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Socio-Scientific Issues as a Vehicle to Promote Soft Skills and Environmental Awareness

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Abstract: This research aims to investigate the effect of socio-scientific issues (SSI) based instruction on preservice science teachers' soft skills and environmental awareness. By applying cluster random sampling, 83 preservice science teachers (PSTs) were selected from the Department of Science Education at a university in Indonesia. The participants were divided into two groups which comprised the experimental group who were taught using SSI-based instruction, while the control group received direct instruction. The quasi-experimental study was carried out through a pre- and posttest control group design. Data was gathered quantitatively using soft skills and environmental awareness questionnaires. The soft skills questionnaire comprised six sub-skills questions: communication, collaboration, problem-solving, creativity, teamwork, and social interaction. The environmental awareness questionnaire contained questions about the PSTs' attitudes, behavior, and willingness to act. These sub-skills were developed based on literature studies and reviews of previous studies. Face validity was conducted by the experts, and Cronbach's alpha coefficients of 0.84 (for soft skills) and 0.86 (for environmental awareness) were obtained. The data were analyzed using the Wilcoxon signed-rank test. The result showed that SSI-based instruction had a significant effect on improving preservice science teachers' soft skills and environmental awareness. After being taught using SSI-based instruction, all the sub-skills of the soft skills of the experimental group had increased compared to before. A similar trend was also found in their scores for environmental awareness. All the components of environmental awareness, after lecturing using SSI-based instruction, showed a significant increase compared to before. These results support the claim that SSI-based instruction fosters soft skills and promotes environmental awareness.

Keywords: *Environmental education, preservice science teachers, generic skills, SSI-based instruction.*

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Introduction

In the current era of the industrial revolution, education needs a new pattern for preparing human resources in accordance with the needs of employers. This requires educators to be literate in these various needs. Hart Research Associates (2015) stated that soft skills are the main abilities that graduates must have to succeed in the world of work. This finding is also in line with Greenberg and Nilssen (2015) who concluded that educational institutions have more persistence in producing graduates who are ready to work toads should be more persistent in work-ready graduates. However, scholars have identified that universities are unable to fully developed the soft skills of their students, so that the resulting graduates are not properly prepared for the world of work (Andreas, 2018; Loughry et al., 2014).

Scholars suggest that universities develop preservice science teachers' soft skills to create qualified prospective educators (Mathew & Reddy, 2018; Tang et al., 2015). Previous research has shown that soft skills and the number of teachers are still low (Robles, 2012; Anderas, 2018). While the preservice teachers were being educated, their soft skills were not developed properly. This statement was also made by Robbles (2012) who stated that soft skills were needed by graduate teachers, but in practice, they graduated without the necessary soft skills.

There is no need to doubt the virtue of soft skills for teachers. Mathew and Reddy (2018) stated that soft skills are part of the affective domain, which is the goal of learning. Cultivating soft skills is the main requirement for the complete development of prospective teachers. The social and personal competencies that professional teachers must possess

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can also be developed through increasing their interpersonal and intrapersonal skills. These two skills are soft skill components that can support the mastery of the competencies needed by professional teachers.

Tang et al. (2015) stated that embedded methods were a better solution for integrating soft skills in learning. They also recommended the need for further research into the right approach to developing soft skills. SSI-based learning is an approach that utilizes social scientific problems related to learning topics and is taught using embedded methods. SSI has a controversial scientific content that is embedded in the cultural and ethical issues of our lives, which influences our communities at the personal, regional, or global levels (Zeidler & Nicholas, 2009). The implementation of SSI-based instruction would be ideally manifested in teaching the sciences (Friedrichsen et al., 2016). SSI-based learning engages students in social connection, communication, and argumentation during learning activities (Klosterman et al., 2011). These skills are the components of soft skills. Briefly, SSI can improve soft skills through discussion of the social issues and the students' interaction in the classroom. However, in the last decade, not many studies have examined the relationship between SSI and soft skills; this attracted the attention of researchers to explore the effect of SSI in promoting soft skills.

One of SSI's topics is environmental issues. Environmental topics are topics that are directly related to environmental problems. Related topics include global warming, pollution, energy saving, natural resources, and environmental conservation. Environmental topics are closely related to students' awareness of the environment. Environmental awareness trains students' sensitivities in the form of their attitudes, behavior, and willingness to act on environmental issues. The need for environmental education and awareness is crucial, as they are important steps to reduce the environmental damage caused by a wide range of activities. Researchers have shown that environmental education is needed (Chen et al., 2020; Flanagan et al., 2019; Moseley et al., 2019; Samuelsson et al., 2019; Woosnam et al., 2018) to maintain environmental awareness. In 2019, research conducted by Flanagan et al. showed that environmental education can develop raise people's environmental awareness. Therefore, it is hoped that it can open new horizons for the future preservice teachers regarding environmental awareness, with SSI-based learning increasing their environmental awareness.

Various studies have assessed that environmental education programs can successfully improve students' performance and environmental awareness (Hui et al., 2017; Hunter & Jordan, 2019; Moseley et al., 2019). Environmental awareness means not only having knowledge about the environment but also relating it to a series of attitudes, behaviors, and a willingness to act to overcome problems related to the environment. Universities should provide the platform needed to increase environmental awareness through various learning activities, discussions, debates, seminars, and other activities (Abbas & Singh, 2014). This will stimulate students' enthusiasm for the environment and encourage them to take certain responsibilities for the environment's preservation. In this regard, it is important to fully understand the environmental awareness of prospective teachers, and teach them why we need to protect the environment. Research conducted by Chen et al. (2020) suggested that environmental education should focus on increasing environmental awareness.

