ATLANTIS PRESS
Advances in Computer Science Research, volume 95
Mathematics, Informatics, Science, and Education International Conference (MISEIC 2019)

Competency Profile of Junior High School Teachers in Developing High Order Thinking Questions of Science Subject

Rinie Pratiwi Puspitawati
Biology Department
Universitas Negeri Surabaya
Surabaya, Indonesia
rinieprattiwi@unesa.ac.id

Bil Bila Ade Laila
Biology Department
Universitas Negeri Surabaya
Surabaya, Indonesia
billaila@mhs.unesa.ac.id

Nurul Hikmah
Biology Department
Universitas Negeri Surabaya
Surabaya, Indonesia
nurulhikmah2@mhs.unesa.ac.id

***Abstract*—This research aim is to describe the ability profile of junior high school teachers in developing high-level thinking questions for science subjects. This research was a quantitative descriptive study of junior high school teachers from Java and Eastern Indonesia. Data was obtained by collecting questions from the teacher's biopsy prepared for five working days in the workshop. Data was analyzed descriptively quantitatively referring to criteria related to cognitive levels and ruled for writing the correct questions. It can be described that 71% of questions were categorized as high-level thinking problems at the implementation level, 61% at the analysis level, 53% at the evaluation level, and 38% at the creativity level. Based on overall aspect of questions, only 54% met the criteria for writing the correct questions.**

Keywords—junior high school's teachers, HOTs questions, science subject)

I. INTRODUCTION

Four main problems in 21st century education were knowledge aspects, skill, character, and metacognitive [1], were related with creative competency, critical thinking, communication, and collaboration [2]. Three demands of 21st century skills were study and innovation skills, life and career skills, and information, media, and technology skills [2]. Study and innovation skills are communication, collaboration, critical thinking, and creative skills (4CS). Creative thinking and critical thinking skills were higher order thinking skills (HOTs) [3], [4] were needed to solved problems in the 21st century [5].

HOTs were the highest level of ability in the cognitive dimensions (analyze, evaluate, create), and 3 levels of the knowledge dimensions (conceptual, procedural, metacognitive) [6], [7]. In learning, HOTs must be trained in students through present problems in a form that was presented through active and student-centered learning [8].

Active and student-centered learning can be applied by teacher with *problem-based learning* (PBL) [9], *project based learning* (PjBL) [10], inquiry learning [11], [12]. Teachers barrier were developed problem based on good HOTs that shown in learning content or questions [13]. This problem implication to students who have lower order skill. Results of the PISA 2015 test measured higher order thinking skill of Indonesia students in four number from last of 73 countries [14]–[16]. Teacher's understanding of HOTs was still not good, because the technique mixed between the meaning of HOTs as a thinking skill and the applied methods in learning [12].

Based on the description, effort was made to improve the quality of Junior High School's teachers in developed questions that had HOTs cognitive levels [17]. Quality improvement was carried out through technical guidance by Directorate General of Junior High School Education which was intended for teachers from schools whose students were selected to be the subject of the PISA test. So, researcher was doing technical meeting to teachers. The technical meeting was a practice and train teachers to make HOTs questions. From that, teachers can train students' skills to analyse, evaluate, and create. The aimed of this research was describing the competency profile of Science teachers in developed HOTs questions and measured the effectiveness of technical guidance on the development of question by the Directorate General of Junior High School Education.

II. METHOD

This research was *Pre-Experimental Designs* with design "*one shot case study*" [18]–[20]. This research was doing by 92 Science teachers of Junior High Scholl from DI Yogyakarta, West Kalimantan, South Kalimantan, East Kalimantan, Lampung, Riau, Bali, Gorontalo, East Java, Central Kalimantan, West Nusa Tenggara, East Nusa Tenggara, North Maluku, Papua, Central Sulawesi, and Southeast Sulawesi. Teachers were given of technical guidance to made HOTs questions were Science teachers that the school be a target in PISA test at 2018.

This research was research which implemented a developed assessment instrument in technical guidance modeling process. Data was a collected developed question by member of technical guidance and data was analyzed by quantitative descriptive. The question was analyzed refers to criteria that relation with question structure and assessment content of questions.

