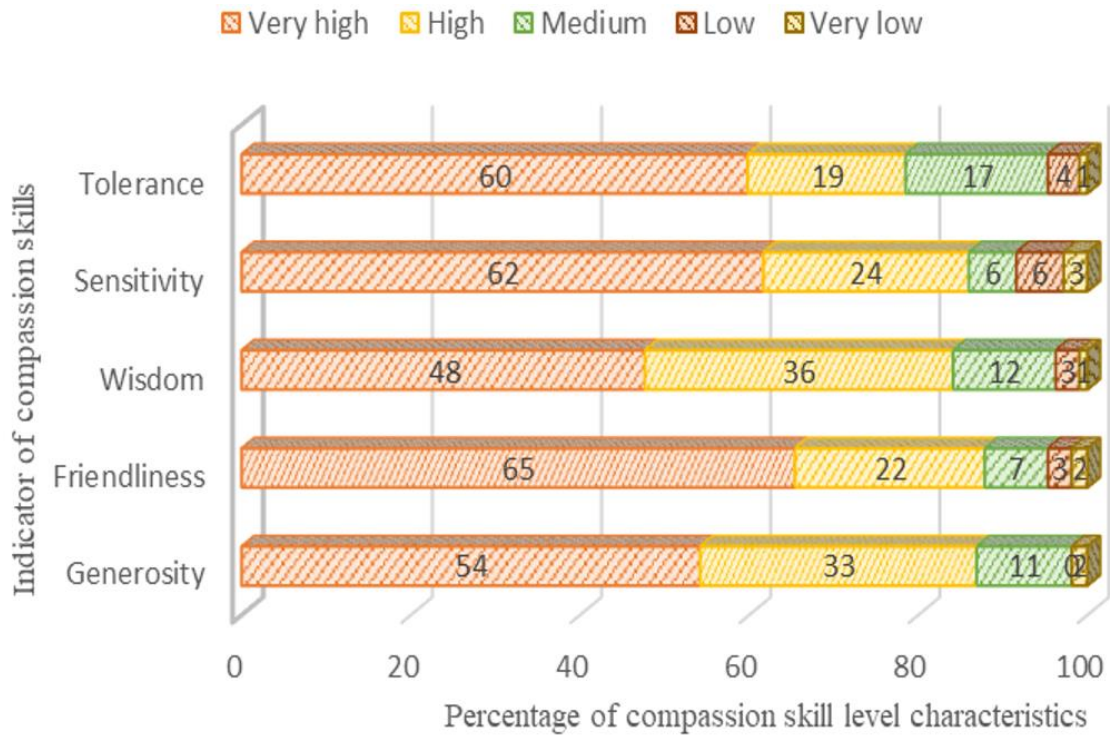


Figure 2. The characteristics of pre-service science teachers' compassion skills.

Figure 2 shows the characteristics of the participants' compassion skills identified in the very high category, ranging between 48% and 60%; in the high category, the interval is between 19% and 22%; the medium category has an interval between 6% and 17%; in the low category, the interval ranges from 0% to 6%; and the very low category ranges from 1% to 3%. These results show that, on average, the compassion skills across the indicators are marked in the very high category. However, it is notable that the improvement in each indicator remains feasible.

This research also aimed to investigate differences in the characteristics of each indicator between genders. Gender is seen to play a role in each individual's characteristics. In this regard, the comparison results are shown in Table 4.

Table 4. Analysis of the influence of gender on compassion skills.

Gender	Components	Indicators of compassion skills				
		Generosity	Friendliness	Wisdom	Sensitivity	Tolerance
Male	Mean (n = 15)	5.36	5.62	5.44	5.53	5.84
	Standard deviation	1.38	1.57	1.47	1.71	1.26
Female	Mean (n = 92)	5.57	5.67	5.29	5.55	5.42
	Standard deviation	1.27	1.36	1.49	1.35	1.48
Statistical tests	Mann-Whitney U	576.500	650.000	656.000	631.000	526.000
	Z	-1.027	-0.362	-0.307	-0.533	-1.481
	Asymp. sig. (2-tailed)	0.305	0.718	0.759	0.594	0.139

Table 4 shows the results of the Mann-Whitney U test, which corroborates that all indicators of compassion skills have a p-value greater than 0.05. This shows no significant difference between males and females in the characteristics of compassion skills. However, Table 4 also reports on pre-service science teachers with varying mean ± SD scores on all indicators of compassion skills, with SD values below the mean. Female pre-service teachers are more likely to demonstrate generosity (5.57 ± 1.27) than males (5.36 ± 1.38), and female pre-service science teachers (5.67 ± 1.36) are also friendlier than males (5.62 ± 1.57). For the sensitivity indicator, female pre-service science teachers (5.55 ± 1.35) are more sensitive than males (5.53 ± 1.71). However, for the wisdom

indicator, male pre-service science teachers (5.44 ± 1.47) are wiser than their counterparts (5.29 ± 1.49). Male pre-service science teachers also demonstrate more tolerance (5.84 ± 1.26) than females (5.42 ± 1.48).