Environmental education not only aims to increase knowledge but must have an impact on improving students' attitudes and behavior towards the environment (Flanagan et al., 2019; Hosany et al., 2017; Moseley et al., 2019). Environmental education is expected to be able to produce knowledgeable and responsible citizens who are able to play an active role in all matters relating to the environment (Dynia et al., 2018; Jiang et al., 2017; Susilawati et al., 2020a). Therefore, effective environmental education plays a role in encouraging responsible citizenship behavior and environmental protection. This assumption is linear with Flanagan et al. (2019), who stated that the goals and strategies of teaching environmental education can strengthen the usefulness of environmental education to achieve learning goals, and inspire human environmental awareness.

As such, environmental awareness and encouraging public participation in environmental protection programs are essential to achieve environmental sustainability and to guide the environmental education goals from a social perspective. Therefore, the researchers conducted a micro-study on environmental awareness and the PSTs' soft skills. Researchers believe that PSTs will be agents and role models for promoting environmental awareness and environmental conservation efforts. Therefore, it is very important to properly understand students' environmental awareness and foster them, to strengthen their environmental competencies to overcome environmental problems (Chen et al., 2020). In this regard, it is important to fully understand the environmental awareness of prospective teachers and teach them why we need to protect the environment.

Environmental issues, especially pollution, are very appropriate to test environmental awareness through SSI-based learning and interpersonal interactions when developing PSTs' soft skills. In addition, when being taught, students are required to select reputable information in a structured manner from various data sources, in order to make decisions and conclusions as democratic citizens (Hilton & Canciello, 2018; Nurwidodo et al., 2020; Visintainer & Linn, 2015; Walters et al., 2018). At this point, improving their creative skills, problem-solving, environmental attitudes, and behavior are considered to be the main elements for increasing the soft skills and environmental awareness of preservice teachers.

This study investigates the impact of the learning process through SSI-based learning on the environmental awareness and soft skills of science teacher candidates. SSI-based learning raises the environmental problems in people's social life and is able to hone the students' sensitivity to the environmental problems that occur around them. In recent years, the restoration of science education around the world has encouraged students' understanding of science concepts and increased scientific literacy. Social awareness can be achieved by utilizing scientific concepts to solve real-world problems (Lester et al., 2006). The significance of science, in both personal and social contexts, is highlighted in the 2012 science education reform (National Research Council, 2012). Littledyke (2008) suggested that social awareness described how people socialize socially to influence individual choices. Soft skills are individual skills for communicating and interacting with the social environment; so that they are able to solve problems that are both individual and social. It is absolutely necessary to direct the goals of environmental education from a social perspective. It is clear from the above discussion that SSI-based instruction promotes the acquisition of soft skills and environmental awareness. This study was guided by the following research questions: Does SSI-based instruction affect an improvement in PSTs' soft skills? Does SSI-based instruction affect PSTs' environmental awareness? How do PSTs respond to learning activities through SSI-based learning?

Literature Review

Environmental Awareness

Environmental problems are very complex problems that must be addressed immediately. Various environmental problems that have a direct impact on society include the preservation of natural resources, pollution, and the prevention of environmental pollution. This environmental problem requires conscious efforts by the public, as well as caring educators, to be able to solve the problem. In this regard, it is important to fully understand the environmental awareness of prospective teachers and teach them why we need to protect the environment. Several studies have been conducted to explore environmental awareness through environmental education (Chen et al., 2020; Fu et al., 2018; Moseley et al., 2019; Nurwidodo et al., 2020).

Various community activities that ignore environmental sustainability raise concerns that must be addressed by environmental conservation educators. The rise of illegal logging activities, forest fires, factory fumes, and unmanaged factory waste have all caused various environmental problems that are very detrimental to the community. Waste products from large industrial plants and home industries that are disposed of without going through a waste treatment plant are an ongoing problem. These environmental problems require the attention of various parties to prevent widespread natural damage. Students, teachers, and prospective teachers need to realize the importance of protecting or preserving the environment. The knowledge they have will hopefully affect the deteriorating attitudes and behavior that people now show. The hope is that this group will become role models to influence other communities to preserve the environment (Nizaar et al., 2020).

According to environmental studies, it is widely agreed that environmental education is able to develop positive attitudes and an awareness of environmental problems, and can promote environmentally responsible behavior (Salequzzman & Stocker, 2001). According to Roth (1992), the development of an environmentally conscious and responsible citizen should be the main goal of environmental education. He distinguished four stages of environmental literacy: awareness, caring, understanding, and action. Likewise, Negev et al. (2008) described three categories of environmental literacy: knowledge (global studies, national issues, general ecological principles), attitudes (awareness, willingness to act, sensitivity to environmental problems and compassion for nature, sense of responsibility), and behavior (environmental, activism, consumption patterns, individual conservation, recreation involving nature). Environmental awareness has emerged as a major component of environmental literacy and the ultimate goal of environmental education (El-Batri et al., 2019; Nurwidodo et al., 2020; Saltan & Divarci, 2017).

