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Profile of Science Inquiry Literacy (SIL) achievements of pre-service physics teacher using rasch model measurements

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ABSTRAK

Pre-service physics teachers must have Scientific Inquiry Literacy (SIL) to prepare to teach physics. This research aims to describe the SIL profile of Pre-service physics teachers using the Rasch model. The mixed method with Convergent Parallel Design was chosen for this research. The mean value of the knowledge aspect is 6.1 (the top score is 35). Person measures -1.96, person separation 0.45, and person reliability 0.17. This condition shows that the consistency of the answers is still low, and the ability is low. The mean value, person measure, and separation of the skill aspect are 10.8 (the top score is 39), -1.10, and 0.00. This condition shows low ability and low diversity. The mean value for the attitude aspect is 79.5 (the top score is 108). Person size, separation, and reliability are 1.33, 2.01, and 0.8. This condition indicates a high ease of agreement on items with a wide variety and a good consistency of answers. The interviews and lesson plan analysis results show that pre-service physics teachers have yet to become accustomed to applying scientific inquiry in learning. Thus, the SIL in the knowledge and skills aspects of and the ability to design inquiry teaching still needs to be improved.

Keywords: Attitude, knowledge, pre-service physics teachers, scientific inquiry literacy, skills.

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INTRODUCTION

Physics learning adopts the scientist's way of discovering concepts through inquiry activities in learning (Georgiou et al., 2021; Kurniawan et al., 2021). Inquiry learning activities are oriented towards providing learning outcomes, which consist of three aspects, namely knowledge, skills, and attitudes (Spernes & Afdal, 2023; Juhji & Nuangchalerm, 2020; Roll et al., 2018). Various components are needed to support the inquiry learning process, including teachers, facilities, time, media, and students (Gandolfi et al., 2023; AlMamun et al., 2020; Wen et al., 2020). Physics teachers need to be prepared to have good Scientific Inquiry Literacy (SIL) to support inquiry abilities so they can teach physics following the goals of science education (Schwartz et al., 2023; Yusmanila & Zaturrahmi, 2020).

Physics teachers with good Scientific Inquiry Literacy (SIL) do not only have a role as teachers tasked with delivering physics material (Krasnova & Shurygin, 2020). However, teachers will help students discover physics concepts and principles (Darman, 2021; Fox et al., 2020; Septiyanto & Darman, 2018). Physics teachers will also motivate students to study physics according to the scientific paradigm (Guntara et al., 2023; Azhar & Chusnana, 2022). Apart from that, physics teachers will be catalysts who help students optimize their potential in inquiry activities (Abaniel, 2021). Physics teachers with good SIL are born with others (Zhu et al., 2023). Various efforts need to be made to prepare pre-service physics teachers through teacher education at LPTK, one of which is physics teachers through the physics education study program (Astuti et al., 2020).

Physics education study programs must prepare lecture programs that practice scientific inquiry in learning (Etkina et al., 2020). This condition will positively impact the SIL abilities of pre-service physics teachers (Christian et al., 2021). These efforts are needed by pre-service physics teachers who will teach physics according to its essence (Bao & Koenig, 2019). So that students can understand the nature of science through scientific inquiry as a provision in life to solve problems found. Based on the description above, SIL is essential for prospective physics teachers, including learning outcomes of knowledge, skills, and attitudes. Thus, research is needed to reveal the profile of SIL and how it is given to pre-service physics teachers in learning to prepare supporting efforts to train pre-service physics teachers' SIL. One measurement model that can be used in this case is the Rasch model measurements (Planinic et al., 2019). Rasch model measurements can better describe a person's condition and measurements than classical test theory (Zoechling et al., 2022). Based on the background of the abovementioned problem, this research aims to describe the profile of science inquiry literacy mastery of pre-service physics teachers using Rasch model measurements. The following guiding questions were formed: 1. What is the SIL profile of pre-service physics teachers in the knowledge aspect? 2. What is the SIL profile of pre-service physics teachers regarding skills? 3. What is the SIL profile of pre-service physics teachers in the attitude aspect? and 4. What is the ability of pre-service physics teachers to apply scientific inquiry in learning?

RESEARCH METHODS

The research used in this research is mixed methods research with the Convergent Parallel Design (Granikov, Hong, Crist, & Pluye, 2020). This design is used because researchers conduct quantitative and qualitative research simultaneously or in the same phase (Çilekrenkli & Kaya, 2023). Quantitative and qualitative methods are equal and independent in data collection and analysis (Christian et al., 2021). After all the data has been collected, the result mixes the data at the comprehensive interpretation stage. The research design is shown in Figure 2.1.

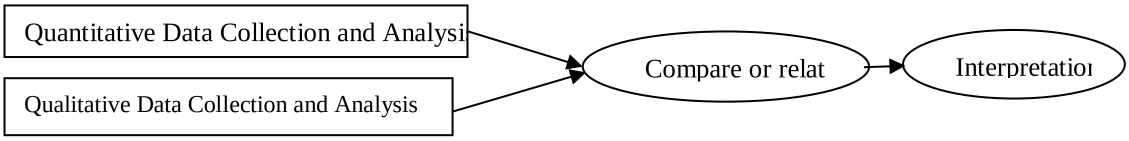

Figure 2. Convergent parallel design

This research was conducted at one of the LPTK in Banten around the end of 2022 to the beginning of 2023. The population in this research were pre-service physics teachers and lecturers at one of the LPTK in Banten, with a sample of 46 pre-service physics teachers and three lecturers. The data collection documents were the pre-service physics teacher's lesson plans. Qualitative research was conducted using interviews of lecture and pre-service physics teacher about their lesson plans. The results of interviews are used to complement the quantitative data obtained. Quantitative research in the form of a written SIL test developed based on ScInqLiT (Wenning, 2007), VOSI (Schwartz et al., 2008), and VASI (Lederman et al., 2014), namely SILI (Darman et al., 2024). SILI consists of 35 multiple-choice questions on knowledge aspects, 39 multiple-choice questions on skills aspects, and 27 questions on attitude aspects using a four-choice Likert scale. The written test results of pre-service physics teachers are processed using the Rasch model using the Winstep 5.4.1 application. The SIL profile of pre-service physics teachers in the Rasch model is depicted on the Wright Map. Wright Map depicts the distribution of pre-service physics teachers' abilities relative to the questions' difficulty level.

