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Research Artikel

BIOLOGY EDUCATION STUDENTS' ANALYSIS OF REASONING ON PLANT TAXONOMY COURSEWHITE RASCH MODEL

ANALISIS PENALARAN MAHASISWA PENDIDIKAN BIOLOGI PADA MATA KULIAH TAKSONOMI TUMBUHAN DENGAN MODEL RASCH

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Abstract

The reasoning is the stage of thinking that tries to connect facts or evidence to reach conclusions. The reasoning includes thinking and reasoning skills that support the formation and modification of concepts. The complexity of learning stages and reasoning gives results in inequality or low levels of reasoning owned by students. This study aimed to analyze the reasoning of students in the Plant Taxonomy course. This research used a descriptive quantitative design. This research used a test instrument administered on 36 students of Biology Education of UIN Raden Fatah Palembang with data collected using questions with indicators based on Toulmin's assessment (2003). The data analysis was conducted by analyzing the level of individual ability (person measure) to determine students' reasoning ability. The data analysis showed that one student had a logit person score of +3.05, namely student number 02, with a high reasoning category. There were twenty-four students, with a medium reasoning category. Two students have the lowest logit person score, namely students 08 and 14, with a logit person score of -0.49. The results indicated that generally, students had difficulty finding plant taxonomy concepts; therefore, thinking needed to be taught more in-depth, so students could manage the information received and conduct a good reasoning analysis in problem-solving.

Keywords: reasoning; plant taxonomy

Abstrak

Penalaran merupakan tahap berpikir yang mencoba menghubungkan fakta atau evidensi untuk mencapai kesimpulan. Penalaran mencakup keterampilan berpikir dan bernalar yang mendukung pembentukan dan modifikasi konsep. Kompleksnya tahapan belajar hingga pada tahap penalaran, mengakibatkan adanya ketidakmerataan atau rendahnya tingkat penalaran yang dimiliki oleh mahasiswa. Penelitian ini bertujuan untuk menganalisis penalaran mahasiswa pada Mata kuliah Taksonomi Tumbuhan. Jenis penelitian adalah deskriptif kuantitatif. Penelitian menggunakan instrumen tes yang dilaksanakan pada 36 mahasiswa Pendidikan Biologi UIN Raden Fatah Palembang. Data dikumpulkan menggunakan soal dengan indikator berdasarkan asesmen Toulmin (2003). Analisis data dengan menganalisis tingkat abilitas individu (person measure) untuk melihat kemampuan penalaran mahasiswa. Hasil analisis menunjukkan bahwa terdapat satu mahasiswa yang memiliki nilai logit person +3,05 yaitu mahasiswa nomor 02, dengan kategori penalaran tinggi. Terdapat dua puluh empat mahasiswa, dengan kategori penalaran sedang. Terdapat dua mahasiswa yang memiliki nilai logit person paling rendah, yaitu mahasiswa 08 dan 14 dengan nilai logit person -0,49. Hasil penelitian menunjukkan bahwa, secara umum mahasiswa banyak mengalami kesulitan dalam menemukan konsep taksonomi tumbuhan sehingga perlu lebih dalam mengajarkan cara berpikir mahasiswa, sehingga mahasiswa dapat mengelola informasi yang diterima dan melakukan analisis penalaran yang baik dalam memecahkan masalah.

***Kata Kunci**: penalara; taksonomi tumbuhan*

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INTRODUCTION

Learning is a way of understanding the world, to give meaning (Marton & Booth, 1997). Learning also mastery of knowledge in the mastery of principles, evidence, and factual information, obtaining methods, techniques, recognition to get the development of behavior based on specific circumstances, so that learning relates to change. Changes in the learning process, one of which is a change in cognitive processes, namely scientific reasoning. A study on students' learning difficulties shows that providing deep learning becomes a difficult task for teachers. The main challenge lies in students' inability to demonstrate a good understanding of the fundamental concepts of a subject (Bides et al., 2017).