Research conducted by Abbas and Singh (2014) revealed that students have high environmental awareness and positive attitudes toward the environment, but their level of participation in environmental protection activities is still low. This data implies that students are aware of the problems related to the environment, but this does not make them actively participate in environmental protection. The facts show that there are other factors that can stimulate students' environmental awareness of environmental conservation efforts. In-depth research is needed to further explore the factors that can encourage students' participation, and society's in general. Overall, this will support the successful achievement of the goals of environmental education (EE), so that environmental sustainability will also be maintained in the long term.

The result of a high level of concern for the environment has not been followed by active participation in environmental conservation activities (Abbas & Singh, 2014). This conclusion gave rise to recommendations for examining other factors that can affect environmental awareness. It is hoped that increased environmental awareness will be accompanied by an active role in environmental conservation efforts. Students are expected to stimulate self-development through awareness of their responsibilities for environmental problems (Chen et al., 2020; El-Batri et al., 2019). This study uses pollution problems as an important topic in environmental science to explore the interaction between environmental awareness and PSTs' soft skills. Learning through SSI-based learning, and raising the issue of

environmental pollution which is directly related to people's lives, is expected to increase the environmental awareness and soft skills of the PSTs.

Traditional teaching practices for environmental science focused primarily on memorizing the theory and facts, but usually neglected any practical experience (Barraza & Walford, 2002). This research is based on constructivist principles, which not only provide a coherent framework for learning, but also a context for understanding socially constructed problems and knowledge (Palmer & Suggate, 2004). This research is based on a social constructivist theoretical framework that encourages students to understand the problems of environmental pollution more deeply. Research into environmental education includes studies on environmental knowledge (Morgil et al., 2004), attitudes (Franzen, 2003; Hwang et al., 2000; Saltan & Divarci, 2017;), awareness (Pata & Metsalu, 2008; Sherburn & Devlin, 2004), behavior (Akitsu & Ishihara, 2018; Negev et al., 2008; Said et al., 2007), and the willingness to undertake pro-environmental action (Ambusaidi et al., 2012; Boyes & Stanisstreet, 2012; Chhokar et al., 2012; Kilinc et al., 2011).

Soft Skills

Noah and Aziz (2020) stated that soft skills are personal skills that support the ability of hard skills, so that they can improve work performance and relationships with other people. According to Fahimirad et al. (2019), soft skills are individual abilities that contribute to one's success in the world of work. The soft skills' components needed in the work environment consist of communication skills, problem-solving skills, creativity, critical thinking, leadership, lifelong learning, and social responsibility (Fahimirad et al., 2019; Irwanto et al., 2018; Saputro et al., 2019). Cimatti (2016) stated that soft skills are individual possession that contributes to producing greater outcomes. Noah and Aziz explained that personal skills are the ability to make critical judgments, undertake lifelong learning, and managing and planning to achieve goals. Interpersonal skills are related to relationships with other people that include problem-solving, decision making, communication, negotiating, and networking (Tsaoussi, 2020; Cimatti, 2016). In this research, the soft skills are defined as inter- and intrapersonal skills that are essential for preservice science teachers to interact with others, and for their own personal development in the teaching profession.

A collaborative study conducted at Harvard University and Stanford Research Institute found that, for the determinants of a person's success at work, 15% are influenced by their technical knowledge and skills, while the remaining 85% are influenced by their soft skills (Crosbie, 2005). This data showed that soft skills are a determining factor for a person's success at work. Especially in the current era of industrial revolution 4.0, various jobs, including the teaching profession, have become very competitive. The teaching profession involves relating to many people, both in teaching itself, or in collaborations with teachers and school administrators, and communicating with people outside of the schools with different cultural backgrounds (Gewertz, 2007). Therefore, in addition to their teaching skills, teachers also need skills that help them successfully carry out these roles (Attakorn et al., 2014). These skills are in the form of intra-personal and interpersonal skills, which are very important for those in the teaching profession.

Soft skills are one of the main components that teachers need to have in the 21st century (Kanokorn et al., 2014; Mathew & Reddy, 2018). To adapt to the current demands, prospective teachers need to be equipped with soft skills (Tang et al., 2015). Teachers need soft skills to answer various complex challenges that they will face in carrying out their professional duties (Tang, 2018). A teacher, in carrying out his/her role, is required to be able to understand the characteristics of the students and be able to apply various strategies for teaching, according to the characteristics of the students and the material being taught; possessing the necessary soft skills is the main requirement for teachers to overcome these problems (Susilawati et al., 2020b).

Methodology

Research Design

This study investigated the effect of SSI-based instruction on PSTs' soft skills and environmental awareness through environmental education courses. Learning activities employing SSI-based instruction were designed to develop environmental awareness and soft skills for designing solutions to prevent pollution. The quasi-experimental study was carried out using a pre- and posttest control group design. A study conducted by Dimitrov and Rumrill (2003) stated the pre- and posttest design was usually applied to compare the results of a treatment given toward one or more experimental groups, and then contrasted with one or more control groups that did not receive the treatment. The research consisted of one independent variable (i.e., SSI-based instruction) and two dependent variables (i.e., soft skills and environmental awareness). At the end of the sixth week of learning, the control group (direct instruction) were contrasted with the experimental group (SSI-based instruction) to see which instructional learning method had a significant effect on the PSTs' soft skills and environmental awareness.