Additionally, Wright Maps displays the symbols M, S, and T on both sides of the vertical line. The symbol M indicates the average, S marks the standard deviation at the top and bottom of M, and T marks the two standard deviations at the top and bottom of M (Boone & Staver, 2020). The criteria for accepting a person in the Rasch model are if the outfit Mean Square (MNSQ) value is between 0.5 to 1.5, the ZSTD value received is between −2.0 and + 2.0, and the Pt Mean Corr value received is between 0.4 to 0.85 (Boone et al., 2014).

RESULTS AND DISCUSSION

The SIL test results of pre-service physics teachers were analyzed using a Rasch model measurement using the Winsteps application version 5.4.1 to see pre-service physics teachers' abilities in three aspects of SIL, namely Knowledge Aspects (KA), Skills Aspects (AS), and Attitude Aspects (AA). The mean SIL value in the knowledge aspect is 6.1 (maximum value of 35), the skills aspect is 10.8 (maximum value of 39), and the attitude aspect is 79.5 (maximum value of 108). The percent measure in the knowledge and skills aspect is (-1.96 and -1.10), meaning that the person's ability to answer questions on the instrument is low. Person reliability, separation, person measure, infit, and MNSQ are presented in Table 1.

Table 1. Reliability, separation, person measure, infit dan outfit MNSQ

No	Aspect of SIL	Mean Person	Person measure	Reliability		Infit MNSQ		Outfit MNSQ		Separation	
				Person	Item	Person	Item	Person	Item	Person	Item
1	KA	6.1	-1.96	0.17	0.74	1.00	1.00	0.98	0.98	0.45	1.68
2	AS	10.8	-1.10	0.00	0.76	1.00	1.00	1.00	1.00	0.00	1.78
3	AA	79.5	1.33	0.8	0.96	1.01	0.96	0.99	0.99	2.01	4.78

Based on Table 1. Person separation in the knowledge and skills aspect is 0.45 and 0.00, which means that person diversity is low, while in the attitude aspect, the separation is 2.01, which shows that people are diverse in this aspect. The person reliability values for the knowledge and skills aspects are 0.17 and 0.00, while item reliability is 0.74 and 0.76. This condition shows that the consistency of personal answers is still low while the quality of the items is quite good. The infit and outfit MNSQ person and item values are almost close to the ideal value according to the Rasch model, namely 1. The interaction of person and items is depicted as a Wright map person-item on a distribution map (Hikmah et al.,2021). The interaction of pre-service physics teachers' responses to SIL items is shown in Figure 1 for the knowledge aspect, Figure 2 for the skills aspect, and Figure 3 for the attitude aspect. The responses of the pre-service physics teachers consist of code "P" for females and code "L" for males.

Figure 1. shows that the mean of the knowledge aspect items is on two scale lines above 0, while the mean person is -2 with 14 scale lines below 0, which means that pre-service physics teachers' ability to answer knowledge SIL questions has a much higher average logit value lower than logit items. The logit ruler shows that N14, N33, and N34 are the most difficult items; they answered them incorrectly. Furthermore, N21, N6, and N4 did not appear to have pre-service physics teachers who could answer because of the small frequency. The item around

M on the logit ruler is N24, which is the item that determines which they have high and low abilities. On the logit ruler, there are no pre-service physics teachers whose positions are around M, either suitable at M or the logit closest to M. This shows that pre-service physics teachers have the same ability, namely having low ability in the knowledge aspect. On the Wright maps are two pre-service physics teachers, 46L and 24P, whose positions are outside T. Then, the logit value for both is the smallest, so the SIL knowledge aspect of these two pre-service physics teachers is the lowest. Generally, pre-service physics teachers are around -0.5 to -3 on the logit rule.

Figure 2. shows that the mean skill aspect item is at measure 0, correct with M items. Meanwhile, the mean person is one scale line below -1 or 12 scale lines below 0, which means that the pre-service physics teacher's ability to answer SIL questions for the skills aspect has an average logit value much lower than the item logit. The logit ruler shows that the three most difficult questions, namely N3, N28, and N23, do not have a partner in the person section because the frequency of pre-service physics teachers who answer these questions correctly is minimal.

Then N13, N29, N36, and N6, the next most difficult, also do not see anyone occupying the same logit because the frequency of pre-service physics teachers who answered the question correctly is tiny. The items around M on the logit ruler are N17 and N37 (closest to M from the bottom of the Wright Maps) and N10, N19, N26, and N30 (closest to M from the bottom of the Wright Maps), which are items that determine which pre-service physics teacher have high and low abilities. On the logit ruler, it is not visible that the position of pre-service physics teacher is around M. This shows that pre-service physics teachers have the same ability, namely having low ability in the skills aspect. On the Wright maps, there is one pre-service physics teacher, 13P, whose position is outside T (standard deviation limit). Then, the pre-service physics teacher's logit value is the smallest, so the SIL skill aspect is the lowest. Generally, pre-service physics teachers are around -0.5 to -2 on the logit rule.

Figure 3. shows the mean value of SIL items in the attitude aspect at measure value 0. The mean person position is on two scale lines above measure value 1, which means that the average SIL for the attitude aspect of pre-service physics teachers is higher than the difficulty of agreeing with the SIL items. Based on the logit rule, the best items for determining ability are around M, namely questions N3 and N27, to select a pre-service physics teacher with a high attitude aspect SIL and a pre-service physics teacher with a low attitude aspect SIL.

