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Perception of Citizen Science Project in Ecology Courses Using Rasch Measurement Model

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Abstract.
The objectives of this study are to obtain information about the knowledge and readiness of students to accept citizen science that is integrated into ecology. Respondents were students of the biology education study program, State Islamic University, Sulthan Thaha Saifuddin Jambi, who had already completed the Ecology course. Respondents amounted to 75 students consisting of 67 female students and 8 male students. The study employed a quantitative descriptive approach. The perception data obtained was analyzed by utilizing Rasch model measurement software, WINSTEPS version 5.2.4.0. Rasch analysis was chosen based on its capability to model the relationship between item's difficulty in rating, person's ability, and possible responses. Data in the feasible category, since the calculated INFIT MNSQ and OUTFIT MNSQ scores are close to 1.0 logit, also the INFIT ZSTD and OUTFIT ZSTD scores are close to 0.0. The Cronbach Alpha value implies that a questionnaire can be accepted to measure student perception. The results of data analysis find out symptoms that students have a desire to try something new that are brought into Ecology courses. The diagnosis of student perceptions also indicates that students are expecting something new to be included in ecology learning that can support the improvement of competence in accordance with their expectations.

Keywords: perception, citizen science project, ecology courses, rasch measurement model

1. INTRODUCTION

Ecology has long been established in the education curriculum, taught from the primary level to the university level. The course presents a variety of knowledge and skills to understand the relationship between organisms or groups of organisms and their environment. The scope of ecological studies that revolve around organic and inorganic environments directs the flow of energy and material cycles to fall into the study of the course. This lesson illustrates that the interrelationship and interdependence of each component must be maintained in a stable and balanced condition, because any alteration to one component can affect the others. These knowledges are learned until one concept is reached.

The interrelation between ecology and the environment has a great impact on life, both directly and indirectly. Ecology has an important role in investigating the interaction of organisms with their environment. The dynamic interaction between ecology and the environment can modify of amount and quality of the environment. This process causes environmental sustainability efforts to focus on environmental balance, which is the continuation of interactions between components despite experiencing changes in structure and function. This linkage clarifies the relationship between ecology, environment and sustainability that shape a natural line of relationship.

The existing education curriculum has great expectations on improving the mastery of life skills along with the mastery of theories and concepts. Opportunities for ecological learning to integrate various environmental problems in the learning process have been opened. Various environmental problems that exist around human life can be used as a training vehicle for students to explore their abilities in mastering various theories, concepts, attitudes and skills. Through various activities in learning, students can be trained to explore their understanding of ecology from inside the classroom, to outside the classroom with real natural settings. The way students come to ecosystems and recognise organisms, understand the processes that occur, and see the impact of humans in a particular ecosystem is a complex skill. It involves not only factual knowledge of ecological content but also the performance to see anthropogenic impacts on natural processes and relate them to environmental issues [1]. At this point, the ecology learning can be organised to achieve specific targets in accordance with the environmental issues raised while not losing the fundamental concepts of ecology.

Ecological learning activities can be used to promote environmental campaigns. Various laws or policies related to the environment, human interaction with the environment, traditions and culture that relate to the environment, until the various threats of damage

to the environment can be introduced in various discussions of ecological course. In addition, the repositioning of human relationships with their natural environment can be organised in the course. It can be done through the reorientation of values, ethics and norms of life which subsequently converge in collective action, as well as the restructuring of social relations between individuals, individuals with groups, groups with groups, and between groups and larger organizations [2]. Furthermore, ecological learning is also oriented to understand the link between ecology and environmental problems and then looking for various solutions that can be applied to overcome these problems.

A possible approach in ecological learning that can be used to support the reorientation of values, ethics and norms of life as well as the restructuring of social relations is citizen science [3]. Based on the terminology used, it closely relates to community participation in scientific projects [4]. Citizen science has a profile as open science, especially in encouraging scientific collaboration that benefits both scientists and society. It also opens up the process of creating, evaluating and communicating scientific knowledge to social actors outside the professional community [5]. The implementation of citizen science in ecological learning activities can provide many benefits, including the development of scientific knowledge in the community, the emergence of public awareness of local problems, the encouragement of policies involving community participation that are more concerned about the environment, both in terms of legislation, politics, advocacy and economics [6]. There are also personal benefits for the participants involved, ranging from skills gained, to knowledge of new subject matter and stronger science literacy [7].