Participants

The participants involved in this study were 83 PSTs (32 males and 51 females). The sample consisted of preservice science teachers from a university in Yogyakarta, Indonesia. The respondents were second-year students taking an environmental science course. The students who took the Environmental Science Course at the Department of Science

Education were separated into two groups, which were the control group and the experimental group. The control group consisted of 39 students who were taught with direct instruction and the experimental group consisted of 44 students who were taught using SSI-based instruction (see Table 1). This sample was obtained using a cluster random sampling method. This technique was applied because the population consisted of university clusters. Both groups had very similar characteristics and no one in either group had received SSI-based instruction before. The participants were taught by the same lecturer who had taught an environmental science course for eight years and had experience in SSI-based instruction.

Table 1. Description of participants

Gender	Control Group	Experimental Group	Total
Male	14	18	32
Female	25	26	51
Total	39	44	83

Research Instruments

Data were collected using a questionnaire and an observation sheet. The questionnaire was used to investigate the PST's soft skills acquired before and after instruction. The soft skills questionnaire was designed based on the soft skill instrument determined by MASS (the measuring and assessing of soft skills). MASS is an instrument that was developed and used by twenty European researchers to explore soft skills in five countries (Kechagias, 2011). MASS was developed the models' and soft skills' assessments to partner institutions in English, Greek, Dutch, Swedish, and Romanian. Based on that study (Kechagias, 2011), the researchers modified the questionnaire by using six sub-skills to discover the PSTs' soft skills. The sub-skills consisted of collaboration, problem-solving, communication, creativity, social interaction, and teamwork. These sub-skills were developed based on literature studies and reviews of previous studies. By adopting the scale from Tang, Nor et al. (2015) and Kanokorn et al. (2014), the researchers selected six sub-skills related to PSTs. Tang, Nor et al. (2015) stated that the soft skills needed for the teaching profession were teamwork, communication, problem-solving, and leadership. These skills are significantly related to the teaching profession. Research conducted by Tang (2018) on 163 college students and eight lecturers from an international college in Thailand concluded that teamwork and lifelong learning were the most important soft skills for students to achieve. Based on qualitative findings, this study described three important aspects for the acquisition of skills, namely: delivery of quality teaching, career enrichment, and management of student skills. Kanokorn et al. (2014) conducted a study into the development of soft skills for 110 novice teachers using a questionnaire. The results of the study concluded that there were 7 skills that needed to be developed. These skills were the development of innovation, communication, lifelong learning, problem-solving, leadership, ethics, and teamwork. The questionnaire was scored using a four-point Likert scale; strongly agree (4), agree (3), disagree (2), and strongly disagree (1).

To reinforce the result, the researchers employed an observation sheet for assessing PST's soft skills. The observation sheet was based on the rubric form. The sheet was a checklist with four category scores (4, 3, 2, and 1), the maximum score was four and the minimum was one. Each score was based on a rubric designed to assess the PSTs' soft skills. The class was divided into four heterogeneous groups and discussed the different topics during each meeting. The observers were four lecturers who observed the improvement in the six sub-skills during five meetings. An observer oversaw the discussion by each group.

In the learning activity, the observers observed the ability of the PSTs to collaborate in teams to solve problems, build social interaction for creative thinking, and communicate ideas for solid teamwork. For instance, for their collaborative skills category, by the observation sheet, the participants were studied for their ability to work together and to generate new ideas when doing group assignments. According to the problem-solving skills category, the participants were observed for their ability to identify problems, find procedures to solve them, and be able to determine the right solution.

To explore the PSTs' environmental awareness, we adapted the questionnaire from Fu et al. (2018). This environmental awareness questionnaire comprised of the preservice science teachers' attitudes, willingness to act, and behavior when addressing the problems of environmental pollution. By using a Likert scale each participant had to fill in 20 items. The Likert scale had four options: strongly agree, agree, disagree, and strongly disagree. The items included statements such as: "I use a bicycle or walk to school," "I will be an environmentalist," "I think sorting out the trash before throwing away is a waste of time." The instruments were constructed by researchers and validated using theoretical and empirical validities.

The feedback questionnaire was applied to investigate PSTs' satisfaction in their learning activities. The questionnaire was scored using a two-point scale with a score of "Yes" (1) or "No" (0). The questionnaire consisted of 8 items to explore PSTs responses on the implementation of SSI-based instruction in the experimental group and direct instruction in the control group. The PSTs response was investigated by 4 items related to the improvement of environmental awareness such as environmental attitudes, knowledge, and behaviors. The researchers also

investigated the PSTs' satisfaction toward teaching and learning processes in the soft skills improvement by employed 4 items related to communication, problem-solving, social interaction, and organizing information.

Related to the face and content validity, these questionnaires were validated by the instructional experts and senior lecturers from both universities. The experts were three professors of scientific learning and assessment, and two lecturers who had taught environmental education for more than ten years. All of the experts gave their approval, in verbal and written form, of the suitability of each item of the instrument.

The empirical validity was tested by a pilot study before the real study. The pilot test of the instrument was carried out with 20 preservice science teachers who had a similar background to the respondents in the survey. Those PSTs involved in the pilot study were excluded from the actual study. Revisions were made based on the suggestions and feedback given by these PSTs. It could be concluded from the pilot-study results that the instrument had high internal consistency. The Cronbach's alpha coefficient of the soft skills questionnaire was $\alpha = 0.84$, and the environmental awareness questionnaire was $\alpha = 0.86$. The coefficient of reliability for both questionnaires was above the acceptable limit of 0.70 (Hair et al., 2010); thus, both tests were considered reliable.

