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Investigation gender difference towards science process skills (SPS) using problem based learning

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Abstract

Physics education students as prospective educators have the task of building student knowledge. This requires physics education students to master SPS because most physics lessons emphasize activity-centered material. The research conducted aims to analyze the level of mastery of SPS in the Melde practicum in terms of gender. This research involves practical activities by applying a problem-based learning model (PBL). This study uses total sampling with participants being first year physics education students class 2019/2020 consisting of 19 male students and 76 female students at Jambi University with sampling technique used is total sampling. The analytical technique used in this study is descriptive statistics with data collection assisted by observation sheets aimed at measuring students' SPS. The results showed that female students had better SPS than male students as indicated by the average score. These results indicate that girls tend to be more active in doing practicum, this tendency arises as a result of a strong curiosity fromthe students themselves

Keywords: Physics, SPS, problem based learning, melde practicum, gender

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1. Introduction

1.1 Conceptual and Teoritical Framework

The development of technology at the present time has made life limitless in all areas. Globalization and technology have changed the implementation of the education system which made present students can use technology and their creative thinking to answer various problems. (Noe et al., 2014; Turiman et al., 2012; Kamid et al, 2022). Thus, demands have an impact on teachers and prospective teachers as educators must be able to fulfill all those competence as teachers of the 21st-century in order to be able to teach student to improve students' knowledge, creativity, and problem-solving skill. In order to give students a good quality of learning, it requires teachers to have competencies and skills beyond literacy and numeracy known as 21st-century skills (Haviz et al., 2018; Kim et al., 2019; Kamid et al, 2022; Syahrial et al, 2022). Physics lessons as part of science took a big role in the development of advanced technology and harmonious concepts with the environment (Koul et al., 2012; Astalini et al., 2021; Ernawati et al, 2022). Therefore, an approach in teaching physics effectively and in accordance with the demands of the 21st-century needs to be considered.

Physics education students as prospective educators do not only need a capable attitude as teachers and know the concept of knowledge to be conveyed, but furthermore, students who take the field of education will certainly become examples and guidance for their students in the future (Darmaji et al., 2018). In an effort to become professional educators, provide good guidance and train to build students' knowledge (Pharis et al., 2018; Astalini et al.,2021). One of the competencies that can be developed to prepare prospective teachers in the 21st century is SPS (Yuliskurniawati et al., 2019). SPS must be applied by teachers to convey facts effectively because science is not only knowledge but also a process that can be learned using a constructivist approach through an SPS investigation (Karamustafaoğlu, 2011). SPS should be owned by prospective physics teachers otherwise students will tend to be more passive and cause students' independence in building themselves (Aydogdu, 2015; Darmaji et al., 2020; Ernawati et al, 2022).

Physical knowledge can be identified into two important aspects, namely process skills and material/content understanding. The concept knowledge consists of subject matter while the process consists of essential skills that need to be mastered by students (Gultepe, 2016; Wahyuni et al., 2017). Both are needed to be mastered by students in learning physics. SPS can help improve understanding in physics concept knowledge (Kamid et al., 2021). SPS is a knowledge of problem solving and understanding of knowledge by utilizing the understanding of scientific thinking and develop understand scientific concepts (Kızılaslan, 2019; Özgelen, 2012). The importance of this skill is that it can support the learning process through a real experience such as laboratory activities (Duda et al., 2019). In physics learning, laboratory activities or practicum are absolutely necessary because they are a forum for building knowledge through practicum activities to prove the correctness of the concept (Astalini et al., 2019; Muslim et al.,2021). Practicum can provide results that can foster creative thinking, defining events, and solving problems. Those skills to done practicum are summed up in SPS.