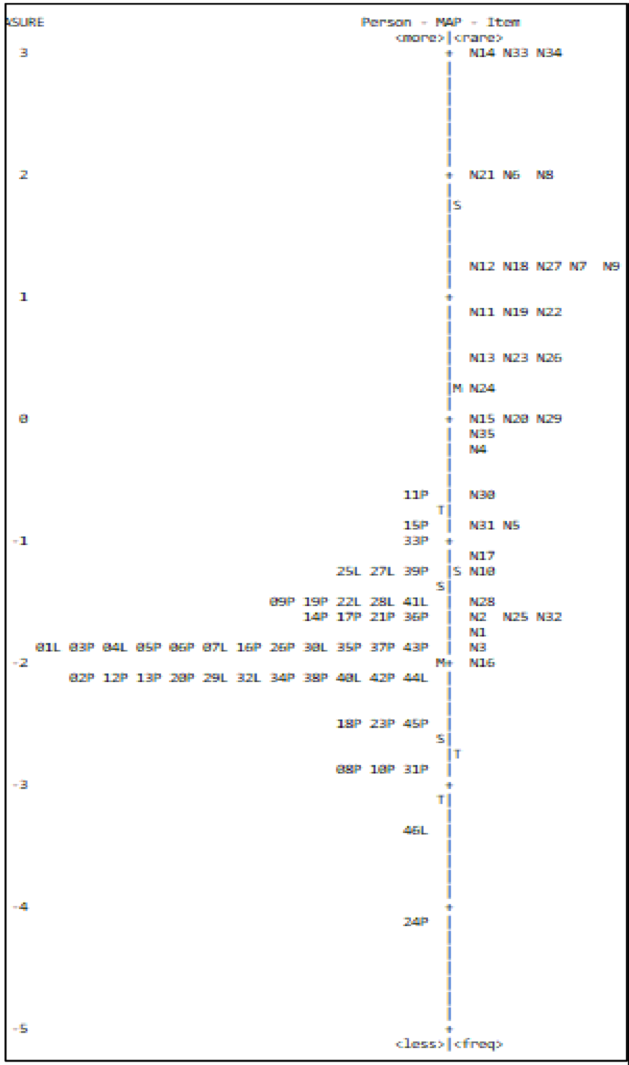

Figure 1. Wrigh maps aspects of knowledge

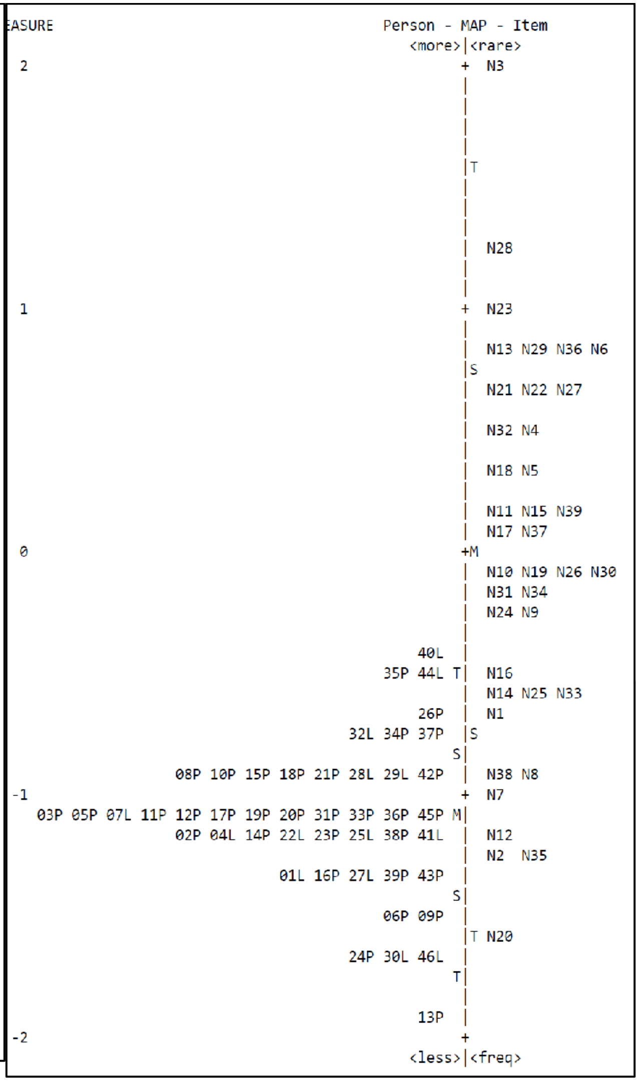

Figure 2. Wrigh maps aspects of skills

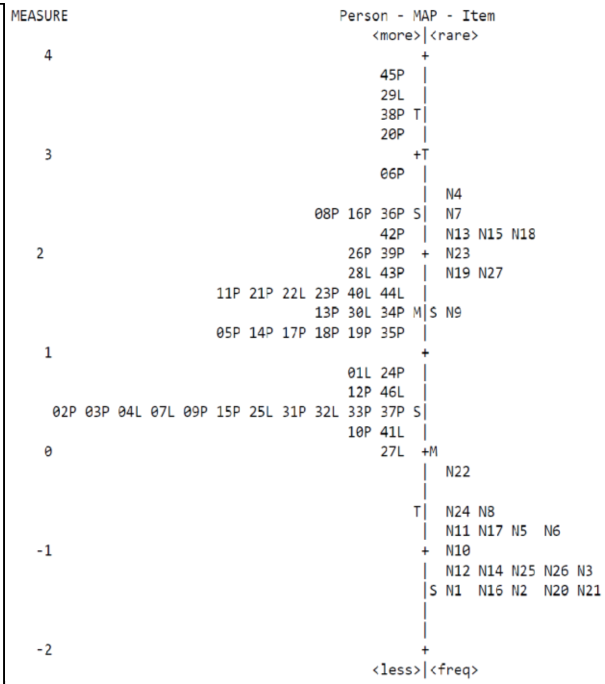

Figure 3. Wright maps attitude aspects

On the Wright Maps, there are no pre-service physics teachers whose position is outside T (standard deviation limit), so the SIL aspect of the skills of pre-service physics teachers is good. On the logit rule, generally, a pre-service physics teacher is at a measure of around 0 to 4. The SIL's response consists of Knowledge Aspects (KA), Skills Aspects (AS), and Attitude Aspects (AA), which are presented in detail in Table 2. The level of individual suitability or person fit of pre-service physics teachers is checked using criteria 1) If the MNSQ value is 0.5 to 1; 2) Z-standard or ZSTD outfit has a value between -2 to 2 and 3) Point measure correlation Pt Mean Corr is between 0.4 and 0.85 (Boone et al., 2014). If a person does not meet the three criteria above, then the person is declared miss fit. Based on Table 2. The person who has the highest score on each aspect of SIL varies. In the knowledge aspect, the person with the highest total score is the 11P pre-service physics teacher, with a total score of 12; the 15P pre-service physics teacher, with a total score of 11; and the 33P pre-service physics teacher, with a total score of 10.

Table 2. JMLE Measure, outfit MNSQ, outfit ZSTD, and PT Measure-Corr person

Person	TOTAL SCORE			JMLE MEASURE			Outfit MNSQ			Outfit ZSTD			PT Measure-Corr		
	KA	SA	AA	KA	SA	AA	KA	SA	AA	KA	SA	AA	KA	SA	AA
01L	6	9	75	-1.90	-1.35	0.71	0.38	0.77	0.46	-1.21	-0.72	-1.88	0.60	0.49	0.80
02P	5	10	72	-2.16	-1.20	0.31	2.36	1.11	0.04	1.68	0.47	-5.55	0.34	0.18	0.97
03P	6	11	72	-1.90	-1.05	0.31	0.88	0.88	0.04	-0.02	-0.41	-5.55	0.39	0.39	0.97
04L	6	10	72	-1.90	-1.20	0.31	0.91	1.35	0.04	0.04	1.25	-5.55	0.43	0.03	0.97
05P	6	11	79	-1.90	-1.05	1.25	1.20	0.83	0.69	0.51	-0.64	-1.12	0.39	0.45	0.63
06P	6	8	90	-1.90	-1.52	2.79	0.39	1.02	1.34	-1.16	0.18	1.32	0.59	0.31	0.75