Data Collection

Before conducting the research, the researchers designed a research tool consisting of lesson plans, learning materials, student worksheets, and assessment instruments. Lectures on the topic of environmental pollution were carried out a total of six times, using SSI-based instruction. The sub-topics were natural resources, air pollution, soil pollution, water pollution, global warming, and environmental conservation. Before the instruction, the experimental group students were divided into four sub-groups. Using role-playing scenarios, each sub-group was asked to solve problems based on the role they played, namely as a government, industrial owners, NGOs' committees, and a community who feel the direct impact of pollution.

According to these roles, the participants had to collect information about various resources to get data about environmental problems, based on their role. Each sub-group had to support their solution with a scientific argument. The other sub-groups were asked to debate the solution if they did not agree with it. Differences in the interests of each role could lead to conflict. The emergence of conflicting interests required the students to present data and facts to support the statement they submitted. During the lectures, the PSTs were taught to solve problems using scientific methods. In the experimental class, they had to share ideas and communicate with a peer group to find a solution related to their role. The PSTs were asked to discuss the environmental problems, gather information from various sources, and design solutions to those problems collaboratively.

While in the control group, the PSTs were taught by direct instruction, which was the usual method used during lectures. At each meeting, the soft skills of both classes were observed using observation sheets by the observers, and peer assessment sheets by their peers. Environmental awareness data were obtained through a questionnaire filled out by the participants at the end of each meeting. At that point, improvements in their creative skills, problem-solving skills, environmental attitudes, and behavior were regarded as the primary elements to enhance the PSTs' soft skills and environmental awareness. Learning activities were carried out by the PSTs who discussed the problems arising from environmental pollution, their impacts, and how to design solutions for environmental conservation.

Data Analysis

The research applied descriptive statistics and quantitative methods (Creswell & Clark, 2010) to explore the effect of SSI-based instruction. The statistics consisted of the standard deviation, mean, maximum, and minimum scores which were employed to acquire the characteristics of the participants. The quantitative data analysis used non-parametric statistics. That particular analysis was utilized because the Kolmogorov-Smirnov test confirmed that the acquired data revealed a non-normal distribution ($p < 0.001$). The researchers applied the Wilcoxon Signed Rank Test to test whether there are significant differences between the pre- and posttest scores of the experimental and the control group.

Findings

At the beginning of each lecture, a pretest was carried out. Participants in both groups demonstrated similar soft skills. However, after receiving the treatment, the posttest scores showed a difference for the overall sub-skills.

Table 2. Descriptive data of the preservice science teachers' soft skills

Sub-Skills	Group	Pretest				Posttest			
		Mean	SD	Max	Min	Mean	SD	Max	Min
Overall Skills	Experimental	16.80	1.502	19	13	22.52	1.759	24	19
	Control	16.21	1.174	18	14	20.18	2.175	24	17
Collaborative	Experimental	2.86	0.510	4	2	3.75	0.488	4	2
	Control	2.77	0.427	3	2	3.31	0.521	4	2
Problem-solving	Experimental	2.59	0.497	3	2	3.70	0.462	4	3
	Control	2.44	0.502	3	2	3.28	0.510	4	2
Communication	Experimental	2.75	0.438	3	2	3.73	0.451	4	3
	Control	2.90	0.307	3	2	3.26	0.549	4	2
Creativity	Experimental	2.59	0.497	3	2	3.52	0.505	4	3
	Control	2.44	0.502	3	2	3.28	0.605	4	2
Social interaction	Experimental	2.77	0.424	3	2	3.89	0.321	4	3
	Control	2.67	0.478	3	2	3.62	0.493	4	3
Teamwork	Experimental	2.93	0.334	4	2	3.93	0.255	4	3
	Control	3.00	0.229	4	2	3.44	0.502	4	3

After being taught using SSI-based instruction, the experimental group experienced an increase in their ability from an average of 16.80 to 22.52 (an increase of 5.72). Meanwhile, the control group, after being taught by direct instruction, showed an increase in their soft skills scores which were relatively lower than the experimental group, as the average only increased from 16.21 to 20.18 (an increase of 3.97) (see Table 2).

Differing from the soft skills scores, the environmental awareness scores for the control group were found to be slightly higher than the score of the experimental group at the beginning of the class. While at the end of the meeting, the experimental group dominated the posttest scores for all the components of environmental awareness.

Table 3. Descriptive data of the preservice science teachers' environmental awareness

Components	Group	Pretest				Posttest			
		Mean	SD	Max	Min	Mean	SD	Max	Min
Overall	Experimental	54.64	3.043	63	49	70.09	4.153	79	62
	Control	55.05	3.026	63	46	65.26	3.905	75	59
Behavior	Experimental	17.57	1.620	21	14	23.98	1.607	28	20
	Control	17.26	1.251	19	13	22.00	1.638	26	19
Attitudes	Experimental	19.91	1.696	26	16	24.98	1.691	28	21
	Control	20.13	1.559	24	17	23.05	1.701	26	20
Willingness to act	Experimental	17.16	1.430	20	12	21.14	1.875	24	18
	Control	17.67	1.475	21	12	20.21	1.765	24	17