A scientific approach can be developed with a learning application model to optimize the empowerment of SPS. One of the teaching models to improving process skills in learning science is the Problem-Based Learning Model (PBL) becaus e it is a student-centered method that emphasizes the problem which is the starting point of the learning process (Susanti et al., 2017). In formulating a problem, a problem is the basis for directing the learning process in class questions which will later be developed into a process of finding answers to problems through scientific methods (Prasasti, 2016). This problem-solving process will be able to facilitate students to develop student process skills (Kenedi

et al., 2019). Based on this, in developing students' cognitive aspects and solving cases, researchers intend to combine practicum with PBL (Duda et al., 2019). It is possible for the practicum to understand a material concept using experiments or observations whose output is an increase in students' abilities in the domain of science; content knowledge, and process skills (Wiwin & Kustijono, 2018; Maison et al., 2020).

1.2 Related Research

There have been gender stereotyping among teachers where gender influenced the level of ability to learn science (Mutisya et al., 2013). The idea that male students are better than female students has been ingrained for a long time in teachers or educators though (Yuliskurniawati et al., 2019). Many studies have been conducted to find out whether men are superior to women in education. The SPS in this study were measured based on the results of the test scores. This is in line with the results of research (Yamtinah et al., 2017) that male students have a higher average score of SPS than female students as measured by the Testlet instrument. The data collection instrument is in the form of multiple-choice questions. There is also many research that showed gender had no effect on competence as explained by (Damyanov & Tsankov, 2018) that male and female students do not have SPS differences between each other.

There have been many studies that have taken SPS as the theme of their research. The research conducted also varies, starting from combining variables, models, and media as media to help measure students' cognitive, affective, and psychomotor skills. Research from Juhji & Nuangchalerm (2020) shows that students' process skills can be interacted with several variables, namely science attitudes and teacher abilities in managing the classroom. Zorlu & Zorlu (2017) have also conducted SPS research which in their research was carried out by comparing SPS with other variables. The same thing was also done by (Cakır, 2017) who also integrated SPS with student attitudes and learning outcomes. This shows that the SPS variable is very flexible and varied to be used as a research variable.

In addition to combining the variables, SPS can be added to several models in its implementation. In the research conducted by the author, the PBL model was chosen because it was considered suitable for the situation and conditions in the classroom. Previous research from Duda et al., (2019) also took the PBL model in the implementation of the practicum, but the difference lies in the differentiator where researchers use gender while they use ethnicity as a data discriminator. The same thing was also done by Serevina et al., (2018) who chose PBL as a model in the implementation of his practicum. As for the research of Tan et al., (2020) it is slightly different because it prefers the inquiry model as its practicum model. The difference in the selection of this model is certainly not a problem, because the way someone teaches practicum is different, causing the selection not only from the model or other aspects, which have different tendencies for each individual.

Then in terms of the differentiating variables, researchers prefer to use gender as the data distinguishing variable. Saban et al., (2019) in their research also chose gender as a differentiating factor. This is also in line with Amanso & Bassey (2017) who conducted research in Nigeria by paying attention to the gender of the sample used. Gender is not the only distinguishing variable that is often used. Research from Tilakaratne & Ekanayake (2019) shows that class differences can also distinguish the data obtained. The same thing was also stated by Tugluk (2020) who took more differences in each class. With the difference in the differentiating variables, it provides a diversity of data analyzed, if the researcher takes gender as the difference, it means that the discussion is deeper into the biological sample. Meanwhile, if you choose a class, then the discussion is more dominant to the situation and condition of the students in the class. The research also takes Melde law material in carrying out its

practicum where this research is different from previous research from Gunawan et al., (2019) which discussed several different concepts such as heat and fluid dynamics. Of course, the selection of melde law is very appropriate because most of these practicums are rarely carried out in high schools.

1.3 Purpose of The Study

Referring to the differences in existing research, the researcher decided to conduct a study to find out the differences in the level of mastery of SPS based on gender through PBL-based practicum activities. This research is conducted to know the level mastery SPS as a 21st centrury skills for prospective teacher based on gender. This study sought to answer these following question:

1. How is the level of mastery of SPS based on gender at physics education students?
2. How is the description of basic and integreted scince process skill of physics education student at Melde's practicum based on PBL?

2. Method and Material

2.1. Research Model

The type of research used by the author is quantitative research. According to Apuke (2017) quantitative research is research that uses data in the form of numbers as an analysis of a variable in an effort to answer several questions, namely what, who, how much, where, how, and when.

