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Conformity Analysis of HOTS (Higher-order Thinking Skills) Based on Critical Thinking in the Evaluation of High School Biology Learning in the East Cirebon Region

Ajeng Mudaningrat[1*], Yuyun Maryuningsih[2], Indah Rizki Anugrah[2]

[1, 2] IAIN Syekh Nurjati Cirebon, Indonesia

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ABSTRACT

This study aims to analyze the suitability of HOTS (Higher-order Thinking Skills) based on critical thinking on the Odd Semester Final Examination questions for high school biology lessons in the East Cirebon Region. The research subjects were schools in the Cirebon area, namely SMAN 1 Lemahabang, MAN 3 Buntet Pesantren Cirebon and MA NU Putri Buntet Pesantren Cirebon. Data analysis is presented in the form of percentages and then described based on critical thinking indicators (characteristic thinking) based on Facione, (2011) on the Biology Final Semester Exam (UAS). The odd semester final exam (UAS) for biology subjects already contains critical thinking skills, but the percentage is still low. The most dominating indicator is interpretation. Based on this research, it shows that the questions made by the teacher are not sufficient to cultivate students' critical thinking skills.

Analisis Kesesuaian HOTS (Higher Order Thinking Skills) Berbasis Berpikir Kritis dalam Evaluasi Pembelajaran Biologi SMA di Wilayah Cirebon Timur

ABSTRAK: Penelitian ini bertujuan untuk menganalisis kesesuaian HOTS (Higher-order Thinking Skills) berdasarkan critical thinking pada soal Ujian Akhir Semester ganjil pelajaran biologi SMA se-Wilayah Cirebon Timur. Subjek penelitian adalah sekolah yang ada di wilayah Cirebon yaitu SMAN 1 Lemahabang, MAN 3 Buntet Pesantren Cirebon dan MA NU Putri Buntet Pesantren Cirebon. Analisis data disajikan dalam bentuk persentase selanjutnya dideskripsikan berdasarkan indikator berpikir kritis (ciritical thinking) berdasarkan Facione, (2011) pada soal Ujian Akhir Semester (UAS) biologi. Ujian Akhir Semester (UAS) ganjil mata pelajaran biologi sudah memuat keterampilan berpikir kritis, namun dengan persentase yang masih rendah. Indikator yang paling mendominasi adalah interpretasiBerdasarkan penelitian tersebut menunjukkan bahwa soal yang dibuat oleh guru belum memadai untuk menumbuhkan keterampilan berpikir kritis siswa.

INTRODUCTION

Global change is accelerating in the 21st century. These changes affect all development sectors, including education (Safrida et al., 2018). Education in the 21st century has been implemented to equip students with thinking, acting, and living skills (Pratiwi et al., 2019). Partnership for 21st-century skills explains one of the skills or expertise students must possess in the 21st century, namely Higher-Order Thinking Skills or HOTS (Agustine et al., 2020).

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Higher-Order Thinking Skills (HOTS) are an internal process that occurs in every individual. The internal process includes the process of thinking to find an idea, decision, or conclusion (Susilowati & Sumaji, 2021). Higher-order Thinking Skills (HOTS) are the result of combining and developing various cognitive concepts, methods, and learning taxonomies so that they can improve students' thinking processes at the cognitive level (Dinna, 2019). According to Ichsan et al. (2019), higher-order thinking skills are a student's ability to think at a higher level. Students with higher-order thinking skills (HOTS) will analyze, evaluate, and create problem-solving innovations.

HOTS consists of critical and creative thinking skills (Angkol et al., 2018). Critical thinking skills are part of higher-order thinking that is important to be taught to students apart from creative thinking (Sari et al., 2021;Agustine et al., 2020). Critical thinking and creative thinking are essential skills possessed by students. They are two complementary skills because they can encourage students to respond critically to problems in an ever-changing world. They enable students to find answers or creative solutions to solve problems to gain new, better, and valuable things for life (Fanani, 2018). However, in recent years, Indonesia has plans to establish a curriculum that requires students to get used to critical thinking in all subjects studied in school.