Scientific reasoning is used to show a logical and consistent mindset used during the scientific inquiry that allows individuals to propose a relationship between observed phenomena (Bides et al., 2017). Scientific reasoning includes the ability to think and reason in investigations, experiments, assessment of evidence, inferences, and opinions that support the formation and transformation of concepts and theories about nature and the social world (Zimmerman, 2005). According to (Lawson, Banks, & Logvin, 2007), scientific reasoning patterns are defined as mental strategies, plans, or rules used to process information and obtain conclusions beyond direct experience.

Scientific reasoning ability is essential in solving everyday problems and developing future careers (Bao et al., 2009). This ability is highly needed by students and prospective biology teachers, especially in Taxonomy courses. This is due to many scientific terms used and the development of taxonomic approaches that are increasingly complex about other science branches. This challenge resulted in some students being unable to understand some of these scientific terms. Data in the field showed that the reasoning skills of Biology Education students of UIN Raden Fatah Palembang are still low. The data was shown from the results of the pretest on the Plant Taxonomy course. Therefore, scientific reasoning skills need to be trained and fostered in the educational process, especially in science education, to obtain good and correct conclusions. This statement is by Ermayanti et al. (2019), which states that the ability to reason is a general concept that refers to the process of thinking to conclude statements or new conclusions from information, and that can be expressed in words or symbols. Also, Robbins (2011) states that scientific reasoning is an essential element to solve problems.

Reasoning as a science process skill is a significant contributor to academic success and everyday life. Science education reforms have long emphasized helping students develop scientific reasoning skills as the primary goal for science education (Eshun & Amoah, 2018). According to Holyoak and Morrison (Zeineddin & Abd-El-Khalick, 2010), the ability of scientific reasoning marks the development of adolescent cognition and is often demanded in effective decision making and problem-solving. Scientific reasoning is complex (Schunn & Anderson, 1999).

The ability of scientific reasoning can be seen based on Toulmin's reasoning assessment. Toulmin's reasoning assessment provides an approach to conduct analysis that has differences from formal thinking. Toulmin's (2003) Argumentation structure consists of 6 primary statement forms: claim/conclusion, data, warrant, backing, modal qualifier, and rebuttal. This reasoning ability is used to support students' success in solving problems in the Plant Taxonomy course because Plant Taxonomy is a course that is difficult to understand with the existence of several scientific terms used.

Based on some of the problems above, this study was conducted to analyze the scientific reasoning of Biology Education students at Islamic State University of Raden Fatah Palembang in the Plant Taxonomy course. This research is used to find out how high the level of scientific reasoning of students in this course, by providing questions whose indicators are based on Toulmin's (2003) assessment, namely claims/conclusions, data, warranties, backing, modal qualifiers, and rebuttal. Scientific reasoning can be explored and implemented in all student activities using structured problems (Mcneill, College, & Krajcik, 2008).

METHOD

This research used a descriptive quantitative design with 36 students participating in Plant Taxonomy courses in the even semester of 2017/2018. The sampling method was nonrandom sampling, typically convenience sampling techniques (Fraenkel & Wallen, 2006). A multiple-choice test instrument obtained data collection by giving reasons for the answers. The test instruments amounted to 20 items, which contained the reasoning in the Plant Taxonomy material.

Students' scientific reasoning skills are measured by using Toulmin's scientific reasoning indicators (2003). This scientific reasoning indicator consists of 6 primary statement forms, each of which has a different role in the reasoning stage. The statement includes claim/conclusion, data, warrant, backing, modal qualifier, and rebuttal (Table 1).

