Rasch analysis of prospective elementary school teacher’s person ability on eco critical thinking skill

Wahyuni Purnami 1), Ashadi2, Suranto3, Sarwanto4, Farida Istianah5, Dwi Yuniasih Saputi6

1*Student of Science Education, Doctoral Program, Faculty of Teacher Training and Education, Universitas Sebelas Maret, Indonesia
2,4,6 Faculty of Teacher Training and Education, Universitas Sebelas Maret, Jl.Ir.Sutami 36.A, Surakarta, Indonesia
3 Faculty of Science, Universitas Sebelas Maret, Jl.Ir.Sutami 36.A, Surakarta, Indonesia
5 Faculty of Education, Elementary School Teacher Education Program, Universitas Negeri Surabaya, Jl. Lidah Wetan, Surabaya, Indonesia
6*Corresponding author: ashadiuns2014@gmail.com

Abstract. The aim of study to examine person’s ability of prospective elementary school teacher program on eco critical thinking skill and quality of instrument measuring the person’s ability. The research uses a quantitative approach by applying Rasch analysis. Data was collected by essay tests of 74 students. Findings show that the person’s ability of student prospective elementary school teacher program on eco critical thinking skill is low. Wright map shows 80% of student have low person ability on eco critical thinking skill and only 20% have high person ability. Mean of 74 measured person is -0.47 and below the standard of minimum criteria. Person reliability is good (0.90) and unidimentionality of an instrument is good (64.7%). There is important to promote efforts to increase personability on eco critical thinking skills.

1. Introduction
Sustainability of the environment is necessary in maintaining survival on planet Earth, due to environmental problems which began to threaten the planet and humanity[1]. Since 1970 the European Union has emphasized the need to promote conservation behavior in order to prevent environmental degradation [2]. There are various initiatives of Environmental Education (EE) focused on teenagers aiming to promote pro-environment behavior by providing knowledge concerning the biophysical environment and its associated problems to individuals [3]. Even not only knowledge as a target of EE, but also belief and other related predictors of behavior (attitudes, intention, norms, ecological identity) need to be targeted and assessed [2].

Education is still seen as a key response to address the issues of environment and sustainability. Various studies on the environment have been carried out. One of the results of the study states that awareness of renewed energy has a significant relationship with the cognitive and affective of students[5]. The effect of cognitive abilities on environmental awareness is positively associated with environmentalism[6]. Findings confirm that environmental education reveals as a powerful tool in
order to generate green behavior among citizens[7]. But anthropocentric ethics is dominant in the content of formal environmental education, while bio centric ethics is less [8].

The theme of the environment education is still one of frameworks in 21-st century learning [9] [10]. One challenge of EE related to the readiness of educators to implement EE, particularly in schools [11]. The readiness also related to the lack of pedagogical content knowledge (PCK) to effective teaching EE in schools, the lack of pre-service and in-service teacher training in EE and leading to teacher deficiencies in both content and pedagogical knowledge for EE [12]. It is necessary to promote the readiness of EE educators.

The readiness of EE educators related to person ability on Eco (ecological) Critical Thinking Skills. Eco critical thinking skill defines as the cognitive skill in identifying problems, interpreting, analyzing, evaluating, and deciding to resolve environmental problems through self-regulation. The skill can be designed and developed in a person [13]. Critical thinking is intellectually disciplined process of actively and skillfully conceptualizing, analyzing, synthesizing [14]. This person’s ability is important for an EE educator, including the student of prospective elementary school teacher program.

Person Ability of eco critical thinking skills can be measured and analyzed through various models including Rasch Model. Rasch analysis can be used to empirically review psychometric properties and rating scale [15][16]. Rasch modeling is one of the analyzes to find out the ability of students compared to the level of difficulty of the questions. The main concept of the measurement process in the Rasch model is the Theory Response Item (IRT). This shows that traits cannot be observed empirically, but the manifestation of those traits and their interactions with the environment will be a measurable indicator[17]. In Rasch's analysis, the validity of an instrument is seen from two parts, namely item fit and person fit [18]. Analysis with the Rasch model has the privilege of providing a description of the distribution of student abilities (person abilities) and the level of difficulty of the questions on the same scale. The description of the distribution of students' abilities is called the Wright map [17][18]. The Wright map in the Rasch model provides some information about the distribution of person abilities, variability in the level of diversity of the questions.

