Skills of elementary school teachers in developing mathematics questions based on Higher-Order Thinking Skills (HOTS)

A Surya*, S Sularmi, S Istiyati, R Rukayah and J I S Poerwanti
Elementary Teacher Education, Universitas Sebelas Maret, Surakarta, Indonesia

*anesasurya@staff.uns.ac.id

Abstract. The purpose of this study was to analyse the teacher's skills in developing mathematics questions based on Higher-Order Thinking Skills (HOTS) in Elementary Schools. This study is a qualitative study. The data were collected using documentation. The subjects of the study were 81 elementary school teachers in 2017/2018 academic year in East Java. The data analysis technique was using descriptive and content analysis. The findings indicated that the teachers’ skills in developing mathematics questions based on Higher-Order Thinking Skills were still low (obtaining Bad and Not Good Scores). Furthermore, the teachers have to get more information to develop mathematics questions based on HOTS in elementary education.

1. Introduction

Giving an issue topic and asking students to solve it can train the students’ divergent and convergent mindset skills [1]. These mindsets are included in the indicators of achievement of the Higher-Order Thinking Skills (HOTS). HOTS can be defined as cognitive skills that are not just remembering or recalling but transferring or linking information solve a problem [2-4]. In accordance with Bloom's taxonomy, HOTS can be identified as a skill at the levels of analysis (C4), evaluation (C5) and creation (C6) [5-7]. HOTS is an important skill used to deal with the challenges of the 21st century [8-10]. The HOTS concept is in accordance with the objectives of mathematics learning in elementary schools, namely that the students can think critically, creatively, rationally, and can solve problems in daily life [11,12]. HOTS can be achieved through the teacher transfer in HOTS-based learning processes and HOTS-based learning assessments [13,14]. Therefore, teachers must understand the HOTS concept, implement HOTS in learning, and measure HOTS to students through HOTS-based mathematical questions.

Various studies suggest that the learning and assessment processes used so far have not been able to measure HOTS [15,16]. In Indonesia, this fact was proven by various studies which found that the teachers’ understanding of the HOTS concept was still low. This study indicates that the content of HOTS analysis needs to be developed in evidence of mathematics texts and examples of HOTS-based mathematics questions [17-20]. Based on the first interview, it was found that some teachers had difficulties in developing HOTS-based questions. The teacher is used to taking the questions based on the existing ones. Whether the questions used were in the HOTS category or not was not examined by the teachers.
2. Method
This study is a qualitative study. The subjects of the study were 81 elementary school teachers in 2017/2018 academic year in East Java. The data were collected using documentation. The documentation consists of HOTS-based questions developed by the teachers. The questions consist of three levels of analysis (C4), evaluation (C5) and creation (C6). Every level has three categories, easy, medium, and difficult questions. The indicators to evaluate every level in HOTS-based questions consist of the skills to develop question indicators, question items, and scoring rubrics [21,22]. The criteria of every indicator to evaluate HOTS-based questions [23] can be seen in table 1.

| Score  | Percentage | Criteria |
|--------|------------|----------|
| 0% - 25% | Bad (B)    |          |
| 26% - 50% | Not Good (NG) |          |
| 51% - 75% | Good (G)   |          |
| 76% - 100% | Excellent (E) |         |

The data analysis technique was using descriptive and content analysis.

3. Results and discussion
The results of the analysis of the questions developed by the teachers, it is divided into 3 aspects: first, the teachers’ skills in developing HOTS-based questions in the analysis level; second, the teachers’ skills in developing HOTS-based questions in the evaluation level; and third, the teachers’ skills in the area of creation level.

3.1. Teachers’ skills to develop questions in analysis level (C4 level)
Analysis ability is the thinking ability to specify aspects/elements. HOTS-based questions developed by the teachers must be improved to identify their students’ abilities. The result of the teachers’ skills to develop HOTS-based questions in the analysis level (C6 Level) can be seen in table 2.

| No. | Questions         | Total of Respondents |
|-----|-------------------|----------------------|
|     | Question Indicators | Question Items | Scoring Rubrics |
|     | B   NG  G  E    | B   NG  G  E    | B   NG  G  E    |
| 1   | Easy Questions    | 21 32 24 4 47 30 4 1 62 15 4 1 |
| 2   | Medium Questions  | 34 38 6 4 49 27 5 1 64 14 3 1 |
| 3   | Difficult Questions| 37 39 4 2 52 28 2 0 65 16 1 0 |
|     | Total             | 92 109 36 10 148 85 11 2 191 45 8 2 |

Based on table 2, for the easy questions consisting of question indicators, there were 21 teachers with bad scores (B). 32 teachers got not good scores (NG). 24 teachers got good scores (G). Then, 4 teachers got excellent scores (E). For the easy questions consisting of question items, there were 47 teachers with bad scores (B). 30 teachers got not good scores (NG). 4 teachers got good scores (G). Then, only one
teacher got the excellent score (E). For the easy questions consisting of scoring rubrics, there were 62 teachers with bad scores (B). 15 teachers got not good scores (NG). 4 teachers got good scores (G). Then, only one teacher got the excellent score (E).

