



# Improving the Competence of Chemistry Teachers in Developing the Assessment Instrument Based on Higher Order Thinking Skills (HOTS)

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**Abstract.** This study aims to describe the profile of the ability of chemistry teachers in developing the assessment instrument based on higher order thinking skills (HOTS), increasing the ability to develop the assessment instrument based on HOTS and participant responses to the training activities carried out. This research is a type of action research which is conducted in 2 cycles. The target of this research is the chemistry teacher members of the chemistry teacher association from Surabaya city, East Java, Indonesia, a total of 15 people. The research data was collected using the test of ability to compose the assessment instrument based on HOTS as well as a participant response questionnaire to the training activities. The research data were analyzed descriptively and quantitatively. The results showed that the chemistry teacher's ability score in developing the assessment instrument based on HOTS after being given training was 88.67 and the n-gain score was 0.73 in the high category. The teacher's ability score in developing the assessment instrument based on HOTS with a cognitive level of C-4 (analysis), C-5 (evaluation), and C-6 (create) were 92, 89, and 85, respectively. Participants gave a positive response to the training provided. Based on the results of the study, it can be concluded that the training activities have been able to improve the ability of chemistry teachers in developing the assessment instrument based on HOTS for chemistry subjects. The ability of teachers in developing the assessment instrument based on HOTS with a cognitive level of C-6 needs to be improved.

**Keywords:** Chemistry teacher · higher order thinking skills (HOTS) · assessment instrument

## 1 Introduction

The teacher is the spearhead in improving the quality of education, because the teacher directly seeks to influence, foster and develop students' abilities to become intelligent, skilled, and highly moral human beings. Teachers must have adequate academic quality

and competence as learning agents to realize quality education [1]. In Indonesia Law No. 14 of 2015 concerning teachers and lecturers, it is stated that professional teachers must have 4 competencies, namely pedagogic competence, professional competence, personality competence and social competence. Professional teachers are also required to improve their competence through continuous professional development activities in order to be able to adapt to the latest demands in the field of education [2].

Based on the regulation of the Minister of Education and Culture of the Republic of Indonesia Number 36 of 2018 concerning the 2013 Curriculum for Senior High Schools, one of the bases for improving the curriculum is the existence of external challenges, including those related to the flow of globalization and various environmental issues, advances in technology and information, the rise of creative industries, culture, and the development of education at the international level. In relation to the issue of the development of education at the international level, the 2013 curriculum is designed with various improvements, including deepening and expanding the material for students which is enriched with students' needs to think critically and analytically in accordance with international standards. Improvements were also made to the assessment standards, by gradually adapting international standard assessment models. Assessment of learning outcomes is expected to help students to improve higher order thinking skills (HOTS), because higher order thinking skills can encourage students to think broadly and deeply about the subject matter [3].

The results of the 2018 PISA showed that the ability of Indonesian students in the aspects of reading, mathematics and science were still 70%, 71% and 60% below the minimum competency, respectively. Therefore the literacy of Indonesian students are still low in reading, mathematics and science. Indonesian students' ability was still low in: (1) integrating information; (2) generalizing case by case into a general solution; (3) formulating real-world problems into subject concepts; and (4) conducting investigations [4]. Based on the facts above, it is necessary to change the system in learning and assessment. The assessment. Developed by the teacher are expected to encourage the improvement of higher-order thinking skills, increase creativity, and build students' independence to solve problems.

The HOTS type assessment is an instrument used to measure higher-order thinking skills, namely thinking skills that are not just remembering, understanding, or applying. The HOTS assessment in the context of assessment measure skills: 1) transfer from one concept to another, 2) process and integrate information, 3) find connections from different kinds of information, 4) use information to solve problems, and 5) examine ideas and critical information. Thus the HOTS type assessment test thinking skills to analyze, evaluate, and create (Mujib and Rasyid, 2019).

