

Student Concept Understanding of Natural Products Chemistry in Primary and Secondary Metabolites Using the Data Collecting Technique of Modified CRI

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ABSTRACT

The concepts of Natural Products Chemistry (NPC) is taught in a hierarchy of complex concepts into simple concepts, beginning of primary metabolites and secondary metabolites through synthesis of alkaloids. This study examines the understanding of the concept of students in the matter of primary metabolites and secondary metabolites. Total respondents involved in this study are 19 students majoring in chemistry education on semester eight from one of the state university of West Nusa Tenggara, Indonesia. All respondents had a previous NPC lectures in semester six. This research uses descriptive method with percentage analysis and statistical tests. Data obtained through the technique of CRI (Certainty Response Index) and the modified CRI. There are significant differences between the techniques of data from CRI and modified CRI. Taking into account the culture of students in Indonesia which is tended not sure of the answer given, so the discussion in this study use data from the modified CRI technique. The results showed 28.95% of students understand the concepts very well; 41.58% had misconceptions, and 29.47% did not know the concept. Misconceptions occur at all levels of learners, both of which have the capability of high, medium, or low.

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Keywords:

Natural Products Chemistry, secondary metabolites, misconceptions.

Introduction

Generally, NPC is used to find drugs (Visht & Chaturvedi, 2012) and pesticides (Mann & Kaufman, 2012). Various methods are used allow the identification of bioactive secondary metabolites from terrestrial and marine sources. There have been many studies of secondary metabolites is currently used as a drug or drug candidate (Dias, et al., 2012). Sources diversity of secondary metabolites derived from biodiversity. Less than 10% of the world's biodiversity has studied the content of secondary metabolites (Dias, et al., 2012). Indonesia has a huge potential in advancing NPC because Indonesia has a very high plant diversity. Indonesia has 25,000 species of higher plants and 40% of which are endemic plants Indonesia (Resosoedarmo, 1993). According to Ahmad (2004), research and technology policy in the United States focused on aspects of communication and information, Japan on manufacturing while in Indonesia is located on the biodiversity of the authorized capital, the recognition of the world to Indonesia as the second largest country after Brazil in terms of biodiversity. Abundant natural resources may be a promising potential to be learned in the study of NPC.

NPC concepts taught in a hierarchy of complex concepts into simple concept, which starts from the characteristics of the secondary metabolites to alkaloid synthesis (Sudarma, 2009). Such concepts of NPC are presented sequentially, not just solving tests contains the characteristics of each different topic. With such

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characteristics can certainly lead learners have difficulty in learning NPC. One huge factor inhibiting his part in understanding the concept of NPC is the misconception in self-learners (Kazambe, 2010). NPC concept analysis results show that most of the concepts in the NPC consists of concepts with critical attributes of abstract but concrete examples. This of course may cause difficulties and misconceptions in understanding the concept of NPC.

Background of the Study

NPC studies have been instrumental in advancing the scientific family, such as in family health and agricultural sciences. There have been many secondary metabolites from plants and animals used by the pharmaceutical industry as drugs or model compounds. NPC can also contribute in the manner of cultivation through the study of compounds of plants that play a role in the regulation of plant life (Syah, 2010).

Content learned in the NPC include primary and secondary metabolites, order/variation of the structure, biosynthesis/biogenesis relations vs molecular structure, the determination of the structure, general properties, synthesis and manufacture of terpenoids, steroids, polyphenols (polyketides and phenyl propanoid), flavonoids, and alkaloids. These concepts are presented sequentially not just a solution containing the tests to the characteristics of each different topic. With such traits can certainly lead learners have difficulty in understanding the concept of NPC.

One of the major factors that inhibit learning in NPC is a misconception. Misconceptions that students experienced was caused by several factors: (1) establishment of informal ideas that come from everyday experience, culture and religion, peer groups and other environmental pressures, (2) the view is incomplete or incorrect that developed by students during learning, and (3) the concept of imprecise, misleading or false submitted by the lecturer or from a book (Kazembe, 2010).