Table 1. Toulmin's scientific reasoning assessment

Assessment	Explanation
Claim/conclusion (C)	Statement can give confidence to others
Data (D)	Principal of the statement, providing evidence that is suitable for making a claim
Warrant (W)	Validate the relationship between data and conclusions (conclusion)
Backing (B)	Provide deeper evidence to support warrant
Modal Qualifier (Q)	Convey the conclusion criteria by formulating a level of trust
Rebuttal (R)	Has the potential to refute conclusions by expressing the state that the conclusions do not apply

The analysis of students' reasoning abilities used the Rasch Model of student level of reasoning (person measure), Guttman Scalogram analysis, and person fit order analysis. Rasch is an instrument to analyze the validity and reliability of research instruments and test people and items' suitability simultaneously (Sumintono & Widhiarso, 2015).

RESULT AND DISCUSSION

The result of students' reasoning abilities can be seen in Figure 1 (person measure analysis), Figure 2 (Guttman Scalogram analysis), and Figure 3 (person fit order analysis). Person measure analysis illustrates the number of scores obtained by students and the value of their logit person. The table showed the students who answered the most were at the top. Guttman scalogram analysis illustrates student answers' pattern; the item column shows the level of difficulty of item questions ranging from easy to difficult. The person column from top to bottom shows the student who answers the most to the least answers correctly. Person fit order analysis illustrates the level of individual suitability or consistency of students in answering the questions given.

From the results of the analysis of person measure, the average logit person of +0.94 and a standard deviation of +0.74, meaning that student reasoning is above average. Based on the average logit person, three levels of student reasoning ability can be determined, namely:

1) If the logit value> +1.68 is a student with high reasoning; there are five students;
2) If +0.20 <logit value <+1,68 are students with moderate / average reasoning; there are 24 people;
3) If the logit value <+0.20 is a student with low reasoning; there are seven people.

Five students with high reasoning abilities consist of one student (02) with a logit value of +3.05, four students (03, 10, 25, 33) with a logit value of +1.94. Students who have moderate/average reasoning consist of twenty students, consist of six students (07, 09, 20, 32, 34, 35) with a logit score of +1.52 and five students (01, 11, 21, 29, 36) with a logit value of +1.14, eight students (04, 05, 06, 16, 19, 22, 23, 31) with a logit value of +0.79, five students (12, 17, 27, 28, 30) with a logit grade +0.46, and four students (13, 15, 18, 24) with a logit of 0.14. There are three students with low reasoning ability, one student (26) with a logit score of -0.17 and two students (08, 14) with a logit value of -0.49.