07L	6	11	72	-1.90	-1.05	0.31	0.78	1.10	0.04	-0.20	0.47	-5.55	0.39	0.17	0.97
08P	3	12	87	-2.83	-0.91	2.34	2.20	1.13	1.22	1.25	0.65	0.99	0.20	0.19	0.45
09P	8	8	72	-1.45	-1.52	0.31	1.32	0.98	1.46	0.80	0.05	1.25	0.27	0.31	0.64
10P	3	12	71	-2.83	-.91	0.17	0.92	1.23	0.08	0.24	1.04	-4.68	0.25	0.15	0.94
11P	12	11	81	-0.68	-1.05	1.52	0.90	1.10	3.93	-0.24	0.49	6.67	0.56	0.27	0.97
12P	5	11	74	-2.16	-1.05	0.57	1.27	1.10	0.15	0.60	0.49	-3.95	0.27	0.18	0.84
13P	5	6	80	-2.16	-1.90	1.38	0.56	0.80	1.76	-0.55	-0.36	2.34	0.44	0.33	0.81
14P	7	10	78	-1.66	-1.20	1.11	0.71	1.53	0.73	-0.45	1.76	-0.88	0.46	0.12	0.30
15P	11	12	73	-0.86	-.91	0.44	1.65	0.95	1.01	1.79	-0.15	0.15	0.34	0.31	0.63
16P	6	9	87	-1.90	-1.35	2.34	0.68	0.64	1.05	-0.41	-1.28	0.29	0.44	0.59	0.45
17P	7	11	79	-1.66	-1.05	1.25	0.85	0.98	0.60	-0.14	0.01	-1.52	0.42	0.34	0.18
18P	4	12	78	-2.47	-.91	1.11	0.76	1.28	0.30	-0.05	1.24	-3.14	0.34	0.09	0.55
19P	8	11	78	-1.45	-1.05	1.11	1.40	1.21	2.85	0.94	0.89	4.23	0.29	0.09	0.48
20P	5	11	93	-2.16	-1.05	3.28	0.48	1.05	1.73	-0.73	0.27	2.22	0.48	0.25	0.38
21P	7	12	82	-1.66	-.91	1.65	0.45	0.76	0.92	-1.19	-1.12	-0.25	0.60	0.53	0.38
22L	8	10	82	-1.45	-1.20	1.65	0.50	0.71	0.47	-1.20	-1.08	-2.60	0.61	0.59	0.41
23P	4	10	82	-2.47	-1.20	1.65	0.90	0.75	0.90	0.15	-0.90	-0.31	0.30	0.54	-0.04
24P	1	7	76	-4.08	-1.70	0.84	0.27	0.86	0.81	-0.28	-0.26	-0.50	0.27	0.29	0.26
25L	9	10	73	-1.24	-1.20	0.44	0.99	1.80	0.15	0.12	2.48	-3.83	0.49	-0.13	0.86
26P	6	14	84	-1.90	-.66	1.92	0.76	0.83	0.55	-0.25	-0.93	-2.20	0.46	0.47	0.29
27L	9	9	70	-1.24	-1.35	0.04	1.98	1.20	2.25	2.02	0.71	2.74	0.10	0.12	0.85
28L	8	12	83	-1.45	-.91	1.79	0.60	1.07	2.30	-0.88	0.38	4.05	0.56	0.22	0.86
29L	5	12	95	-2.16	-.91	3.66	0.35	0.85	2.28	-1.06	-0.63	3.13	0.57	0.41	0.31
30L	6	7	80	-1.90	-1.70	1.38	1.44	1.24	3.39	0.85	0.71	5.55	0.24	0.09	0.96
31P	3	11	72	-2.83	-1.05	0.31	2.51	1.54	0.21	1.42	1.98	-3.28	0.10	-0.18	0.86
32L	5	13	72	-2.16	-.78	0.31	0.92	1.06	0.04	0.11	0.36	-5.55	0.33	0.22	0.97
33P	10	11	72	-1.05	-1.05	0.31	1.32	0.65	0.04	0.92	-1.53	-5.55	0.48	0.63	0.97
34P	5	13	80	-2.16	-.78	1.38	1.24	0.92	0.38	0.55	-0.36	-2.92	0.27	0.40	0.32