One example that the causes of misconceptions in learning NPC is the presence of environmental factors that could affect the content of secondary metabolites in plant species. Learners can have the view that environmental factors will not affect the content of a species of plant secondary metabolites because these species have similar morphology for metabolism, so it will perform the same steps and will also produce secondary metabolites as well the type and the quantity. Alternatively, learners can have the view that environmental factors can cause this type of secondary metabolites produced a similar species to be different due to the absorbed nutrients or light intensity obtained by the plant. The second misconception as described above due to an incomplete concept of the learner. They assume that environmental factors can cause different types of secondary metabolites produced by a plant species even though the research results (Venkataraman 1972) suggests that environmental factors will affect only the quantity of secondary metabolites, but it will not affect the type of secondary metabolites produced by a plant species due to same stage of the process of metabolism. Misconception that a protracted NPC will damage the system as a whole understanding of learners, given the NPC concepts largely related to one another.

Certainty of Response Index (CRI). CRI is one way to distinguish between the know the concept, misconceptions, and do not know the concept. Misconception identification error will cause an error in break a way, for overcoming misconceptions and do not know the concept is very different. CRI is a measure of certainty of the students answer the questions given. Certainty of the answer scale portrayed in CRI, CRI value <2.5 indicates lack of confidence of students to answer questions (Hasan, et al., 1999).

CRI is based on a scale provided with each answer a question. Degree of certainty is reflected in the scale of CRI answers given, a low CRI indicates uncertainty on self-concept respondent to answer a question, in this case the answer is usually determined on the basis of mere conjecture. Instead of high CRI reflects the confidence and certainty that the concept of high self-respondents in answering the question, in this case a very small element of guesswork. One respondent had misconceptions or do not know a simple concept can be distinguished by comparing whether or not the answer to a problem with the level of certainty of response index (CRI) is given for that question (Tayubi, 2005). CRI is often used in surveys, especially those asking respondents to provide a degree of certainty that he had from his ability to select and utilize the knowledge, concepts, or laws formed well within himself to determine the answer to a question (Saehana & Kasim, 2011).

The CRI is a measure of the degree of certainty respondents answered every question. This index is generally considered the type of Likert scale. In particular, for each question in the form of multiple-choice tests, for example, respondents were asked to: (a) selecting an answer that is considered right from the alternative options available, (b) provide CRI, between 0-5, for each answer choice. CRI 0 requested if the answer selected results of pure guesswork, while CRI 5 asked if the answer has been selected on the basis of knowledge and skills which she believed the truth (Hasan, et al. 1999). CRI scale between 1-4 have used by Potgieter, et al. (2005) with certain provisions (4), almost certain (3), almost a guess (2) or a totally guessed answer (1). The downside of this method can occur if learners have low confidence. Students actually understand the concepts presented in the question but because it has low confidence will lead to them giving a low CRI values, thus categorized guess the answers to questions.

By considering the strengths and weaknesses of CRI as well as the culture of the students in Indonesia are likely to always be not sure of the answers given, the instrument developed in this study for detection misconceptions Natural Products Chemistry at the primary and secondary metabolites material by using CRI modified by adding open grounds in the test.

Context of the Study

NPC is a part of science that examines the types, distribution and function of secondary metabolites contained in an organism, so that the NPC is strongly associated with the manufacture of pharmaceuticals, cosmetics, and pesticides. NPC has excellent potential in Indonesia because Indonesia has a very high diversity of plants. However, based on analysis of the concept of the NPC material can be seen that most of the NPC concept consists of the critical attributes of an abstract concept but a concrete example. If students have not reached the stage of formal operations is a critical attribute of abstract concepts with concrete examples, but can lead to misconceptions. This is supported by the results of research Kazembe (2010) which states that the NPC learning students often have misconceptions that cause learners difficulty understanding the concept of NPC. This study aims to assess the understanding of the concept of material NPC particularly primary and secondary metabolites. Based on these objectives, the following research questions:

- How effective data collection techniques to capture the percentage of students who already understand the concept, have misconceptions, and do not know the concept of the material of primary metabolites and secondary metabolites?
- What percentage of students who already understand the concept, have misconceptions, and do not know the concept of the learning material NPC for primary and secondary metabolites?
- How to understand the concept of distribution criteria, have misconceptions, and do not know the concept of the material of the metabolites in primary and secondary students with high proficiency, moderate, and low at the lecture NPC?