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Person
2	18	20	3.05	.84	.56	-.8	.21	-.4	.56	.39	94.7	89.8	02
3	16	20	1.94	.67	.44	-1.8	.26	-.7	.71	.50	94.7	84.2	03
10	16	20	1.94	.67	1.18	.6	1.95	1.1	.37	.50	84.2	84.2	10
25	16	20	1.94	.67	.76	-.6	.45	-.4	.61	.50	84.2	84.2	25
33	16	20	1.94	.67	.59	-1.1	.37	-.5	.66	.50	94.7	84.2	33
7	15	20	1.52	.63	.69	-.9	.45	-.6	.66	.53	84.2	81.8	07
9	15	20	1.52	.63	1.14	.5	.79	.0	.50	.53	73.7	81.8	09
20	15	20	1.52	.63	.94	-.1	.65	-.2	.57	.53	84.2	81.8	20
32	15	20	1.52	.63	1.10	.4	.80	.0	.51	.53	73.7	81.8	32
34	15	20	1.52	.63	.56	-1.4	.38	-.7	.70	.53	94.7	81.8	34
35	15	20	1.52	.63	.66	-1.0	.43	-.6	.67	.53	84.2	81.8	35
1	14	20	1.14	.60	1.47	1.5	1.24	.6	.38	.55	68.4	79.5	01
11	14	20	1.14	.60	1.28	.9	1.11	.4	.45	.55	78.9	79.5	11
21	14	20	1.14	.60	1.00	.1	.78	-.1	.57	.55	78.9	79.5	21
29	14	20	1.14	.60	.64	-1.2	.46	-.8	.70	.55	89.5	79.5	29
36	14	20	1.14	.60	.91	-.2	.80	-.1	.59	.55	78.9	79.5	36
4	13	20	.79	.58	1.79	2.4	2.96	2.5	.18	.57	63.2	76.6	04
5	13	20	.79	.58	1.23	.9	1.06	.3	.49	.57	73.7	76.6	05
6	13	20	.79	.58	1.01	.2	.80	-.2	.58	.57	84.2	76.6	06
16	13	20	.79	.58	.96	.0	.76	-.3	.60	.57	73.7	76.6	16
19	13	20	.79	.58	1.28	1.0	1.69	1.2	.44	.57	63.2	76.6	19
22	13	20	.79	.58	.58	-1.7	.41	-1.2	.75	.57	84.2	76.6	22
23	13	20	.79	.58	1.24	.9	1.02	.2	.49	.57	63.2	76.6	23
31	13	20	.79	.58	.86	-.4	1.36	.8	.59	.57	84.2	76.6	31
12	12	20	.46	.57	.66	-1.4	.50	-1.0	.73	.58	89.5	75.7	12
17	12	20	.46	.57	1.44	1.6	1.92	1.6	.36	.58	78.9	75.7	17
27	12	20	.46	.57	1.07	.3	1.43	.9	.53	.58	78.9	75.7	27
28	12	20	.46	.57	.57	-1.9	.42	-1.3	.76	.58	89.5	75.7	28
30	12	20	.46	.57	.86	-.5	.65	-.6	.66	.58	78.9	75.7	30
13	11	20	.14	.57	1.16	.7	2.10	1.9	.46	.59	84.2	75.1	13
15	11	20	.14	.57	.96	-.1	.80	-.3	.62	.59	73.7	75.1	15
18	11	20	.14	.57	.96	-.1	.71	-.5	.63	.59	73.7	75.1	18
24	11	20	.14	.57	.71	-1.2	.53	-1.0	.72	.59	84.2	75.1	24
26	10	20	-.17	.57	1.00	.1	.76	-.4	.62	.60	68.4	75.6	26
8	9	20	-.49	.57	1.91	2.8	4.57	3.9	.10	.60	57.9	75.7	08
14	9	20	-.49	.57	.92	-.2	.75	-.3	.65	.60	78.9	75.7	14
MEAN	13.3	20.0	.94	.61	.97	-.1	1.01	.1			79.7	78.7	
S.D.	2.0	.0	.74	.05	.34	1.1	.84	1.1			9.4	3.6	

Figure 1. Table of results of the person measure. The average value of a logit person is +0.94 with a standard deviation of 0.74

(Entry number: student number; total score: total score states the number of correct answers for each student; measure: logit value for each student is sorted from highest to lowest; person: student code)

```
GUTTMAN SCALOGRAM OF RESPONSES:
Person |Item
       |     1 1   1 1 1112111
       |69373871295845160420
       |--------------------
     2 +11111111111111111100  02
     3 +11111111111111110000  03
    10 +11111011111011111100  10

    24 +11111111100100100000  24
    26 +11111100101001010000  26
     8 +10111000010100001101  08
    14 +11111100100001100000  14
       |--------------------
       |     1 1   1 1 1112111
       |69373871295845160420
```