5. DISCUSSION

5.1. Discussion on the Level of Compassion Skills of Pre-Service Science Teachers

The results of the data analysis in [Figure 2](#) are used to explain the research question regarding the characteristics of compassion skills among pre-service science teachers. In the generosity indicator, the respondents' answers were in the very high category. This high level of generosity is assumed to be due to several factors: (1) the respondents easily accept suggestions and criticism from other people; (2) they view that others' happiness is as important as their own happiness; and (3) they are used to helping other people. The findings related to the generosity indicator confirm previous research conducted by [Rao \(2019\)](#) who noted that students in private schools in Delhi, India, have a high level of generosity with regard to socio-economic conditions. This is also in line with the findings presented by [Heiphetz and Young \(2019\)](#) who reported that adults have high generosity presumably due to their upbringing. In Indonesia, habituations from an early age, such as charity, zakat (almsgiving), and helping friends in need, have an impact on generosity ([Nurpratiwi, Effendi, & Amaliyah, 2021](#)).

The friendliness indicator demonstrates that most of the pre-service science teachers were identified to be in the very high category. By extension, they find it easy to initiate communication with other people and provide assistance to others regardless of their background. The findings corroborate prior research conducted by [Fong et al. \(2021\)](#) which suggests that students commonly exhibit high levels of friendliness, stemming from positive interactions and feedback received during classroom learning, thereby fostering constructivism. Furthermore, this finding aligns with the conclusions of research by [Tajeddin and Alemi \(2019\)](#) which indicated that pre-service teachers demonstrate a high degree of friendliness, contributing to an inviting classroom atmosphere. Friendliness is known to be a social identity actuated through communication and social networking ([Martins et al., 2013](#)). In the same vein, there is potential to improve the respondents' friendliness as an important skill to become future professional teachers ([Ko & Chung, 2014](#)).

The majority of the respondents in this study fall into the very high category for the wisdom indicator. These findings align with previous research by [Durmus Çemçem, Korkmaz, and Cakir \(2023\)](#) who found that prospective teachers exhibit high levels of wisdom, particularly in digital aspects. Additionally, these results support the findings of [Jeste et al. \(2019\)](#) who found that respondents' wisdom is generally high.

Sensitivity, defined as a quick reaction to an event, was assessed in this study, with results indicating that the majority of pre-service science teachers fall into the very high category. This suggests that these teachers are inclined to offer assistance without being prompted. These findings contrast with those of [Kron et al. \(2021\)](#) who found that science teachers generally exhibit low sensitivity, but are consistent with the findings of [Ceyhan \(2022\)](#) who indicated that teachers generally demonstrate high ethical sensitivity.

The final finding pertains to the tolerance indicator, with the majority of science teacher candidates falling into the very high category. This suggests that these science teachers are likely to collaborate effectively with peers from diverse backgrounds of knowledge, ethnicity, religion, and customs. These findings align with prior research by [Tican \(2020\)](#) who found that prospective teachers in Turkey exhibit very high levels of tolerance. Additionally, these results are consistent with the findings of [Hasan, Hamzah, and Awang \(2014\)](#) who reported that prospective teachers generally demonstrate high levels of tolerance.

5.2. Discussion on the Role of Gender on the Compassion Skills of Pre-Service Science Teachers

The data analysis, documented in [Table 4](#), was carried out to address the research question concerning the role of gender on the compassion skills of pre-service science teachers. Several factors influence the compassion skills of pre-service science teachers, one of which is gender ([Karinda, 2020](#)). The results of the Mann-Whitney U test

revealed no significant difference in the compassion skills between genders. However, female pre-service science teachers were identified to have a higher mean score for generosity than male teachers, who tended to have more diverse generosity scores. This coheres with previous works (Aguiar, Brañas-Garza, Cobo-Reyes, Jimenez, & Miller, 2009; Cox & Deck, 2006) which acknowledge that female pre-service science teachers tend to be more generous than males due to several driving factors, *inter alia* reciprocal motivation, level of reward, and social strata.