Method

Participants

Participants consisted of 19 students on semester eight from one of state university of West Nusa Tenggara, Indonesia. All participants have attended NPC courses in semester six.

Procedure

This study uses descriptive. At the end of the second semester 2011/2012, the participants who had attended the previous year lecture given questionnaires containing 10 questions about the concepts in the matter of primary metabolites and secondary metabolites that are prepared using the modified CRI data collection techniques. Here are some examples of questions used in this study:

Direction: Mark the one alternative that best answerers the question and give the reason. For each selected response provide a degree of certainty from 0-5 such that 0 Total guess the answer; 1 almost guess, 2 not sure, 3 sure, 4 is almost certain; 5 for sure.

- How is the distribution of primary metabolites in each species?
- A. Every species of plant metabolites containing the same primary
- B. Each species contains a different primary metabolites
- C. Each species contains both primary metabolites of different types and quantity
- D. Each plant species contain flavonoids, steroids, terpenoids same

Reason:.....

Degree of Certainty: 0 1 2 3 4 5

- Taking into account environmental factors. Is the same species but from different locations of the same secondary metabolites containing both types and quantity?
- A. Species contains the same secondary metabolites in type or quantity
- B. Plant species they contain secondary metabolites of the same type but different quantity
- C. Plant species they contain secondary metabolites of different types but the same quantity
- D. Species contains different secondary metabolites in type or quantity

Reason:.....

Degree of Certainty: 0 1 2 3 4 5

- How is the distribution of secondary metabolites in the flesh of the fruit, rind and seeds of a plant species?
- A. Must contain the same secondary metabolites
- B. Certainly contain different secondary metabolites
- C. Secondary metabolites can contain the same or different
- D. Contains flavonoids similar

Reason:.....

Degree of Certainty: 0 1 2 3 4 5

Previously, researchers have explained about the charging procedure questionnaire regarding the procedure of choosing the answers and write down the reasons specified in section as well as an explanation of the CRI modified techniques are used to the participants.

Instruments

This research instrument combines data collection techniques-choice test on the grounds open (Amir, 1987; Krishnan, 1994) and techniques Certainty of Response Index (CRI) (Hasan, et al., 1999). CRI values (0-5) shows the magnitude of the level of confidence in answering questions. Following criteria set by the CRI value: 0 Total guess the answer; 1 almost guess; 2 not sure; 3 sure; 4 is almost certain; 5 for sure. Basically, the scale gives a level of confidence that the students in answering questions. Number 0 indicates the level of confidence held learners are very low, students answer questions by guessing. This indicates that learners do not know anything about the concepts in question, while figure 5 shows the confidence level of the students in answering questions is very high. They answer questions with knowledge or concepts correct guesses with no element at all. This value is the value given by the students themselves about beliefs when answering each question. In other words, when learners give CRI, actually provide an assessment of the learners themselves for choosing rules or concepts that have been ingrained in his mind so that they can determine the answer to a question.

CRI scale 0-2 indicating a low degree of certainty. It describes the factors guessing the answer is very high regardless of right or wrong answers. CRI values were low, 0-2, showed that learners do not know the concepts underlying answers. High CRI values that have scale 3-5. Learners have high confidence in selecting rules or concepts that are used to arrive at an answer. At the scale of high CRI level right or wrong

answers very influential. If the answer is correct, so the students have high trust and truth of its concepts can be tested properly. If the answer is one of the students suffered misconceptions in determining the answer to the question. This event can be used as an indicator of the occurrence of misconceptions in self-learners. Provisions and explanation, CRI method can be used to distinguish between students who had misconceptions with students who do not know the concept. CRI provides a measurement of the degree of certainty or reliance on any response learners (Hasan, et al., 1999).

Furthermore, based on the value of CRI embodied learners will be used to determine the criteria to understand the concept well, misconceptions, or do not know the concept. Here's an example of the determination of the CRI criteria developed by Hasan, et al. (1999) on one of the questions that have been described previously:

- How is the distribution of primary metabolites in each species?
 - A. Every species of plant metabolites containing the same primary
 - B. Each species contains a different primary metabolites
 - C. Each species contains both primary metabolites of different types and quantity
 - D. Each plant species contain flavonoids, steroids, terpenoids same

Reason:.....