This study is intended to provide an overview of the perceptions of prospective biology teacher students regarding citizen science that will be integrated into ecology learning. The objectives are to obtain information about the knowing and readiness of students in accepting citizen science that is integrated into ecology learning. Hence in the future it may become more convenient to develop the learning programme. In particular, it is also to facilitate the future direction of ecology learning to be closer to various projects in the context of citizen science-based learning.

2. RESEARCH METHOD

The Study employed a quantitative descriptive approach. The perception data obtained was analysed by utilising Rasch model measurement software, WINSTEPS version 5.2.4.0. Rasch analysis was chosen based on its capability to model the relationship

between item difficulty rating, person ability, and possible responses [8]. Respondents were students of the Biology Education Study Programme, State Islamic University, Sulthan Thaha Saifuddin Jambi, who had already completed the ecology course. Respondents amounted to 75 students consisting of 67 female students and 8 male students. The questioner instrument was developed by review of literature related to student perceptions in deep ecological learning through citizen science [4, 9, 10]. The construction of statements was composed of four important indicators, specifically the student perceptions of ecology courses, knowing about citizen science, the performance of citizen science to develop awareness of environmental issues, and the performance of citizen science to foster ecological awareness. The instrument consists of 10 statement items with answer options using 4-point Likert scale, ranging from strongly disagree (1) to strongly agree (4). The item construction of this research statement can be seen in Table 1.

Table 1: Construct of questionnaire items.

Construct of the statement	Statement Item
Student perceptions of ecology courses	S1. I am very happy going to ecology lectures S2. Ecology courses support the improvement of my expected competencies S3. Field observation activities in ecology courses are fun activities for me
Knowing about citizen science	S4. Citizen science is new insight for me S5. I believe citizen science is a great support for ecology course activities
Performance of citizen science enables to increase awareness of environmental issues	S6. I believe that citizen science can provide me with insights and knowledge about environmental issues around me S7. I believe that citizen science will provide real experience for me in addressing environmental issues
Performance of citizen science enables to fosters ecological awareness	S8. I believe working with the communities on citizen science projects helps solve environmental issues S9. I believe the citizen science project will affect my personal attitude to environment S10. The citizen science project will raise my conscious awareness that my life affects the quality of the environment

2.1. Data analysis

Rasch analysis is probabilistic and inferential, focusing on item response patterns that are able to establish the interaction between item and person based on the latent characteristics of reciprocity. Rasch is able to predict the possible abilities of respondents (who have different ability levels) in a single case that forces respondents to provide a response for a statement item with different difficulty levels. The likelihood of success in delivering a response depends on the difference between the respondent's ability

and the difficulty level of the item [11]. In the analysis process, Rasch converts ordinal data into measurable ratios. Rasch measurement theorem refers to two fundamental expectations: (i) Respondents who own better ability or knowledge, have a greater chance of answering all statement items correctly, (ii) Easy statement items, have a chance to be answered correctly by all respondents. This theorem confirms if the Rasch model is able to assume that the difficulty of the question is an attribute that affects the response of the person (respondent) while the ability of the respondent is an attribute that affects the estimation of item difficulty [12]. In the study of student perception of citizen science projects in ecology courses, respondents who tend to agree more are likely to support items with high difficulty levels than respondents who most disagree.

3. RESULT AND DISCUSSION

3.1. Fit Statistic

Fit statistics in Rasch are used to identify whether the data utilised in this study is feasible or not. The identification can be done by looking at the INFIT and OUTFIT values (mean square and standardised values) of the person and item. The term of fit refers to “INFIT” (weighted by the distance between the person position and item difficulty) and “OUTFIT” (an unweighted measure) [13]. Data will fit the Rasch model if the mean values of INFIT MNSQ and OUTFIT MNSQ are close to 1.0 or equal to 1.0. In addition, data will fit the Rasch model if the mean values of INFIT ZSTD and OUTFIT ZSTD are close to 0.0 or equal to 0.0 [14]. Normally, outfit is more sensitive to extreme responses than infit [15]. INFIT and OUTFIT person and item data in this study can be seen in Figure 1.

Since the calculated INFIT MNSQ and OUTFIT MNSQ scores are close to 1.0 logit. Also, the INFIT ZSTD and OUTFIT ZSTD scores are close to 0.0. The findings indicate that the data in this study are in the feasible category.