Johnson, (2014) suggests that critical thinking is a directed and straightforward process used in mental activities, such as solving problems, making decisions, persuading, analyzing assumptions, and conducting scientific research. Critical thinking skills are thinking activities that direct a person to decide what to do or believe is the best thing (Ennis & Eric, 1985;Irawan et al., 2017). Critical thinking skills, according to Facione, (2011), include six skills: 1) Interpretation; 2) Analysis; 3) Evaluation; 4) Inference; 5) Explanation; and 6) Self-regulation. The critical thinking referring to Facione, (2011) can be seen in Table 1.

Table 1. Indicators of Critical Thinking Skills According to Facione, (2011).

Critical Thinking Skills Indicator	Sub-Indicator of Critical Thinking Skills	Description
Interpretation	• Grouping • Encode meaning • Clear Meaning	Questions make students understand and express the meaning of experiences, situations, data, judgmental events, conventions, beliefs, rules, procedures, or criteria.
Analysis	• Test ideas • Recognize arguments • Identify reasons and statements	Questions that support students in analyzing the intended and actual inferential relationships between statements, questions, concepts, descriptions, or other forms of representation intended to express beliefs, judgments, experiences, reasons, information, or opinions.
Inference	• Make a statement • Think of alternatives • Conclude (Maryuningsih, et al., 2020).	Questions support students to draw reasonable conclusions, form conjectures and hypotheses and consider relevant information.
Evaluation	• Assess the credibility of the statement • Assess the quality of the arguments made using inductive and deductive reasoning	Questions that support students in assessing the credibility of a statement or other representation are an explanation or description of a person's perception, experience, situation, judgment, belief, or opinion, whether it is correct or not.

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Critical Thinking Skills Indicator	Sub-Indicator of Critical Thinking Skills	Description
Explanation	• Declare Results • Support Procedures • Present arguments	Questions that support students to state and justify reasoning in terms of evidentiary, conceptual, methodological, criteriological, and contextual considerations form the basis of a result and present the reasons in convincing arguments.
Self-regulation	• Self-monitoring • Self-improvement	Questions that support students to monitor their cognitive activities, the elements used in these activities, and the results obtained, especially by applying skills in analysis and evaluation of their inferential judgments to ask, confirm, validate, or correct one of the questions, someone's reasons, or results.

The purpose of critical thinking is to maintain objectivity. It will measure all sides of the argument and evaluate the weaknesses and strengths. Critical thinking skills require some ability to actively look for all sides that support an argument and examine the requirements of claims made from the evidence used to support claims. The main thing about critical thinking the objectivity of the arguments put forward is proven (Linda & Lestari, 2019).

Critical thinking is needed by individuals to address the problems of life experienced. In critical thinking, a person can adjust and change or improve his thoughts to act more appropriately (Rika & Luluk, 2021). Someone who thinks critically is skilled at reasoning. A person can use his reasoning in a context where his reasoning is used as the basis of his thinking (Kartimi, 2012).

The importance of critical thinking skills is that 1) critical thinking skills are necessary capital or intellectual capital (knowledge), which is very important for everyone, 2) critical thinking skills are a fundamental part of human maturity, 3) critical thinking skills are skills that must be taught to students through various kinds of natural sciences or other disciplines in order to prepare students to be successful in life (Agustine et al., 2020).

In reality, many biology teachers in Cirebon Regency have not implemented learning that makes students think at a higher level (HOTS). Thus, they use evaluation easy category tools. The analysis by researchers in the odd semester biology final exam questions for the eleventh-grade students in the East Cirebon area found that the coverage of questions with the HOTS category is only 17-23%. The percentages represent that the odd semester final examination questions are in the easy category and have not been adequately used for high school students. Furthermore, the questions do not reflect students' ability to think critically.