Degree of Certainty: 0 1 2 3 4 5

If the students choose the correct option, choice (A), with CRI values > 2.5, so the students are classified as respondents understand the concept very well. If the students choose the wrong option, in addition to choice (A), with CRI values > 2.5, so the students are classified as respondents who have misconceptions. Learners with CRI values <2.5 choose option right or wrong categorized into those who did not know the concept. Table 1 shows the terms CRI developed Hasan, et al. (1999) for each answer learners.

Table 1. Terms CRI for each answer given (Hasan, et al., 1999)

Criteria for Answers	Low CRI (<2.5)	High CRI (>2.5)
Answer correctly	Answer correctly but lower CRI means do not know the concept (lucky guess)	Answer correctly and high CRI means mastering the concept
Wrong answers	Wrong answers mean and low CRI did not know the concept	Wrong answers but higher CRI means there is the misconception

The terms CRI constrained in its application in Indonesia because of the character of the students in Indonesia tend to be convinced by their answers. In other words, students actually understand the concepts provided but they are not sure of the answer. The solution to these problems is to add the reason for each answer given learners, so that when students choose the correct answer and the reason is true even though the students are not sure of the answers we can categorize the students understand the concept. This instrument named CRI modified for detection Natural Products Chemistry misconceptions that combines CRI techniques and multiple-choice data collection techniques with open grounds. Here is an example of the determination of the CRI criteria on one of the questions that have been described previously:

- Taking into account environmental factors. Is the same species but from different locations of the same secondary metabolites containing both types and quantity?
 - A. Species contains the same secondary metabolites in type or quantity
 - B. Plant species they contain secondary metabolites of the same type but different quantity
 - C. Plant species they contain secondary metabolites of different types but the same quantity
 - D. Species contains different secondary metabolites in type or quantity

Reason:.....

Degree of Certainty: 0 1 2 3 4 5

If the students choose the correct option, option (B), and the reasons expressed correctly, the same species have the same metabolic step that same kind of secondary metabolites but because of different environmental factors such as available nutrients causes the quantity of a type of secondary metabolites produced different, with CRI values > 2.5, so the students are classified as respondents understand the concept very well. If the students choose the right choice and the reasons expressed by the true value of CRI <2.5, so the learners are classified as respondents understand the concept very well too. The students choose the wrong option, in addition to option (B), with right or wrong reasons and CRI values > 2.5 are classified into respondents who have misconceptions. The students choose the wrong option, with right or wrong reasons and CRI values <2.5 are classified into those who did not know the concept. The students choose the correct option with wrong the reason and CRI values <2.5 are classified as respondents do not know the concept too. These provisions modified CRI for every answer learners.

Table 2. Terms CRI modified for each answer given

Answers	Reasons	CRI value	Description
True	True	> 2.5	Understand the concept of well
True	True	< 2.5	Understand the concept but are not confident with the answers given
True	False	> 2.5	Misconceptions
True	False	< 2.5	Do not know the concept
False	True	> 2.5	Misconceptions
False	True	< 2.5	Do not know the concept
False	False	> 2.5	Misconceptions
False	False	< 2.5	Do not know the concept

The validity of the instrument is determined by using a type of content validity is done by requesting the opinion of experts, while reliability was determined using the formula Alfa (Arikunto, 2011).

$$r_{11} = \frac{(n)}{n - 1} \left(1 - \frac{\sum \sigma_i^2}{\sigma^2} \right)$$

- r_{11} = reliability of the instrument
- n = number of respondents
- $\sum \delta_i^2$ = number of variant scores of each item
- δ^2 = total variance

From the results perhitungan using the above formula is obtained for 0.863 reliability of the instrument.

Data Analysis

Percentage analysis and statistical tests used for data processing. T test used to see the difference in the results of data collection techniques CRI and CRI modified. Data analysis was also performed to see the percentage of students who understand the concept, have misconceptions, and do not know the concept. The results of analysis of research data is also used to see the spread of misconceptions at all levels of learners who have the ability to either high, medium, or low.

The results of the research data processing using the provisions of modified CRI and CRI are shown in the following table.

