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Implementing the rasch model to assess the level of students' critical and reflective thinking skills on the photoelectric effect

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Abstract: This study aims to determine the level of students' critical and reflective thinking skills on the topic of photoelectric effects. In this study, the cross-sectional survey approach was employed in conjunction with purposive sampling techniques. The data collection instruments are questionnaires for critical thinking and reflective thinking skills, with 20 critical thinking items and 24 reflective thinking items. A total of 35 students, 6 males and 29 females, with an average age of 20 years, agreed to fill out the questionnaire that was distributed. The acquired quantitative data were evaluated using the Rasch model, with critical thinking skills showing that 11% of students were at a very low level, 49% were at a low level, 26% were at a high level, and 14% were at a very high level. Meanwhile, data analysis of reflective thinking skills revealed that 20% of pupils had low levels, 63% had moderate levels, and 17% had high levels. As a result, it is suggested that critical thinking and reflective thinking skills be continuously debriefed.
Keywords: critical thinking skills; reflective thinking skills; rasch model; photoelectric effect

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Introduction

The Rasch rating scale model approach is used to assess the data. This is because student involvement in learning includes hidden traits that refer to students' opinions, perceptions, and attitudes in activities that require appropriate measurement models (Andrich & Marais, 2019; Boone & Staver, 2020). This model is ideal for evaluating learning since it takes a probabilistic approach to examining the features of a measuring item. Education is one of the most important means of imparting diverse life skills. Given the importance of these abilities, the activities at each level of schooling must be concurrent and comprehensive. As the highest educational institution, the college is expected to produce graduates who are ready to work competitively (Braun, Shavelson, Zlatkin-Troitschanskaia, & Borowiec, 2020; Sellars et al., 2018; Wahidin & Romli, 2020) because higher education is the final gateway of the formal sector to achieve qualifications as teachers. The task of the educational personnel teaching institution is to provide various skills needed by prospective teachers to support and develop the potential of their students in the future (Straková & Cimermanová, 2018). Thinking skills are one of the talents that kids must be taught. Thinking abilities are critical processes in thinking that contribute to comprehending things, making judgments, making decisions, solving issues, generating arguments, and altering those arguments to apply in new contexts. (Noh, Zin, & Mohamed, 2020; Sellars et al., 2018).

High-level thinking skills require students to interpret, analyze, and manipulate information (Azid, Ali, El Khuluqo, Purwanto, & Susanti, 2022; Nitriani, Darsikin, & Saehana, 2022). Various efforts are made to provide potential instructors with high-level thinking skills since it will serve as a barometer for the teacher's ability to maximize the thinking ability of his students (Straková & Cimermanová, 2018). Therefore, the provision of higher-level thinking skills is expected to be part of higher education instruction for all teaching staff (Puig, Sánchez-Martí, Ruiz-Bueno, & Sánchez-Santamarí, 2020) to become a dynamic academic culture within the institution.

Critical and reflective thinking skills are part of higher-order thinking skills. Complex problem-solving involves critical thinking processes otherwise known as higher-order thought processes (Wahidin & Romli, 2020). Critical thinking skills and reflective thinking are two terms of thinking skills that have an important urgency in teacher education (Erdoğan, 2020; Hendriana, Putra, & Hidayat, 2019). These two terms differ specifically but have a hierarchy of development with each other (Straková & Cimermanová, 2018) i.e. mutual support and sequential. Critical and reflective thinking skills must be provided to students. Promoting higher-order thinking skills (critical and reflective thinking skills) is one of the goals of higher education because college students need these skills to build meaning (Hidayati, Zubaidah, Suarsini, & Praherdhiono, 2020; Puig et al., 2020). Familiarizing students with critical and reflective thinking can train them to evaluate the activities that have been carried out and plan for future improvements.

The provision of higher-order thinking skills is not limited to one particular area of discipline (Murtadho, 2021; Pursitasari, Suhardi, Putra, & Rachman, 2020; Sellars et al., 2018) and should even be encouraged at various levels of education and committed to developing it throughout life. Higher-order thinking skills are the type of thinking that faculty create by challenging the cognitive structure of students (Erdoğan, 2020; Gülen, 2018). Learning will be rich with ideas and more meaningful if the facilitator has credible competencies and broad knowledge.