III. RESULTS AND DISCUSSION

The results showed that teachers can developed a question physic and biology subject. In physic subject, teachers made a question with 14 topics, and in biology made 20 question topics. A question that made was filter by cognitive level, a question such as apply level, analysis, evaluate, and create. From the questions generated, identification of items was the right thing to measure each level. From the all the question, apply level was 71%, analysis level was 61%, evaluate level was 53%, and create level was 38%.

The variation questions were used such as multiple choice, essay, matchmaking, and short fill. The questions were made by literacy, such as the example in modeling (Figure 1).

The result showed that all questions were literacy basic, and the questions can be measured HOTs, it was in accordance with the 2013 Curriculum and relevant to Bloom's revised taxonomy [6]. HOTs was three main components from dimensions of cognitive processes (analysis, evaluation, and create) with three main component knowledge dimensions (conceptual, procedural, and metacognitive). Based on the result, the teachers were understood about HOTs concept. The modelling made the teachers understood the concept and implemented to make a question. Technical guidance was very important to the teachers, so the teachers got more abilities and skills to understood about HOTs with this event.

Some problems were found in technical guidance, such as some interpretations in training and limited time so the material can't completely [14] were got answers from modelling activities of technical guidance.

HOTs was cognitive level that must be trained to solve problem, students can be succeeded in the school and gave positive contribution to society [21]. Material content complexity gave influence to arrange HOTs questions [22].

KOMPETISI PADI DAN ALANG-ALANG

Padi merupakan salah satu tanaman budidaya terpenting dalam peradaban dan sumber karbohidrat utama bagi mayoritas penduduk dunia. Padi gogo adalah jenis padi yang cocok ditanam pada daerah ladang atau perbukitan. Salahsatu gulma tanaman padi yang ditanam di lahanadalah alang alang. Gulma ini memiliki sistem perakaran (rhizoid) meluas dengan tinggi tanaman maksimal 100 cm. Tingkat penyebaran, perkembangan, dan daya alelopatinya yang tinggi menyebabkan keberadaan alang-alang di lahan budidaya sering menyebabkan penurunan produktivitas tanaman. Alang-alang diketahui menyebar hingga berbagai Negara di dunia, meliputi Negara di benua Asia, Afrika, Eropa, Australia, dan Amerika. Kendati demikian, alang-alang tidak ditemukan dalam skala luas di daerah sub tropis hingga kutub.Alang-alang mampu berkembang biak sangat cepat dan mudah. Bunganya memiliki biji matang berbulu dan ringan sehingga mudah menyebar ke area lain dan berkembangbiak menjadi tumbuhan pengganggu.

Pertanyaan 1 : Kompetisi Padi dan alang-alang **IPA_YOG_01_01**

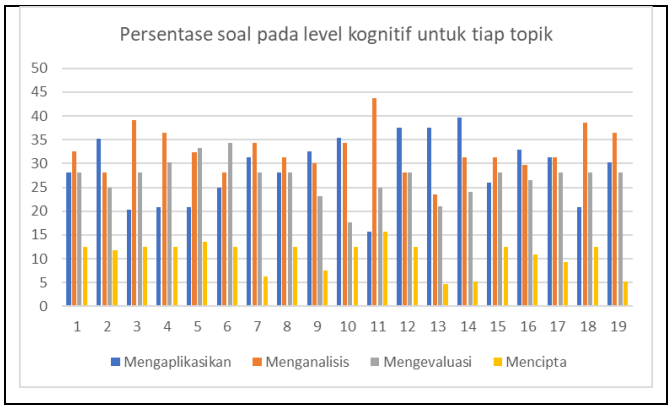
Alang-alang mampu tumbuh dengan cepat dan tinggi sehingga menutupi tanaman budidaya. Keuntungan yang diperoleh dari pernyataan tersebut adalah ...

A. Alang-alang mampu berkembang biak dengan cepat
B. Tanaman budidaya tidak terpengaruh adanya alang-alang
C. Alang-alang mampu berkompetisi lebih baik dalam mendapatkan sinar matahari
D. Tanaman budidaya mampu tumbuh lebih baik dengan keberadaan gulma