Another essential finding is that, on average, female pre-service science teachers have higher scores for friendliness than male teachers. In addition, following Luong (2007), women tend to be friendlier because they can have better relational aspects than men. Furthermore, female pre-service science teachers have a lower mean score in wisdom than male teachers, although the latter group has the opposite variance score. This finding aligns with Aldwin (2009) who suggested that male pre-service science teachers tend to exhibit higher levels of wisdom compared to their female counterparts. It is important to note that wisdom is influenced by personal experiences, which vary among individuals and can impact their attitudes, as highlighted by Cheston, Hancock, and White (2019). Regarding the sensitivity indicator, male pre-service science teachers in this study showed a higher variance in sensitivity scores than women, despite having a lower average sensitivity score. This finding is consistent with research by Cox and Deck (2006) which suggests that female science teachers tend to be more sensitive than males.

Based on the results in Table 4, male pre-service science teachers have a higher mean score for the tolerance indicator than females, although the variance of answers was higher among the females. This suggests that men are more tolerant than female pre-service science teachers, although tolerance is also influenced by habits, consistent with research by (Corneo & Jeanne, 2009). On average, female teachers demonstrate higher compassion skills than their male counterparts, likely due to their stronger advocacy for feminism (López et al., 2018).

The research results have shown that in Indonesia gender does not have a significant effect on compassion skills. However, in several other countries, it turns out that gender does influence compassion skills, as reported by previous works (Chen & Phillips, 2018; López et al., 2018). Therefore, alternative initiatives to develop the compassion skills of pre-service science teachers become increasingly important to enable both male and female pre-service science teachers to achieve the highest possible level of compassion skills. These initiatives need to focus on encouraging pre-service science teachers to process and co-construct knowledge through a learning method called "smart discussion". This smart discussion provides an opportunity for discussions based on the analysis of problems and solutions. One possible line of research in this area could involve a random selection of individuals from heterogeneous groups based on gender, ethnicity, and race to inculcate friendliness, wisdom, and tolerance. Conditioning the learning of pre-service science teachers through this discussion makes it easier for them to learn from their peers. This concept resonates with the Zone of Proximal Development (ZPD) theory. The ZPD benefits pre-service science teachers by engaging them in a collaboration and empowering them to accomplish difficult tasks, which would be otherwise unfeasible without the help of their peers (De Kleijn, 2023; Newman & Latifi, 2021; Puntambekar, 2022; Santrock, 2022). Such collaborative learning is conducive to developing male and female teachers through interacting with others (Cheston et al., 2019; Martins et al., 2013). Studying with peers can support development in a positive direction and is an important part of adolescence. Moreover, collaboration can foster interpersonal growth through a series of social activities, which eventually increases their generosity (Rao, 2019).

An alternative measure for developing compassion skills is by allowing pre-service science teachers to carry out "self-group reflection" to examine new information against their background knowledge in a group. This reflection provides the steppingstones to develop compassion skills. The ability to reflect on writing can influence compassion skills (Beck & Verticchio, 2018). Self-group reflection carried out by pre-service science teachers through writing is a concrete action for developing generosity (Jääskeläinen & Helin, 2021). Self-group reflection can also transform a person's mindset (Kwan, Hung, & Lam, 2022).

6. CONCLUSION

Compassion skills are essential for pre-service science teachers to establish emotional connections with their students through attentiveness, gentleness, and kindness. This study has examined the characteristics of compassion skills and their relationship with gender roles. The research findings indicate that pre-service science teachers need not be concerned about their level of compassion skills, since the indicators of generosity, friendliness, wisdom, sensitivity, and tolerance are well-represented. Additionally, gender does not appear to significantly affect these skills. Instead, they are advised to focus on developing their compassion skills through classroom experiences and lessons.

7. LIMITATIONS

This study has two limitations. The first limitation is that the distribution of males and females is disproportional; a proportional distribution would otherwise lead to better data and more concrete conclusions. However, the sample proportion in this study is sufficient to provide an overview of the influence of gender on pre-service science teachers' compassion skills. The second limitation is related to the proportion of ethnic origin and family background of male and female pre-service science teachers. Notwithstanding, this research has already included participants from different tribes and backgrounds that reflect Indonesia's diversity. Future researchers should consider the proportion of different genders, ethnicities, and origins of potential research participants.