Table 2. The results of data analysis using a technique CRI and modified CRI

CRI			Modified CRI		
% P	% M	%T	% P	% M	%T
54,74	14,21	31,05	28,95	41,58	29,47

Description:

P = understand the concept; M = misconceptions; T = do not know the concept

Further understanding of the concept, misconceptions, and do not know the concept to any concept of matter primary and secondary metabolites by using a technique modified CRI presented in Table 3.

Table 3. The percentage of well-understood concepts, misconceptions, and do not know the concept of primary and secondary metabolites

No	Concepts	% P	% M	%T
1	Distribution of primary metabolites	47,37	31,58	21,05
2	Distribution of secondary metabolites	21,05	47,37	31,58
3	Indicators of secondary metabolites	52,63	21,05	26,32
4	The content of secondary metabolites in all parts of the plant	42,11	21,05	36,84
5	The content of secondary metabolites in each species of plant	10,53	68,42	21,05
6	The content of the primary metabolite in each species of plant	31,58	47,37	21,05
7	Biological activity of secondary metabolites	52,63	26,32	21,05
8	The relationship of secondary metabolites with biological activity	15,79	42,11	42,11
9	Quantity relationship of secondary metabolites with biological activity	0	47,37	52,63
10	Environmental influences on secondary metabolites	15,79	63,16	21,05
Average		28,95	41,58	29,47

Description:

P = understand the concept; M = misconceptions; T = do not know the concept

Test results on the percentage distribution of well-understood concepts, misconceptions, and do not know the concept of primary and secondary metabolites on the material and learning outcomes NPC of 19 participants in this study are presented in Figure 1.

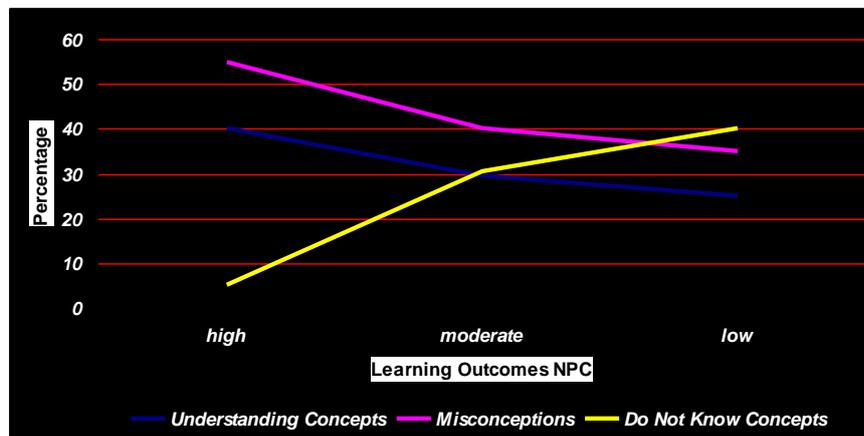


Figure 1. Percentage Relationship of Good Understanding Concepts, Misconceptions, and Do Not Know Concepts in the matter of primary and secondary metabolites with Learning Outcomes NPC

Discussion

Different test results mean (t-test) using SPSS 12 on the data into two data collection techniques misconceptions (CRI and modified CRI technique) of 19 respondents indicated that there were significant differences for the categories to understand the concepts and misconceptions with the sig. 0012 respectively, and 0.009 (<0.05), whereas for the category does not know the concept is not the case a significant difference (sig.0, 799). Data analysis using CRI technique produces the largest percentage in the understanding of concepts (54.74%) and lowest on misconceptions (14.21%), while data analysis using modified CRI technique produces the largest percentage on misconceptions (41.58%) and lowest in the understanding concepts (28.95%). Explanation of the data analysis revealed that these two techniques cannot be used together because there are significant differences. Based on consideration of the Indonesian culture that tends not sure of the answer provided more details and criteria in CRI technique modified the interpretation of the data for the following discussion will use the techniques of data analysis of the modified CRI

The results of data analysis using a technique modified CRI shows the percentage of respondents misconceptions on the material is quite high (41.58%), as well as the percentages do not know the concept (29.47%). This could be a matter of considerable concern because misconceptions that students will experience a smooth and successful learning obstruct. This is in line with that expressed by Pujayanto, et al. (2007), the occurrence of accidental misconceptions will continue to disrupt learning. NPC concepts taught in

a hierarchy of complex concepts into simple concept, which starts from the concept of primary and secondary metabolites through synthesis and manufacture of secondary metabolites (Sudarma, 2009). This suggests that the material of primary and secondary metabolites is considered the most complex, which can cause difficulties and misconceptions in learners. Misconceptions can lead learners increasingly difficult and has an error in understanding the concept, so that eventually can cause students to be no longer interested in studying NPC.

