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Attributes of Students' Critical Thinking Skills on Economics : A Rasch Model Analysis

Friyatmi, Tri Kurniawati

Universitas Negeri Padang, Padang, Indonesia
Email: ri.yatmi@fe.unp.ac.id

ABSTRACT
Critical thinking skills are needed by the students to adapt to various changes in modern society and to face the challenges of 21st-century learning. Classroom assessment can be an alternative strategy to promote critical thinking skills. This research explores the psychometric properties of the critical thinking skills test for economic students. Students' critical thinking skills are assessed using economic tests that measure interpretation, analytical, evaluation, and inference skills. It is validated using expert judgment and then analyzed using Aikens' content validity. Two hundred eighty-eight high school students were involved in this research by taking a set of multiple-choice tests on economics. Data were analyzed using the Rasch Model. The results show that all items test meet the content validity with a minimum Aikens' index of 0.87. Students' critical thinking skills are in the moderate category, and all attributes measurement of the data fit the Rasch model.

Keywords*: critical thinking skills, assessment, Rasch model*

1. INTRODUCTION

The enactment of the industrial revolution 4.0 and society 5.0 era that collaborates with cyber and automation technology has resulted in changes in human life. Gradually human activities will shift towards digital so that various forms of employment will disappear and shift to new jobs based on automation (Ghufron, 2018).People who do not have the provision of qualified competencies must be prepared to lose job opportunities because automatic machines and robots replace them. All institutions must improve themselves in facing these challenges, primarily educational institutions.

They need to improve the curriculum and the learning process so that the skills of graduates can meet the skill standards required by the market. Partnership for21st Century Skills formulates the four skills that students should have in 21st-century learning, namely critical thinking and problem solving, communication skills, collaborative skills, and creativity. These skills cannot be mastered if the learning process is still based on understanding or application, so learning capable of activating higher-order thinking skills is needed to produce highly competitive graduates.

Critical thinking skill is one of the essential skills that can be used to encourage students' higher-order thinking skills (HOTS) (Lewis & Smith, 1993). Critical thinking ability is necessary for students to be able to adapt to various changes in the social environment, to the development of knowledge and knowledge, and to cope with various practical problems. Nevertheless, some research shows that students' critical thinking and HOTS skills have not yet developed to their fullest.

Saido, Siraj, Nordin, and Al_Amedy (2015)shows that 79.7% of the abilities of students in Thailand are still at lower-order thinking. Similar research also reveals the poor ability of Indonesian students to solve reasoning problems (Amirulloh, Rustaman, & Sriyati, 2014; Herman, 2007).The reasoning is a thinking ability that is needed in stimulating critical thinking. The low capacity of HOTS students is not directly affected by the competence of educators in teaching and assessment. Analysis of exam questions at several educational institutions shows that most exam questions asked by educators are still in lower-order thinking (Iskandar & Senam, 2015; Shidiq, Masykuri, & Van Hayus, 2014). Some of the results of these studies have implications for the importance of maximizing the students' HOTS ability.

Assessment is an effective way to promote HOTS (Van den Berg, 2004).Integrated assessment for learning in the classroom in the form of questions, exercises, or quizzes that encourage critical thinking skills will be able to hone students' HOTS abilities. This study aims to validate the critical thinking test on economics and explore the attributes of the students' critical thinking skills abilities. The critical thinking skills assessment focuses on the cognitive dimensions by adapting the concept of the California Critical Thinking Skills Test (CCTT).

2. METHODS

The study is preliminary research onresearch and development. Multiple-choice tests of 13 items were developed to measure students' critical thinking skills for interpretation, inference, analysis, and evaluation sub-skills. It is validated using expert judgment by involving experts in economics and educational assessment. The results were analyzed using Aikens content validity. Aiken formulated Aiken's formula V to calculate the content validity index based on the results of an expert panel assessment of n people on an item in terms of the extent to which the item represented the built measured. The formula proposed by Aiken is as follows.

$$V = \frac{S}{n(c-1)}$$

(Aiken, 1985)

V = content validity index

S = score set by each rater minus the lowest score in the category used (S = r - lo, where r = score of the rater's choice and lo = lowest score in the rating category).

n = number of raters

c = number of rating/ criteria

Field testing is done to estimate students' critical thinking ability. This study involved 288 high school students from the Padang city, who passed a series of economic tests. Data were analyzed using the Rasch model assisted by the Winstep to estimate test and person attributes.The Rasch model incorporates an algorithm that states the probabilistic expectations of item i and n respondents (Bond & Fox, 2007). The mathematical equation of the Rasch model is

$$\log(P_{ni}(X_{ni} = 1/\beta_n, \delta_i)) = \beta_n - \delta_i.$$

The formula shows that the probability correct of an item depends on the testee's ability and the difficulty of the item.