2. Methods
The study wants to answer the following research questions:
- What is the person ability (person measure and person reliability) of prospective elementary school teacher program on eco critical thinking skill?
- How is the items quality of instrument (Reliability of items, unidimentionality of item, function of differential items?)

The research is quantitative approach non-experimental design. The data have been collected through instrument consisted of 8 test essay items. The 74 students of prospective elementary school teacher program have been asked to answer the questions as respondent. Respondent come from university at the big city (34 students) and from small town (40 students). Data then have been analyzed in the rating scale of Rasch model. Rasch model measure the item reliability, person reliability, unidimentionality items, item difficulty, person abilities, and the probability of a given response

3. Result
The result section is organized into five findings: 1) item reliability, 2) person reliability, 3) person measure (distribution of student ability), 4) unidimentional items, 5) DIF items.
Figure 1 shows the distribution of person’s ability (at the right side) and item difficulty (at the right side) on Eco Critical Thinking Skill divided by vertical line at the center of map. There are 74 person abilities shows by 01PD – 74PK. PD means the respondent is a female from small town and PK is a female from the city. LD means a male from small town and LK is a male from the city. The numbers start from 01 until 74 continuously both for male and female; for city and small town. The map shows that there are 20% (15 respondents) have the high level of person ability and 80% have low level (54 respondents) on Eco Critical Thinking Skill. At the right side of vertical line shows the level of item difficulty. E1 until E8 shows the number of essays questions have been asked by respondent. The distribution of items shows that the item E6 is the most difficult item and item E1 is the easiest.
Table 1. SUMMARY OF 74 MEASURED Person
INPUT: 74 Person 8 Item REPORTED: 74 Person 8 Item 5 CATS MINISTEP 4.3.2

|          TOTAL                         | MODEL       | INFIT     | OUTFIT    |
|          SCORE     COUNT     MEASURE    S.E.      MNSQ   ZSTD   MNSQ   ZSTD |
|------------------|-------------|-----------|-----------|
| MEAN             22.2       7.9       -.47       .58       .99   -.15    .99   -.15 |
| SEM              .8         .1        .25        .01       .08   .16      .08   .16 |
| P.SD             6.7        .5        2.10       .05       .68   1.35     .68   1.36 |
| S.SD             6.7        .5        2.12       .05       .68   1.36     .68   1.37 |
| MAX.             37.0       8.0       4.25       .88       3.56  3.45     3.56  3.43 |
| MIN.             7.0        5.0       -.46       .53       .08  -3.31    .08  -3.31 |
| REAL RMSE        .65 TRUE SD 2.00 SEPARATION 3.06 Person RELIABILITY .90 |
| MODEL RMSE       .58 TRUE SD 2.02 SEPARATION 3.46 Person RELIABILITY .92 |
| S.E. OF Person MEAN = .25 |

Person RAW SCORE-TO-MEASURE CORRELATION = .99
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .94 SEM = 1.70

Table 1 shows that a person’s reliability of this research is 0.90, it means that the respondents have good consistence to answer the questions. Person ability are poor based on the result of mean value of person measurement which under the 0,00 standard (only – 0, 47) [17].