Based on this description, the quality of the questions made by the teacher in measuring students' higher-order thinking is low (Musdalifah et al., 2020). Questions in the easy category produce students who do not have higher-order thinking skills (Amalia & Wahyuni, 2020). The inability of students to develop higher-order thinking skills or critical thinking will cause them to be unable to develop new ideas needed for the development of works or businesses (Rifana et al., 2021).

Moreover, the low question quality affects students when they face Olympic questions and SBMPTN (university enrollment test) questions. The 21st-century learning and the industrial revolution era 4.0 are more oriented toward critical thinking skills. In learning, teachers are expected to familiarize students with critical thinking through Higher-order Thinking Skills (HOTS) so that students can compete, be creative, innovative and competitive to compete globally (Ernawati, 2020).

This research analyses questions on the odd semester final examination for

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biology subjects focused on one aspect of higher-order thinking (HOTS), namely critical thinking, based on Facione, (2011). This research needs to be done because previous researchers have never done it. Therefore, this research aims to analyze the suitability of HOTS (Higher-order Thinking Skills) based on critical thinking on the odd semester final examination for high school biology lessons in the East Cirebon Region.

This research is expected to be a reflection for teachers to apply 21st-century skills to students, one of which is critical thinking skills, by familiarizing students with answering questions in the higher-order thinking category (HOTS).

METHOD

The researchers applied the descriptive-quantitative method. The research was carried out in February 2022. The research subject was the odd semester final exam questions for biology lessons in the eleventh grade of the 2021/2022 academic year. This research was carried out in SMAN 1 Lemahabang, MAN 3 Buntet Pesantren Cirebon, and MA NU Putri Buntet Islamic Boarding School Cirebon. The considerations for choosing these schools as places of observation are based on the level of accreditation (A).

The data collection technique in this research consisted of two stages: 1) The preparation stage is where the researchers made research letters and research instruments to analyze the final semester exam questions. 2) The implementation stage consisted of data analysis and data tabulation. The data were analyzed and presented in percentages and then described using critical thinking indicators based on Facione, (2011).

Indicators of critical thinking skills, according to Facione, (2011), cover six skills: 1) Interpretation, 2) Analysis, 3) Evaluation, 4) Inference, 5) Explanation, and 6) Self-regulation. However, this research was limited to five indicators: interpretation, analysis, inference, evaluation, and explanation. The limitation was that the self-regulation indicators have never been found in questions that measure students' cognitive levels.

The research instrument was based on the suitability of HOTS using critical thinking skills by Facione, (2011) with five indicators: 1) Interpretation; 2) Analysis; 3) Evaluation; 4) Inference; and 5) Explanation.

Table 2. Research Instrument

No.	Indicators *Critical Thinking*					Description
	IP	A	IF	EV	EX	
Etc						
Total						

Information:
IP: Interpretation
A: Analysis
IF: Inference
EV: Evaluation
EX: Explanation
Instruction:
Fill the table with numbers 1 (having critical thinking characteristics) and 0 (not having critical thinking characteristics) based on the results of the analysis according to Facione, (2011).

RESULTS AND DISCUSSION

The suitability of the HOTS questions was analyzed in SMAN 1 Lemahabang, MAN 3 Buntet Islamic Boarding School Cirebon, and MA NU Putri Buntet Islamic Boarding School Cirebon (Putri et al., 2022)

Table 3. Results of Analysis of Critical Thinking Characteristics

Critical Thinking	Results of Analysis of Critical Thinking Characteristics											
	SMAN 1 Lemahabang				MAN 3 Buntet Cirebon				MANU Putri Buntet Cirebon			
	Number of Questions	Total Question	Formula	Results (%)	Number of Questions	Total Question	Formula	Results (%)	Number of Questions	Total Question	Formula	Results (%)
Interpretation	10	40	10:40x100%	25%	12	35	12:35x100%	34,29%	14	45	14:45x100%	31,11%