Person	TOTAL SCORE			JMLE MEASURE			Outfit MNSQ			Outfit ZSTD			PT Measure-Corr		
	KA	SA	AA	KA	SA	AA	KA	SA	AA	KA	SA	AA	KA	SA	AA
35P	6	15	79	-1.90	-.53	1.25	0.63	1.01	0.62	-0.52	0.09	-1.41	0.45	0.29	0.64
36P	7	11	87	-1.66	-1.05	2.34	0.83	0.64	1.45	-0.17	-1.59	1.80	0.43	0.66	0.28
37P	6	13	72	-1.90	-.78	0.31	0.83	0.97	0.04	-0.12	-0.11	-5.55	0.41	0.32	0.97
38P	5	10	94	-2.16	-1.20	3.46	1.75	0.74	0.67	1.13	-0.95	-1.18	0.26	0.51	0.78
39P	9	9	84	-1.24	-1.35	1.92	0.73	0.88	1.35	-0.60	-0.33	1.44	0.52	0.31	0.67
40L	5	16	82	-2.16	-.41	1.65	0.79	0.91	0.49	-0.10	-0.52	-2.44	0.43	0.45	0.39
41L	8	10	71	-1.45	-1.20	0.17	1.40	1.49	1.77	0.94	1.65	1.89	0.20	-0.08	0.33
42P	5	12	86	-2.16	-.91	2.20	0.54	0.85	1.28	-0.58	-0.62	1.22	0.46	0.45	0.02
43P	6	9	83	-1.90	-1.35	1.79	0.41	0.67	1.51	-1.11	-1.15	1.91	0.58	0.53	0.49
44L	5	15	81	-2.16	-.53	1.52	0.62	0.73	0.41	-0.42	-1.71	-2.85	0.46	0.60	0.00
45P	4	11	96	-2.47	-1.05	3.86	0.42	0.86	1.45	-0.66	-0.52	1.30	0.45	0.43	0.77
46L	2	7	74	-3.31	-1.70	0.57	1.35	1.05	0.33	0.67	0.26	-2.55	0.11	0.18	0.91
MEAN	6.1	10.8	79.5	-1.96	-1.10	1.33	0.98	1.00	0.99	0.05	0.00	-0.82			
P.SD	2.2	2.1	7.0	0.60	0.31	0.99	0.54	0.26	0.91	0.84	0.96	3.19			

The highest score in the skill aspect is 40L, with a total score of 16. Then, the pre-service physics teacher with codes 28L, 29L, 42P, 44L, and 35P with a total score of 15. Next are pre-service physics teachers with 32L, 34P, and 37P, scoring 13. Then, pre-service physics teachers with codes 08P and 18P had a total score of 12. For the attitude aspect of pre-service physics teachers, the highest total score is 45P with a total score of 96, 29L with a total score of 95, 38P with a total score of 94, and 20P with a total of 93.

Based on the data in Table 2, it was found that there were miss fit persons according to the Rasch model for the knowledge aspect, namely pre-service physics teacher with code 24P, MNSQ outfit was worth 0.27, ZSTD outfit was 0.28, and Pt Mean Corr was 0.27 then 27L with MNSQ outfit was worth 1.98 then ZSTD outfit was 2.02, and Pt Mean Corr is 0.10. Then, no pre-service physics teacher needed to fit in the SIL skills aspect marked by all the criteria, both MNSQ outfit and ZSTD outfit and Pt Mean Corr that met at least one of the abovementioned criteria. The highest number of miss fit pre-service physics teachers, according to the Rasch model, was in the attitude aspect of SIL, 11 people, namely 02P, 03P, 04L, 07L, 10P, 11P, 20P, 25L, 34P, 40L, and 44L means that only 35 pre-service physics teacher meet the person fit according to the Rasch model. A comparison of male and female pre-service physics teachers' responses to SIL items in the form of average score items is presented in Figure 4. for the knowledge aspect, Figure 5. for the skills aspect, and Figure 6. for the attitude aspect.