Considering that Rasch takes into account the relationship between item difficulty and respondent ability, it is necessary to look at fit of item and fit of respondent carefully. Fit of item refers to an index that indicates the functionality of the item. Meanwhile, fit of respondent refers to the index that indicates the person’s response. A mismatched item means that the item is considered too difficult or too easy for the person; or alternatively, it indicates that the item does not actually measure the desired latent trait. Similarly, an irregular or unpredictable response could be an indication of a mismatch in the responses given by the respondent [14].

SUMMARY OF 75 MEASURED PERSON

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	30.4	10.0	3.10	1.03	.84	-.22	.88	-.14
SEM	.3	.0	.26	.02	.11	.14	.16	.13
P.SD	2.8	.0	2.28	.17	.95	1.20	1.41	1.12
S.SD	2.8	.0	2.29	.17	.96	1.21	1.42	1.13
MAX.	39.0	10.0	9.76	1.32	4.38	2.86	8.18	3.40
MIN.	24.0	10.0	-1.70	.65	.15	-1.96	.07	-1.97

REAL RMSE	1.18	TRUE SD	1.95	SEPARATION 1.66	PERSON RELIABILITY .73
MODEL RMSE	1.04	TRUE SD	2.03	SEPARATION 1.94	PERSON RELIABILITY .79
S.E. OF PERSON MEAN = .26					

CRONBACH ALPHA (KR-20) PERSON RAW SCORE "TEST" RELIABILITY = .84

SUMMARY OF 10 MEASURED ITEM

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	228.1	75.0	.00	.36	.95	-.25	.88	-.36
SEM	4.2	.0	.49	.01	.14	.52	.22	.56
P.SD	12.7	.0	1.46	.04	.41	1.57	.65	1.69
S.SD	13.3	.0	1.54	.04	.44	1.65	.69	1.78
MAX.	240.0	75.0	3.62	.39	1.93	3.08	2.34	2.78
MIN.	194.0	75.0	-1.56	.26	.54	-2.01	.29	-2.12

REAL RMSE	.39	TRUE SD	1.40	SEPARATION 3.59	ITEM RELIABILITY .93
MODEL RMSE	.37	TRUE SD	1.41	SEPARATION 3.84	ITEM RELIABILITY .94
S.E. OF ITEM MEAN = .49					

Figure 1: Summary statistic.

More parameters that can be used to diagnose fit statistics are the results of unidimensionality analysis and rating scale. Based on the analysis of the wistep application for unidimensionality, it is obtained that the undimensional measure falls into the good category. The results of the analysis can be seen in Figure 2.

Table of STANDARDIZED RESIDUAL variance in Eigenvalue units = ITEM information units

	Eigenvalue	Observed		Expected
Total raw variance in observations =	21.1937	100.0%		100.0%
Raw variance explained by measures =	11.1937	52.8%		51.7%
Raw variance explained by persons =	9.4446	44.6%		43.6%
Raw Variance explained by items =	1.7490	8.3%		8.1%
Raw unexplained variance (total) =	10.0000	47.2%	100.0%	48.3%
Unexplned variance in 1st contrast =	2.2986	10.8%	23.0%	
Unexplned variance in 2nd contrast =	1.5332	7.2%	15.3%	
Unexplned variance in 3rd contrast =	1.4429	6.8%	14.4%	
Unexplned variance in 4th contrast =	1.0681	5.0%	10.7%	
Unexplned variance in 5th contrast =	1.0230	4.8%	10.2%	

Figure 2: Analisis unidimensionalitas.

Unidimensionality of the instrument is an important measure to evaluate whether the instrument developed is able to measure precisely stated objectives. The principle of measuring unidimensionality in this study is to determine the extent of the diversity of the instrument in measuring student perception of citizen science projects in ecology

courses [16]. The measurement benchmark is by looking at value of “the raw variance explained by measure”, if the score is above 40%, its mean the size of the unidimensionality is good [10]. The raw variance explained by measure value in this study obtained its percentage of 52.8%, it means the size of the unidimensionality this study has a good category.

Rating scale analysis can be employed to verify whether the rating options used in the instrument cause confusion among respondents or not [17]. The results of rating scale analysis in this study are presented in Table 2.