2.2. Participants

The study used a total sampling. This study used a sample of 95 students with details of 76 female students and 19 male students. The sample used is an active class of 2019/2020 physics education students who are actively doing practicum in the laboratory.

2.3. Data Collection

The data collection was carried out by observers who assess students' SPS while students were doing Melde's practicum based on PBL. In carry out the practicum students are using a practicum guide that has been arranged based on PBL in the procedure. To measure students' SPS, the researcher used the assessment instrument which explained in table 1. In this case, the observer is a laboratory assistant who is authorized to assess students' SPS by using the assessment instruments that have been provided by researcher.

Table 1 . Number of items on SPS indicators

SPS	Indicator	Item Number	Number of item
Basic	Observation	1,2,3,4,5,6,7	7
	Classifying	10,11	2
	Measuring	12,13,14,15	4
	Communicating	8,9	2
	Predicting	16	1
	Inferring	44,45,46,47,48,49	6
Integrated	Identifying variables	17, 18,19	3
	Compiling data table	20,21,22,23	4
	Making graph	24	1
	Describing realationship between variables	25,26,27	3
	Collecting and processing data	28,29,30	3

	Formulating hypotheses	31	1
	Analyzing an practicum	32,33	2
	Defining variables operationally	34,35,36	3
	Designing investigation	37,38	3
	Practicuming	39,40,41,42,43	5
Total			49

The observation sheet has 49 statement items consist of 16 indicators of SPS which can be seen in Table I. The observation sheet use four likert scales. Intervals for the SPS category can be seen in table below.

Table 2 . Category of students' SPS mastery

Interval	Category
1.00 – 1.75	Very Poor
1.76 – 2.50	Poor
2.51 – 3.25	Good
3.26 – 4.00	Excellent

2.4. Data Collection Process

This research was mostly conducted in the laboratory room of Jambi University. The first thing to do in this research is to do a practicum, then the observers collect data using an observation sheet. The data obtained were analyzed using SPSS, and then conclusions were drawn according to the research objectives.

2.5. Data Analysis

Reasercher used IBM SPSS Statistics 25 software for processing data. The data that has been collected then processed with descriptive statistics to make descriptions and to explain the data about the population under investigation, consisting of the mean, median, mode, frequency, and percentage of each indicator of SPS between female students and male students. The interval used refers to the average value of each SPS indicator.

3. Result

After doing the practicum and collecting data, the researcher then analyzed the data that had been obtained. For the results of students' mastery of SPS can be seen in table below.

Table 3. The result of students' mastery of SPS

Gender	Mean	Median	Modus	Std. Deviation	N
Female	3.35	3.38	3.31	.21942	76
Male	3.32	3.44	3.44	.27024	19

Based on the results of the data processing presented in table 3 which shows the results of the assessment of SPS between female and male students in the Jambi University physics education study program. From the data that has been processed, it is known that female students get an average score of 3.35, median 3.38, mode 3.31, and standard deviation of 0.21942. This result is not much different from that of male students, with an average of 3.32, median of 3.44, mode of 3.44, and standard deviation of 0.27024. Based on the data obtained above, it can be seen that there is no big difference in the mastery of SPS between female and male students.The following tables are a profile of the mastery

of SPS of female and male physics education students in conducting Melde's practicums. This is viewed from the 16 indicators of student SPS. Furthermore, the basic SPS description can be seen in table 4.

