UNESA Journal of Chemical Education *ISSN: 2252-9454*
Vol. 15, No. 2, pp. 165–171, May 2026

DEVELOPMENT OF NHT-BASED STUDENT WORKSHEETS TO TRAIN STUDENTS' COMMUNICATION SKILLS ON REACTION RATE MATERIAL

Sudzuasmais and Bertha Yonata*

Department of Chemistry, FMIPA, Universitas Negeri Surabaya

e-mail: berthayonata@unesa.ac.id

Abstract

The purpose of this study is to develop student worksheets based on the NHT cooperative learning model to train students' communication skills regarding reaction rates. This Research and Development project employs the 4-D model (Define, Design, Develop), omitting the Disseminate. A limited pilot test was conducted with twelve students from Class XI-1 at Ngoro State Senior High School, Jombang in the second semester of the 2025/2026 academic year using One Shot Case Study design. The feasibility of the worksheets was assessed in terms of validity, practicality, and effectiveness. Data were collected using validation sheets, student response questionnaires, activity and oral communication observation sheets, and cognitive learning outcome tests. Validation results showed that the worksheet met valid and highly valid criteria with mode values of 3 and 4 for content and construct validity. Practicality was demonstrated by 85,71% of student response questionnaire items categorized as very positive, and 92,35% of student activities observed as very good. Effectiveness was reflected in improvements in oral communication skills; the quantity of opinion-giving increased from 50% to 58,3% and question-asking from 33,3% to 41,6%, both in the fairly good criterion. The quality of oral communication also improved, with opinion quality rising from 41,67% to 44% and question quality from 36,1% to 41,6%, both categorized as fairly good. Written communication quality across all groups reached ≥66,67%, categorized as good. All students achieved cognitive learning mastery with scores of ≥75. Thus, the developed NHT-based worksheets are suitable for training students' communication skills on reaction rate material.
Keywords: worksheets, numbered heads together, communication skills

INTRODUCTION

Chemistry education requires mastery of various 21st century skills relevant to the demands of the modern era, and among these skills, communication is one of the most fundamental [1]. This is inseparable from the nature of chemistry itself, which does not merely address abstract concepts, laws, and theories, but also real world phenomena that directly intersect with daily life [2]. The topic of reaction rates, taught in the first semester of 11th grade, is a specific area of chemistry that requires students to understand the concept of collision theory, calculate reaction rate constants, determine reaction orders, and analyze the various factors influencing them [2].

In efforts to understand this complex material, oral and written communication skills serve as a bridge connecting new knowledge with prior knowledge [3]. According to the study, the dominant activities in the learning process show that 1,02% of the first session was spent expressing opinions, while 4,67% of the second session was spent on this activity [4]. In the first session, the proportion of student questions was only 25% and increased to 55,56% in the third session, while the proportion of students expressing opinions was 41,67% in the first session and rose to 75% in the third session [5].

Before the cooperative learning model was implemented, student engagement in chemistry class was only 46,19%, which falls within the adequate category [6]. The contributing factors include students' lack of familiarity with expressing opinions in public, a tendency to provide rambling and unstructured answers, and insufficient training in taking systematic discussion notes [6].

Problems also arise regarding learning materials. The worksheets currently in use in schools generally consist only of summaries of the material and collections of practice questions adapted from various publishers, without any adjustments to meet the specific needs of students [7]. Most teachers have not yet developed worksheets that align with students' needs and the requirements of the current curriculum [8], and even the existing worksheets have not been designed to support specific learning models aimed at fostering active communication and collaboration skills [9].

Given these conditions, a learning model supported by learning tools designed to meet specific needs is required. One such learning model is the NHT cooperative learning model, which is characterized by encouraging student interaction through heterogeneous group work in problem-solving [10]. More specifically, the Numbered Heads Together (NHT) model developed by Spencer Kagan is considered highly suitable because it incorporates four syntaxes that directly stimulate communication activities, namely Numbering, Questioning, Heads Together, and Answering [11].

The application of the NHT type cooperative model can improve student learning outcomes in the reaction rate material [19]. Research shows the effectiveness of the cooperative learning model in developing oral communication skills, with positive student responses reaching 84% [15]. However, based on the literature review conducted, no studies have been found that specifically develop NHT-based worksheets to simultaneously train students' skills in asking questions, expressing opinions, and writing about reaction rates.

Based on this background, this study aims to develop a Student Worksheet (LKPD) using the Numbered Heads Together (NHT) cooperative learning model to develop students' communication skills in the context of reaction rates. The feasibility of the developed worksheet was assessed in terms of validity, practicality, and effectiveness.

METHOD

This study falls under the category of research and development (R&D) based on the 4-D model, which consists of four stages: Define, Design, Develop, and Disseminate. This study only covers up to the Develop stage, including a limited pilot test [14].