3. RESULTS AND DISCUSSION

3.1 Item Validation

Test validation was performed to determine the accuracy of the items to measure critical thinking skills. The validation involves five experts, namely three experts in economics and two experts in educational assessment. Each expert assesses the accuracy of the items by assigning a score from 1 to 4. The criteria for each

score are 1: very imprecise, 2: imprecise, 3: less precise, and 4: precise.

Item content validity is calculated using theAiken formula. The item validity decision is made by comparing the Aiken index for each item with the Aiken table. The value of the Aiken table for items validated by five experts, the rating used was four, and the significance used was 0.05 was 0.8787 (Aiken, 1985).

Each item that has a minimum Aiken Index calculation result of 0.87 can be considered a valid item or pass content validation. The results of the Aiken index for each item are described in Table 1.

Table 1. Aiken Validity Index

Item	Difficulty Index	Outfit Mnsq	Outfit Zstd
Item 11	1,38	.82	-0,4
Item 4	1,26	1.10	0,4
Item 8	1,26	.70	-0,9
Item 1	0,74	1.07	0,4
Item 10	0,65	1.01	0,1
Item 9	0,19	1.00	0,2
Item 3	-0,27	.91	0,1
Item 5	-0,40	1.07	-0,8
Item 7	-0,46	1.11	0,7
Item 6	-0,82	1.05	1,2
Item 12	-0,95	.90	0,6
Item 13	-1,19	0,92	-0,9
Item 2	-1,39	1.10	0,8
Mean	0,00	.99	0,1
S.D	0,98	.12	0,7

Source : Primary Data 2020

The results show that all items are in the valid category because they have a minimum Aiken index of 0.87. Based on the results and suggestions from the validator, all items can be used for further testing.

3.2 The Attributes of The Critical Thinking Test

Field tests were conducted in the form of written tests for 288 high school students. It aims to measure students' initial abilities in critical thinking and to estimate test attributes. All student responses were inputted into the Rasch

model, but Winstep software only used 75 data for further analysis.

The results of item analysis using the Rasch model categorizethe item's parameter from the most difficult to the easiest item. Item difficulty rangeson -1.39 to 1.38logit scales, see Table 2. All the items have outfit mean-square value between 0.5 to -1.5 and Outfit Z-standardbetween -2.0 and 2.0. It can be said that all the critical thinking items have good quality because they fit with the Raschmodel.

Table 2. Item Parameters using the Rasch Model

Item	Difficulty Index	Outfit Mnsq	Outfit Zstd
Item 11	1,38	.82	-0,4
Item 4	1,26	1.10	0,4
Item 8	1,26	.70	-0,9
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Source : Primary Data 2020

Rasch developed a measurement model that determines the relationship between person ability and item difficulty by using the logarithmic function to produce measurements with the same interval(Wright & Mok, 2004). A result is a new unit called a logit (log odds unit) that shows students' abilities and item difficulties. Based on the logit value, it was concluded that the level of success of students in answering the item depended on the students' ability and the item difficulty.

The measurement results with the Rasch model show that the test items have good quality.

The difficulty of each item can be calculated to determine the difficulty of each sub-skills of critical thinking,as presented in Table 3.

