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Science Learning Management Based on Higher Order Thinking Skills (HOTS)

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Abstract: The purpose of this study was to describe Science Learning Management Based on Higher Order Thinking Skills (HOTS) in public high schools in Bantul Regency. This research is a quantitative research. The research locations were in 19 public high schools in Bantul Regency. This research was conducted from May to August 2019. The data source for this research was science teachers at public senior high schools in Bantul Regency. Data collection techniques using document studies. Data analysis techniques using quantitative data analysis techniques with percentages. The results showed that in terms of planning in public high schools in Bantul Regency, 82.5% were HOTS-based, but this percentage tended to decrease during the implementation of learning, namely 54.4% and about 58.3% in learning evaluation which should also HOTS based.

Keywords: Higher Order Thinking Skills (HOTS); Management; Science learning

Introduction

The curriculum 2013 demands that students besides having good attitudes and knowledge are also required to have the skills to reason, process, and present creatively, productively, critically, independently, collaboratively, and communicatively in concrete and abstract realms (Suwarsi et al., 2018). The curriculum 2013 learning is directed at students being able to observe, ask, try, reason, present, and create (Mulyasa, 2021; Wanojaleni, 2021). The teacher's task is to develop these skills (creative, productive, critical, independent, collaborative, and communicative) interactively, inspiring, fun, challenging, motivating students according to students' physical and psychological development (Aspini, 2020).

Various kinds of learning models have been developed to maximize students' comfort in learning and developing their thinking skills, one of the models offered in the curriculum 2013 is the Problem Based Learning (PBL) (Susilawati et al., 2022). The PBL model according to Fitriono, 2015 is a learning approach centered on constructivism in students based on analysis, resolution, and discussion of the problems given. Susanto (2016) argues that thinking skills can be developed with special treatment to train thought processes to enter long-term storage memory, so that the knowledge gained will be more meaningful, including science learning such as Biology, Physics, and Chemistry.

Questions on science subjects are made more difficult and require high reasoning power or Higher Order Thinking Skills (HOTS) (Sani et al., 2019). HOTS is related to the demands of thinking skills in the curriculum 2013 in accordance with Krathwohl's opinion who adopted Bloom's realm of thinking categorizing indicators to measure higher thinking skills including analyzing, evaluating and creating: (1) analyzing: students are skilled in separating material into its constituent parts and detect how one part relates to another; (2) evaluating: students are skilled in making decisions based on standard criteria (3) creating: students are skilled in planning a way to make a design to complete a given task and complete it (Jayanti, 2020).

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The level of thinking ability, which is divided into low and high levels, is part of one of the domains proposed by Bloom, namely the cognitive domain. The other two domains, affective and psychomotor, have their own levels (Purba et al., 2022). This cognitive domain was later revised by Lorin Anderson et al. in 2001. The order was changed to (1) remember; (2) understand (understand); (3) apply (apply); (4) analyze (analyze); (5) evaluate (evaluate); and (6) create (create). Levels 1 to 3, according to the initial concept, are categorized as low-order thinking skills (LOTS), while items 4 to 6 are categorized as high-order thinking skills (HOTS) (Taubah, 2019).

HOTS-based learning has actually been introduced in line with the implementation of the curriculum 2013, but in reality there are still many who do not understand and have not implemented HOTS-based question-making, and the learning carried out by teachers has not understood students with a high level of thinking ability in students. So far, teachers have participated in training to support students' skills in thinking highly. During the training, the instructors only conveyed theories about HOTS learning without being accompanied by examples or practice, so teachers still experience problems or confusion in learning practices in their respective schools.

National exam results data show that the results of the National Examination, especially for students' Physics subject, have decreased, reaching an average of 54.33 for the 2017/2018 school year, which previously reached an average of 60.18 for the 2016/2017 school year. The aim of the Ministry of Education and Culture is to increase the difficulty level of the questions which are basically good, namely working on HOTS questions, it is hoped that students' analytical skills and critical thinking skills can be honed. This is also part of the implementation of character education, where students never give up and are serious about working on problems. To create learning conditions that are challenging and enjoyable, the teacher's ability to manage learning is needed (Purnawanto, 2019).