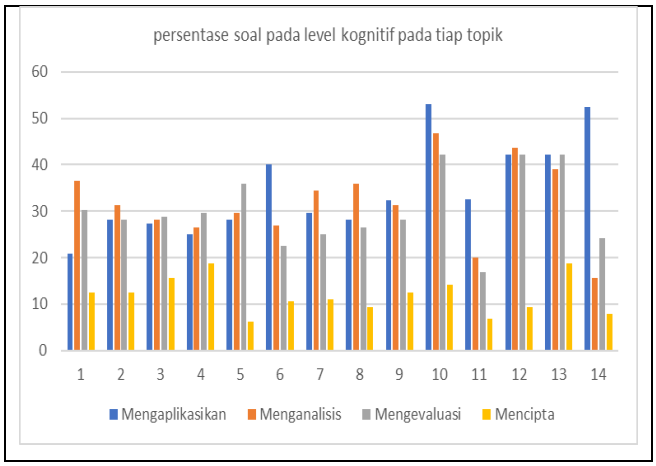
Fig. 1 Example of Question Form

This result of this study in more details showed the achievements of the questions that had been successfully arranged in the topic of biology and physic study had a relatively similar spread, as shown in Figures 2.

The aimed of science learning that HOTs oriented was to improve students' HOTs. Measured of students' HOTs in science was important because it helped to know the aim of learning was success or not success. Students HOTs measured with task and test which arranged by HOTs aspects and indicators. The tasks can be implemented with arranged a rubric, but testing did with some testing, such as multiple choice or essay. Task and test had specification to measured students' thinking skills. Multiple choices were good to measured analyzing and evaluating skills, while essay was good to measured creating skill. Beside, Watson, Collis, Callingha, dan Moritz were recommended an opened question to measured students' knowledge [23]. Students' ability was followed by assessment system. This research was conducted on 25 science teacher candidates in Turkey, which found that the teachers were still making mistakes in assessing students' thinking skills by using science model of the given problem [24]. They also showed that many teachers who only assessing students' thinking skills based on last results (only give true or false assessment, matching or not matching).



(a)



(b)

Fig. 2 Achievement of the Questions in the topic of biology and physic

Meanwhile, only some students who assessing with observation of settlement process. Teacher's knowledge about higher order thinking skills and learning strategy can be concluded that teachers have good understanding in assessing of students' thinking skills. It can be seen from teaching responses that measured HOTs can be easier did which contains contextual problem. Assessment not only focus in students' last answer but in settlement process too. This result was relevant with Altun and Akkaya [25], most teachers thought that the reason for students' low ability to answer questions such as PISA was that the dentist was familiar for them. Teachers were respondents to give recommendation that evaluate of learning outcomes must be did with essay and contextual question. Some researches in some country Altun & Akkaya [25]; Stahnke, Schueler & Roesken-Winter [26] said that one of the determinants of student success in improving competency and thinking skills were teacher competence and teacher mastery of learning content. Other than it, it was not just pedagogical science.

From the questions that made by teachers, the lower percentage was create cognitive level, it caused teachers' knowledge in material philosophically was still lack. The lack of mastery of material philosophically and the breadth of insight will prevent the teachers from directing students to create through a stimulus question.

IV. CONCLUSIONS

Competency of Junior High School science teacher in developing HOTs questions has a tendency similar to the study of biology and physics. It can be explained that 71% of questions were categorized as high-level thinking problems at the implementation level, 61% at the analysis level, 53% at the evaluate level and 38% at the create level. Topic characteristics determine the percentage of successful questions arranged at the cognitive level. From that, teachers made students had analyze, evaluate, and create skills. The future of this research was trained Senior High School's teacher to made HOTs questions.

ACKNOWLEDGMENT

The researchers would like to thank to all participants of workshop that made HOTs questions.

REFERENCES

[1] M. Bialik, M. Bogan, C. Fadel, and M. Horvathova, "Character education for the 21st century: What should students learn," *Cent. Curric. redesign. Bost. Massachusetts*, pp. 23–180, 2015.

[2] L. A. Scott, "21st century skills early learning framework," *Partnersh. 21st Century Ski.*, 2017.

[3] B. Miri, B.-C. David, and Z. Uri, "Purposely teaching for the promotion of higher-order thinking skills: A case of critical thinking," *Res. Sci. Educ.*, vol. 37, no. 4, pp. 353–369, 2007.

[4] D. Moseley *et al.*, *Frameworks for thinking: A handbook for teaching and learning*. Cambridge University Press, 2005.

[5] S. M. Brookhart, *How to assess higher-order thinking skills in your classroom*. ASCD, 2010.

[6] D. R. Anderson, L. W. & Krathwohl, *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. . New York: Longman, 2001.