The provision of high-level skills must be carried out by each level of education in all subjects. The integration of elements of thought, intellectual standards, and higher-order thinking skills can support the completion of tasks in life (Sellars et al., 2018; Straková & Cimermanová, 2018). The reality in the field is different, the provision of higher-order thinking skills is still not massive, and the lack of literacy of teaching staff on the characteristics and concepts of higher-level thinking skills causes the concentration of most teaching staff in learning to be still at the level of completing content alone. The challenges of this century require educators to look for ways to improve individual abilities not only conceptual knowledge (Jarrah, 2019; Jiménez-Gómez, Cárdenas-Becerril, Velásquez-Oyola, Carrillo-Pineda, & Barón-Díaz, 2019; Straková & Cimermanová, 2018). But also, on other life skills such as collaborative, cooperative, communicative, problem-solving, critical thinking, and reflective thinking.

Given the importance of higher-order thinking skills (critical and reflective) to be supplied, many related studies have been conducted (Aloisi & Callaghan, 2018; Gómez & Suárez, 2020; Kahlke & Eva, 2018; Reynders, Lantz, Ruder, Stanford, & Cole, 2020; Straková & Cimermanová, 2018; van Peppen et al., 2018). Likewise, the skill of reflective thinking is one of the skills of the 21st century that is very important to be supplied (Aloisi & Callaghan, 2018; Kember et al., 2000; Murtadho, 2021; Zach & Ophir, 2020). However, these studies are still being carried out partially, and not yet carried out in an integrated manner to measure critical thinking skills and reflective thinking skills simultaneously.

Critical and reflective thinking skills are needed in modern physics lectures. Given that the content of modern physics concepts is classified into abstract and microscopic categories (Arabatzis, 2017; Hermann, 2020). Therefore, thinking skills are the main capital to be able to do more rational reasoning in understanding every phenomenon of modern physics must be a concern. Many studies on the content of modern physics have been carried out including, Compton scattering of electron scattering and electron momentum (Talmantaite et al., 2019; Xu et al., 2019), wave packet scattering (Khomitsky & Kulakov, 2020), electron diffraction (Kulygin, Kulygin, & Avilov, 2020). Research on cognitive abilities for comprehending the text is still infrequently conducted, nevertheless. Therefore, the purpose of this study was to evaluate the critical and reflective thinking abilities of participants regarding the photoelectric effect in contemporary physics. The photoelectric effect is the release of an electron from a metal surface when that surface is irradiated by a photon with energy over the metal's work function threshold. The energy of the photon is as large as

$$E = hf \tag{1}$$

If energy hf photons are larger than the work function ϕ a material, then the photoelectron can be detached. Its excess energy turns into the kinetic energy of electrons

$$K_{max} = hf - \phi \quad (2)$$

The measurement of critical thinking skill levels using critical thinking skills instruments includes five indicators, namely elementary clarification, basic support of an argument, inferences, advanced clarification, strategies, and tactics (Nitko & Brookhart, 2014). Meanwhile, to measure the level of reflective thinking skills, reflective thinking skills instruments are used with four indicators, namely habitual action, understanding, reflection, and critical reflection (Kember et al., 2000). In general, the mechanism for measuring the level of critical thinking skills and reflective thinking skills can be seen in Figure 1.

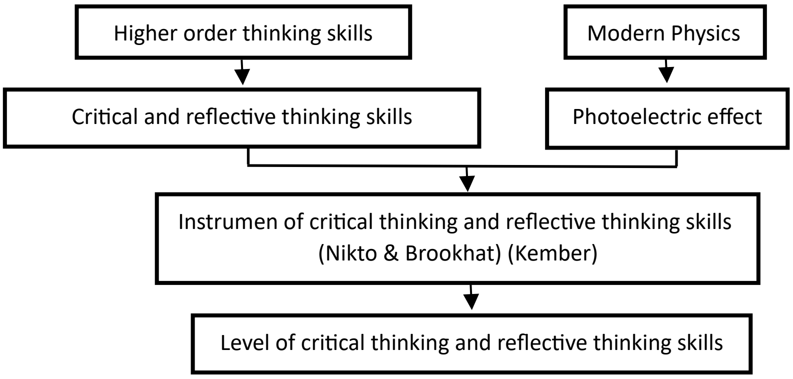

Figure 1. Assessment diagram of critical thinking and reflective thinking skills

Higher-order thinking abilities include the value of introspective and critical thinking abilities. Therefore, it is important to monitor kids' critical and reflective thinking abilities from the start. The purpose of this study is to evaluate students' critical and reflective thinking abilities on the topic of the photoelectric effect.