The teaching of thinking skills is basically based on two philosophies. First, there must be material or special lessons about thinking. Second, integrate thinking activities into every lesson. Thus, thinking skills, especially higher-order thinking, must be developed and become part of everyday learning. With this approach, thinking skills can be developed by helping students become better problem solvers. For this reason, the teacher must provide problems (questions) that allow students to use high-order thinking skills (Sagala, 2014).

A number of basic teacher skills in managing learning as presented by Allen et al. (1987) include: (a) the ability to open lessons, (b) the ability to provide stimulus, (c) the ability to ask questions, (d) the ability to use signs, (e) the ability to use illustrations/examples, (f) the ability to communicate, (g) the ability to provide reinforcement or feedback, and (h) the skills to close the lesson. These various abilities need to be continuously trained and strengthened both for prospective teachers and teachers who have taught as an effort to create professional teachers. At the time of learning, the teacher carries out the design that has been prepared in the lesson plan. As is known, in the curriculum 2013, teachers are expected to apply a scientific (scientific) approach consisting of 5 M, namely; (1) observing, (2) asking, (3) gathering information, (4) reasoning/associating, and (5) communicating. These five things are not a systematic matter, and must exist in every lesson, but are adapted to the situations, conditions, and characteristics of the subject matter being studied by students. The application of a scientific approach is expected to realize HOTS-based learning (Fadhilaturrahmi, 2017).

Teachers are highly recommended of course to apply the model or method that has been set in the lesson plans. Usually the dominant teacher uses the lecture method. This does not mean that teachers cannot lecture, because lectures cannot be avoided in learning. Besides lectures, teachers are expected to use more varied models and methods, leading to cooperative, communicative, collaborative, creative and innovative learning, building critical thinking skills, and solving problems in accordance with the demands of 21st century competencies.

Method

Research Approach

This research is a type of research that is quantitative. Quantitative research has general characteristics, namely the objectives, approaches, subjects, and data sources have been solid and detailed from the start, this causes research to be more focused according to plan (Arikunto, 2021). Based on this description, this research is a quantitative descriptive research, because researchers want to find data about the efforts of science teachers in senior high schools, where the data is in the form of numbers and analyzed using statistics.

Research Subject

The population is a generalized area consisting of objects and subjects that have certain qualities and characteristics determined by researchers to study and then draw conclusions (Sugiyono, 2017). The population of this study were all teachers of Mathematics majoring in Natural Sciences at State High Schools in Bantul Regency.

Data Collection Technique

The data collection technique used in this study was a questionnaire as the main technique, and observation as a supporting technique.

Data Analysis Technique

One of the functions of descriptive analysis is to present research data in a simple form so that it is easy to get an overview of the research results (Nalendra et al., 2021). Quantitative data acquisition in the form of scores in the form of numbers will be measured by percentages. Furthermore, the percentage score will be interpreted qualitatively based on the classification with categorization, then the data will be interpreted. The next activity is to perform data analysis by calculating the percentage of the raw value obtained from the tabulation results according to the number of questions. The percentage used to calculate the percentage of each criterion component, component, and instrument as an evaluation instrument is determined based on the frequency of respondents' answers with the following formula (Winarsunu, 2006).

$$p = \frac{F}{N} x100\% \quad (1)$$

Information:

P : Percentage number
F : Score obtained
N : Maximum score

Quantitative data conversion from the analysis results in the following categorization.

Table 1. Categorization of Research Data

Score Intervals (%)	Criteria
84 – 100	Very good
68 – 83	Good
52 – 67	Enough
36 – 51	Not enough
20 – 35	Very less

Result and Discussion

Learning Planning

Data at this stage were collected through document studies from the syllabus for science subjects for class XII high school which were tested nationally, namely Biology, Chemistry, and Physics. The following is a summary of the research data.