[7] T. Thompson, "Mathematics teachers' interpretation of higher-order thinking in Bloom's taxonomy," *Int. Electron. J. Math. Educ.*, vol. 3, no. 2, pp. 96–109, 2008.

[8] Z. Akyol and D. R. Garrison, "Understanding cognitive presence in an online and blended community of inquiry: Assessing outcomes and processes for deep approaches to learning," *Br. J. Educ. Technol.*, vol. 42, no. 2, pp. 233–250, 2011.

[9] M. Mokhtar, J. Surif, and N. H. Ibrahim, "Implementation of Problem Based Learning in Higher Education Institution and It's Impact on Students' Learning," in *The 4th International Research Symposium on Problem Based Learning (IRSPBL)*, 2014.

[10] H. E. Vidergor and M. Krupnik-Gottlieb, "High order thinking, problem based and project based learning in blended learning environments," in *Applied practice for educators of gifted and able learners*, Brill Sense, 2015, pp. 215–232.

[11] D. C. Orlich, R. J. Harder, R. C. Callahan, M. S. Trevisan, and A. H. Brown, *Teaching strategies: A guide to effective instruction*. Cengage Learning, 2012.

[12] J.-Y. Wang, H.-K. Wu, S.-P. Chien, F.-K. Hwang, and Y.-S. Hsu, "Designing applications for physics learning: Facilitating high school students' conceptual understanding by using tablet pcs," *J. Educ. Comput. Res.*, vol. 51, no. 4, pp. 441–458, 2015.

[13] H. Retnawati, S. Hadi, and A. C. Nugraha, "Vocational High School Teachers' Difficulties in Implementing the Assessment in Curriculum 2013 in Yogyakarta Province of Indonesia.," *Int. J. Instr.*, vol. 9, no. 1, pp. 33–48, 2016.

[14] P. OECD, "Results: Creative Problem Solving: Students' Skills in Tackling Real-Life Problems (Volume V), PISA." OECD publishing, 2014.

[15] P. Indonesia, "What Students Know and Can Do Student Performance in Mathematics, Reading, and Science." 2018.

[16] OECD, "PISA 2015 results (Volume I): Excellence and equity in education." OECD Publishing Paris, 2016.

[17] S. W. Sajidan, M. Ramli, and A. Joko, "Kualitas dan Kuantitas Pertanyaan Guru dan Peserta Didik Sebagai Indikator Proses

Berpikir Pada Pembelajaran Biologi di SMA Surakarta," *Lap. Akhir*, 2015.

[18] J. R. Fraenkel, N. E. Wallen, and H. H. Hyun, *How to design and evaluate research in education*. New York: McGraw-Hill Humanities/Social Sciences/Languages, 2011.

[19] J. W. Creswell, *Educational research: Planning, conducting, and evaluating quantitative*. Prentice Hall Upper Saddle River, NJ, 2002.

[20] B. W. Tuckman and B. E. Harper, *Conducting educational research*. Rowman & Littlefield Publishers, 2012.

[21] W. Conklin, *Higher-order thinking skills to develop 21st century learners*. Teacher Created Materials, 2011.

[22] H. Djidu and Jailani, "Activity in Mathematics Teaching and Learning that Fostering Students' Higher Order Thinking Skills," in *Mathematics National Seminar 10th Proceeding*, 2016, pp. 367–376.

[23] J. M. Watson, K. F. Collis, R. A. Callingham, and J. B. Moritz, "A model for assessing higher order thinking in statistics," *Educ. Res. Eval.*, vol. 1, no. 3, pp. 247–275, 1995.

[24] M. G. Didis, A. K. Erbas, B. Cetinkaya, E. Cakiroglu, and C. Alacaci, "Exploring prospective secondary mathematics teachers' interpretation of student thinking through analysing students' work in modelling," *Math. Educ. Res. J.*, vol. 28, no. 3, pp. 349–378, 2016.

[25] M. Altun and R. Akkaya, "Mathematics Teachers' Comments on PISA Math Questions and Our Country's Students' Low Achievement Levels," *Hacettepe Üniversitesi E{\u{g}}itim Fakültesi Derg.*, vol. 29, no. 29–1, pp. 19–34, 2014.

[26] R. Stahnke, S. Schueler, and B. Roesken-Winter, "Teachers' perception, interpretation, and decision-making: a systematic review of empirical mathematics education research," *ZDM*, vol. 48, no. 1–2, pp. 1–27, 2016.

.