From the 10 concepts that are tested to the respondent shows that respondents understand the concepts of the primary metabolite rather than the concepts of secondary metabolites. The results of testing of the concept of distribution of primary metabolites showed 47.37% of respondents to master concepts; misconceptions 31.58%, and 21.05% did not know the concept, while the concept of distribution of secondary metabolites of respondents who mastered the concept of 21.05%, 47.37% misconceptions ; and do not know the concept of 31.58%. This is consistent with the results of testing the concept of the primary metabolite content in each plant species to understand the concept of 31.58%; misconceptions 47.37%, and 21.05% did not know the concept, while the results of testing the concept of secondary metabolites content in each plant species 10 , 53% understood the concept; misconceptions 68.42%: 21.05% did not know the concept.

Based on data from 10 tested the concept that these concepts can be categorized into:

- The concept consists of an easily understood: the concept of secondary metabolites and the concept of indicators of biological activity of secondary metabolites.
- The concept that often lead to misconceptions consists of: the concept of secondary metabolites content in each plant species and environmental influences on the concept of secondary metabolites.
- The concept is difficult to understand the concept of the relationship of quantity of secondary metabolites with biological activity.

Test results on the percentage distribution to understand the concepts, misconceptions, and do not know the concept of the material of primary and secondary metabolites by the NPC study of 19 participants shows that understanding the concept of learning is directly proportional to the NPC. Participants with higher learning outcomes 40% understand the concepts being tested, whereas participants in the study was to understand the 29.57% of the tested concepts and learning outcomes of participants with low-understand 25% of the tested concepts. Similar results were also seen from the criteria of misconception, that respondents with higher learning outcomes have misconceptions about 55% of the tested concepts. Respondents to the study were having misconceptions 40% of the tested concepts and respondents with low learning outcomes have misconceptions 35% of the tested concepts. While the criteria do not know the concept of learning is inversely proportional to the NPC. Respondents with higher learning outcomes only 5% who do not know the concept, while respondents in the study was 30.43% have no idea and concept of the respondents with a low learning outcomes have 40% did not know the concept.

Based on these results shows that misconceptions can occur either in the good learners and learners who are less intelligent. This is in line with the said Berg (1991) that misconception can happen to all categories of students. From the data shown the tendency of respondents with high ability have a misconception that is also high and low responders with the ability to have the misconception that low. This is due to the respondents with high ability have many alternative concepts capable of thinking, but most of the concept is different from the concept agreed upon by experts. Based on these explanations the students with high ability learning require a complete concept so the concepts are built not cause the misconceptions. It is also revealed from the results of research conducted Arnyana (2006) which showed that students with high ability are likely to have the potential of having misconceptions were also high.

Conclusions

The results showed a difference in the results of data analysis a significant association between CRI and CRI modified technique. CRI modified technique can overcome the problem of culture in Indonesia learners who tend not sure of the answer given. CRI modified technique allows learners to give reasons for answers

given. If the students choose the correct answer along with the right reasons, even though the low CRI then it can be assumed that learners understand the concept but has a low confidence level

The results of data analysis using the modified technique shows the percentage of CRI understands the concept of 28.95%, 41.58% and misconceptions do not know the concept of 29.47% on a matter of primary metabolites and secondary metabolites. Of the findings shows that the percentage is high misconceptions. This could be a matter of considerable concern because misconceptions that students will experience a smooth and successful learning hamper.

The results also showed misconceptions on the matter of primary and secondary metabolites occur in students with high proficiency, moderate and low. The data showed a trend of students with high abilities has a misconception that high and low-ability students have a misconception that low. This could be due to the high ability learners have many alternative concepts, but most of these concepts differ markedly from that of the experts agreed. Based on the explanation of the concept of learning NPC requires a complete study of the concepts so that students are not built caused of misconceptions

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