Table 3. Difficulty Index for Critical Thinking Sub-skills

Sub-skills	Difficulty Index
Interpretation	-.95
Analysis	.01
Inference	.15
Evaluation	.74

Source : Primary Data 2020

Although each aspect has a good level of difficulty, the evaluation skill tends to be more difficult than others. Otherwise, interpretations skill easier than analysis, inference, and evaluation. Therefore, the higher ability is required to answer evaluation items correctly compared to the other three sub-skills.Empirical research shows that a person begins to develop critical thinking skills at a very young age, especially in high school students(Halpern, 2013). The ability to think critically is necessary for students to be able to adapt to various changes in the social environment, to the development of knowledge and knowledge, and to cope with various practical problems. So simply Snyder and Snyder (2008)revealed that students who have critical thinking skills would be able to solve problems effectively. It means that there is a close relationship between critical thinking and problem-solving ability, where critical thinking ability is needed in the process of problem-solving.

Several studies have shown that the use of critical thinking skills has been used successfully in economic learning in high schools (Snyder & Snyder, 2008). Other studies have even shown that critical thinking skills are the highest cognitive strategy in business and economic learning in high school (Bartlett, 2002). According to Snyder and Snyder (2008: 45), critical thinking skills can be measured by questions in the form of analysis, synthesis, and evaluation to solve problems and make decisions.Further investigation regarding students' abilities will be discussed in detail.

Overall, the mean of students' ability is -.82. Almost all students have amoderate ability scale of up to 93%, 3% of students have a high ability; the remaining 4% of students have low ability.It is shown in Table 4.

Table 4. Students' Abilities

Category	Score range	Percentage
High	X > M + 1.5 SD (> 0.425)	3
Moderate	M + 1.5 SD< X ≤ M + 1.5 SD (-2.065 – 0.425)	93
Low	X < M + 1.5 SD (<-2.065)	4
	Mean	-.82
	S.D	.83
	Max	.56
	Min	-4.11

Source : Primary Data 2020

There are two students with the highest ability who are on.56logit scale. They were able to answer eight items with different numbers correctly. Although both students have the same ability, the response pattern information shows that there are differences in the abilities of them. This information can be obtained through the Guttman scalogram, which is is one of the excellent features of the Rasch Model. It produces unusual response model information that can be seen on a scalogram.

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GUTTMAN SCALOGRAM OF RESPONSES:
Person |Item
       |  11     1   1
       |2326753901481
       |-------------
    26 +1111111000010  IS1
    55 +1110110010101  IS2
    16 +1111110010000  IA1
    17 +1111001101000  IA1
    19 +0111110100010  IA1
    52 +0100011110110  IS2
    53 +1010001110110  IS2
    64 +1110111100000  IS2
    67 +0111111000001  IS2
    68 +1001111100010  IS2
    70 +0100111110001  IS2
    74 +1101101101000  IA3
     9 +1111100010000  IA1
    10 +1110100100100  IA1
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Figure 1. Scalogram of Responses

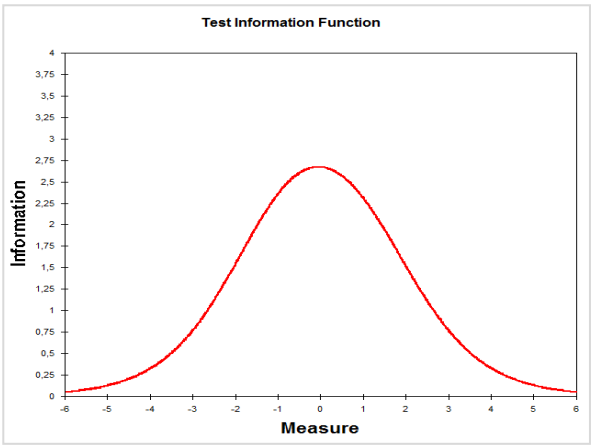
The 26th student (IS1 code) has higher consistency and precision abilities than the 55th student (IS2code). The 26th student cananswer correctly seven consecutive questions, then he/she give incorrect responses for the difficult items. The strangeness of this student is that he/shecan answer item 8, which is more complicated than the previous fouritems.It indicates that the 26thstudent guessed item 8. On the other hand, although the 55thcan answer the first eight items correctly, then his/her ability becomes inconsistent.

He/she was able to answer the most challengingitem but incorrectly answered the fiveeasier items. The lack of other information can be obtained, for instance, the case of the 67th student. This student is not able to answer the easiest questions, but he/she could answers correctly the most difficult item. It indicates that there was a misconception in item 2, which is relatively easy.This scalogram information can then be used to diagnose various errors made by students to improve the learning process.