Table 2. Standardized Residual variance

| Component                      | Eigenvalue | Observed Variance | Expected Variance |
|--------------------------------|------------|-------------------|------------------|
| Total raw variance in observations | = 22.6426  | 100.0%            | 100.0%           |
| Raw variance explained by measures | = 14.6426  | 64.7%             | 64.3%            |
| Raw variance explained by persons | = 11.6130  | 51.3%             | 51.0%            |
| Raw variance explained by items  | = 3.0296   | 13.4%             | 13.3%            |
| Raw unexplained variance (total) | = 8.0000   | 35.3%             | 100.0%           |
| Unexplained variance in 1st contrast | = 1.9967   | 8.8%              | 25.0%            |
| Unexplained variance in 2nd contrast | = 1.6443   | 7.3%              | 20.6%            |
| Unexplained variance in 3rd contrast | = 1.3512   | 6.0%              | 16.9%            |
| Unexplained variance in 4th contrast | = 1.0806   | 4.8%              | 13.5%            |
| Unexplained variance in 5th contrast | = .7216    | 3.2%              | 9.0%             |

Unidimensionality is a measurement main to evaluate whether an instrument is able to measure what should be measured. Unidimensionality in the Rasch model is shown by the raw variance explained. The results of Rasch's analysis shows that raw variance data of 64.7% is classified as good based on standard criteria of raw variance which above 40%[17]

Rasch's analysis also detected a Differential item functioning (DIF) in the item. The item or instrument can be biased in its measurement if the item is more favorable or chooses to a particular individual or group. The results of the DIF analysis on the items can be seen in the table below
Table 3. DIF class/group specification is: DIF=$S3W1$

| Person | SUMMARY DIF | CLASSES | CHI-SQUARED | D.F. | PROB. | BETWEEN-CLASS/GROUP Item | UNWTD MNSQ | ZSTD | Number | Name |
|--------|-------------|---------|-------------|------|-------|---------------------------|-------------|------|--------|------|
| 2      | 2.3342      | 1       | .1266       | 2.6650| 1.29  | 1 E1                      |             |      |        |      |
| 2      | .3069       | 1       | .5796       | .3231 | -.19  | 2 E2                      |             |      |        |      |
| 2      | 1.4306      | 1       | .2317       | 1.5851| .82   | 3 E3                      |             |      |        |      |
| 2      | 2.4133      | 1       | .1203       | 2.7748| 1.33  | 4 E4                      |             |      |        |      |
| 2      | .3057       | 1       | .5804       | .3233 | -.19  | 5 E5                      |             |      |        |      |
| 2      | .4033       | 1       | .5254       | .4285 | -.05  | 6 E6                      |             |      |        |      |
| 2      | 2.5943      | 1       | .1072       | 3.0001| 1.41  | 7 E7                      |             |      |        |      |
| 2      | .0000       | 1       | .0000       | .0005 | -1.48 | 8 E8                      |             |      |        |      |

Table 3 shows that all items have a probability value above 0.05, it means that all items can be used for all categories of respondent and not only for certain individuals or groups. Deviation occur in the E8 essay item, because the probability of 1.00 is the possibility of a factor that does not appear to have an effect. To find out more about the DIF on E8, can be crosschecked through the chart below.

Figure 2. Measure Item Difficulty

Figure 2 shows that the E8 question is still within the limits of trust and there is no misfit response. It can also be seen that the E8 problem can be used to measure because it is in accordance with the existing model. Therefore, all essay questions given are items that are fit to be used by respondents.

4. Conclusion

Based on the Wright map, there are only 20% of prospective elementary school teacher program can be categorized on high level category on eco critical thinking skill and 80% stay on low level category. According to summary of 74 measured person, the mean value is -0.47, which mean that the person ability of respondent on Eco critical thinking skill is low and need to be improved.
The unidimensionality of instrument has row variance on 64.7% which meant that this instrument has been classified as a good instrument. The differential item functioning (DIF) have probability value above 0.05 which means that all items of instrument are not bias and can be used for all individuals or groups.

Acknowledgments
My thanks go to Mr. Bambang Sumintono for providing Rasch analysis training. UNS Chemical Education Study Program which has conducted Rasch analysis training. PGSD UNS lecturer Mr. Idam Ragil and Mrs. Yuliana Wahyu (UNIKA St. Paulus) who have assisted in data collection.