Figure 2. Summary of the results of the Guttman Scalogram analysis

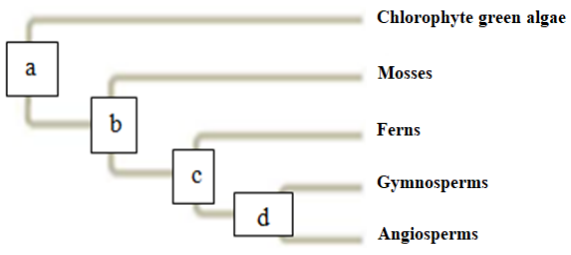
ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Person
8	9	20	-.49	.57	1.91	2.8	4.57	3.9	A .10	.60	57.9	75.7	08
4	13	20	.79	.58	1.79	2.4	2.96	2.5	B .18	.57	63.2	76.6	04
13	11	20	.14	.57	1.16	.7	2.10	1.9	C .46	.59	84.2	75.1	13
10	16	20	1.94	.67	1.18	.6	1.95	1.1	D .37	.50	84.2	84.2	10
17	12	20	.46	.57	1.44	1.6	1.92	1.6	E .36	.58	78.9	75.7	17
19	13	20	.79	.58	1.28	1.0	1.69	1.2	F .44	.57	63.2	76.6	19
1	14	20	1.14	.60	1.47	1.5	1.24	.6	G .38	.55	68.4	79.5	01
27	12	20	.46	.57	1.07	.3	1.43	.9	H .53	.58	78.9	75.7	27
31	13	20	.79	.58	.86	-.4	1.36	.8	I .59	.57	84.2	76.6	31
11	14	20	1.14	.60	1.28	.9	1.11	.4	J .45	.55	78.9	79.5	11
23	13	20	.79	.58	1.24	.9	1.02	.2	K .49	.57	63.2	76.6	23
5	13	20	.79	.58	1.23	.9	1.06	.3	L .49	.57	73.7	76.6	05
9	15	20	1.52	.63	1.14	.5	.79	.0	M .50	.53	73.7	81.8	09
32	15	20	1.52	.63	1.10	.4	.80	.0	N .51	.53	73.7	81.8	32
6	13	20	.79	.58	1.01	.2	.80	-.2	O .58	.57	84.2	76.6	06
21	14	20	1.14	.60	1.00	.1	.78	-.1	P .57	.55	78.9	79.5	21
26	10	20	-.17	.57	1.00	.1	.76	-.4	Q .62	.60	68.4	75.6	26
18	11	20	.14	.57	.96	-.1	.71	-.5	R .63	.59	73.7	75.1	18
16	13	20	.79	.58	.96	.0	.76	-.3	r .60	.57	73.7	76.6	16
15	11	20	.14	.57	.96	-.1	.80	-.3	q .62	.59	73.7	75.1	15
20	15	20	1.52	.63	.94	-.1	.65	-.2	p .57	.53	84.2	81.8	20
14	9	20	-.49	.57	.92	-.2	.75	-.3	o .65	.60	78.9	75.7	14
36	14	20	1.14	.60	.91	-.2	.80	-.1	n .59	.55	78.9	79.5	36
30	12	20	.46	.57	.86	-.5	.65	-.6	m .66	.58	78.9	75.7	30
25	16	20	1.94	.67	.76	-.6	.45	-.4	l .61	.50	84.2	84.2	25
24	11	20	.14	.57	.71	-1.2	.53	-1.0	k .72	.59	84.2	75.1	24
7	15	20	1.52	.63	.69	-.9	.45	-.6	j .66	.53	84.2	81.8	07
35	15	20	1.52	.63	.66	-1.0	.43	-.6	i .67	.53	84.2	81.8	35
12	12	20	.46	.57	.66	-1.4	.50	-1.0	h .73	.58	89.5	75.7	12
29	14	20	1.14	.60	.64	-1.2	.46	-.8	g .70	.55	89.5	79.5	29
33	16	20	1.94	.67	.59	-1.1	.37	-.5	f .66	.50	94.7	84.2	33
22	13	20	.79	.58	.58	-1.7	.41	-1.2	e .75	.57	84.2	76.6	22
28	17	20	.46	.57	.57	-1.9	.42	-1.3	d .76	.58	89.5	75.7	28
2	18	20	3.05	.84	.56	-.8	.21	-.4	c .56	.39	94.7	89.8	02
34	15	20	1.52	.63	.56	-1.4	.38	-.7	b .70	.53	94.7	81.8	34
3	16	20	1.94	.67	.44	-1.8	.26	-.7	a .71	.50	94.7	84.2	03
MEAN	13.3	20.0	.94	.61	.97	-.1	1.01	.1			79.7	78.7	
S.D.	2.0	.0	.74	.05	.34	1.1	.84	1.1			9.4	3.6	

Figure 3. Analysis of Person Fit Order

Figure 1 shows that student 02 has the highest logit person value (+3.05), meaning that this student has high reasoning ability because most are correct in solving problems and giving the right arguments. This high reasoning is by the concept of Toulmin's reasoning assessment. Students can provide appropriate statements, provide evidence relevant to the choice of answers, the link between answers and reasons, with good sources, and conclude the solutions explained. This can be seen in the Guttman Scalogram total score analysis column; student 02 gets a score of 18 from a total of 20 questions (Figure 2).