The chemistry teacher association (CTA) in Surabaya city has members from public and private senior high schools in the Surabaya city. The Surabaya city CTA has facilitated the implementation of activities in an effort to improve the professional competence of its members, either through training/workshops, seminars, and comparative studies. Based on the results of an interview with the head of the Surabaya city CTA, the ability of chemistry teachers in preparing the HOTS-based chemistry assessment instruments still needs to be improved even though they have received training either from the Surabaya city education office or from other parties. Meanwhile, the teacher's ability in preparing

HOTS type assessment is very necessary because the student assessment instrument in schools must contain HOTS type questions.

Based on the description of the background above, we are interested in carrying out research to determine the impact of training activities on the ability of chemistry teachers in Surabaya city in preparing HOTS-based assessment instruments in an effort to improve teacher professional competence and the quality of education in schools.

## 2 Methods

This type of research is action research that carried out in 2 cycles, each cycle consisting of the action planning, action implementation, observation, and reflection [5]. The learning model in the training used is the STAD type cooperative learning model. The number of chemistry teachers who were the target of this study were 15 people from members of the CTA in Surabaya city. The training activities were carried out at Senior High School 21 Surabaya on 15 October 2022 and 29 October 2022. Before the training activities were carried out, the researchers developed training materials in the form of a guidebook for the preparation of HOTS-based chemistry assessment instruments, training activity sheets, and a test of the ability to compose HOTS-based chemistry assessment instruments. The training materials were validated by experts before being used in research.

The instrument used for data collection consisted of a validation sheet, a test of the ability to compose a HOTS-based chemistry assessment instrument and a participant response questionnaire. The data obtained were analyzed descriptively and quantitatively [6]. The validity of the research instrument was determined based on the average score of the validity assessment results according to the validity criteria, both content validity and construct validity [7–9]. The chemistry teacher's ability profile in compiling HOTS-based chemistry assessment instruments is expressed as a percentage. The increase in the ability of participants to develop HOTS-based chemistry assessment instruments was determined using n-gain analysis [10]. The reliability of the validation results was determined based on the value of the percentage of agreement from the validator [11]. Meanwhile, the questionnaire responses to training participants were expressed in percentages [12, 13].

## 3 Results and Discussion

### 3.1 Validation of Training Materials

This research is an action research type of school action research. This research is aimed to improve the professionalism of teachers, especially in preparing HOTS-based chemistry assessment instruments. This ability is very important for teachers because student assessment instruments in schools must contain HOTS type questions to encourage higher-order thinking skills, increase creativity, and build students' independence to solve problems [3].

**Table 1.** The results of experts assessment on the training materials

No	Training materials	Validation score			Category	Reliability (%)	Category
		V1	V2	Average			
1	Lesson plan	3.66	3.80	3.73	Very valid	95.47	Reliable
2	Guidebook for preparing the HOTS-based chemistry assessment instruments	3.75	3.77	3.76	Very valid	97.78	Reliable
3	Training activity sheet	3.80	3.94	3.87	Very valid	97.84	Reliable
4	Test of ability to develop the HOTS-based chemistry assessment instruments	4.00	4.00	4.00	Very valid	100	Reliable
	Average score	3.80	3.88	3.87	Very valid	97.44	Reliable

Before the training activities were carried out, the training materials were developed in the form of a training implementation plan, a guidebook for the preparation of HOTS-based chemistry assessment instruments, training activity sheets, and a test of the ability to compose HOTS-based chemistry assessment instruments. Two experts validated the training materials before implementation and the results of assessment are showed in Table 1.

Table 1 showed that the four research materials developed showed a validation score above 3.25, namely 3.87 so that it was categorized as very valid [7–9]. The reliability of the validator's assessment of all research tools is greater than 75% so that it is categorized as reliable [11]. Thus the device is suitable for use in training activities for the preparation of HOTS-based chemistry assessment instruments for chemistry teachers.

### 3.2 Ability of Chemistry Teacher in Developing the HOTS-Based Chemistry Assessment Instruments

The training activity for the preparation of HOTS-based chemistry assessment instruments for chemistry teachers in Surabaya city was held in 2 meetings, namely on 15 October 2022 and 29 October 2022. At the first meeting, the HOTS type assessments were discussed at the cognitive analysis level (C-4) and evaluation (C-5). Meanwhile, the HOTS type assessment at creation cognitive level (C-6) were discussed at the second meeting. The training activities began with giving a pre-test at the beginning of the first meeting and giving a post-test at the end of the second meeting. The ability test to compose HOTS-based chemical assessment instruments consists of the ability to compose the HOTS type assessment at the cognitive analysis (C-4), evaluation (C-5) and creation (C-6) levels. The results of the HOTS-based chemistry assessment instrument test are presented in Table 2.