8. IMPLICATIONS AND RECOMMENDATIONS

The research results have confirmed the potential to develop satisfactory compassion skills through training. The results also point to the insignificant impact of gender on the compassion skills of pre-service science teachers. As such, educators or lecturers in science education departments need to provide opportunities for pre-service science teachers to carry out smart discussions by (1) guiding pre-service science teachers to sincerely discuss each of their smart ideas through the formulation of problems and solutions in groups, and (2) providing the opportunities to search for literary sources from books, articles, and any relevant sources from the internet.

Another implication highlights the need to carefully choose words and phrases for kindness, friendliness, and tolerance through collaborative learning. In addition, pre-service science teachers implement self-group reflection by (1) allowing students to study new information with the aid of worksheets after receiving input from other groups, (2) providing further explanation of difficult concepts, and (3) helping students to draw conclusions. In this self-group reflection, educators can use scripts so that when students get new information, they can easily accept suggestions and criticism from others. With their awareness, students acknowledge the truth of information from other groups, preventing them from blaming one another or themselves.

Based on the limitations and implications, future research could implement smart discussions and self-group reflection in science learning in higher education. This can be achieved through the direct application and integration of these two methods. Future researchers can also do this by integrating these two approaches into other learning models.

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Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.

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APPENDIX

This appendix presents the questionnaire used to measure the compassion skills of pre-service science teachers.

Instructions:

1. Read each statement carefully.
2. Choose the number that corresponds to your idea or opinion.

Statement 1:

I am inclined to help other students in improving their competencies, irrespective of my familiarity with them.

This statement is entirely untrue about me.	1	2	3	4	5	6	7	This statement is highly characteristic of me.
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Statement 2:

I readily accept suggestions and critique from both lecturers and peers.

This statement is entirely untrue about me.	1	2	3	4	5	6	7	This statement is highly characteristic of me.
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Statement 3:

The well-being and competency development of fellow students hold as much importance to me as my own happiness and competency advancement.

This statement is entirely untrue about me.	1	2	3	4	5	6	7	This statement is highly characteristic of me.
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Statement 4:

I am highly motivated to extend assistance to newly acquainted friends, going to great lengths to support them.

This statement is entirely untrue about me.	1	2	3	4	5	6	7	This statement is highly characteristic of me.
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Statement 5:

I exhibit considerable empathy toward fellow students from diverse backgrounds.

This statement is entirely untrue about me.	1	2	3	4	5	6	7	This statement is highly characteristic of me.
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Statement 6:

I find it easy to initiate verbal and written communication with fellow students.

This statement is entirely untrue about me.	1	2	3	4	5	6	7	This statement is highly characteristic of me.
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Statement 7:

I approach problem-solving with objectivity, demonstrating a capacity to manage my ego.

This statement is entirely untrue about me.	1	2	3	4	5	6	7	This statement is highly characteristic of me.
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Statement 8:

When in doubt about my opinions, I seek input and comments from other students.

This statement is entirely untrue about me.	1	2	3	4	5	6	7	This statement is highly characteristic of me.
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Statement 9:

I am deliberate in my actions, avoiding undue attribution of blame to other students.

This statement is entirely untrue about me.	1	2	3	4	5	6	7	This statement is highly characteristic of me.
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Statement 10:

I am proactive in offering assistance without waiting to be asked.

This statement is entirely untrue about me.	1	2	3	4	5	6	7	This statement is highly characteristic of me.
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Statement 11:

I readily share information with other students, even in the absence of a request.

This statement is entirely untrue about me.	1	2	3	4	5	6	7	This statement is highly characteristic of me.
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Statement 12:

I am always willing to extend apologies first, regardless of fault.

This statement is entirely untrue about me.	1	2	3	4	5	6	7	This statement is highly characteristic of me.
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Statement 13:

I refrain from seeking or expecting to be on a team with familiar friends when dividing team members for discussions.

This statement is entirely untrue about me.	1	2	3	4	5	6	7	This statement is highly characteristic of me.
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Statement 14:

I engage in discussions and collaborations with friends from diverse knowledge, ethnic, religious, and customary backgrounds.

This statement is entirely untrue about me.	1	2	3	4	5	6	7	This statement is highly characteristic of me.
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Statement 15:

I am open to differing opinions from other students, even when confident in the correctness of my own views.

This statement is entirely untrue about me.	1	2	3	4	5	6	7	This statement is highly characteristic of me.
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