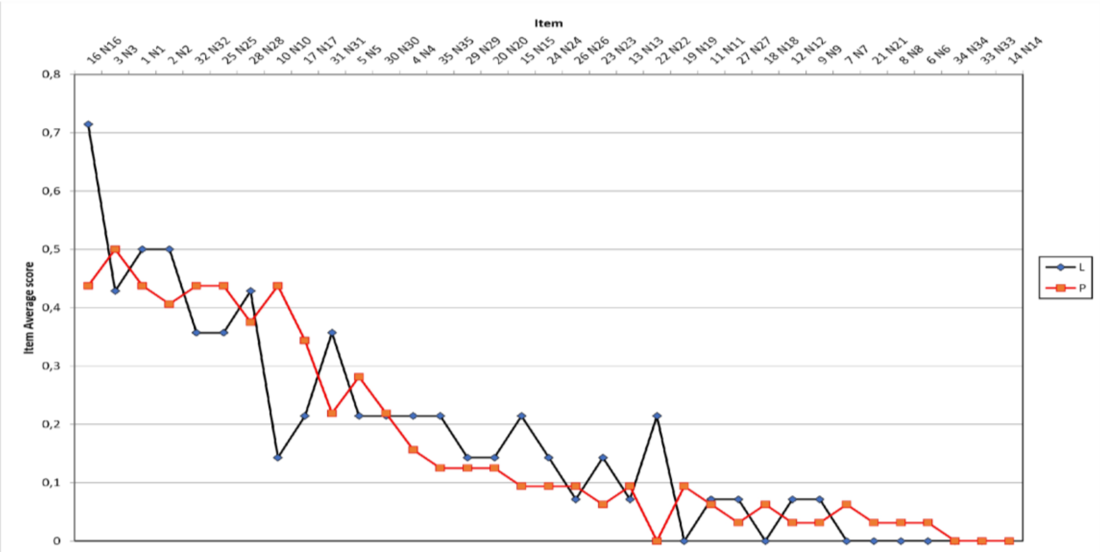

Figure 4. Range of SIL average scores for knowledge aspects

Figure 4 shows the average score between pre-service physics teachers for different aspects of knowledge for each item. The responses of male pre-service physics teachers are depicted with black lines and blue rhombuses. In contrast, the reactions of female pre-service physics teachers are figured out with red stripes and orange squares. There are striking differences in items N10, N16, and N22. On items N10 and N22, male pre-service physics teacher candidates have a higher average score than female pre-service physics teachers. This condition differs from N16, where female pre-service physics teachers have a much higher average score than male pre-service physics teachers. Meanwhile, on items N34, N33, and N14, female and male pre-service physics teachers have the same average score.

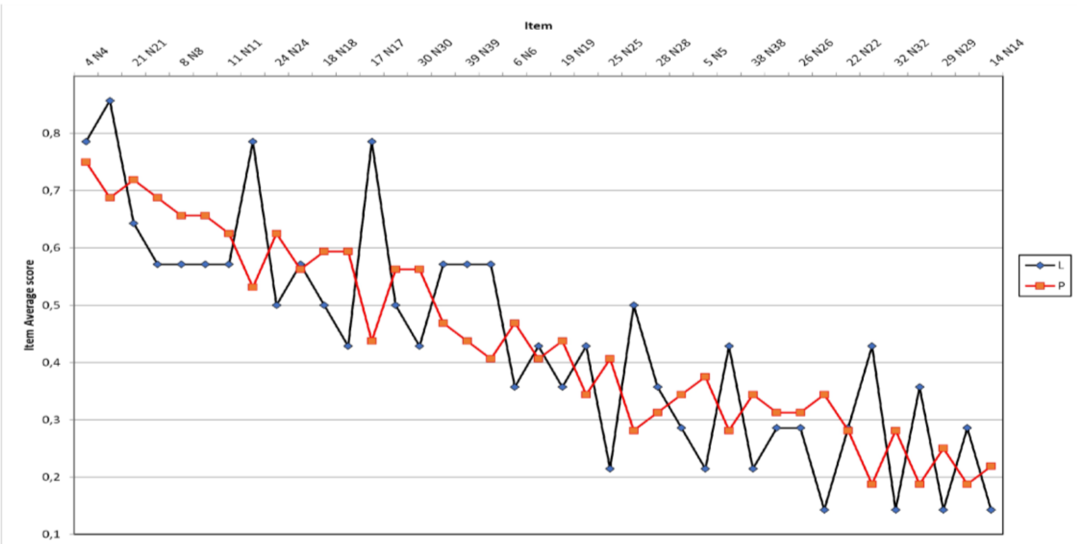

Figure 5. Range of SIL average scores for skills aspects

Based on Figure 5. Average score between pre-service physics teachers for different skill aspects for each item. The responses of male pre-service physics teachers are depicted with black lines and blue rhombuses. In contrast, the reactions of pre-service physics teachers are shown with red stripes and orange squares. There are striking differences in items N17, N22, and N26. On items N17 and N22, male physics teacher candidates have a much higher average score than females, which differs from N26, where female pre-service physics teachers have a much higher average score than male pre-service physics teachers. Meanwhile, female and male pre-service physics teachers have almost identical average scores on other items.