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Critical Thinking	Results of Analysis of Critical Thinking Characteristics											
	SMAN 1 Lemahabang				MAN 3 Buntet Cirebon				MANU Putri Buntet Cirebon			
	Number of Questions	Total Question	Formula	Results (%)	Number of Questions	Total Question	Formula	Results (%)	Number of Questions	Total Question	Formula	Results (%)
Analysis	3	40	3:40x100%	7,5%	4	35	4:35x100%	11,43%	3	45	3:45x100%	6,67%
Inference	2	40	2:40x100%	5%	9	35	9:35x100%	25,71%	3	45	3:45x100%	6,67%
Evaluation	2	40	2:40x100%	5%	1	35	1:35x100%	2,86%	0	45	0:45x100%	0%
Explanation	3	40	3:40x100%	7,5%	6	35	6:35x100%	17,14%	1	45	1:45x100%	2,22%

Based on the analysis using critical thinking based on Putri et al., (2022), the characteristics of critical thinking at each end-of-semester exam question tested in senior high school in the East Cirebon area were different. The first indicator was interpretation contained in the odd semester final exam questions. The interpretation indicator on the final semester examination questions tested at SMAN 1 Lemahabang consisted of ten questions (25%), with a total of 40 questions tested. At MAN 3 Buntet Pesantren Cirebon, there were twelve questions with a total of 35 questions tested, so the percentage was 34,29%. MA NU Putri Buntet Cirebon's interpretation indicator was 14 (31.11%), with 45 questions tested. Interpretation indicators are questions that make students understand and express the meaning or significance of various experiences, situations, data, assessment events, conventions, beliefs, rules, procedures, or criteria (Putri et al., 2022).

Questions with interpretation indicators dominate other indicators because students are only required to explain and interpret the meaning or concept presented in the question. According to Agustine et al., (2020), the interpretation indicator requires students to only understand the problem indicated by what is known or asked about the question correctly. Examples of questions with interpretation indicators are found in the odd semester final examination questions tested at MAN 3 Buntet.

The question in Figure 1 reads, "The difference between the digestive system of ruminants and humans mainly lies in ...". The question requires students to classify the differences in the digestive system of ruminants and humans. Grouping is included in the Interpretation sub-indicator in critical thinking, according to Putri et al., (2022).
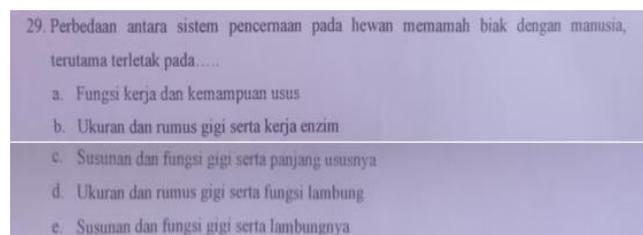

Figure 1. Question with Interpretation Indicator

The analysis indicators identify relationships between statements, questions, concept descriptions, or other forms of representation intended to express beliefs, judgments, experiences, reasons, information or opinions (Amalia & Wahyuni, 2020). The analysis indicators contained in the odd semester final examination questions tested at SMAN 1 Lemahabang consisted of three (7.5%) questions with a total of 40. At MAN 3 Buntet Pesantren Cirebon, the questions with analysis indicators consisted of four questions (11.43%), with a total of 35 questions tested. Then, in MA NU Putri Buntet Pesantren Cirebon, there were three questions (6.67%) with a total of 45.