Table 2. Summary of Learning Planning Document Analysis (Syllabus)

Subjects	CC/BC HOTS		Approach HOTS		Process HOTS		Learning Model			
	Yes	No	Yes	No	Yes	No	Inquiry Learning	Problem-Based Learning	Project-Based Learning	Not included
Biology	64.8	35.3	82.4	17.7	64.8	35.3	38.2	8.8	44.1	8.8
Chemistry	55.9	44.1	85.3	14.7	73.6	26.4	69.1	4.4	16.2	10.3
Physics	82.4	17.7	76.5	23.6	70.6	29.5	33.8	22.1	33.8	10.3

Based on table 2, it can be seen that in terms of the formulation of Core Competencies (CC) and Basic Competencies (BC) in the five studied subject syllabuses, most (50% <) are already in the HOTS area, both at C4, C5, and C6 levels. In terms of the learning approach designed in the syllabus, it shows that 50% of the five subjects studied have used a scientific approach (observing, asking questions, gathering information/trying out, associating/processing information, and communicating). In terms of the learning process, the syllabus of the five studied subjects showed that 50% had developed 4C abilities (creative, critical thinking, collaboration, and communication). In terms of learning models designed in the five syllabuses studied, most (50%) have used learning models that can shape scientific behavior, using both discovery/inquiry learning models, project based learning and problem based learning.

The formulation of Core Competencies and Basic Competencies have a very important role in achieving learning outcomes towards the HOTS model. The HOTS area is located at levels C4, C5 and C6. Core Competencies and Basic Competencies are directed at learning activities that apply students' critical thinking, namely by making and choosing questions that will trigger students to think critically. For this reason, students need to be trained to think critically through critical reading, critical writing, and answering critical questions (Ridwan, 2021).

The stages of critical thinking according to Thyer (2013) are: (1) observation, namely students determine, obtain, confirm, explore and identify information from various sources; (2) Analysis, namely breaking down information into themes or main arguments; (3) Evaluation, namely discriminating against values, distinguishing opinions and facts and prioritizing important information; (4) Contextualization, namely in relation to history, ethics, politics, culture and the environment; (5) Asking, namely considering possible alternatives and developing new hypotheses. (5) Reflective, namely asking questions, testing conclusions and possible impacts. Based on this opinion, the Biology, Chemistry, and Chemistry subjects have the formulation of Core Competencies and Basic Competencies which are in the HOTS area <50%, meaning that the teacher has not applied basic skills in critical thinking related to

problem solving. Problem solving is an alternative solution by mapping a network of problems using a mind map to analyze the causes of problems (Ismayani et al., 2020). Critical thinking can also be done by using mind mapping based on brainstorming. In measuring students' abilities in problem analysis in Biology, Chemistry, and Physics lessons, they can use 5W (Who, What, Why, When, Where) and 1 H (How) questions, as well as find alternative solutions (Ridwan, 2021).

In terms of the learning approach designed in the syllabus there are four subjects (Mathematics, Physics, Chemistry and Biology) 50% more use a scientific approach namely observing, asking questions, gathering information, processing information and communicating. From these data students' creative thinking needs to be built in two ways to produce creativity, namely broad knowledge (several fields of knowledge) and mastering one or two fields in depth. According to Sani et al. (2019) there are three main domains of creative expression, namely artistic creativity, scientific creativity, and everyday creativity. Scientific creativity can be analyzed from a person's ability to build hypotheses, design experiments and test facts. The scientific creativity test is carried out based on a divergent exploratory thinking process (developing multiple responses in a challenge) and a convergent integrative thinking process (developing the most creative single response) (Ridwan, 2021).

In terms of the learning process, it shows that more than 50% of the five syllabus subjects have developed 4C abilities (Creative, Critical Thinking, Collaboration and Communication). The data illustrates the importance of the teacher in building students to think actively, and HOTS-based learning directs the teacher as a facilitator by making it easy for students to think. Therefore the teacher needs to prepare assignments or questions that can make students think creatively, critically, and solve problems. Learning activities with an inquiry approach enable students to formulate problems and this is in accordance with HOTS-based learning. Inquiry learning can foster students' independence in learning and make them actively investigate or learn to solve problems related to issues that are relevant and meaningful to students. Student involvement in inquiry-based learning will increase the ability to explore knowledge or discover new knowledge (Lismaya, 2019).

Students are also brought to the ability to solve contextual problems related to various fields of science. Cooperative and collaborative learning train students to think critically, for example Thayer-Bacon (2000) emphasizes the importance of relationships with other people in critical thinking. This is in line with the opinion of Bailin et al. (1999) that critical thinking includes the ability to give positive responses to others during discussions in groups.