For the medium questions consisting of question indicators, there were 34 teachers with bad scores (B). 38 teachers got not good scores (NG). 6 teachers got good scores (G). Then, 4 teachers got excellent scores (E). For the medium questions consisting of question items, there were 49 teachers with bad scores (B). 27 teachers got not good scores (NG). 5 teachers got good scores (G). Then, only one teacher got the excellent score (E). For the medium questions consisting of scoring rubrics, there were 64 teachers with bad scores (B). 14 teachers got not good scores (NG). 3 teachers got good scores (G). Then, only one teacher got the excellent score (E).

For the difficult questions consisting of question indicators, there were 37 teachers with bad scores (B). 39 teachers got not good scores (NG). 4 teachers got good scores (G). Then, 2 teachers got excellent scores (E). For the difficult questions consisting of question items, there were 52 teachers with bad scores (B). 28 teachers got not good scores (NG). 2 teachers got good scores (G). For the difficult questions consisting of scoring rubrics, there were 65 teachers with bad scores (B). 16 teachers got not good scores (NG). Only 1 teacher got a good score (G).

Based on the above description, the result of the teachers’ skills to develop questions in the evaluation Level (C5) indicated that they had difficulties in developing questions in the evaluation level (C5). Most of them obtained bad scores (B) and not good scores (NG). The result of this study is in line with that of Piltena explaining that the teachers’ skills in developing HOTS-based mathematical questions were still low [24].

3.2. Teachers’ skills to develop questions in evaluation level (C5 level)

Evaluation ability is the thinking ability to make decisions based on facts/information. The questions developed by the teachers must encourage their students to make decisions based on the facts/information from the context provided. The results of the questions that have been developed by the teachers can be seen in table 3.

| No. | Questions          | Total of Respondents |
|-----|--------------------|----------------------|
|     |                    | Question Indicators  | Question Items  | Scoring Rubrics |
|     |                    | B | NG | G | E | B | NG | G | E | B | NG | G | E |
| 1   | Easy Questions     | 26 | 40 | 14 | 1 | 44 | 32 | 4 | 1 | 62 | 16 | 2 | 1 |
| 2   | Medium Questions   | 31 | 36 | 13 | 1 | 49 | 30 | 2 | 1 | 67 | 11 | 2 | 1 |
| 3   | Difficult Questions| 39 | 39 | 3  | 0 | 56 | 24 | 1 | 0 | 68 | 12 | 1 | 0 |
|     | Total              | 96 | 115| 30 | 2 | 149| 86 | 7 | 2 | 197| 39 | 5 | 2 |

Based on table 3, for the easy questions consisting of indicator questions, there were 26 teachers with bad scores (B). 40 teachers got not good scores (NG). 14 teachers got good scores (G). Then, only one teacher got the excellent score (E). For the easy questions consisting of question items, there were 44 teachers with bad scores (B). 32 teachers got not good scores (NG). 4 teachers got good scores (G). Then, only one teacher got the excellent score (E). For the easy questions consisting of scoring rubrics, there were 62 teachers with bad scores (B). 16 teachers got not good scores (NG). 2 teachers got good scores (G). Then, only one teacher got the excellent score (E).

For the medium questions consisting of indicator questions, there were 31 teachers with bad scores (B). 36 teachers got not good scores (NG). 13 teachers got good scores (G). Then, only one teacher got the excellent score (E). For the medium questions consisting of question items, there were 49 teachers with bad scores (B). 30 teachers got not good scores (NG). 2 teachers got good scores (G). Then, only one teacher got the excellent score (E). For the medium questions consisting of scoring rubrics, there
were 67 teachers with bad scores (B). 11 teachers got not good scores (NG). 2 teachers got good scores (G). Then, only one teacher got the excellent score (E).