Table 4. Description of students' basic SPS

Indicator	Gender	Statistic Description			
		Mean	Me	Mo	Category
Observation	F	3.67	4.00	4.00	Excellent
	M	3.68	4.00	4.00	Excellent
Classifying	F	3.26	3.00	4.00	Excellent
	M	3.11	4.00	3.00	Good
Measuring	F	2.30	2.00	2.00	Poor
	M	3.20	4.00	3.00	Good
Communicating	F	3.54	4.00	4.00	Excellent
	M	3.68	4.00	4.00	Excellent
Predicting	F	2.68	3.00	3.00	Good
	M	3.00	3.00	3.00	Good
Inferring	F	3.63	4.00	4.00	Excellent
	M	3.58	4.00	4.00	Excellent

As table 4 above showed there seem differences in the mastery of SPS on several indicators of SPS. Female students have basic SPS that are in the excellent, good, and poor categories. The male students have basic SPS which are in the excellent and good categories. Indicators of SPS that are mastered very well by female students and male students are indicators of observation, communicating, and inferring which are indicated by the results of the assessment being in the excellent category. Meanwhile, the good category by female students and male students is a predicting indicator. The difference in the mastery of SPS between male and female students can be seen in the classifying indicator where female students are in the excellent category while male students are in a good category. It also happened in indicator measuring where female students are in the poor category while male students are in a good category. Based on the results of this measurement, it can be concluded that the basic SPS of male students are better than female students. Furthermore, the integrated SPS description can be seen in table 5.

Table 5. Description of students' integrated SPS

Indicator	Gender	Statistic Description			
		Mean	Me	Mo	Category
Identifying variables	F	2.35	2.00	2.00	Poor
	M	2.10	2.00	2.00	Poor
Compiling data table	F	3.09	3.00	3.00	Good
	M	2.50	2.00	2.00	Poor
Making graph	F	3.65	3.00	3.00	Good
	M	2.53	3.00	2.00	Good
Describing relationship between variables	F	3.12	3.00	3.00	Good
	M	1.86	2.00	2.00	Poor
Collecting and processing data	F	3.39	4.00	4.00	Excellent

	M	3.00	4.00	4.00	Good
Formulating hypotheses	F	2.88	3.00	4.00	Good
	M	3.05	3.00	3.00	Good
Analyzing an practicum	F	3.11	3.00	3.00	Good
	M	3.05	3.00	3.00	Good
Defining variables operationally	F	2.50	2.00	2.00	Poor
	M	3.57	4.00	4.00	Excellent
Designing investigation	F	3.68	4.00	4.00	Excellent
	M	3.94	4.00	4.00	Excellent
Practicuming	F	3.68	4.00	4.00	Excellent
	M	3.47	4.00	4.00	Excellent

Based on Table 5, it obtained that female students have integrated SPS that are in the excellent, good, and poor categories. Female students have integrated SPS that are in the excellent, good, and poor categories. The indicator for SPS which was mastered very well by male students and male students was indicator designing investigation and practicuming which was indicated by the results of the assessment being in the excellent category. Meanwhile, the good category by female students and male students is indicator making graph, formulating hypotheses, and analyzing an practicum. Meanwhile, the poor category by female students and male students is an indicator identifying variable.

The difference in the mastery of SPS between male and female students appears in the compiling data table indicator and describing the relationship between variables where female students are in a good category while male students are in the poor category. Next is the defining variable operationally indicator where female students are in the poor category while male students are in the excellent category. Next is the collecting and processing data indicator where female students are in the excellent category while male students are in a good category. Based on the results of this measurement, it can be concluded that the integrated SPS of female students are better than male students. Then the percentage of student SPS for each indicator can be seen in table 6.

Table 6. Percentage of students' mastery of SPS indicators

Indicator	Category							
	Very Poor		Poor (%)		Good (%)		Excellent(%)	
	F	M	F	M	F	M	F	M
Observation	0%	0%	5.3%	10.5%	22.4%	10.5%	72.4%	78.9%
Classifying	2.6%	0%	14.5%	31.6%	36.8%	26.3%	46.1%	42.1%
Measuring	6.6%	0%	52.6%	15.8%	38.2%	57. 9%	2.6%	26.3%
Predicting	5.3%	0%	31.6%	10.5%	52.6%	78. 9%	10.5%	10.5%
Communicating	0%	0%	7. 9%	5.3%	30.3%	21.2%	61.8%	73.7%
Inferring	0%	0%	2.6%	5.3%	31.6%	31.6%	65.8%	63.2%
Identifying variables	13.2%	15.8%	51.3%	47.4%	23.6%	36.8%	11.8%	0%
Compiling data table	1.3%	15.8%	27.6%	47.4%	31.6%	31.6%	39.5%	5.3%
Making graphs	0%	15.8%	34.2%	42.1%	53. 9%	31.6%	11.8%	10.5%
Collecting and processing data	1.3%	5.3%	14.5%	26.3%	27.6%	31.6%	56.6%	36.8%
Describing Relationship Between Variables	2.6%	0%	15.8%	63.2%	48.7%	26.3%	32. 9%	10.5%