In terms of the learning model, the data shows that only chemistry subjects use learning models that can shape scientific behavior, namely using discovery/inquiry learning. Discovery learning is a cognitive learning method that requires teachers to be more creative in creating situations that can make active learning students discover their own knowledge. According to Sani et al. (2019) the discovery method suggests that students learn actively to build concepts and principles, namely through experimental activities so that students gain knowledge and skills simultaneously. Chemistry subjects often carry out science experiments in the laboratory and need the help of teachers to build concepts, so that the term guided discovery appears which requires supervision from the teacher in building concepts and theories in students. Discovery learning can be combined with inquiry by submitting a hypothesis about an experiment in chemistry learning.

Implementation of Learning

Data at this stage were collected through a document study from a sample of student worksheets for sc111111zience subjects for class XII Public Senior High Schools that were tested nationally, namely Biology, Physics, and Chemistry. The following is a summary of the research data.

Biology student worksheets

The following table presents a summary of the data analysis of worksheets in Biology class XII Public Senior High Schools in Bantul Regency. From the Table 3 it can be seen that the worksheets for Biology students show that: (1) 50% of Biology subject matter contains elements of facts, concepts, principles, and procedures; (2) About 42% of the questions on the worksheets for Biology students are at the HOTS level, which is indicated by the verbs: formulate, collect, conclude. The rest (58%) are at the LOTS level, which is indicated by the verbs: specify, calculate, show, determine, relate, apply, sequence, practice; (3) The questions on the Biology subject worksheets are 66% based on contextual problems (real-world contexts), such as being preceded by pictures and discourse. The rest (34%) are not based on contextual issues; (4) 84% of the questions on the Biology subject worksheet already have a stimulus that is appropriate to the problem (information at the beginning of the case, for example: tables, graphs, and discourse).

Table 3. Summary of Biology Student Worksheet Data Analysis

Question	Choice	Percentage (%)	Information
Does the teaching material contain elements of facts, concepts, principles, and procedures?	Yes	50	procedure, concept
	No	50	-
Do the questions in the worksheet measure higher order thinking skills (analyzing, evaluating, and creating)?	LOTS	58	C2: detailing C3: calculate, show determine, relate, apply, sequence, practice
	HOTS	42	C4: formulate, gather, conclude
Are the questions in the worksheet based on contextual problems (real world context)?	Yes	66	image, discourse
	No	34	-
Do the questions in the worksheet have a stimulus that is appropriate to the questions (information at the beginning of the case, for example: pictures, graphs, and discourse)?	Yes	84	tables, discourses, pictures
	No	16	-

Chemistry student worksheet

The following table presents a summary of the data analysis of Chemistry subject worksheets for class XII Public Senior High Schools in Bantul Regency.

Table 4. Summary of Chemistry Student Worksheet Data Analysis

Question	Choice	Percentage (%)	Information
Does the teaching material contain elements of facts, concepts, principles, and procedure?	No	50	principles, procedures
	Yes	50	-
Do the questions in the student worksheets measure higher-order thinking skills (analyzing, evaluating, and creating)?	LOTS	100	C3: apply, investigate
	HOTS	0	-
Are the questions in the Student Worksheet based on contextual problems (real world contexts)?	Yes	100	discourse
	No	0	-
Do the questions in the student worksheet have a stimulus that is appropriate to the problem (information at the beginning of the case, for example: pictures, graphs, and discourse)?	Yes	100	case
	No	0	-

From the table 4 it can be seen that the worksheets for Chemistry students show that: (1) 50% of Chemistry teaching materials contain elements of facts, concepts, principles, and procedures; (2) The questions on the chemistry student worksheets are 100% still at the LOTS C3 level, which are indicated by the verbs: apply and investigate; (3) 100% of the questions on the chemistry student worksheets are based on contextual problems (real-world contexts), as preceded by pictures; (4) 100% of students' worksheets for Chemistry subject already have a stimulus that corresponds to the problem (information at the beginning of the case, for example a case).