Table 2 showed that before the training activities were carried out, the average score of chemistry teachers in preparing HOTS-based chemistry assessment instruments was low, namely 52.56. However, after being given treatment in the form of training in the preparation of HOTS-based chemistry assessment instruments, the teacher's ability

**Table 2.** The results of the ability of chemistry teachers to develop the HOTS-based chemistry assessment instrument

No	Name code of participants	Pretest score	Posttest score	<i>n-gain</i>
1	ANK	46.67	86.67	0.75
2	WD	68.33	91.67	0.74
3	SW	66.67	96.67	0.90
4	DRD	50.00	73.33	0.47
5	RAR	73.33	100.00	1.00
6	NE	36.67	96.67	0.95
7	MV	56.67	86.67	0.69
8	ANP	43.33	96.67	0,94
9	AH	63.33	86.67	0.64
10	NH	53.33	76.67	0.50
11	MU	46.67	93.33	0.87
12	SS	36.67	73.33	0.58
13	ER	60.00	100.00	1.00
14	IT	26.67	76.67	0.68
15	DI	56.67	95.00	0.88
	Average	52.56	87.33	0.73

increased to 87.33 with an *n-gain* value of 0.73 in the high category [10]. Thus the training activities provided had been able to improve the ability of chemistry teachers in preparing HOTS-based chemistry assessment instruments. The ability of chemistry teachers in compiling HOTS-based chemistry assessment instruments at the cognitive level of analysis, evaluation and creation also increased their scores from 71.33 to 92.0; 42.33 to 89.0, and 43.33 to 85.0, respectively. In general, the ability of teachers to develop HOTS-based chemistry assessment instruments after training activities is good category because the average score obtained is greater than 80. The ability of chemistry teachers to develop HOTS-based chemistry assessment instruments at the creation cognitive level (C-6) showed the lowest score (85.0), meanwhile the highest score was indicated by the ability to compile HOTS-based chemistry assessment instruments at the cognitive analysis level (C-4) (92.0). The ability of teachers to develop chemistry assessment instruments at the creation cognitive level needs to be improved even though the average score is already above 80.

The high increase in the ability of participants to develop HOTS-based chemistry assessment instruments showed that the STAD type cooperative learning model used in the training had succeeded in activating participants during the activity. The group discussions that have been carried out have enabled more intelligent participants to provide guidance to other participants whose less understanding so that scaffolding occurs. According to Vygotsky, this will further increase participants' understanding

of the material being studied [14–16]. The mentoring process from resource persons who were more experienced, professional, and expert to provide support, guidance, and advice and share experiences with chemistry teachers supported their understanding in developing HOTS-based chemistry assessment instruments [17]. Collaboration between teachers during training activities was able to improve professional skills which had an impact on improving the quality of learning [18]. The results of this study were also supported by previous research that action research given to teachers was able to improve their professional competence so that it will have an impact on improving the quality of learning in schools [19–21].

### 3.3 Participant's Responses to Training Activities

At the end of the training activity for the preparation of the HOTS-based chemistry assessment instrument, a questionnaire was given to determine the participant's response to the training activities that had been carried out. There are 18 aspects that become questions in the questionnaire. The results of the questionnaire was presented in Table 3.