Method

Instrumentation

A quantitative approach is used in this study by a cross-sectional survey method that aims to examine current attitudes, beliefs, opinions, or practices (Creswell & Creswell, 2018). Instruments of critical thinking skills as many as 20 items developed from the framework of Nitko & Brookhart (Nitko & Brookhart, 2014), and the instrument of reflective thinking skills as many as 24 items developed from the Kember framework (Kember et al., 2000) to measure students' critical and reflective thinking skills. Both questionnaires used a four-point Likert-type scale, namely strongly agreeing (4), agreeing (3), disagreeing (2), and strongly disagreeing (1).

Participants

A total of 35 participants with details of 6 men and 29 women of an average age of 20 years, came from the physics education study program who contracted modern physics courses to be the respondents to this study. Purposive sampling techniques were used to determine the research sample where respondents were given an online survey. The choice of purposive sampling technique is because respondents are limited to the class of 2018-2020 where the questionnaire is given online and can be accessed by students openly. Of the generally distributed and open questionnaires, only 35 students filled out and were willing to return the accepted questionnaires.

Data Analysis Techniques

The collected data is then fed into Microsoft EXCEL and subsequently imported into WINSTEPS version 4.3.1, a Rasch Model measurement software to detect deviant responses. The results of WINSTEPS are used to examine students' critical and reflective thinking skills levels using descriptive statistics.

Validity and Reliability of the Instrument

The findings of the analysis of the validity and reliability of the instrument of critical and reflective thinking skills were conducted using WINSTEPS version 4.3.1. The validity and reliability of the questionnaire are known based on Table 1. All of the items on the critical thinking skills questionnaire are valid because their probability values are all higher than 0.05. According to the values of (0.87) and (0.61) for the reliability of the questionnaire as it was presented, the reliability of people and items falls into the "good" and "low" categories, respectively (Sumintono & Widhiarso, 2015). In Table 1, you can also see the separation person (3.63) and item (1.25) index values, this value indicates that the separation person is at the acceptance value because the separation value is > 3.00 while for the separation item, it is outside the receipt value because the separation value is < 3.00. So, it can be said that the item does not work well to estimate the ability of the respondent.

Table 1. Descriptive data of instrument students' critical and reflective thinking skills

Description	Critical thinking		Reflective thinking	
	Person	Item	Person	Item
Separation	3.63	1.25	1.35	3.04
Reliability	0.87	0.61	0.64	0.99
Cronbach's alpha	0.90		0.71	
Probability DIF		> 0.05		Q1, Q2 < 0.05

For the reflective thinking skills questionnaire, it is known that there are two invalid items because the PROBABILITY value of DIF is below 0.05, namely Q1 and Q2. While the reliability of persons and items (0.64) and (0.99) respectively, shows that the reliability of persons of the category is "low" while the reliability of items of the category is "excellent". Then the separation person index (1.35) and the separation item index (3.04), show that the separation person is outside the acceptance value because the separation value is < 3.00 while the separation item is at the acceptance value because the separation value is > 3.00 (Ling Lee, Chinna, & Sumintono, 2021). The Cronbach alpha coefficient value (0.90) with the category "very good" means that the interaction between the person and the question items is very good.

Results and Discussion

For the photoelectric effect, categories of critical and reflective thinking skills based on the logit value of a person (LVP), and individual conformity level, research data will be presented in this section in the form of summary (logit) values of a person and items.

Critical and reflective thinking skills

Students' critical and reflective thinking skills data have been analyzed, Figure 2 shows the summary of critical thinking skills data, the average measurement score for persons is +1.82 logit. This shows that students have a positive tendency towards the appearance of critical thinking, the elementary person value of 1.72 which shows that there is a very wide spread of data throughout the logit data. While the average measurement value of items (logit) is 0.00 and SD items are 0.67, this indicates a not-so-wide spread across the logit scale regarding the difficulty of the questions.