This analysis indicator contains questions that require students to make strategies to solve a problem using the concepts they have understood. Agustine et al., (2020) state that questions with analysis indicators are included in examining ideas, obtaining opinions, and analyzing opinions as part of the analysis. Facione, (2011) states that questions support students in analyzing the intended and actual inferential relationships between statements, questions, concepts, descriptions, or other

forms of representation intended to express beliefs, judgments, experiences, reasons, information, or opinions (Nafisa & Wardono, 2019). In the analysis indicators, students are expected to make connections between statements, questions, and concepts from the questions to improve students analysis skills in solving problems (Ratna, et al., 2016). Questions with the analytical indicators were found in the odd semester final examination questions tested at SMAN 1 Lemahabang.
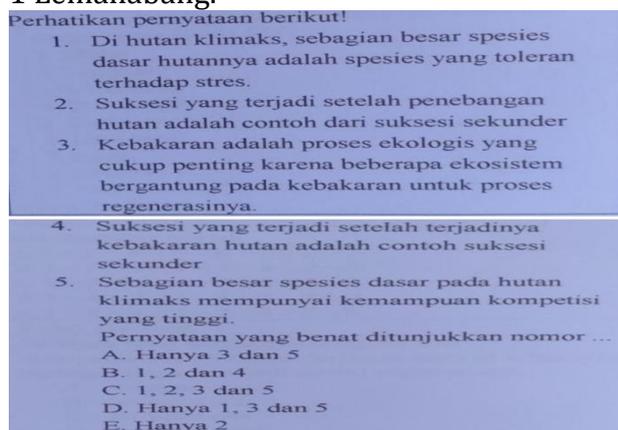

Figure 2. Question with Analysis Indicator

The question in Figure 2 reads, "Pay attention to the following statement! 1) In climax forest, most of the forest base species are stress-resistant species; 2) succession that occurs after felling is an example of secondary succession; 3) fire is an important ecological process because some ecosystems depend on fire for their regeneration process; 4) succession that occurs after a forest fire is an example of secondary succession; 5) Most of the basic species in the climax forest have high competitiveness. Numbers indicate the correct statements...." The questions require students to identify the arguments that are considered correct by students. Recognizing the arguments themselves is included in the sub-indicator of analysis on critical thinking, according to Facione, (2011).

Inference indicators are skills for students to solve questions according to the information in the questions. The subject draws conclusions from what is asked logically (Puspitawati, et al., 2021). The inference indicators were contained in the

odd semester final examination questions tested at SMAN 1 Lemahabang, which consisted of two questions (5%) with a total of 40 questions tested. At MAN 3 Buntet Pesantren Cirebon, there were nine questions (25.71%), with a total of 35 questions tested. Then, at MA NU Putri Buntet Pesantren Cirebon, three questions had an inference indicator with a percentage of 6.67%, and a total of 45 questions were tested. Inference indicators can make students collect essential elements needed to make conclusions. Questions with inference indicators can make students solve problems according to the information in the questions where the subjects conclude what has been asked logically (Puspitawati, et al., 2021). Facione, (2011) states that questions containing inference indicators support students in drawing reasonable conclusions, forming conjectures and hypotheses, and considering relevant information. Questions with inference indicators were found in the odd semester final examination (UAS) tested at MA NU Putri Buntet Pesantren Cirebon (Sani, R. A., & Bunawan, 2022)(Ratna Purwati, Hobri, 2016).
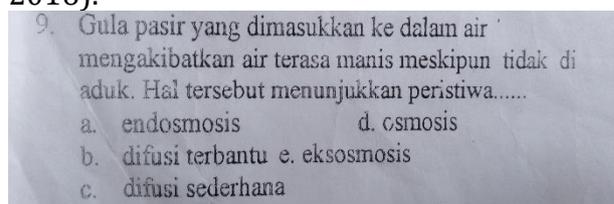

Figure 3. Question with Inference Indicator

The problem in Figure 3 reads, "Sugar added to water causes the water to taste sweet even though it is not stirred. It shows the process of...". The question has an indicator of "asking a statement". It requires students to understand the statements in the questions, answer questions based on available information, and conclude the events that occurred in the explanation. Asking one's statement is included in the sub-indicator of inference in critical thinking, according to Cahyani (2019).