For the difficult questions consisting of question indicators, there were 39 teachers with bad scores (B). 39 teachers got not good scores (NG). 3 teachers got good scores (G). For the difficult questions consisting of question items, there were 56 teachers with bad scores (B). 24 teachers got not good scores (NG). Only 1 teacher got a good score (G). For the difficult questions consisting of scoring rubrics, there were 68 teachers with bad scores (B). 12 teachers got not good scores (NG). 1 teachers got good scores (G).

Based on the above description, the result of the teachers’ skills to develop questions in the evaluation Level (C5) indicated that they had difficulties in developing questions in the evaluation level (C5). Most of them obtained bad scores (B) and not good scores (NG). The result of this study is in accordance to that of Kusaeri showing that HOTS-based mathematical questions need to be developed as the existing questions have not been able to measure HOTS [25].

### 3.3. Teachers’ skills to develop questions in creation level (C6 level)

Evaluation ability is the thinking ability to make decisions based on facts/information. The questions developed by the teachers must encourage their students to make decisions based on the facts/information from the context provided. The results of the questions that have been developed by the teachers can be seen in table 3.

Creation ability is the thinking ability to construct and generate ideas. The HOTS-based mathematical questions developed by the teachers can improve the students’ thinking processes. The result of the teachers’ skills to develop HOTS-based questions in the creation level (C6 Level) can be seen in table 4.

#### Table 4. The result of the teachers’ skills to develop questions in creation level (C6).

| No. | Questions               | Total of Respondents | Indicator Questions | Question Items | Scoring Rubrics |
|-----|-------------------------|----------------------|--------------------|----------------|-----------------|
|     |                         |                      | B  | NG | G  | E  | B  | NG | G  | E  | B  | NG | G  | E  |
| 1   | Easy Questions          |                      | 28 | 40 | 12 | 1  | 45 | 31 | 3  | 2  | 64 | 14 | 2  | 1  |
| 2   | Medium Questions        |                      | 33 | 37 | 10 | 1  | 49 | 30 | 1  | 1  | 68 | 11 | 1  | 1  |
| 3   | Difficult Questions     |                      | 40 | 39 | 2  | 0  | 56 | 24 | 1  | 0  | 69 | 11 | 1  | 0  |
| Total|                         |                      | 101| 116| 24 | 2  | 150| 85 | 5  | 3  | 201| 36 | 4  | 2  |

Based on table 4, for the easy questions consisting of indicator questions, there were 28 teachers with bad scores (B). 40 teachers got not good scores (NG). 12 teachers got good scores (G). Then, only one teacher got the excellent score (E). For the easy questions consisting of question items, there were 45 teachers with bad scores (B). 31 teachers got not good scores (NG). 3 teachers got good scores (G). Then, 2 teachers got excellent scores (E). For the medium questions consisting of scoring rubrics, there were 64 teachers with bad scores (B). 14 teachers got not good scores (NG). 2 teachers got good scores (G). Then, only one teacher got the excellent score (E).

For the medium questions consisting of question indicators, there were 33 teachers with bad scores (B). 37 teachers got not good scores (NG). 10 teachers got good scores (G). Then, only one teacher got the excellent score (E). For the medium questions consisting of question items, there were 49 teachers with bad scores (B). 30 teachers got not good scores (NG). Only 1 teacher got a good score (G). Then, only one teacher got the excellent score (E). For the medium questions consisting of scoring rubrics, there were 68 teachers with bad scores (B). 11 teachers got not good scores (NG). Only 1 teacher got a good score (G). Then, only one teacher got the excellent score (E).

For the medium questions consisting of question indicators, there were 40 teachers with bad scores (B). 39 teachers got not good scores (NG). 2 teachers got good scores (G). For the difficult questions consisting of question items, there were 56 teachers with bad scores (B). 24 teachers got not good scores (NG). 1 teachers got good scores (G).
Only 1 teacher got a good score (G). For the difficult questions consisting of scoring rubrics, there were 69 teachers with bad scores (B). 11 teachers got not good scores (NG). Only 1 teacher got a good score (G).

Based on the above description, the result of the teachers’ skills to develop questions in the creation level (C6) indicated that they had difficulties in developing questions in the creation level (C6). Most of them obtained bad scores (B) and not good scores (NG). The result of this study is in line with that of Saul and Wutke indicating that the understanding of HOTS assessment concept is needed [26].

4. Conclusion
Based on the results, it can be concluded that the teachers are difficult to develop the HOTS-based mathematical questions in elementary education. Of the three levels of HOTS (C4, C5, and C6), the highest number of bad scores and not good scores was in the C6 Level. Furthermore, teachers have to get more information to develop HOTS-based questions in elementary education.