There was an improvement in the pretest and posttest scores from 54.64 to 70.09 (an increase of 15.45) and 55.05 to 65.26 (an increase of 10.21) for the experimental and control groups respectively. The data implied that the PSTs who were taught by SSI-based instruction had a greater improvement in their environmental awareness than those taught using direct instruction (see Table 3)

At the beginning of the lectures, the researchers had conducted a pretest to explore the initial ability of the PSTs before being given any treatment. To investigate whether there was a significant difference in pre- and posttest scores of soft skills between the experimental and the control groups, this study adopted a Wilcoxon signed-rank test non-parametric test. The Kolmogorov-Smirnov test confirmed that the obtained data showed a non-normal distribution ($p < 0.001$); therefore the non-parametric A Wilcoxon signed-rank test was used to compare the data from the post- and pretest of the experimental and control groups. The p-value < 0.05 was considered significant for the data's analysis.

Based on the results of the Wilcoxon signed-rank test, the asymp.sig (2-tailed) is obtained at 0.000 ($p < .05$). This result concluded there was a significant difference between the pretest and posttest scores. That means there was an effect of the application of SSI-based instructions to improve the soft skills of PSTs. Overall, Table 4 shows all of the PSTs in the experimental group had the post- higher than the pretest score (negative = 0). Although nobody had the post- lower than the pretest score, some of the PSTs showed the same score of post- and pretest in components of soft skills. Collaborative and problem-solving skills reflecting 6 PSTs had the same score in pretest and posttest. In accordance with communication and creativity that showed 3 PSTs had the same score, social interaction (ties = 5) and teamwork (ties = 1) showed the same score before and after treatment by SSI-based instruction.

Table 4. The pre- and posttest scores of preservice science teachers' soft skills in the experimental and control groups

Sub-skills	Rank of Experimental Group			Mean	Sig.
	Negative[a]	Positive[b]	Ties[c]		
Overall	0	44	0	22.5	0.000
Collaborative	0	38	6	19.5	0.000
Problem-solving	0	38	6	19.5	0.000
Communication	0	41	3	21.0	0.000
Creativity	0	41	3	21.0	0.000
Social Interaction	0	39	5	20.0	0.000
Teamwork	0	43	1	22.0	0.000
Rank of Control Group					
Overall	0	39	0	20.0	0.000
Collaborative	1	22	16	12.0	0.000
Problem-solving	1	29	9	15.5	0.000
Communication	2	16	21	9.5	0.001
Creativity	1	30	8	16.0	0.000
Social Interaction	2	23	14	13.0	0.000
Teamwork	1	18	20	10.0	0.000

a. Negative: Posttest < Pretest
b. Positive: Posttest > Pretest
c. Ties: Posttest = Pretest

According to the control group, the result showed a significant difference between pre- and posttest scores. Even though the overall posttest score is higher than the pretest score, the data revealed some of the PSTs had negative scores. That means the PSTs had posttest scores lower than the pretest. Collaborative skill revealed a PST had lower and 16 PSTs had the same score in both tests. Collaborative, problem-solving, creative, and teamwork skills showed a PST had a lower score of post- than pretest score. Communication and social interaction revealed 2 PSTs had a lower score as well. Based on the positive rank, the result indicated that not all PSTs in the control group had a higher score of posttest than pretest scores. Most of them had the same score of soft skills before and after instruction. Tabel 4 reflected most of PSTs had the same score in communication (ties = 21) and teamwork skills (ties = 20). This result reflected more PSTs do not show an increase in posttest scores compared to an increase. The same score of pre- and posttest also revealed in collaborative, problem-solving, creativity, and social interaction with ties 16, 9, 8, and 14 respectively.

After getting the treatment, the environmental awareness of PSTs revealed higher than before in the experimental group. A Wilcoxon signed-rank test showed a statistically significant difference in all components of environmental awareness. This result indicated the SSI-based instruction affected the improvement of environmental awareness. Table 5 shows all of the PSTs in the experimental group had a higher score of post- than pretest scores (negative = 0), except one of them showed the same score in both tests. The components of willingness and attitude revealed two PSTs had steady scores before and after treatment with SSI-based instruction. This result inline with the component of PSTs' behavior that showed the same score.

Table 5. The pre- and posttest scores of preservice science teachers' environmental awareness in the experimental and control groups

Components	Rank of Experimental Group			Mean	Sig.
	Negative[a]	Positive[b]	Ties[c]		
Overall	0	43	1	22.0	0.000
Behavior	0	43	1	22.0	0.000
Willingness	0	42	2	21.5	0.000
Attitude	0	42	2	21.5	0.000
Rank of Control Group					
Overall	0	39	0	20.0	0.000
Behavior	0	37	2	19.0	0.000
Willingness to act	0	32	7	16.5	0.000
Attitude	0	37	2	19.0	0.000

A Wilcoxon signed-rank test showed a statistically significant difference in the pre- and posttest scores of the control group. The data revealed most of PSTs had an improvement score in the posttest. The component of behavior and attitude showed 37 PSTs had the improvement score and 2 had a steady score. In addition, the 7 of PSTs revealed a steady score of willingness component before and after application.

According to the observation sheet, the observer in each sub-group collected the data based on the rubric form in the Likert scale. The data revealed the improvement of soft skills in the experimental is better than the control group. The result showed all sub-skills have a very high level in the experimental group. Social interaction and teamwork revealed the highest mean score (3.9). Collaborative (3.8), problem-solving (3.7), and communication (3.7) also revealed a very high level of soft skills. Contrastly, the control group showed a lower level than the experimental group had.