Physics student worksheet

The following table presents a summary of data analysis worksheets for Physics students for class XII Public Senior High Schools in Bantul Regency. From the table 5 it can be seen that the worksheets for Chemistry subject students show that: (1) 50% of Physics subject matter contains elements of facts, concepts, principles, and procedures; (2) The questions on the worksheets of 100% Physics students are still at the LOTS C3 level, which are marked by the verbs: apply and investigate; (3) 64% of the questions on the worksheets of Physics students are based on contextual problems (real-world contexts), such as preceded by pictures and discourse; (4) 84% of the questions on the worksheets of Physics subject students already have a stimulus that is appropriate to the problem (information at the beginning of the case, for example graphs, tables, discourses, and pictures).

The implementation of learning or teaching and learning processes is a situation where a dialogic process occurs between the learning environment, learning resources, educators, and students. In this process, strategies, methods and learning media are needed, which are relevant to the characteristics of the goals to be achieved, the characteristics of the teaching materials, as well as the characteristics of students. One of the components needed for the implementation of learning is learning resources, both in the form of textbooks, modules, and handouts. Student worksheets are learning resources designed to achieve certain learning objectives, which contain material (usually shorter than textbooks) accompanied by practice questions.

Table 5. Summary of Physics Student Worksheet Data Analysis

Question	Choice	Percentage (%)	Information
Does the teaching material contain elements of facts, concepts, principles, and procedures?	Yes	50	principles, procedures
	No	50	-
Do the questions in the worksheet measure higher order thinking skills (analyzing, evaluating, and creating)?	LOTS	66	C2: understand
	HOTS	34	C4: analyze
Are the questions in the worksheet based on contextual problems (real world context)?	Yes	66	image, discourse
	No	34	-
Do the questions in the worksheet have a stimulus that is appropriate to the questions (information at the beginning of the case, for example: pictures, graphs, and discourse)?	Yes	84	tables, discourses, pictures
	No	16	-

The student worksheets in this study were chosen because they represent the teaching methods used and the teaching materials delivered during the learning process. From the research results, it was found that the results varied between the subjects studied. In student worksheets for mathematics, for example, 66% of the content of student worksheets is still at the LOTS level.

The transfer of teaching materials should be adapted to their nature, namely as a product, process, and scientific attitude, so it is hoped that a scientific attitude will also be formed in students. The application of several HOTS-based learning models needs to be carried out through various stimulating learning models so that students can develop this scientific attitude. Project based learning, problem based learning, discovery/inquiry learning are opportunities for teachers to implement learning activities at the HOTS level. However, in practice the application of HOTS learning is not something that is easily carried out by teachers. Besides the teacher must really master the material and learning strategies, the teacher is also faced with challenges with the environment and the input of the students he teaches.

Learning Evaluation

Data at this stage were collected through a document study from samples of daily questions/midterm examination/final semester examinations for science subjects for class XII Public Senior High Schools that were tested nationally, namely Biology, Physics, and Chemistry). The following is a description of the data analysis.

Daily questions/ midterm examination/final semester examinations subject of biology

The following table presents a summary of the data analysis of the daily questions/midterm examination/final semester examinations Biology class XII Public Senior High Schools in Bantul Regency.

Table 6. Summary of Data Analysis of Biology Daily Questions/Midterm Examination/Final Semester Examinations

Question	Choice	Percentage (%)	Information
Do the daily questions/Midterm Examination/Final Semester Examination measure HOTS?	LOTS	62.5	C2: explain, explore, predict, explain C3: apply, define, sequence, describe, solve, explain,
	HOTS	33.5	C4: examine, analyze, measure C5: compare
Are daily questions/Middle Semester Exams/Final Semester Exams based on contextual problems (world context real)?	Yes	62.5	case, pictures
	No	33.5	-
Do the daily questions/Middle Semester Exams/Final Semester Exams have a stimulus that is appropriate to the questions (information at the beginning of the questions, for example: tables, cases, pictures, and graphs)?	Yes	62.5	graphs, tables of figures, charts case
	No	33.5	-
Are the daily questions/Midterm Examination/Final Semester Examinations in accordance with Basic Competency?	Yes	100.0	-
	No	0.0	-