Table 3 showed that the participants gave a positive response to the training activities. Participants showed very high motivation to take part in the training as indicated that all participants stated that participating in the training was to increase their knowledge

**Table 3.** The results of participant's responses

No	Aspect	Percentage of Response (%)			
1	The Reason for attending training	Ordered by the Principal / Head of MGMP	Follow a friend's invitation	Want to get a certificate	Want to improve knowledge and skills
		0%	0%	0%	100%
2	The suitability of the training materials provided to the teacher's needs	Very suitable	Suitable	Suitable enough	Not suitable
		80.0%	20.0%	0%	0%
3	The benefits of the chemistry MCA guide book to develop the chemistry MCA	Very helpful	Helpful	Helpful enough	Not helpful
		93.0%	7.0%	0%	0%
4	The benefit of training activity sheet to develop the chemistry MCA	Very helpful	Helpful	Helpful enough	Not helpful
		73.0%	27.0%	0%	0%

(continued)

**Table 3.** (continued)

No	Aspect	Percentage of Response (%)			
5	Interest in training	Very interesting	Interesting	Interesting enough	Not interesting
		73.33%	26.67%	0%	0%
6	Understanding of the material presented by the resource person	Very easy to understand	Easy to understand	Quite easy to understand	Difficult to understand
		53.33%	46.67%	0%	0%
7	Interactive and communicative level of resource persons to participants	Very interactive and communicative	Interactive and communicative	Quite interactive and communicative	Not interactive and communicative
		80.0%	20.0%	0%	0%
8	Techniques for presenting training materials	Very systematic and coherent	Systematic and coherent	Quite systematic and coherent	Not systematic and coherent
		53.0%	47.0%	0%	0%
9	Feedback given by resource persons to participants	Very good	Good	Good enough	Bad
		86.67%	13.33%	0%	0%
10	Resource persons skills in using media during training	Very good	Good	Good enough	Bad
		73.33%	20.0%	6.67%	0%
11	Enthusiasm of participants in participating in the training	Very enthusiastic	Enthusiastic	Quite enthusiastic	Not enthusiastic
		60.0%	40.0%	0%	0%
12	Participants' satisfaction with training activities	Very satisfied	Satisfied	Quite satisfied	Not satisfied
		80.0%	20.0%	0%	0%

(continued)

**Table 3.** (continued)

No	Aspect	Percentage of Response (%)			
13	Benefits of this training activity for participants	Very useful	Useful	Quite useful	Not useful
		86.67%	13.33%	0%	0%
14	Increased knowledge and ability of participants in developing MCA after participating in training activities	Greatly improved	Improved	Quite improved	Not improved
		26.67%	73.33%	6.67%	0%
15	Participants' confidence in continuing the results of this training activity after returning to school	Very confident	Confident	Quite confident	Not confident
		40.0%	60.0%	0%	0%
16	Participation of participants in similar training activities	Very often	Often	Often enough	Never
		0%	6.67%	20.0%	73.33%
17	Organizing training activities	Very good	Good	Good enough	Bad
		66.67%	33.33%	0%	0%
18	Facilities and equipment to support training activities provided	Very representative	Representative	Less representative	Not representative
		46.67%	53.33%	0%	0%

and skills (100%). In addition, regarding the suitability of the training materials to the needs of the participants, 80% of the participants stated that they were very suitable and 20% stated that they were suitable. As many as 60% of the participants stated that they were very enthusiastic, while the other 40% stated that they were enthusiastic. Regarding the participants' satisfaction with the training activities, 80% said they were very satisfied and 20% said they were satisfied. A total of 86.67% of participants stated that the training activities provided were very useful for them, while others stated that it was useful (13.33%). Regarding the participants' confidence in continuing the results of this training activity after returning to school, as many as 40% of the participants stated



that they were very confident, while the other 60% stated that they were confident. This high motivation had an impact on increasing the ability of participants in compiling HOTS-based chemistry assessment instruments which are indicated by a high n-gain score (0.73) [14, 15].

## 4 Conclusion

Based on the results of the study it can be concluded:

1. The training materials in the form of training implementation plans, guidebooks for preparing HOTS-based chemistry assessment instruments, training activity sheets and tests of ability to compose HOTS-based chemistry assessment instruments are very valid so that they are suitable for use in training activities.
2. Training activities have been able to improve the ability of chemistry teachers in preparing HOTS-based chemistry assessment instruments, at cognitive level analysis (C-4), evaluation (C-5) and creation (C-6).
3. The participating chemistry teacher gave a very positive response to the training activities so that it had an impact on increasing their ability to develop HOTS-based chemistry assessment instruments.

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