One example of questions and answers of students who have high reasoning is as follows:

In the cladogram below, pair the derived characters with the "a and b" branching points. Answer the questions and give reasons!



Answer

Pairs of characters derived from the branching points "a and b" based on the cladogram are embryos and vascular tissue (C) because characters are markers that refer to the shape, composition, content, or behavior of creatures that can be used to compare and group organisms with other organisms (D) while the cladogram is a branched diagram showing kinship ties between organisms based on evolutionary origin (W). Therefore, it can be concluded that the character pair cladogram derived from the "a" and "b" branching points is based on the development of the embryonic and vascular tissue due to evolution so that plants are more complex than before. (Q). The development of these characters can be seen in the following table (B):

Branching "a" (Embryo)	
Green Algae	**Moss, ferns, seed plants (Angiosperms and Gymnosperms)**
Algae do not experience embryonic development. This means that the results of zygote fertilization do not develop into embryonic stages in the female reproductive organs.	Embryos live in female gametangium

Branching "b" (vascular tissue)	
Moss	**ferns, seed plants (Angiosperms and Gymnosperms)**
Does not have vascular tissue (transport) Water enters the body through imbibition	Having vascular tissue (carrier) in the form of xylem and phloem. Xylem acts as a carrier for water and mineral salts. Phloem acts as a means of transporting the results of photosynthesis from the leaves to organs in need.

The suitability or consistency of student 02 in answering questions, can be seen in Figure 3 (person fit order analysis).

Figure 3 shows that student 02 is very consistent in answering questions. The suitability of each question that is not appropriate (outliers or misfit) is checked using the following parameters:

1) The mean square outfit (MNSQ) value received: 0.5 <MNSQ <1.5.
2) Accepted Z-standard (ZSTD) outfit values: -2.0 <ZSTD <+2.0.
3) Point measure correlation value (Pt mean Corr): 0.4 <Pt mean Corr <0.85 (Sumintono & Widhiarso, 2015).

Based on the above criteria, student 02 has the response pattern of answering having high consistency in answering questions. The student can meet all reasoning indicators because he has a good mastery of the Plant Taxonomy course material. This is seen from the MNSQ value of 0.21; ZSTD -0.4; Pt mean Corr 0.56, the value of which is still within the acceptable range.

Students with moderate reasoning ability, there are twenty-four students who have a logit value of +0.20 <logit value <+1,68, namely students 07, 09, 20, 32, 34, 35, 01, 11, 21, 29 , 36, 04, 05, 06, 16, 19, 22, 23, 31, 12, 17, 27, 28, 30, 13, 15, 18, and 24. Figure 1 shows that this student got a score of 11- 16 of the 20 questions were given. Shows that this student is only able to answer 11-16 questions. If seen from the Guttman Scalogram analysis (figure 2), it can be seen that this student has moderate reasoning because the pattern of answering questions is not accompanied by evidence that can convince others. Examples of answers that have moderate reasoning with the same problem are pairs of characters derived from the branching points "a and b" based on the cladogram are the embryo and vascular tissue (C) because the cladogram is a diagram used to show the relationship between organisms (W). Therefore, it can be concluded that in a and b, the development of embryonic characters and vascular tissue (Q) occurs.