Tabel 6. The result of the observation sheet of soft skills in the experimental and control group

Sub-skills	Group	Frequency and Percentage										
		4	%	3	%	2	%	1	%	*N*	Mean	Level
Collaborative	Experimental	34	77.3	9	20.5	1	2.3	0	0	44	3.8	Very high
	Control	0	0	30	76.9	9	23.1	0	0	39	2.8	High
Problem-solving	Experimental	31	70.5	13	29.6	0	0	0	0	44	3.7	Very high
	Control	0	0	22	56.4	17	43.6	0	0	39	2.6	High
Communication	Experimental	32	72.7	12	27.3	0	0	0	0	44	3.7	Very high
	Control	0	0	35	89.7	4	10.3	0	0	39	2.9	High
Creativity	Experimental	23	52.3	21	47.7	0	0	0	0	44	3.5	Very high
	Control	0	0	17	43.6	22	56.4	0	0	39	2.4	Low
Social interaction	Experimental	39	88.6	5	11.4	0	0	0	0	44	3.9	Very high
	Control	4	10.3	34	42.0	1	2.6	0	0	39	3.1	High
Teamwork	Experimental	41	93.2	3	6.8	0	0	0	0	44	3.9	Very high
	Control	1	2.6	37	94.9	1	2.6	0	0	39	3.0	High

Mean 1.00 – 1.75: level –very low
Mean 1.76 – 2.50: level – low
Mean 2.51 – 3.25: level – high
Mean 3.26 – 4.00: level – very high

In contrast to the experimental group, not all sub-skills in the control group revealed a high score. Table 6 showed the creativity had a lower score than others. The sub-skills such as collaborative, problem-solving, communication, social interaction, and teamwork indicated a high level of soft skills based on the observation sheet. This data indicated in the control group that preservice science teachers had the improvement skill after taught by direct instruction.

To explore the last research question, the researchers applied a feedback questionnaire with a score of "Yes"(1) or "No"(0) to investigate PSTs' satisfaction with the implementation of SSI-based instruction in the experimental group and direct instruction in the control group. A descriptive statistic was calculated for the PSTs' satisfaction with the teaching and learning processes in the experimental and control groups.

Table 7. Preservice science teachers' Responses to Learning Activity

Items	Experimental Group (*n*=44)		Control Group (*n*=39)		*t*
	M	*SD*	*M*	*SD*	
1. The instruction is effective for developing environmental behavior	3.27	0.52	2.63	0.49	5.17***
2. The instruction makes it easier for students to understand information about the environment	3.61	0.50	2.63	0.49	8.01***
3. The instruction sharpens students' environmental attitudes	3.21	0.42	2.72	0.47	4.56***
4. Discussion of environmental problems with the instruction becomes easier and more interesting	3.45	0.51	2.44	0.51	8.12***
5. The implementation of the instruction effectively builds interactions between lecturers and students (social interaction is more intense)	3.30	0.53	2.75	0.44	4.57***
6. Learning through instruction is effective for developing students' problem-solving skills	3.45	0.51	2.63	0.49	6.70***
7. Discussion on environmental issues with the instruction hones the students' communication skills	3.33	0.60	2.47	0.51	6.30***
8. The instruction is effective for training students to organize information	3.27	0.57	2.47	0.67	5.20***

***$p < 0.001$

The feedback questionnaire used eight items to evaluate the improvement of environmental awareness and soft skills based on PSTs' perspective. The data revealed the mean score, standard deviation, and t value of the PSTs' perception (Table 7). Table 7 showed a significantly different response toward the implication of the instructions in both groups.

Most of the PSTs students in the experimental group who received SSI-based instruction showed a positive response toward the teaching and learning activities. Most of the PSTs considered that SSI-based instruction effectively improved their attitude, behavior, and knowledge. The implementation of SSI-based instruction also contributed to developing their communication skills, social interactions, problem-solving, and organizing information skills. Generally, the PSTs were satisfied with the learning activities used to magnify their environmental awareness and soft skills.

According to the control group, Table 7 reflects positive responses to the application of direct instruction in developing environmental awareness and soft skills. However, most of the students in the control group were not motivated by instruction. This fact is shown by the lower mean score in the control group than in the experimental group. The data show that there are significant differences in all items of the PSTs response to learning activities between the control group and the experimental group. These findings indicate that students believe that SSI-based instruction is effective in enhancing environmental awareness and soft skills.

Discussion

According to the first research question, the researchers were eager to investigate the effect of SSI-based instruction for improving PSTs' soft skills. The results of the data analysis using the Wilcoxon signed-rank test on the pre- and posttest scores showed significant differences between pre- and posttest of the soft skills and the environmental awareness scores. The PSTs that were taught using SSI-based instruction showed better posttest values than those who received direct instruction. This finding reflects that SSI-based instruction was more effective in improving the PSTs' soft skills than direct instruction was. It is assumed that the experimental group now has better soft skills than the control group because they built their skills by exploring problems with sub-skills such as problem-solving, collaboration, creative thinking, and communication. By implementing role play, each group was required to play its role by defending the opinions it chose and finding appropriate solutions to the problems raised in accordance with the characteristics of SSI-based instruction. This finding refers to a study by Sadler et al. (2017) which stated that SSI is a suitable choice for increasing the ability to argue and think critically. The PSTs are aware that social problems such as environmental pollution have different points of view, so arguments and reasoning are needed to strengthen any proposed solution. This may have stimulated them to improve their problem-solving skills and creativity. By discussing social issues, the PSTs developed their communication skills, collaboration, teamwork, and social interaction. To find a solution, the PSTs worked collaboratively, as a team, to find the data and facts that could support their problem-solving ideas. This finding is linear with suggestions from Sadler et al. (2017) that SSI is an appropriate context for involving students in discussions of social problems. Therefore, this activity sharpened the PSTs' soft skills for the better.