From the table it can be seen that for daily questions/midterm examination/final semester examinations in Biology subject, it shows that: (1) Daily questions/midterm examination/final semester examinations in Biology subject 62.5% are still at LOTS level C2 and C3, which are marked by verbs: explain, apply, determine, solve, explore, sort, describe, predict, explain, and solve. The rest (33.5%) are already at the HOTS C4 and C5 levels, which are indicated by the verbs: analyze, study, measure, solve, and compare; (2)

Biology subject daily/midterm examination/final semester examinations questions 62.5% were based on contextual problems (real world context), such as preceded by graphs, tables, pictures, charts, and cases; (3) daily questions/midterm examination/final semester examinations in Biology subject 62.5% have a stimulus that is appropriate to the questions, either in the form of graphs, tables, pictures, charts, and cases; (4) Daily questions/midterm examination/final semester examinations in Biology subject 100% are in accordance with Basic Competency contained in the syllabus.

Daily questions/midterm examination/final semester examinations subject of chemistry

The following table presents a summary of data analysis of the daily questions/midterm examination/final semester examinations of Chemistry subject for class XII Public Senior High Schools in Bantul Regency.

Table 7. Summary of Data Analysis of Chemistry Daily Questions/Midterm Examination/Final Semester Examinations

Question	Choice	Percentage (%)	Information
Do the daily questions/Midterm Examination/Final Semester Examination measure HOTS?	LOTS	10	-
	HOTS	90	C4: analyze
Are daily questions/Middle Semester Exams/Final Semester Exams based on contextual problems (world context real)?	Yes	66.7	case
	No	33.3	-
Do the daily questions/Middle Semester Exams/Final Semester Exams have a stimulus that is appropriate to the questions (information at the beginning of the questions, for example: tables, cases, pictures, and graphs)?	Yes	59.3	graphs, tables, case
	No	33.5	-
Are the daily questions/Midterm Examination/Final Semester Examinations in accordance with Basic Competency?	Yes	100.0	-
	No	0.0	-

From the table it can be seen that for Chemistry subject daily questions/midterm examination/final semester examinations it shows that: (1) Daily questions/midterm examination/final semester examinations in Chemistry subject 90% are already at the HOTS level, which is indicated by the verb: analyze (C4). The rest (10%) are still at the LOTS level; (2) Daily questions/midterm examination/final semester examinations in Chemistry subject 66.7% were based on contextual problems (real world context), as preceded by a case; (3) Daily questions/midterm examination/final semester examinations Chemistry subject 58.3% had a stimulus that was in accordance with the questions, either in the form of cases, pictures or tables; (4) Daily questions/midterm examination/final semester examinations in Chemistry subject 100% are in accordance with the Basic Competency contained in the syllabus.

Daily questions/ midterm examination/final semester examinations subject of physics

The following table presents a summary of the data analysis of the daily questions/midterm examination/final semester examinations of Physics subject for Class XII Public Senior High Schools in Bantul Regency. From the table it can be seen that for the daily questions/midterm examination/final semester examinations in the Physics subject, it shows that: (1) The daily questions/midterm examination/final semester examinations in the Physics subject are 81.8% still at LOTS C1 and C3 levels, which are marked by the verbs: calculate and determine. The rest (18.2%) are at the HOTS level C4 and C5, which are indicated by the verbs: analyze, compare and conclude; (2) Daily questions/midterm examination/final semester examinations in the Physics subject are 100% based on contextual problems (real-world contexts), as preceded by cases and pictures; (3) Daily questions/midterm examination/final semester examinations in the Physics subject 100% have a stimulus that is appropriate to the questions, in the form of cases, tables, and pictures; and (4) 100% of the daily questions/midterm examination/final semester examinations in the Physics subject are in accordance with the Basic Competency contained in the syllabus.

Learning reform is carried out by changing/shifting traditional LOTS-based learning to HOTS-based learning. According to Sani et al. (2019) states schools must teach higher-order thinking skills in an effort to prepare graduates to work and learn for life.

The data shows that 24.8% of the the daily questions/midterm examination/final semester examinations in the mathematics subject are at the HOTS C4 level, 66.7% are based on contextual problems (real world context), 41.7% have a stimulus that is appropriate to the questions in the form of cases or discourse and 100% according to the Basic Competency contained in the syllabus. The form of HOTS questions must meet several criteria, namely questions used to assess critical thinking skills. Sani et al. (2019) can test critical thinking skills by listing several statements and asking test takers

to choose the type of statement, essay questions, and questions that use a rating scale (multiple ratings).