Defining Variables Operationally	17.1%	0%	42.1%	10.5%	30.3%	42.1%	10.5%	47.4%
Formulating Hypotheses	6.6%	5.3%	31.6%	21.1%	28. 9%	36.8%	32. 9%	36.8%
Analyzing practicum	2.6%	5.3%	15.8%	15.8%	50%	47.4%	31.6%	31.6%
Designing investigation	0%	0%	5.3%	0%	21.1%	5.3%	73.7%	94.7%
Practicuming	0%	0%	6.6%	15.8%	18.4%	21.1%	75%	63.2%

The table above describes the percentage of mastery of SPS in each indicator. The table describes the percentage of each level of mastery which has four levels, namely very poor, poor, good, and excellent. Based on the table above, it can be seen that most of the students are in good and excellent level. However, on several indicators of integrated SPS, there are still some indicators that are in a very poor and poor level of mastery.

4. Discussion

SPS are one of the competencies that physics education students must possess as prospective teachers. SPS are a competency that must be owned by students of physics education because physics is a scientific study that requires observation and investigation in order to test or obtain a law, concept, principle, or theory (Darmaji et al., 2019). Students as candidate physics teachers or educators who not only teach, but also train, foster, and student guide. This requires students to master SPS because most of the physics taught emphasizes activity-centered material. SPS are very useful to be able to find the concepts learned by participating in conducting laboratory experiments. SPS generally has two types, namely basic and integrated which has 16 indicators in total.

Previous study show there was different level of mastery between female and male students on SPS. As it show in research which conducted by (Abungu et al., 2014) that male students have a higher average value of SPS than female students. The SPS in this study were measured based on the results of the test scores. This study has the same results as previous research from (Yamtinah et al., 2017) that male students have a higher average score of SPS than female students as measured by the Testlet instrument. These result contradict with the research by (Hamdani, 2017) which shows that female have a better science process skill score than male students. Referring to the differences in existing research, the researcher decided to conduct a study to find out the differences in the level of mastery of SPS. The students' SPS are measured when students do practical activities. This is based on (Duda et al., 2019) that practicum activities have an important role in developing SPS.

The description of SPS of physics education students at Jambi University is shown in Table 3. It is describe that both male and female students has different level of mastering SPS. Female students was only slightly had a higher average score for SPS than male students. These results are in line with research conducted by (Beaumont-Walters & Soyibo, 2010) and (Yuliskurniawati et al., 2019) that female have better SPS than male because female students are more careful in acting, especially when doing practicum than male, and also female have a more perfectionist nature than male, it can be seen that emale often check what they are doing. Quoted from the research results of (Yamtinah et al., 2017) that female are better on concept understanding and interpretation data. Female students have a relatively high level of science and good science laboratory participation that make them performed well in group (Cahyanto et al., 2019). However, achievement in education should not be determined by gender but by talent and efforts. Other studies suggest that it is very difficult to find a general description of influence individual perceptions or behavioral or cognitive differences (Kristyasari et al., 2018). Both girls and boys should receive equal treatment, equal attention and equal opportunity to learn since each of them has

different learning styles (Sahin, 2014). Achievements in education should not be determined by gender but by talent and efforts (Sonnert & Fox, 2012; Kurniawan et al, 2022).