TABLE 2: Rating scale analysis.

Rating scale	AndrichThreshold
1	0.00
2	-5.31
3	-1.39
4	6.70

The Andrich Threshold value in rating scale analysis is used to test whether the options used in the instrument are appropriate. The Andrich Threshold value moves from zero, through negative until the positive value sequentially indicates that the option given is valid for the respondent. The Andrich Threshold values in Table 2 show the movement of values in line to these criteria. So it can be argued that the rating options used in the instrument make it easy for respondents to recognise that the options given are valid for them.

3.2. Validity

The results of statistical Summary analysis (Figure 1) show that the Cronbach Alpha value is 0.84 that implies it can be accepted to measure student perception of citizen science project in ecology courses. However, the Person Reliability value is only 0.73 logit which means that respondents of person quite well to the items in the questionnaire. While the item reliability value is 0.92 logit which informs that this hierarchical order of items has a high level of probability to measure respondents’ perceptions. So the instrument used in this study can reliably separate the perception of the person.

3.3. Analysing Student Perceptions through Wright Map

Wright’s map is a major component of Rasch analysis that visually illustrates the relationship between person and item[18]. The Wright Map presented in Figure 3 displays the

distribution of respondents' abilities and the distribution of item difficulty on the same scale. The vertical line on the Wright Map is the logit interval scale which is the same unit of measurement for person (respondent) and item. The position of respondents on the Wright Map is spread on the right side while the questioner items are spread on the left side, both separated by a vertical line. The respondent's position on the logit scale shows the respondent's ability level, this means that respondents positioned at the highest logit value are respondents having high ability to respond items in the questionnaire. For example, the position of respondents who are above logit 4.5 is able to answer statement items that are scattered below logit 4.5. It means that the respondent is capable of answering well all the items given in the questioner in this study. The distribution of statement items along the vertical wright map line is also has meaning, items in high positions indicate that items are difficult to approve, gradually descending until the lowest items are easy to approve. Respondents occupying the same spot along the scale as a particular item have a 50% chance of agreeing with that item. Symbol information for 'M' is the mean value, 'S' is one standard deviation from the mean value, and 'T' is two standard deviations from the mean value.

Respondents' perceptions related to their knowing about citizen science in Figure 3 for item 4 show that almost 91% of people agree that "citizen science is new knowledge for them". Respondents also gave the same agreement to the statement about "citizen science can support ecology course activities". This indication is seen from item 5 which is positioned in the same line as item 4. Respondents' perceptions related to the statement "citizen science's performance to raise awareness of environmental issues" in item 6 revealed that almost 91% of respondents agreed with the item. Respondents are convinced that citizen science allows them to broaden their horizons and knowledge about the environmental issues around them. Afterwards, almost all respondents agreed that the citizen science project would provide real experience for them, especially in addressing environmental issues. This is clear from item 7, which is at the bottom of the list, which received more agreement than the other items, totalling close to 99%. Respondents' perceptions concerning the ability of citizen science projects to foster ecological awareness are presented in item 8, item 9 and item 10. Item 8 provides information almost 84% of people agree that working with the community in citizen science projects on environmental issues will contribute to solving environmental problems. Item 9 and Item 10 obtained a greater frequency of agreement than Item 8, which is around 97%. So the majority of respondents agree that citizen science projects encourage people to change their behaviour towards the environment, and respondents also agree that