Table 8. Summary of Data Analysis of Physics Daily Questions/Midterm Examination/Final Semester Examinations

Question	Choice	Percentage (%)	Information
Do the daily questions/Midterm Examination/Final Semester Examination measure HOTS?	LOTS	81.8	C1: mention C3: calculate, determine
	HOTS	18.2	C4: analyze C5: compare, conclude
Are daily questions/Middle Semester Exams/Final Semester Exams based on contextual problems (world context real)?	Yes	100.0	case, pictures
	No	0.0	-
Do the daily questions/Middle Semester Exams/Final Semester Exams have a stimulus that is appropriate to the questions (information at the beginning of the questions, for example: tables, cases, pictures, and graphs)?	Yes	100.0	cases, pictures, tables
	No	0.0	-
Are the daily questions/Midterm Examination/Final Semester Examinations in accordance with Basic Competency?	Yes	100.0	-
	No	0.0	-

Killoran (1992) states that critical thinking tests can be made in the form of multiple choices related to databases and standards. Data-driven questions are based on the data provided in the questions. For example questions about knowing terms and or people, questions about comparing/contrasting, questions about cause and effect, questions about chronology, questions about distinguishing facts from opinions. Sugrue (1994) questions made to assess critical thinking skills are an open question or task, authentic problems related to the real world, and problems that are less structured. Students do reasoning by providing evidence or logical arguments to support decisions, choices, claims or demands.

Data on Daily questions/midterm examination/final semester examinations in Physics subject 81.8% are still at the LOTS C1 and C3 levels, 100% are based on contextual problems (real world contexts), 100% have stimuli that are appropriate to the questions, whether in the form of cases, tables, and pictures and 100% in accordance with the Basic Competency (KD) contained in the syllabus. Another HOTS question criterion is a question to assess creative thinking, which is commonly used is the Torrance test in research and learning. This test is in the form of image creations or sentence descriptions. The Torrance test is usually used to measure students' creative thinking skills.

Developing HOTS questions with criteria for critical thinking includes identifying the problem, defining the problem, explaining meaning by making careful observations, looking for alternative solutions with mind mapping, deductive thinking, inductive thinking, and differentiating arguments and explanations. In addition, the teacher must also be able to make questions that have characteristics according to the needs of problem solving, both for learning models or strategies.

Conclusion

This research is a quantitative study with the aim of describing HOTS-based science learning management in public high schools in Bantul Regency. Based on the research results, it can be seen that from a planning perspective in public high schools in Bantul Regency, 82.5% have HOTS-based but this percentage tends to decrease during the implementation of learning, which is around 54.4% and around 58.3% in learning evaluation should also be HOTS based.

References

Allen, D. da. R., & K. (1987). *Microteaching*. Addison-Wesley Publishing Company.

Arikunto, S. (2021). *Penelitian tindakan kelas: Edisi revisi*. Bumi Aksara.

Aspini, N. N. A. (2020). Implementasi Pembelajaran PBL Berbantuan Media Kartu Soal Untuk Meningkatkan Kemampuan HOTS Pada Siswa Kelas VI SD. *Jurnal Edutech Undiksha*, *8*(1), 72–79. https://doi.org/10.23887/jeu.v8i1.27087

Bailin, S., Case, R., Coombs, J. R., & Daniels, L. B. (1999). Conceptualizing critical thinking. *Journal of Curriculum Studies*, *31*(3), 285–302. https://doi.org/10.1080/002202799183133

Fadhilaturrahmi, F. (2017). Penerapan Pendekatan Saintifik Untuk Meningkatkan Kemampuan Komunikasi Matematik Peserta Didik di Sekolah Dasar. *EduHumaniora | Jurnal Pendidikan Dasar Kampus Cibiru*, *9*(2), 109–118. https://doi.org/10.17509/eh.v9i2.7078

Ismayani, R. M., Permana, A., & Sukawati, S. (2020). Pelatihan penyusunan soal berbasis HOTS bagi guru bahasa Indonesia tingkat SMP Se-Kabupaten Subang. *Abdimas Siliwangi*, *3*(1), 173–185.

https://doi.org/10.22460/as.v3i1p

Jayanti, E. (2020). Instrumen tes higher order thinking skill pada materi kimia SMA. *Orbital: Jurnal Pendidikan Kimia*, *4*(2), 135–149. https://doi.org/10.19109/ojpk.v4i2.4368

Lismaya, L. (2019). *Berpikir Kritis & PBL (Problem Based Learning)*. Media Sahbat Cendekia.