Reference
[1] T. A. Sondergeld, A. R. Milner, and C. Rop, “Evaluating teachers’ self-perceptions of their knowledge and practice after participating in an environmental education professional development program,” vol. 18, no. 3, pp. 281–302, 2014.
[2] R. Barata, P. Castro, and M. A. Martins-Loução, “How to promote conservation behaviours: the combined role of environmental education and commitment,” Environ. Educ. Res., vol. 23, no. 9, pp. 1322–1334, 2017, doi: 10.1080/13504622.2016.1219317.
[3] H. R. Hungerford and T. L. Volk, “Changing learner behavior through environmental education,” J. Environ. Educ., vol. 21, no. 3, pp. 8–21, 1990, doi: 10.1080/00958964.1990.10753743.
[4] L. Parker, “Religious environmental education? The new school curriculum in Indonesia,” Environ. Educ. Res., vol. 23, no. 9, pp. 1249–1272, 2017, doi: 10.1080/13504622.2016.1150425.
[5] S. L. Turan, “Awareness of secondary school students about renewable energy,” vol. 116, 2018, doi: 10.1016/j.renene.2017.09.034.
[6] R. Salahodjaev, “Is there a link between cognitive abilities and environmental awareness? Cross-national evidence,” Environ. Res., vol. 166, no. March, pp. 86–90, 2018, doi: 10.1016/j.envres.2018.05.031.
[7] L. Varela-Candamio, I. Novo-Corti, and M. T. García-Álvarez, “The importance of environmental education in the determinants of green behavior: A meta-analysis approach,” J. Clean. Prod., vol. 170, pp. 1565–1578, 2018, doi: 10.1016/j.jclepro.2017.09.214.
[8] B. Gola, “Is formal environmental education friendly to nature? Environmental ethics in science textbooks for primary school pupils in Poland,” Ethics Educ., vol. 9642, no. July, pp. 1–17, 2017, doi: 10.1080/17449642.2017.1343619.
[9] M. M. Pane and R. Patriana, “The Significance of Environmental Contents in Character Education for Quality of Life,” Procedia - Soc. Behav. Sci., vol. 222, pp. 244–252, 2016, doi: 10.1016/j.sbspro.2016.05.153.
[10] F. Reimers, “Education for the 21st Century: Executive Summary Education for the 21st Century,” 2014.
[11] C. Eames and S. Birdsall, “Teachers’ perceptions of a co-constructed tool to enhance their pedagogical content knowledge in environmental education,” Environ. Educ. Res., vol. 25, no. 10, pp. 1438–1453, 2019, doi: 10.1080/13504622.2019.1645445.
[12] N. Evans, H. Whitehouse, and M. Gooch, “Barriers, successes and enabling practices of education for sustainability in far north Queensland schools: A case study,” J. Environ. Educ., vol. 43, no. 2, pp. 121–138, 2012, doi: 10.1080/00958964.2011.621995.
[13] P. a. Facione, “Critical Thinking: What It Is and Why It Counts,” Insight Assess., no. ISBN 13: 978-1-891557-07-1, pp. 1–28, 2013, doi: ISBN 13: 978-1-891557-07-1.
[14] C. Fadel and M. Bialik, “Skills for the 21st Century: What Should Students Learn?,” no. May, 2015.
[15] C. Van Zile-tamsen, “Using Rasch Analysis to Inform Rating Scale,” Res. High. Educ., 2017, doi: 10.1007/s11162-017-9448-0.
[16] S. Wei, Z. Ismail, and B. Sumintono, “A Rasch Model Analysis on Secondary Students’ Statistical Reasoning Ability in Descriptive Statistics,” *Procedia - Soc. Behav. Sci.*, vol. 129, pp. 133–139, 2014, doi: 10.1016/j.sbspro.2014.03.658.

[17] B. Sumintono and W. Widhiarso, *Aplikasi pemodelan rasch pada assessment pendidikan*, Pertama. Trim komunikata, 2015.

[18] M. Stone, B. D. Wright, and M. H. Stone, “MEASUREMENT 2nd Edition,” 1999.