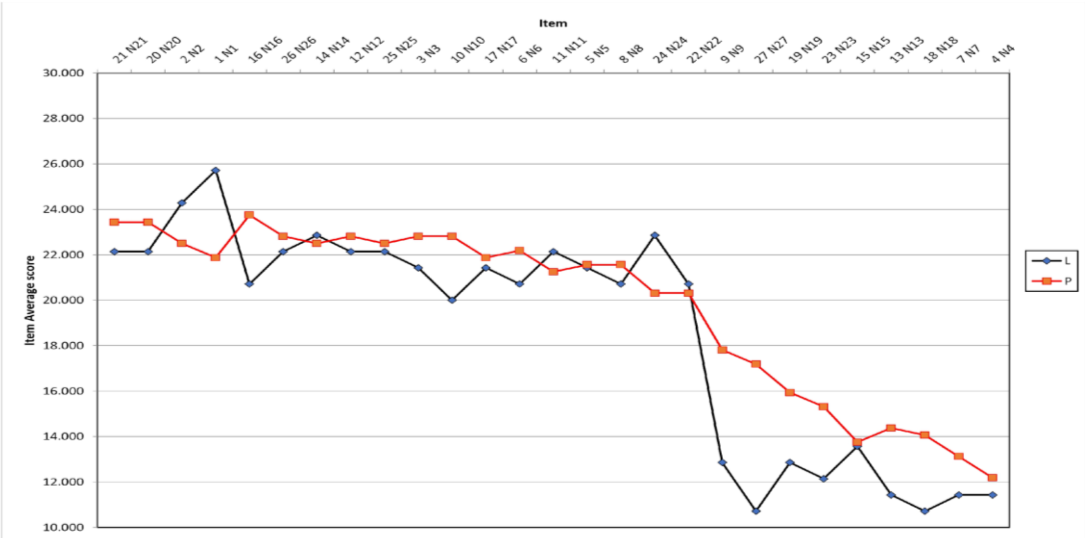

Figure 6. Range of SIL average scores for attitude aspects

Figure 6. shows Average responses among pre-service physics teachers for different aspects of knowledge for each item. The score value in this aspect shows the level of agreement between pre-service physics teachers regarding the items. There are striking differences in items N1, N27, and N9. In item N1, female pre-service physics teachers have an average score much higher than men, which differs from N27 and N9, where male prospective teachers have an average score much higher than females. Meanwhile, in N14, female and male pre-service physics teachers have almost the same average score. For each pre-service physics teacher, changes can be measured when an item is administered by looking at the person's measure after each item. This statistic measures the suitability of a pre-service physics teacher after helping with each item (Krell et al., 2020). These statistics are presented in Figure 7. for the knowledge aspect, Figure 8. for the skills aspect, and Figure 9. for the attitude aspect.

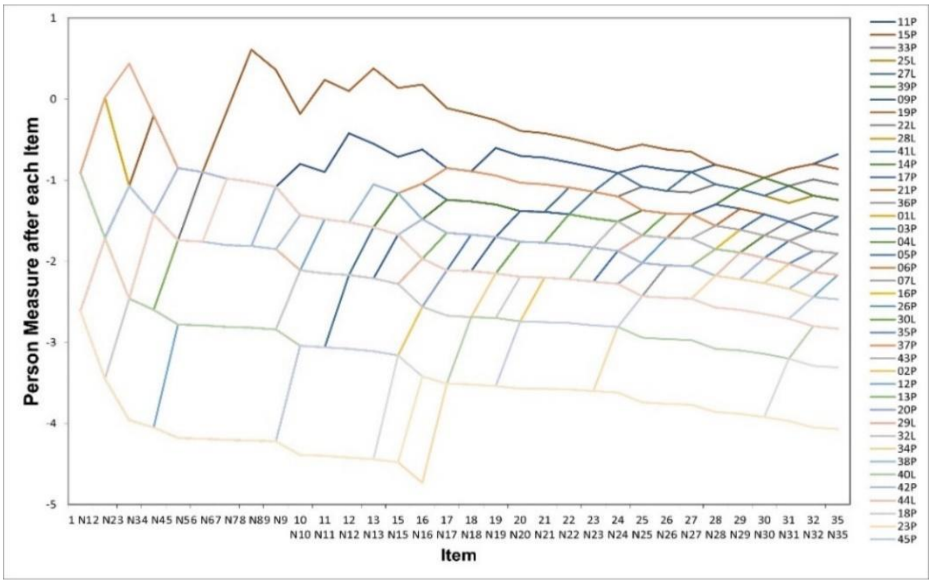

Figure 7. A person measures after each Item SIL aspects of knowledge

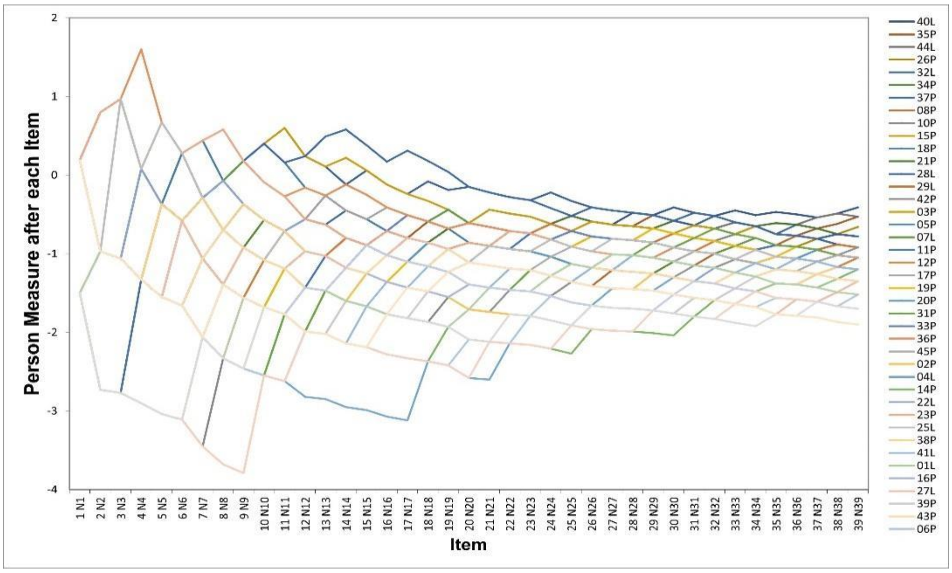

Figure 8. A person measures after each Item SIL aspects of skills

The "person measures after each item" graph consists of pre-service physics teachers' scores so far, calculated values so far, observation measures so far, info so far, and box average wear so far. The graphic depiction in Figures 6, 7, and 8 starts from the first to the last observation by eliminating missing words. Each pre-service physics teacher is marked with a different colored line as presented on the right vertical axis of each graph. The item number is displayed on the horizontal part of the graph. The suitability value of each person is presented on the left vertical axis of the graph. Figure 6 shows that the range of person measures in the knowledge aspect is the most minor compared to other elements, namely seven scale ranges between -5 to 1. Figure 7. explains the range of person measures in the skills aspect, namely seven scale ranges between -4 to 1. Figure 8. illustrates that the content of person measures in the attitude aspect is the largest compared to other elements, namely eleven scale ranges between -4 to 6.