SUMMARY OF 35 MEASURED PERSON

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	59.5	20.0	1.82	.55	.97	-.20	1.03	-.20
SEM	1.1	.0	.30	.02	.11	.27	.14	.27
P.SD	6.1	.0	1.72	.10	.63	1.56	.80	1.60
S.SD	6.2	.0	1.75	.10	.64	1.59	.81	1.62
MAX.	79.0	20.0	7.75	1.03	3.00	3.39	3.70	3.30
MIN.	48.0	20.0	-.94	.42	.06	-3.33	.05	-3.33

REAL RMSE .61 TRUE SD 1.61 SEPARATION 2.63 PERSON RELIABILITY .87
MODEL RMSE .56 TRUE SD 1.63 SEPARATION 2.93 PERSON RELIABILITY .90
S.E. OF PERSON MEAN = .30

PERSON RAW SCORE-TO-MEASURE CORRELATION = 1.00
CRONBACH ALPHA (KR-20) PERSON RAW SCORE "TEST" RELIABILITY = .90 SEM = 1.95

SUMMARY OF 20 MEASURED ITEM

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	104.1	35.0	.00	.40	1.00	.01	1.03	.00
SEM	1.0	.0	.15	.00	.06	.20	.13	.26
P.SD	4.1	.0	.67	.02	.26	.89	.55	1.12
S.SD	4.3	.0	.69	.02	.27	.92	.56	1.15
MAX.	111.0	35.0	1.09	.42	1.76	2.26	3.11	3.49
MIN.	97.0	35.0	-1.16	.37	.54	-1.94	.49	-1.80

REAL RMSE .42 TRUE SD .53 SEPARATION 1.25 ITEM RELIABILITY .61
MODEL RMSE .40 TRUE SD .54 SEPARATION 1.35 ITEM RELIABILITY .65
S.E. OF ITEM MEAN = .15

Figure 2. Summary (logit) value of person and item for critical thinking skills

Figure 3 shows summary reflective thinking skills data with an average measurement value (logit) for a person of +1.35 logit. This shows that students have a positive tendency towards reflective thinking skills, but this score is lower than the average score of the person's critical thinking appearance.

SUMMARY OF 35 MEASURED PERSON

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	70.8	24.0	1.35	.38	1.00	-.28	1.00	-.32
SEM	.9	.0	.12	.00	.11	.36	.11	.36
P.SD	5.0	.0	.72	.01	.65	2.08	.65	2.08
S.SD	5.1	.0	.73	.01	.66	2.11	.66	2.11
MAX.	80.0	24.0	2.73	.39	2.54	3.95	2.55	3.74
MIN.	61.0	24.0	-.01	.36	.20	-3.87	.19	-3.91

REAL RMSE .43 TRUE SD .58 SEPARATION 1.35 PERSON RELIABILITY .64
MODEL RMSE .38 TRUE SD .61 SEPARATION 1.61 PERSON RELIABILITY .72
S.E. OF PERSON MEAN = .12

PERSON RAW SCORE-TO-MEASURE CORRELATION = 1.00
CRONBACH ALPHA (KR-20) PERSON RAW SCORE "TEST" RELIABILITY = .71 SEM = 2.68

SUMMARY OF 24 MEASURED ITEM

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	103.2	35.0	.00	.32	.99	-.04	1.00	-.03
SEM	2.3	.0	.22	.00	.06	.24	.06	.24
P.SD	11.1	.0	1.07	.01	.29	1.14	.29	1.16
S.SD	11.3	.0	1.09	.01	.29	1.16	.30	1.19
MAX.	125.0	35.0	2.80	.34	1.51	1.79	1.54	1.85
MIN.	72.0	35.0	-2.26	.29	.59	-1.77	.58	-1.78

REAL RMSE .33 TRUE SD 1.02 SEPARATION 3.04 ITEM RELIABILITY .90
MODEL RMSE .32 TRUE SD 1.02 SEPARATION 3.23 ITEM RELIABILITY .91
S.E. OF ITEM MEAN = .22

Figure 3. Summary (logit) value of person and item for reflective thinking skills

The SD person value is 0.72, which shows that the logit data has a relatively narrow distribution of data. The SD value of this item suggests that the level of difficulty of the question is extensive across the logit scale, even if the average measurement value of the item (logit) is 0.00 and the SD is 1.07. It is argued that someone has a favorable mentality about an item if their average logit person is positive (much above their average logit item), but for the SD logit, the higher the number, the better the distribution of the data on the measurement (Wei, Chee, Looi, & Sumintono, 2020; Widhiarso & Sumintono, 2016).