Another advantage of the Rasch model is its ability to produce a map of the distribution of pupils' abilities and the distribution of the item difficulty on the same scale. The map on the left shows the distribution of student abilities, and the distribution of item difficulty is shown on the right. The distribution of the students' abilities shows that two pupils have a high mark, which is close to one logit scale. Conversely, three pupils have a shallow score, which is a close to -3logit scale.

The distribution of item difficulty shows that there are three items with severe difficulty greater than one logit scale. These three items have a higher difficulty than the highest students' abilities. Therefore it is fair for students to be unable to answer the items correctly because the difficulty of the items exceeds their ability level.

There are two items with the lowest difficulty level with indexes less than -1logit scale.A comparison of the abilities and item difficulty distribution shows that the level difficulty of the items tends to be higher than students' abilities. In other words, it can be said that students' abilities are relatively poor to answer the critical thinking test.



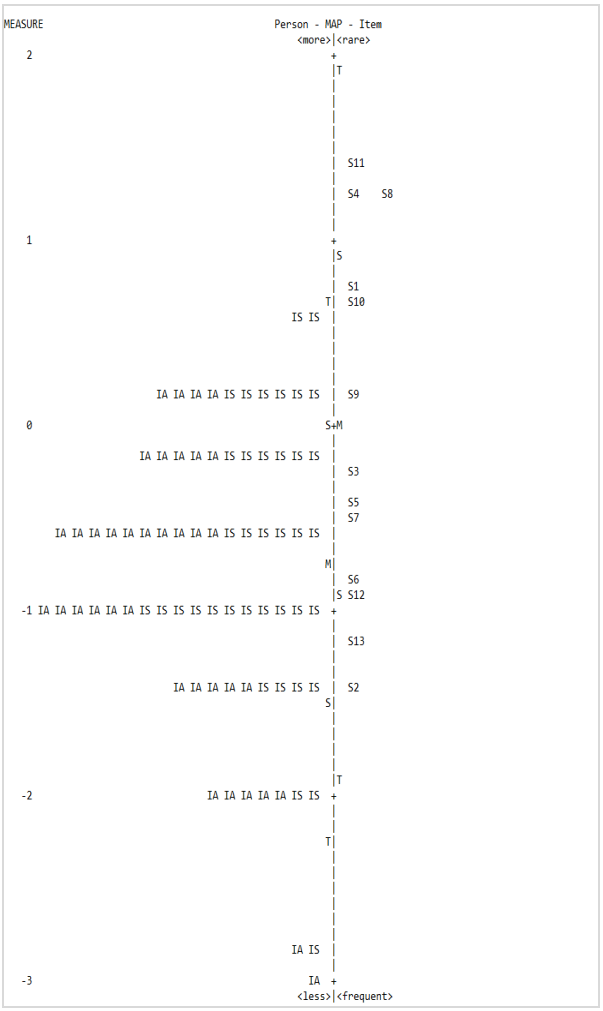


Figure 2. Item Map

The test measurement has a person reliability of 0.63 and item reliability of 0.91. It means that the items produced high reliability, while the consistency of student responses is moderate.The multiple-choice test is expected to cause weak reliability in student abilities because it rises to students' opportunities to guess the answers. However, the test information function shows good results. This test produces optimal information when tested on students who have moderate abilities. Thegraph shows that when students' scores are low, the function of the test information also tends to below. The more the students' ability to take the test is increased, the higher the function of the test information obtained until it reaches its maximum at ability is 0 logit scale. This highlight illustrates the maximum information value of 2.75, which was achieved when the student's score was 0. The graph shows that the critical thinking test produces optimal information when tested on students who have average abilities.

4. CONCLUSIONS

This study resulted in the critical thinking test meets the content validity requirements. Then preliminary research shows that critical thinking tests have good quality attributes because they have suitable difficulty parameters, average students' abilities, and the data fit with the Rasch model. This test is reliable and has a maximum information function when tested on students with moderate abilities. The lack of consistency in student responses can be further analyzed using a model of three parameters logistic that includes guessing parameters in estimating students' abilities.

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Figure 2. Test Information Fun

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