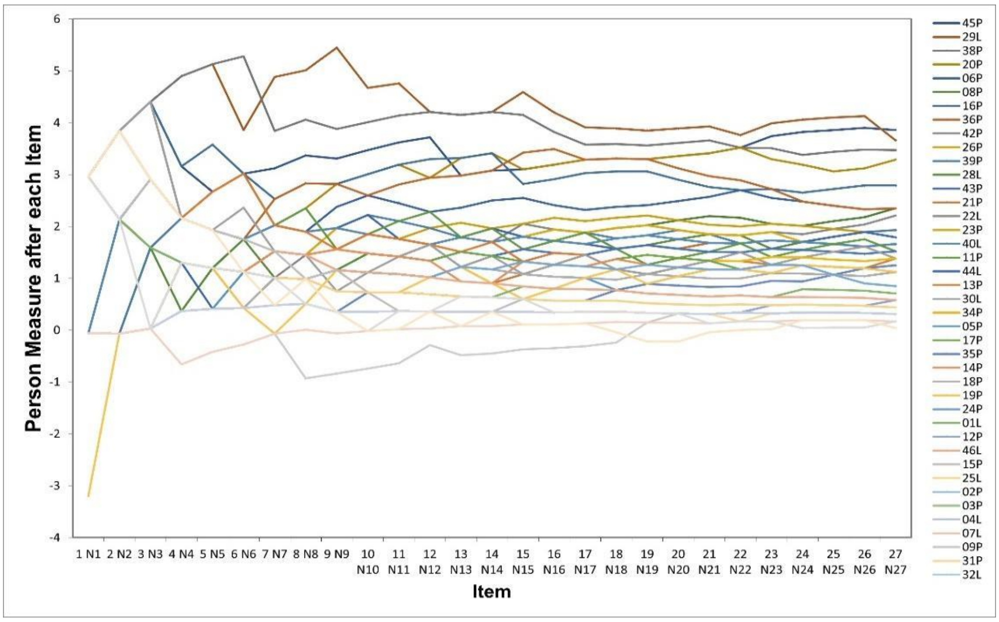

Figure 8. A person measures after each Item SIL aspects of attitude

Person measures of pre-service physics teachers in the attitude aspect generally concentrate on positive values. The results of interviews with lecturers found that the ability to carry out inquiry among pre-service physics teachers had yet to be maximally trained because not all university physics concepts can be taught using inquiry learning. Generally, training in inquiry skills for pre-service physics teachers is carried out in lessons related to physics teaching preparation, such as lesson implementation plans by pre-service physics teachers' ability to integrate inquiry into physics learning implementation plans. The lecturer in charge of the Education course provided information that a few pre-service physics teachers could integrate scientific inquiry learning into their lesson plans and microteaching.

Based on the results of the analysis of the lesson plans made by pre-service physics teachers, it was found that they still needed to integrate scientific inquiry into their lesson plans. There are laboratory activities, demonstrations, and observations that they plan in learning that are still teacher-centered, as can be seen from the absence of leading questions prepared by pre-service physics teachers to direct students to discover physics concepts. The demonstrations and laboratory activities carried out are still verification activities, where students are guided to carry out laboratory activities through worksheets designed to be directly imitated to verify the concepts they have previously acquired, making it clear that the learning used by pre-service physics teachers still needs to integrate scientific inquiry.

Based on the results of interviews with pre-service physics teachers, there is additional information that pre-service physics teachers feel they need more confidence when implementing scientific inquiry in their lesson plans and micro-teaching. Some pre-service physics teachers fear making mistakes when creating leading questions to guide scientific inquiry activities. Some pre-service physics teachers also think they must become proficient when using inquiry to teach physics. Some pre-service physics teachers feel that the equipment for conducting scientific inquiry learning needs to be improved, making it challenging to provide the necessary equipment. In addition, there is no requirement to use scientific inquiry in creating lesson plans and micro-teaching lessons that are carried out, so pre-service physics teachers prefer the lecture learning method using learning media that are easier to obtain, such as videos, animations, and PowerPoint.

The need for more integration of scientific inquiry in lesson plans and micro-teaching for pre-service physics teachers is in line with the lack of SIL pre-service physics teachers in the knowledge and skills aspects, as explained above. However, SIL pre-service physics teachers are already promising in terms of attitude. So, it is necessary to improve aspects of SIL knowledge and skills so that they can teach physics based on the nature of science.

CONCLUSION

The mean SIL value for the knowledge aspect of pre-service physics teachers using the Rasch model was 6.1 (maximum score of 35). The percent measure for the knowledge aspect was negative, namely -1.96, and the person reliability value is 0.17, which shows that the ability and consistency of people's answers are still low. The mean person is at measure -2 at Wright maps, which means that the ability of pre-service physics teachers to answer SIL knowledge questions has a far logit average value lower than logit items. This condition shows that pre-service physics teachers need to learn more SIL. The mean SIL value for the skill aspect of pre-service physics teachers using the Rasch model is 10.8 (maximum of 39). The percentage measure is -1.10, which means that the person's ability to answer questions on this instrument is low, and the person's reliability value is 0.00, which shows that the consistency of people's answers is low. The mean person is one scale line below -1 at Wright maps, which means that the ability of pre-service physics teachers to answer SIL questions for the skills aspect has an average logit value much lower than the item logit. This condition shows that pre-service physics teachers have low skills in SIL. The mean SIL value for the attitude aspect of pre-service physics teachers using the Rasch model is 79.5 (maximum of 108). The percent measure for skills is 1.33, and the person reliability value is 0.8, which shows that the ability and consistency of the answers of pre-service physics teachers are high in this aspect. The mean value of the SIL item in the attitude aspect at Wright Maps is located at measure value 0, and the mean person position at Wright Maps is above the measured value 1, which means that the average SIL for the attitude aspect of pre-service physics teachers is higher than the difficulty of agreeing with the SIL item. There are no pre-service physics teachers whose positions are outside T at the Wright Maps, so the attitude aspect of pre-service physics teachers' SIL is good. The results of interviews and the lesson plan analysis for micro-teaching understanding found that most pre-service physics teachers still needed to incorporate scientific inquiry into the lesson plans. A small number use scientific inquiry, but it still needs improvement, which is in line with the lack of SIL in the knowledge and skills of pre-service physics teachers.

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