Individual conformity level

Rasch modeling can also detect patterns of inappropriate individual responses, namely the discrepancy of the answers given based on their ability compared to the ideal model (Wei et al., 2020; Widhiarso & Sumintono, 2016). There is a misfit of persons or person response patterns that are not appropriate to the questionnaire of critical thinking skills and reflective thinking skills. There are 10 persons who have a unique response pattern in querier of critical thinking skills, namely respondents with codes 08M1, 01M1, 30F2, 11F1, 14F1, 15F1, 20F2, 33F2, 12F1, and 22F2. The response pattern given can be seen in Figure 4 (a), while on the questionnaire of reflective thinking skills, there are 14 persons indicated by a misfit, namely respondent no. 01M1. 08M1, 14F1, 15F1, 6M1, 20F2, 30F2, 4F1, 12F1, 26F2, 17M1, 22F2, 11F1, and 5F1, the given response pattern can be seen in Figure 4 (b). These respondents were classified as misfits because they gave responses that did not match the model, for example, respondents 14F1, 15F1, and 20F2, to the critical thinking skills questionnaire had the same response, this indicates that it is likely that these three respondents did not read the questionnaire seriously or even agreed to choose the same option (Wei et al., 2020; Widhiarso & Sumintono, 2016).

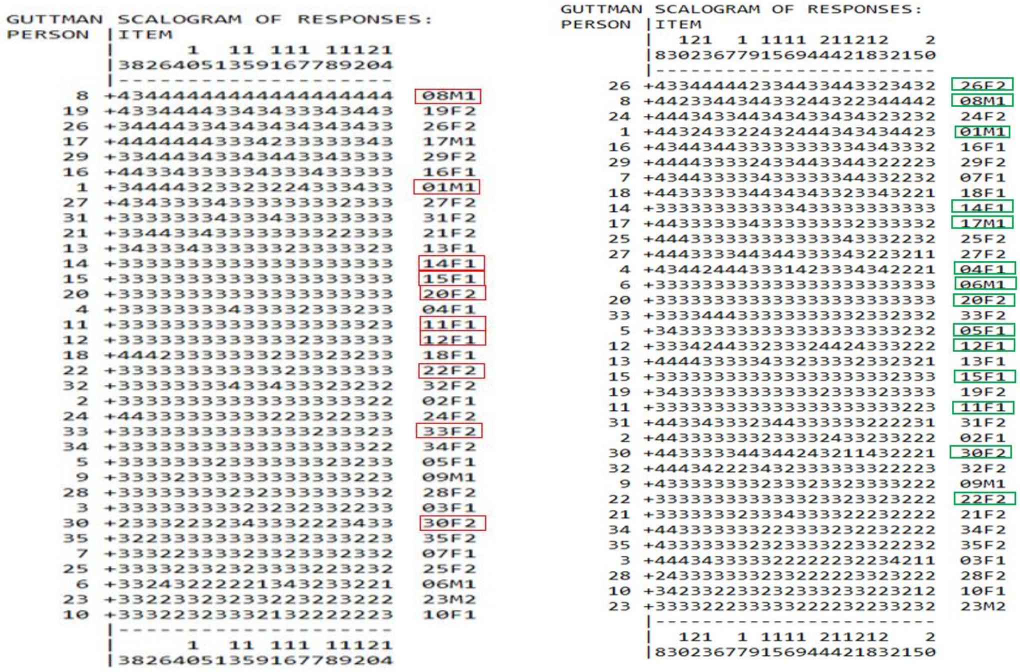

Figure 4. Person measure with misfit (a) critical thinking, (b) reflective thinking

Students' level of critical and reflective thinking skills

The four criteria for critical thinking skill levels determined using person logit values are very low, low, high, and very high as shown in Table 3. A total of 11% of students at very low levels, 49% of students at low levels, 26% of students at high levels, and 14% of students at very high levels. Each student needs to improve his critical thinking skills and needs guidance to be able to improve their critical thinking skills (Mutohhari, Sutiman, Nurtanto, Kholifah, & Samsudin, 2021; Sutama et al., 2022). If students have critical thinking skills, they will tend to have good learning outcomes (Darmaji et al., 2020).

For reflective thinking skills, there are three criteria for the level of reflective thinking skills based on the person's logit value, namely low, medium, and high. The results of the data analysis showed 17% of students at a high level of reflective thinking skills, 63% of students at a level of medium reflective thinking skills, and 20% of students at a low level of reflective thinking skills, the categorization is shown in Table 2.