Science Process Skill (SPS) contains two aspects of skills, namely cognitive skills and sensory-motor skills as intellectual skills and basic knowledge behind the mastery of SPS (Aydogdu, 2015). One of the activities that can support process skills is to do practicum (Lee & Sulaiman, 2018; Liew et al., 2019). Thus practicum is essential in learning science so that everything related to its implementation is important to pay attention to, one of which is the selection of the model used. In this study, practicum activities for Melde's practicum were carried out base on PBL model. The model that is suitable for use in practicum is certainly a learning model that emphasizes training in the learning process through skills, one of these implementations can be seen in the PBL-based practicum (Sakir & Kim, 2020).

From table 4, table 5 and table 6, it can be concluded that physics education students are already in the good category in mastering SPS at Melde's practicum using the PBL model. It was indicated by 11 out of 16 SPS indicators that were in the good and excellent category. The indicators of SPS that are in the poor category are measuring, identifying variables, compiling data tables, describing the relationship between variables, and defining variables operationally. Several factors made students have undeveloped skills at those indicators. The reason for the undeveloped measuring skills is because students doing practicums in groups so that only a few students have the opportunity to take measurements due to limited tools. The lack of laboratory infrastructure can affect the student's experience. The lack of measuring skills affected students' defining variable operationally skills (Sujarwanto & Putra, 2018; Asrial, Maison & Perdana, 2022). In this study, students were still unable to determine the variables because they were not used to them. This is partly due to the fact that the practicum manual used does not require carrying out this stage. The factor of students has undeveloped identification variables skills is also because of the traditional teaching that is still used by the teacher (Kalemkuş et al., 2016).

The importance of SPS for physics education students where they are trained and trained to become a teacher is that later the students they teach will be directly involved in a practicum. SPS must be utilized by teachers in effectively teaching science. Teachers need to make use of more interactive approaches that actively involve learners in the teaching and learning process (Zulkarnaen et al., 2018). The teacher plays an important role as a facilitator so that they must be able to direct and assist students to find important information so that students are able to understand the material being taught properly (Ahied & Ekapti, 2020). Physics education students as prospective teachers or professional educators or teachers have the task of increasing their knowledge, guidance, and skills training. This requires students to master SPS because most of the physics taught emphasizes activity-centered material.

The implications of this research can be divided into for students, for observers, and for teachers or lecturers. For students, this can significantly improve their expertise or skills in conducting practicals. In the short term, learning to use practicum to measure student SPS is expected to make it easier for students to understand some abstract and imaginative material. In the long term, students in this case as prospective physics teachers certainly need these skills in teaching in the classroom (Kramer et al., 2018; Harahap et al., 2019). Learning should not only dwell on one method, but there must be variations so that learning in class is not boring. For observers themselves, this is very useful to train how to do good and correct research, especially in practicum. In addition, by observing the sample, the observer indirectly trains to assess individuals who will later be useful as a teacher (Kruea-In et al., 2015). Then for teachers or lecturers, this is very important to do because it can be a benchmark for how effective learning is, if learning is considered ineffective then an in-depth evaluation is needed.

5. Conclusion

The level of mastery of SPS in Melde practicum based on PBL, it was found that female students showed better SPS than male students. Female students performed better in interpreting the data while male students performed better in measuring. The profile of mastery of SPS in Melde's practicum vary considerably. Overall, students have a good level at mastery SPS, but there are still some indicators that are still underdeveloped. This implies that the importance of teaching physics is not only focused on theoretical explanations but also emphasizes practicumal activities in which it can improve the ability of SPS. Developing and/or using practice guides which arranged based on SPS might improve students' abilities. The results of this study have limitations due to the availability of uncontrollable factors which caused by practicum activities that held in groups so that several factors can affect the measurement such as student participation in groups or equal opportunities for each group member in carrying out practicum. These factors might be considered for further investigation.

6. Recommendation

This research basically only looks at students' SPS abilities using a problem based learning model. This research can be developed and varied again by changing or adding other research variables such as cognitive and affective variables. In addition, the author also suggests adding pretest and post-test questions so that the effectiveness of the model used in practice can be seen. The analysis of the data used is only limited to descriptive statistics so that for further research it is recommended to add the hypothesis test as well

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