Students with low reasoning ability, two students, have the same logit value, namely students 08 and 14, with a logit value of -0.49. Figure 1 showed that these two students got a score of 9 out of the 20 questions given. Show that this student is only able to answer nine questions. Seen from the Guttman Scalogram analysis (figure 2), it can be seen whether the two students indicated a guess (lucky guess) because the pattern of answering questions was very different. Examples of answers that have low reasoning with the same problem are seeds and vascular tissue. The answers submitted are wrong and do not use data arguments and conclusions.

Student 14 is more likely to answer questions in an easy and medium category. This can be seen from the person fit order results, namely MNSQ 0.75 and ZSTD -0.3 are outside the accepted limits, but the Pt mean Corr value of 0.65 is still between the accepted limits. From the Guttman scalogram analysis, students 14, when answering easy questions, can answer. When answering questions with a high degree of difficulty, they cannot answer. Although answering, this answer is obtained from guesswork.

Compared to student 14, student 08 tends to be more likely to guess. The answer pattern in the form of guesses is carried out by students who lack reasoning and mastery of theory about the Plant Taxonomy course. Based on picture 3, student 08 shows the person who is the most misfit. This can be seen from the MNSQ value of 4.57; ZSTD 3.9; and Pt mean Corr 0.10. This value is outside the accepted limit. This student answer pattern 08 from the Guttman scalogram analysis shows an inconsistent answer pattern because it provides answers to questions with a high degree of

difficulty but cannot answer questions with easy and moderate difficulty levels.

The inability of students in answering questions is influenced by the following factors: 1) students are not able to absorb information from the mateti presented in the Plant Taxonomy course, 2) the lack of student attention to the material, 3) the assumption that learning material in the Plant Taxonomy course is filled with memorization. This statement is per information conveyed by Hidayat (2015) that difficulties faced by students in studying plant taxonomy occur because of 1) the lack of student curiosity to study and explore the material, 2) the focus of students on subjects tends to be low, 3) students consider lecture material Plant Taxonomy is filled with memorization, 4) some students have the opinion that the course is theoretical and can cause boredom (Hidayat, 2015).

When students answer questions, a learning process occurs that demands to think in memory. Thinking is the stage of manipulating or managing and transforming information in memory. In memory, the information received will be processed through three stages, namely the encoding stage (the entry of information into memory); storage phase (safeguarding information from time to time); and retrieval stage (retrieval of information from memory) (Santrock, 2008). Retrieval is transferring what we know but does not think about the current situation. Information retrieval is the process of recognizing and recalling.

The use of varied teaching materials and appropriate learning models and media are indispensable in the stages of learning to overcome the difficulties of students in accepting a material. This statement is per the opinion of Aswin et al. (2018) that using various teaching materials is needed to facilitate lecturers in designing learning and helping students study concepts efficiently. Variations in learning activities can be done by applying various kinds of scientific learning models—effective learning activities by providing opportunities for students to construct their knowledge.

Tafonao (2018) states that learning media is a tool for teachers in the teaching and learning process to increase student creativity and attention in the learning process. Learning media have an essential role in the learning process. The media acts as a means of channeling information from the sender to the recipient. Learning media can create teaching and learning activities more effectively and efficiently so that there is a good relationship between teacher and student. Also, the media has a role as a solution to boredom in learning.

Reasoning ability is one of the critical targets to be achieved in the teaching and learning process and other targets such as knowledge, skills, products, and affectivity(Stiggins, 1994). Students' reasoning ability is needed because it can facilitate them in making decisions and solving life problems (Matlin, 2003). Reasoning ability can also help students deal with things more critically(Ennis, 1996). The reasoning is the stage of thinking in drawing conclusions based on the knowledge learned and helps in making decisions about the problems faced in life.

CONCLUSION

Students' reasoning is at a high, medium, and low level. The level of reasoning of students with the largest number of samples is moderate. Students have difficulty finding the concept of plant taxonomy; therefore, students need to be taught more ways of thinking to manage the information received and transform it into memory. This is good for concept formation, reasoning, problem-solving, decision making, critical thinking, and creative thinking.

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