References
[1] M T Dumauli 2015 Estimate of the private return on education in Indonesia: Evidence from siblig data International Journal of Educational Development 42 pp. 14–24
[2] Lewis and Smith, J 1993 Defining higher order thinking In Teaching for Higher Order Thinking, 32 pp. 131-137
[3] Elias, M J 2014 The importance of asking questions to promote higher-order competencies “Retrieved February 13, 2016
[4] Gillies, R M, Nichols, K, Burgh, G, and Haynes M 2014 Primary students’ scientific reasoning and discourse during cooperative inquiry-based science activities International Journal of Educational Research 63(0) pp. 127-140
[5] Thomas A and Thorn G 2009 How to Increase Higer Order Thinking (Los Angeles: Center for Development and Learning)
[6] Liu X 2010 Essentials of sciences classroom assessment (Los Angeles: Sage Publication)
[7] Fisher R 2010 Thinking skill learning to teach in the primary school (New York: Routledge)
[8] T Wrahatnolo, and Munoto 2018 21st centuries skill implication on educational system J. Phys: IOP. Conf. Ser. 296 012036
[9] S Handajani, H Pratiwi and Mardiyana 2018 The 21st century skills with model eliciting activities on linear program J. Phys.: Conf. Ser. 1008 012059
[10] D H Putri , E Risdianto and S Sutarno 2017 Pre-Service Physics Teachers' Perception toward Hands-on Lab Activity and 21st Century Skills J. Phys: IOP Conf. Ser. 895 012015
[11] Hamzah A and Muhlisarini 2014 Perencanaan dan Strategi Pembelajaran Matematika (Jakarta: Raja Graha Persada)
[12] Shadiq F 2014 Pembelajaran Matematika Cara Meningkatkan Kemampuan Berpikir Siswa (Yogyakarta: Graha Ilmu)
[13] Art-in S 2012. Development of teachers’ learning management emphasizing on analytical thinking in Thailand In Procedia - Social and Behavioral Sciences 46 (2012) 3339 – 3344.
[14] Wall T F 2015. The transferability of higher order cognitive skills In Procedia - Social and Behavioral Sciences 174 pp.233 – 238
[15] Volk, M, Cotič, M, Zajc, and Istenic Starcic A 2017 Tablet-based cross-curricular maths vs. traditional maths classroom practice for higher-order learning outcomes Computers & Education 114 pp. 1–23
[16] Zohar A, Degani A, and Vaaknin E 2001 Teachers’ beliefs about low-achieving students and higher order thinking Teaching and Teacher Education 17(4) pp 469–485
[17] Andriani A, Dewi I, and Budi H 2018 Development of mathematics learning strategy module, based on higher order thinking skill (HOTS) to improve mathematic communication and self efficacy on students mathematics department. In IOP Conf. Series: Journal of Physics: Conf.
[18] A Budiman and Jailani 2014 Pengembangan Instrumen Penilaian Higher Order Thinking Skill (HOTS) Pada Pembelajaran Matematika SMP Kelas VIII Semester 1 Jurnal Riset Pendidikan Matematika 1 2 pp. 139-151

[19] G S Pratama and H Retnawati 2018 Urgency of Higher Order Thinking Skills (HOTS) Content Analysis in Mathematics Textbook J. Phys: IOP Conf. Ser. 1087 012147

[20] Retnawati H, Djidu H, Kartionom, Apino E and Anazifa R D 2018 Teachers’ Knowledge about Higher-Order Thinking Skills and Its Learning Strategy Problems of Education In The 21st Century 76 pp. 215-230

[21] D Mardapi 2008 Teknik penyusunan instrumen tes dan nontes (Yogyakarta: Mitra cendekia)

[22] R J Stiggins 1994 Student classroom assessment (New York: Macmillan)

[23] S Riduwan 2011 Pengantar Statistika Untuk Penelitian Pendidikan, Sosial, Ekonomi, Komunikasi, dan Bisnis (Bandung: Alfabeta)

[24] Putri R I I and Zulkardi Z 2018 Higher-order thinking skill problem on data representation in primary school: A case study J. Phys.: Conf. Ser. 948 012056

[25] Kusaeri, L Usadieda, T Indayati, and M Ifaizien 2018 Developing an Assessment Instrument of Higher Order Thinking Skills in Mathematics with in Islamic Context J. Phys.: Conf. Ser. 1097 012151

[26] Saul C and Wuttke H 2011 Perzonalized Assesment of HOTS Proceeding of the 3rd International Conference on Computer Supported Education, 2011 pp. 425-430