The evaluation indicators require students to assess the credibility of information (Amalia & Wahyuni, 2020). The

evaluation indicators contained in the odd semester final examination questions tested at SMAN 1 Lemahabang consisted of two questions (5%) with a total of 40. MAN 3 Buntet Pesantren Cirebon had one question (2.86%) of this indicator, totalling 35 questions. At MA NU Putri Buntet Pesantren Cirebon, the final examination questions did not have evaluation indicators, so the percentage of the 45 questions tested was 0%. Evaluation indicators enable students to think critically by making a decision based on existing criteria. Irawan et al., (2017) state that evaluation indicators mean an assessment of the trust (credibility) of statements or representations from the description of someone who is an expert in perception, experience, assessment, and for interpretation of existing logical skills. Evaluation skills decide the value to be measured using existing criteria. Students can synergize cognitive aspects in assessing a fact or concept at this stage. Desi (2019) states that the evaluation indicator can support students in assessing the credibility of a statement or other representation, explanation, or description of a person's perception, experience, situation, judgment, belief, or opinion, whether it is correct or not. Based on the analysis results, the low percentage of evaluation indicators contained in the final semester examination questions tested in high schools in the East Cirebon Region made the students unable to assess the credibility of statements based on predetermined criteria. Questions with evaluation indicators were contained in the odd semester final examination questions at SMAN 1 Lemahabang.
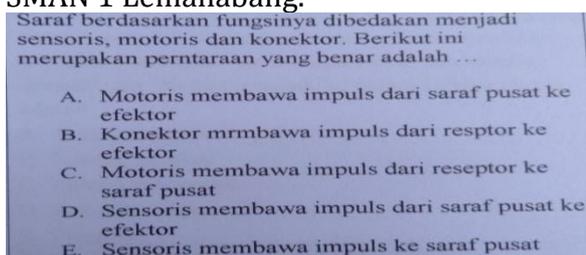

Figure 4. Question with Evaluation Indicator

The problem in Figure 4 reads, "The nerves, based on their function, are divided into sensory, motoric, and connector. The true statement is ...." The problem requires students to assess the quality of the arguments made using inductive and deductive judgments about the nervous system. Indicators assessing the quality of arguments made using inductive and deductive considerations are included in the sub-indicators of evaluation in critical thinking (Lestari et al., 2016).

According to Irawan et al., **(**2017), the explanation indicator is defined as a skill in convincing in a way that makes sense of the results in a reason by giving students a full view of the big picture. The evaluation indicators contained in the odd semester final exam questions were tested at SMAN 1 Lemahabang, consisting of three questions (7.5%) with a total of 40. MAN 3 Buntet Pesantren Cirebon had six questions (17.14%), with a total of 35 questions tested. MA NU Putri Buntet Pesantren Cirebon had one question that contained an explanation indicator with a percentage of 2.22%, and the total questions tested were 45 questions. Questions containing explanation indicators require students to provide logical reasons based on the results obtained. Agustine et al., (2020) state that the explanation indicator is a skill to determine and provide logical reasons based on the results obtained. Meanwhile, according to Rositawati (2019), questions with explanation indicators will support students to state and justify reasoning in terms of evidentiary, conceptual, methodological, criteriological and contextual considerations that form the basis of the results. Examples of questions with the explanation indicators were found in the odd semester final examination questions tested at MAN 3 Buntet Pesantren Cirebon.

The question in Figure 5 reads, "The correct order of the digestive system starting from the mouth is ..." The question requires students to describe and support the procedure for the correct order of the organs of the digestive system, starting from