The Define stage aims to establish the foundation and direction for the development of the student worksheet through a series of analyses, namely the front end analysis, student analysis, task analysis, concept analysis, and learning objective analysis. The frontend analysis begins with a review of the Merdeka curriculum to identify relevant learning outcomes. Student analysis is conducted by considering the cognitive, affective, and psychomotor characteristics of 11^{th} grade students. Concept analysis focuses on the material regarding factors affecting reaction rates, which includes the effects of concentration, surface area, temperature, and catalysts [23].

The design phase consists of two activities selecting the format of the student worksheet and developing a preliminary draft. The worksheet format was designed to include standard components, such as the title, learning outcomes, learning objectives, a summary of the material, and discussion tasks based on the NHT syntax. All activities in the worksheet were organized according to the learning phases, including introduction, numbering, questioning, heads together, and answering. From this stage, Draft Worksheet I was produced [23].

The Development phase consists of four sequential steps: (1) review of the student worksheet by a chemistry lecturer to obtain initial feedback; (2) revision based on the review results to produce Draft student worksheet II; (3) validation by three validators consisting of two chemistry lecturers and one high school chemistry teacher; and (4) a limited pilot test with twelve students from class XI-1 at Ngoro State Senior High School, Jombang conducted over two sessions during the second semester of the 2025/2026 academic year.

The experimental design used was a one-shot case study, which involved using only one class without a control group:

$$\mathbf{X \rightarrow O}$$

with details,

X : The approach used was the NHT cooperative learning model for the core topic of factors affecting reaction rates, with the aim of developing students' communication skills during the learning process

O : Assessing students' communication skills through observation and administering tests to determine cognitive learning achievement

[12]

Data collection was conducted using four methods: (1) validity assessment using a 0–4 scale validation sheet completed by three validators, (2) observation of student activities using an observation sheet completed by three observers every five minutes, (3) a student response questionnaire, and (4) a learning outcome test in the form of multiple-choice questions that had been validated beforehand.

The data analysis techniques used are as follows. Content and construct validity were analyzed using the mode statistic of the validation sheet scores. The worksheets were deemed valid if the mode value fell within the range of 3 (valid) or 4 (highly valid), based on criteria as presented in Table 1.

Table 1. Criteria for Interpreting Modal Results

Range Mode	Category
0 - 0,9	Invalid
1,0 - 1,9	Somewhat invalid
2 - 2,9	Fairly valid
3,0 - 3,9	Valid
4	Very valid

[12]

The practicality of the worksheets was assessed based on student responses analyzed using the Guttman scale. The questionnaire consisted of positive and negative questions with two response options: "Yes" and "No." The percentage of student responses was calculated using the following formula:

$$Student\ response\ (\%) = \frac{\sum Y}{\sum PD}\ x\ 100\%$$

With details,

$\sum Y$: the number of correct answers.

$\sum PD$: number of students.

A worksheet is considered practical if ≥ 61% of the criteria receive a positive response. In addition to student responses, practicality is also assessed based on the results of observations of student activities, which are deemed satisfactory if the percentage of activities reaches ≥ 61%.

The effectiveness of the worksheet is measured using three instruments: (1) an observation sheet for questioning communication skills, covering both quantity and quality; (2) an observation sheet for the skill of expressing opinions, covering the quantity and quality of logical analytical reasoning; and (3) an assessment sheet for written communication skills based on four aspects: accuracy of content, clarity of language and arguments, completeness of answers, and correctness of spelling and grammar.

Table 2. Criteria for Asking Questions, Expressing Opinions, and the Quality of Written Communication

Score (%)	Criteria
0-33,3	Poor
33,4-66,66	Fairly Good
66,67-100	Good

[13]

An analysis of learning achievement was conducted to determine students' mastery of the material following instruction. Individually, a student is considered to have mastered the material if they achieve a minimum passing score (KKM) of ≥ 75 [16], calculated as follows

$$student\ grades\ = \frac{\sum B}{N}\ x\ 100$$

With details:

∑B = the number of questions answered correctly

N = the number of questions

Student learning outcomes are considered met for the class as a whole if at least 75% of the students have achieved a score of 75 or higher.

RESULTS AND DISCUSSION

Validity of Student Worksheet

The validation of the student worksheet was conducted by three validators two chemistry

lecturers and one chemistry teacher from Ngoro State Senior High School, Jombang using a validation sheet with a scale of 0–4. The validation process took place from April 20 to May 6, 2026. The validation results were assessed in terms of content validity and construct validity.

Content validity covers three main aspects. First, the alignment of the student worksheet with the curriculum including alignment with the Merdeka curriculum, learning outcomes (CP), learning objectives, and the questions within the student worksheet received a score of 4 from all three validators, meeting the criterion of "highly valid." This indicates that the content included in the student worksheet aligns with the requirements of the current curriculum and the learning outcomes for Phase F of Grade 11. Second, the alignment of the material with communication skills components received a rating of valid to highly valid. Although one sub-aspect received a score of 3 from two validators, overall the material was deemed adequate to support the development of students' communication skills. Third, the alignment of the student worksheet with the syntax of the NHT cooperative learning model covering the skills of expressing opinions, asking questions, and writing received ratings ranging from valid to highly valid, indicating that the student worksheet has been well-integrated into the learning phases of the NHT [11].