Table 2. Categories of critical and reflective thinking skills based on the logit value of a person (LVP)

Thinking skills	Very Low LVP < +0.10	Low +0.10 ≤ LVP <+1.82	High +1.82 ≤ LVP <+3.54	Very High LVP ≥ +3.54
Critical	4	17	9	5
	Low LVP ≤ +0.63	Moderate +0.63 < LVP <+2.07		Hight LVP ≥ +2.07
Reflective	7	22		6

Logit value of the person (LVP) is one way to determine the levelization of the characteristics of research variables (Adams, Chuah, Sumintono, & Mohamed, 2022; Planinic, Boone, Susac, & Ivanjek, 2019; Widhiarso & Sumintono, 2016). Levelization is performed by referring to the average person/item logit combined with standard deviation (SD). The small number of students with a high level of reflective thinking skills is inseparable from previous knowledge and habits (Soltani & Askarizadeh, 2021). One way to improve reflective thinking skills is to use structured worksheets (Rosmiati, Liliasari, Tjasyono, Ramalis, & Satriawan, 2020).

The ultimate goal of lectures is not only to help students master the content well but also to develop their various thinking skills. The student's perception of his high-level thinking skills is how much knowledge is learned and grows in cognitive ability through his learning and academic experience (Kim, Yi, & Hong, 2020). For this reason, the first step is needed as an effort to identify the position of students' higher-level thinking skills, especially critical thinking skills, and reflective thinking skills. This study aims to determine the level of critical thinking skills and reflective thinking skills of students. Based on the data analysis carried out can be described both data as shown in Table 2. There is a difference in the average person value of the two thinking skills, the average value of the person of critical and reflective thinking skills is respectively +1.82 (logit) and +1.35 (logit), this value is greater than the average item 0.00 (logit). This explains that the level of critical thinking skills and reflective students is on average good because it is above the average item. However, if you look carefully according to Table 3, namely the level of thinking skills of students is mostly in a low position, it is necessary to elaborate more deeply on these two averages. In addition to paying attention to the average person, it is also necessary to pay attention to the level of the misfit person (Rusland, Jaafar, & Sumintono, 2020; Widhiarso & Sumintono, 2016), because the high average value is likely caused by the participants' inertia in responding.

For critical thinking skills, 11% of college students are at a very low level, 49% of college students at a low level, 26% of college students at a high level, and 14% of college students at a very high level. These results mean that the critical thinking skills of students attending modern physics courses are mostly low. Many factors cause students' low critical thinking skills (Lu, Yang, Shi, & Wang, 2021) ranging from supporting facilities to the competence of teaching staff. Although the concepts in modern physics are abstract and microscopic (Arabatzis, 2017) does not mean that critical thinking skills become hindered from being supplied. Thus, with this condition, a teacher will think hard to find ways to make the learning process more meaningful (Miriam & Costa, 2019; Prieto, Palma, & Jes, 2019). The occurrence of this condition is inseparable from the program design made by lecturers who have not accommodated the provision of critical thinking skills.

In the data analysis of reflective thinking skills, most students dominate the position of reflective thinking skills at the "moderate" level as shown in Table 3. However, the average value of a person and an SD person's reflective thinking skills is smaller than the average value of a person's critical thinking skills. This illustrates that the actual position conditions of reflective thinking skills are no better than those of critical thinking skills. Reflective thinking skills are an advanced part of critical thinking skills (Chee Choy, Yim, & Sedhu, 2019) in other words, if a person has reflective thinking skills then it can be said that he also has critical thinking skills. But not vice versa, if a person has critical skills, then it is not necessarily that he has the skills of reflective thinking. Reflection is seen as the process of re-examining the activities that have been carried out in establishing interaction, understanding, and meaning-making throughout the learning process (Pieridou & Kambouri-Danos, 2020). So, if a person has the skills of reflective thinking then he easily makes the right decisions during learning (Yilmaz, 2020).

The instruments used to measure higher-order thinking skills are certain instruments that must be understood by students (Ichsan et al., 2019). If you pay attention to the ability of persons for critical thinking skills, the highest (+7.75) and lowest (–0.94) person values (logit), while the highest (+1.09) and lowest (-1.16) item values (logit), this means that all questions are understood and can be done by the respondent. Then for reflective thinking skills, the highest (+2.73) and lowest (–0.01) person values (logit), while the highest (+2.80) and lowest (-2.26) item values (logit), mean that there is one item that is likely to be a bit difficult to answer the rest of the items are understandable and answered well.