Mulyasa, H. E. (2021). *Implementasi kurikulum 2013 revisi: dalam era industri 4.0*. Bumi Aksara.

Nalendra, A. R. A., Rosalinah, Y., Priadi, A., Subroto, I., Rahayuningsih, R., Lestari, R., & Zede, V. A. (2021). *Statistika Seri Dasar Dengan Spps*. Media Sains Indonesia.

Purba, P. B., Chamidah, D., Anzelina, D., Saputro, A. N. C., Panjaitan, M. M. J., Lestari, H., & Kato, I. (2022). *Keterampilan Berpikir Tingkat Tinggi*. Yayasan Kita Menulis.

Purnawanto, A. T. (2019). Pembelajaran PAI Berbasis High Order Thinking Skills (HOTS. *Jurnal Pedagogy*, *12*(1), 20–37. https://www.jurnal.staimuhblora.ac.id/index.php/pedagogy/article/view/42

Ridwan, S. L. (2021). Peningkatan Kemampuan Berpikir Kritis dan Hasil Belajar Peserta Didik Melalui Model Pembelajaran Discovery Learning. *Jurnal Didaktika Pendidikan Dasar*, *5*(3), 637–656. https://doi.org/10.26811/didaktika.v5i3.201

Sagala, P. N. (2014). Penerapan Metode Brain Based Learning Pada Mata Kuliah Sebagai Upaya Meningkatkan Komunikasi Matematis Dan Ketrampilan Berpikir Tingkat Tinggi Mahasiswa. *Jurnal Tarbiyah*, *21*(1). https://doi.org/10.30829/tar.v21i1.218

Sani, R. A., Rahmatsyah, & Bunawan, W. (2019). *Soal Fisika HOTS Berpikir Kreatif, Kritis, Problem Solving*. Bumi Aksara.

Sugiyono. (2017). Metode penelitian bisnis: pendekatan kuantitatif, kualitatif, kombinasi, dan R&D. Penerbit CV. In *Alfabeta: Bandung*.

Susanto, A. (2016). *Teori Belajar & Pembelajaran di Sekolah Dasar*. Prenadamedia Group.

Susilawati, S., Rahmana, F., Kosim, K., & ... (2022). Practicality of Problem-Based Physics Learning Tools with Video Assistance to Improve Problem-Solving Ability of Students. *Journal of Science and Science Education*, *3*(1), 55–59. https://doi.org/10.29303/jossed.v3i1.1614

Suwarsi, S., Mukti, Z., & Prabowo, A. (2018). Meningkatkan Keterampilan HOTS Siswa melalui Permainan Kartu Soal dalam Pembelajaran PBL. *PRISMA, Prosiding Seminar Nasional Matematika*, *1*, 248–255. https://journal.unnes.ac.id/sju/index.php/prisma/article/view/19612

Taubah, M. (2019). Penilaian HOTS dan penerapannya di SD/MI. *Jurnal Elementary*, *7*(2), 197–214. https://doi.org/10.21043/elementary.v7i2.6368

Thayer-Bacon, B. J. (2000). *Transforming critical thinking: Thinking constructively*. Teachers College Press.

Thyer, B. A. (2013). *The Handbook of Social Work Research Methods*. SAGA.

Wanojaleni, K. (2021). Konsep Dan Implementasi Pembelajaran Scientific Kurikulum 2013. *QALAM: Jurnal Pendidikan Islam*, *2*(2). https://doi.org/10.57210/qlm.v2i2.89

Winarsunu, T. (2006). *Statistic in Psychology and Education Research*. University of Muhammadiyah Malang.