The PSTs fostered themselves to form and develop concepts during the discussions, accordingly they utilized social interactions correctly. SSI-based instruction is designed to encourage social interactions. The fact is that SSI-based teaching has increased student-teacher interactions. Pupils are guided to identify problems, as a result, they gain the ability to provide an analysis of their solution to the problems. Hence, the learning activity becomes more dynamic because each student tries to become involved in the learning activity. This truth is in agreement with Vitiello and Williford (2016) who pointed out that the discussion method was more impressive than a lecture. Discussions and reasoned arguments improve students' social skills, in terms of their collaboration, ethics, mutual respect, and communication. SSI-based instruction is able to advance their soft skills, which may simplify their comprehension of the content, processes, and context of science. This fact is in compliance with the statements of Vitiello and Williford (2016) about the good social skills of students who involve them in class and do good work. In line with this, SSI is considered to be a thoughtful tool to use when participating in societal discussions and constructing knowledge about social issues (Sadler et al., 2007). This fact reflects that SSI-based instruction emphasizes social skills in learning activities, to build interaction, and to comprehend scientific knowledge. Because the experimental group was directed to analyze social problems and link scientific knowledge to them, they were trained to connect with the soft skills' dimension in the SSI method of teaching. So, the experimental group was more enthusiastic than the control group.

The same thing is also seen in environmental awareness scores. The second research question was to investigate the effect of SSI-based instruction on increasing the environmental awareness of preservice science teachers. The results showed a significant increase in environmental awareness in the posttest scores of the experimental group, compared to the control group. This data proves that SSI-based instruction is effective for increasing environmental awareness.

The steps taken in SSI-based instruction could enhance environmental awareness. Discussion activities that talked about social issues such as air pollution, water pollution, global warming, and the exploitation of natural resources honed the PSTs' attitudes and concerns for the environment. The PSTs support the collection of data related to environmental emissions and improvements in finding solutions to this problem. Presentation of the facts and data about environmental damage opened the students' eyes to care and know about the current natural conditions. This fact is consistent with the statement of Karahan and Roehrig (2015) who believed discussions about environmental

issues are appropriate for exploring environmental awareness, and environmental education could be achieved by talking about the environmental issues (El-Batri et al., 2019; Nurwidodo et al., 2020). In this study, the PSTs' awareness was not only reflected by their attitude but also expressed by their behavior and willingness to act to take concrete actions to protect the environment. These results are consistent with the research of Karahan and Roehrig (2015) which stated that environmental education promotes environmental attitudes and behavior. This enhances the adoption of SSI-based instructions which can raise the environmental awareness of the PSTs.

Conclusion

Based on the results, it could be concluded that there were significant differences in the soft skills and environmental awareness of the PSTs in the experimental group taught by SSI-based instruction and the control group taught by direct instruction. The results of the data analysis revealed that SSI-based instruction had a significant effect on the PSTs' soft skills and environmental awareness. At the end of the course, the experimental group students dominated the posttest scores for all the soft skills and environmental awareness sub-skills. The PSTs who were taught using SSI-based instruction methods increased their soft skills and environmental awareness to a greater extent than those in the direct instruction (control) group did. The findings are beneficial, all the students in the experimental group showed excellent performance in solving problems during the course, discussion, and share ideas under SSI-based instruction. The participants were eager to engage in discussions about their role to find solutions to the problem. Through the role-playing and the conflicting interests created by their role, the preservice science teachers were supported to solve problems creatively, collaborate as a team to solve problems, communicate the problems' solutions accurately, and interact with each other to build solid teamwork.

Suggestions

According to the results, using SSI-based instruction methods enables students to improve their problem-solving skills, collaboration, communication, creativity, teamwork, and social interaction. These skills promoted preservice science teachers' soft skills properly. Similar trends are also found in their environmental awareness scores. Their attitude, behavior, and willingness to act after being taught using SSI-based instruction methods showed a significant improvement compared to the control group. This finding implies that SSI-based instruction needs to be made a priority in the teaching of science subjects at all levels of education, and especially during teacher training. These results provide an alternative method for lecturers to apply SSI-based instruction for promoting the soft skills and environmental awareness of preservice science teachers.

Limitations

Some limitations were experienced in this research. The design of the learning activities needs to be more structured, especially for the discussion and presentation steps. The steps challenged participants to foster their soft skills to become more skillful. The limited-time became the most challenging thing in this study. Time constraints meant that not all the PSTs had the opportunity to express their opinions during the class presentations. Because of time constraints, it was difficult for observers to observe all the participants' soft skills precisely. Time constraints also resulted in prevented the PSTs from nurturing each of the sub-skills properly. Hopefully, for future research, the length of time allocated can be a consideration for better results.

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