Because the item's logit is higher than the person's ability logit then the chance of answering the item correctly is less than 50% (Andrich & Marais, 2019; Boone & Staver, 2020).

However, there is a misfit of persons both in critical thinking skills and reflective thinking skills. Based on Figure 4 (a) there are 10 students who misfit, meaning that the student has a response pattern that comes out of the normal pattern. For example, respondents with codes 14F1, 15F1, and 20F2, these three respondents have the same response pattern, so it can be predicted that these three respondents agreed to answer the choice of "agree" or the respondent did not read the questionnaire in answering. The same thing also happened in Figure 4 (b) there were 14 students who misfit, interestingly respondents with the same code in (a) namely 14F1, 15F1, and 20F2 were identified as misfits again. This reinforces the allegation that the person concerned did not read the questionnaire in giving a response.

The large number of people who misfit indicates that learning modern physics of photolistic effect material still does not show practice involving critical thinking and reflective skills. Even though photoelectric effect material is abstract so it requires more thinking skills to do reasoning (Arabatzis, 2017; Hermann, 2020). The photoelectric effect is the release of electrons from the surface of a metal. If the metal surface is irradiated by photons that have energy greater than the threshold of metal work function (Talmantaite et al., 2019) (Sutarno et al., 2019).(Sutarno, Setiawan, Kaniawati, & Suhandi, 2019) The kinetic energy of the electron-photon does not depend on the intensity of the incident light used but depends on the frequency of the incident photon (Chiang et al., 2015; Hernández & Fernández, 2018). Changes in the intensity of light coming on photocells only affect the number of photoelectrons produced (Gulomov et al., 2021; Han et al., 2019). The higher the intensity of the incoming light, the greater the number of electrons produced. If the potential difference is magnified, any amount of kinetic energy of an electron will not be enough to reach the collector(Khomitsky & Kulakov, 2020) This potential is then referred to as stopping potential (V_S). The magnitude can be determined by magnifying the potential difference until the measured current on the ammeter is equal to zero. The maximum kinetic energy of the electron as it leaves the emitter is equal to the kinetic energy eV_S.

Learning modern physics, which contains high abstraction elements, requires media assistance with a combination of the latest technology. Therefore, the learning activity that occurs must refer to the present and future developments in technology and science. With the continuous development of information technology, the combination of education and information technology has led to the continuous development and renewal of educational applications(Tang & Hai, 2021). Students are comfortable with using digital technology and adopting new technology easily and quickly (Kim et al., 2020) The rapid development of technology and science requires teaching staff to have 21st-century literacy skills that must be given to their students. Although there are many obstacles to developing literacy skills, especially reading literacy and developing higher-order thinking tests(Damaianti, Abidin, & Rahma, 2020; Ramadhan, Mardapi, Prasetyo, & Utomo, 2019) But educators' knowledge of literacy, and higher-order thinking skills, is essential for creating a learning atmosphere that accommodates 21st-century skills.

In digital era should refer to the competencies needed in the 21st century, such as critical thinking skills, problem-solving skills, collaboration skills, and communication skills known as higher-order thinking skills (Ichsan et al., 2019; Sutarno et al., 2019). So far, the provision of higher-order thinking skills has not been carried out massively in institutions and educational units, causing teaching staff to not be familiar with the higher-level thinking skills test (Ramadhan et al., 2019). So, the evaluation of learning that is often carried out is limited to checking low-thinking skills. Given the lack of provision of critical thinking skills and reflexes accompanied by evidence of low competency results of these two skills, it is necessary to conduct training, workshops, and more intense education for educators and educators related to the life skills needed in the 21st century including critical thinking skills and reflective thinking skills.

Conclusion

The results showed that the level of critical thinking skills and reflective thinking skills of students was classified as low. The results of the data analysis for critical thinking skills showed that 11% of students at a very low level, 49% of students at a low level, 26% of students at a high level, and 14% of students at a very high level. Meanwhile, the results of the data analysis of reflective thinking skills showed that 17% of students at a high level of reflective thinking skills, 63% of students at a level of medium reflective thinking skills, and 20% of students at a low level of reflective thinking skills. Measuring the level of critical thinking skills and reflective thinking skills has been carried out, and the results of data analysis show that only a small percentage of students are at a high level. Therefore, there needs to be a serious effort to improve the students' higher-level thinking skills through various programs. Thus, it can be recommended that there should be a continuous provision of higher-order thinking skills to students, especially critical thinking skills and reflective thinking skills.

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