the mouth. Indicators supporting the procedure itself are included in the sub-indicators of explanation in critical thinking, according to Alya (2022). The following graph displays the percentage of critical thinking indicators based on the analysis of the final exam questions for class XI biology subjects in senior high schools in the East Cirebon area.
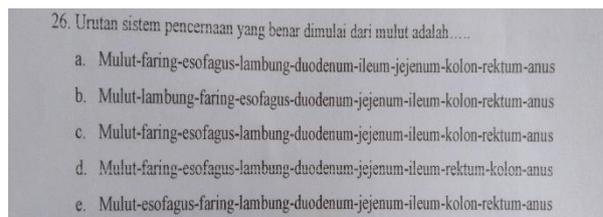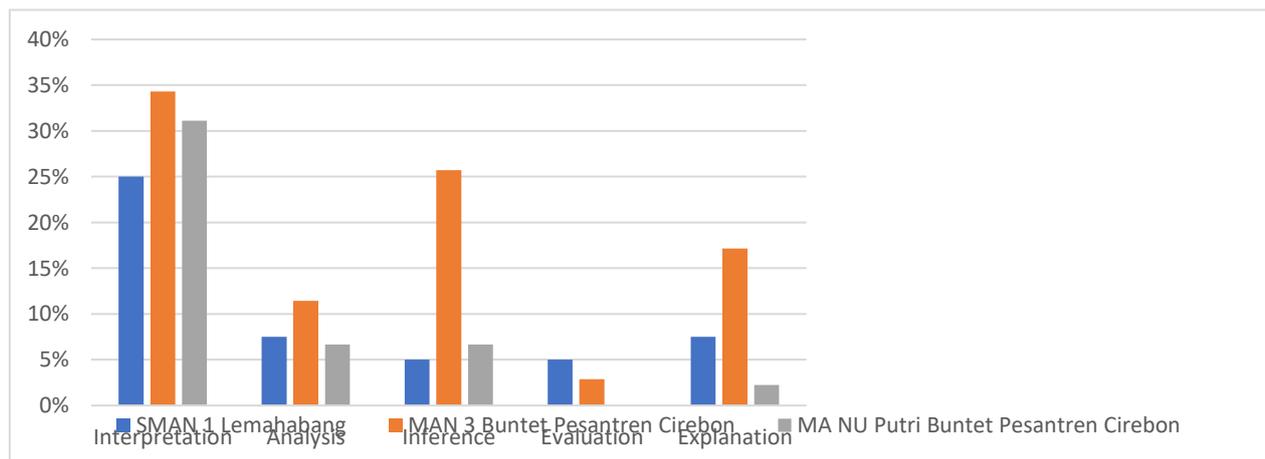

Figure 5. Question with Explanation Indicator

Figure 6. The Percentage of Critical Thinking Characteristics at High Schools in the East Cirebon Area

Based on Figure 6, the odd semester final exam questions for biology subjects tested at SMAN 1 Lemahabang, MAN 3 Buntet Pesantren Cirebon, and MA NU Putri Buntet Pesantren Cirebon had low percentages, less than 50% in each indicator. The lowest was the evaluation indicator. The data showed that the questions made by the teacher were not enough to develop students' critical thinking skills. Critical thinking skills are necessary for students. Students who can think critically have a confident attitude, are very open, appreciate honesty, respect for clarity and thoroughness, look for different perspectives, and will change attitudes when there is an opinion considered suitable and explicit (Yunita et al., 2018). More than that, critical thinking skills are helpful and can be used as a provision in dealing with life now and in the future. With critical thinking skills, a person can think rationally and logically in receiving information and solve problems systematically (Linda & Lestari, 2019).

CONCLUSIONS AND SUGGESTIONS

Based on the results of research and discussion, the odd semester final exam questions for biology subjects already contained critical thinking skills, but the percentage was low. The most frequent indicator was interpretation at SMAN 1 Lemahabang (25%), MAN 3 Buntet Pesantren Cirebon (34.29%), and MA NU Putri Buntet Pesantren Cirebon (31.11%). The lowest indicator was the evaluation indicators at SMAN 1 Lemahabang (5%), MAN 3 Buntet Pesantren Cirebon (2.85%), and MA NU Putri Buntet Pesantren Cirebon (0%). Based on this research, the questions made by the teacher were insufficient to cultivate students' critical thinking skills. So, it is vital to have support and an active role from the local government to provide training and reinforcement in compiling higher-order thinking questions (HOTS) with critical thinking characteristics for high school students.

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