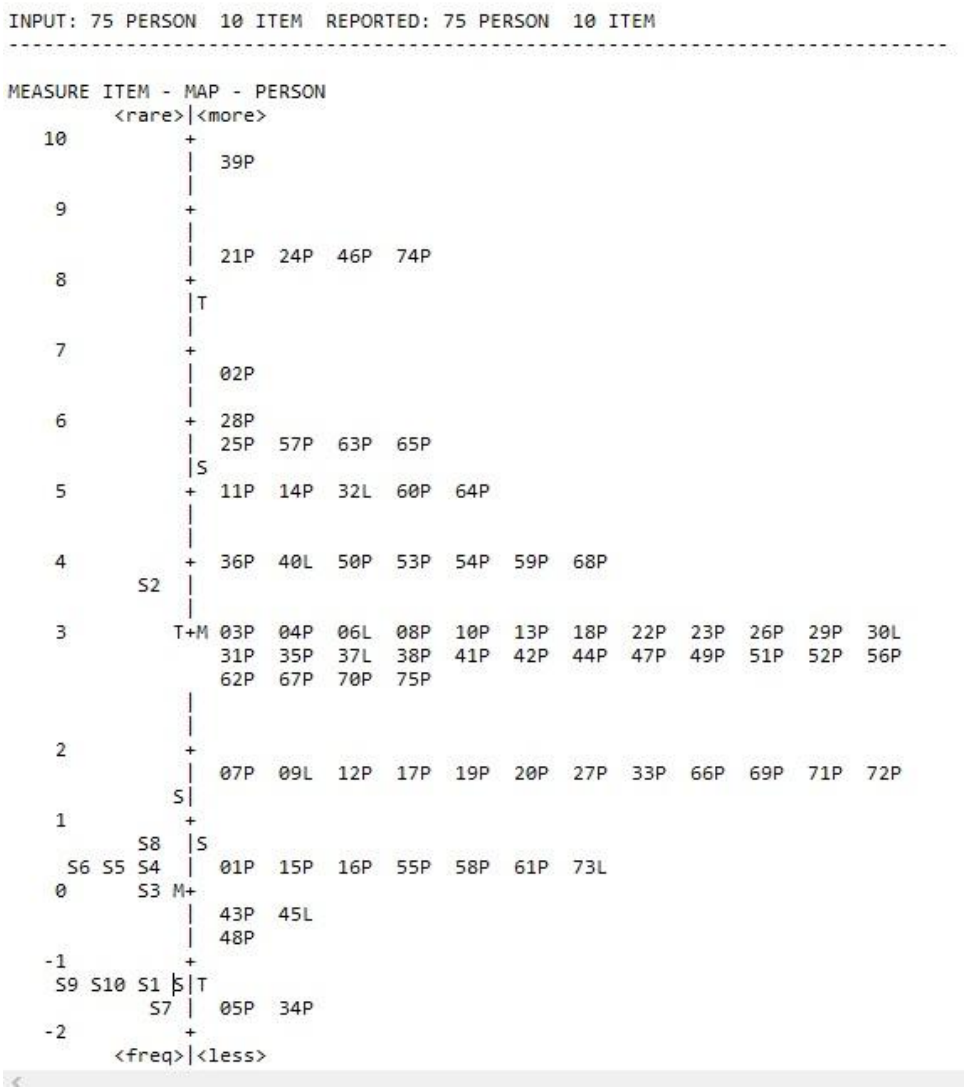

Figure 3: Wright map students perception of citizen science project in ecology courses.

citizen science projects raise awareness about how life activities affect the quality of the environment.

The perception of students towards ecology courses is presented in items 1, 2 and 3. Based on the wright map data analysis, almost 97% of respondents felt excited about the ecology course. This overvie is visible in item 2 occupying the same spot by items 9 and 10. About 93% of respondents favoured the field observation activities in the ecology course. This is evident in item 3 which stands at the mean position. Unfortunately, the majority of respondents did not agree that the Ecology courses they had taken contributed to the increase in competence they had expected. This is in accordance with the results shown by the wright map for item 2. Considering that statement 2 is quite difficult to agree with. Around 30% only of respondents agreed to this statement and approximately 70% of respondents have not given their approval yet to the statement.

4. CONCLUSION

The results of the three statement constructs used to measure student perceptions of citizen science in ecology courses show that most respondents agree on each item. The response given by students towards integrating citizen science in ecology courses shows symptoms that students have a desire to try new ideas that are brought into ecology courses. This indication also in line with the statement “that students are happy with ecology courses and enjoy participating in field observation activities”. The results of this statement were obtained from the perception data provided by respondents on ecology courses, 97% and 93% of students stated that they enjoyed doing observation activities in the field. On the other hand, 70% of students found difficult to agree with the statement that “the ecology courses they have taken support their expected competence improvement”. Based on the data, it can be diagnosed that students are expecting something new to be included in ecology learning that can support the improvement of competence in accordance with their expectations.

The results of this study can be used as information to use citizen science in ecology courses. However, this study has some weaknesses, such as the number of items used in the questionnaire and differences in student demographic characteristics. Therefore, future research may consider the appropriate number of items to be used. In addition, future research is expected to involve a larger number of respondents and more balanced between the number of male and female respondents, so that data can be presented and generalised better.

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