Construct validity was assessed from three aspects. In terms of language, all sub-aspects received a score of 4 from all three validators, meeting the "highly valid" criterion. Regarding presentation, most sub-aspects met the highly valid criterion; however, the sub-aspects of sufficient answer space and cover appropriateness received a score of 3 from one validator, while the overall completeness of the worksheet components received a score of 4 from all three validators. In the graphic aspect, the illustrations were assessed as being consistent with the content, while the layout of text, images, and tables, as well as print quality, received a score of 4 under the "highly valid" criterion. Overall, the results of the content and construct validation of the NHT-type cooperative worksheet can be stated as meeting the valid and highly valid criteria with mode values of 3 and 4, thus the worksheet is deemed suitable for use [12].

Practicality of Student Worksheet

The practicality of the student worksheet was assessed using two data sources: a student response questionnaire and observations of student activities during two learning sessions.

The results of the student response questionnaire, completed by twelve students using a Guttman scale, were very positive. Of the fourteen items, twelve (85,71%) met the criteria for a very positive response with a 100% rating, covering several aspects including readability, visual appeal, clarity of instructions, alignment of questions with the material, the usefulness of experimental activities, and the effectiveness of NHT syntax in fostering student engagement and a sense of responsibility toward learning. This indicates that the developed worksheets are capable of maximizing students' relevant learning activities and cognitive understanding [21]. Based on Vygotsky's constructivist theory, the high level of positive response to the NHT syntax and the willingness to collaborate reflect this theory, wherein each student actively assumes a sense of responsibility by having their number randomly called to represent their group [20].

Two survey items that require attention are item 11, anxiety caused by random calls, which scored only 66,67%, and item 14, adequacy of discussion time, which scored only 50%. These results are consistent with the weaknesses of NHT, namely potential issues during the "answering" phase and the relatively long time required for implementation [22]. Overall, twelve items which score 85,71% met the practicality criterion of ≥61% [12]. This worksheet meets the practicality criteria, with a recommendation to adjust the time allocation in the lesson plan for the next session.

Table 3. Student Response Questionnare Results

N	Type of Statement	Percentage (%)		Criteria
		Yes	No	
1.	Positive	100%		RVP
2.	Positive	100%		RVP
3.	Negative		100%	RVP
4.	Negative		100%	RVP
5.	Positive	100%		RVP
6.	Positive	100%		RVP
7.	Positive	100%		RVP

N	Type of Statement	Percentage (%)		Criteria
		Yes	No	
8.	Negative		100%	RVP
9.	Negative		100%	RVP
10.	Positive	100%		RVP
11.	Negative		66,67%	RP
12.	Negative		100%	RVP
13.	Positive	100%		RVP
14.	Negative		50%	RLP

Description:
RVP = responded very positively
RP = responded positively
RLP = responded less positively

The average percentage of relevant activity observed by the three observers was 92,35%. Students were considered active if the percentage of relevant activity was ≥ 61% [16]. The dominant activities included expressing opinions, conducting experiments, recording experimental results, analyzing data, drawing conclusions, and presenting results. This high level of active engagement reinforces that NHT-based worksheets successfully foster cooperative learning, where heterogeneous group work encourages interaction and collaboration [10].

Effectiveness of Student Worksheet

The effectiveness of the student worksheet was measured through oral communication skills including asking questions and expressing opinions, written communication skills, and cognitive learning outcomes.

Table 4. The Quantity of Students' Oral Communication Skills

Skills	Lesson (%)		Criteria
	1	2	
Ask	33.3	41,6%	Poor-Fairly Good
Opinion	50%	58,3%	Fairly Good

In terms of oral communication skills, observational data from the two sessions showed an increase. The frequency of expressing opinions increased from 50,00% in the first session to 58,3% in the second session, falling into the fairly good criterion [16]. Similarly, the frequency of asking questions increased from 33,3% to 41,6%. The frequency of asking questions in the first session was in the poor criterion, this is understandable given the lack of time management during the lesson.

Table 5. The Quality of Students' Oral Communication Skills

Skills	Lesson (%)		Criteria
	1	2	
Ask	36,1%	41,6%	Fairly Good
Opinion	41,67%	44%	Fairly Good

The quality of oral communication showed fairly good results. The quality of expressing opinions improved from 41,67% to 44% in the fairly good category, while the quality of asking questions improved from 36,1% to 41,6% in the fairly good category. Although the quality of communication falls into the fairly good criterion, it still needs further improvement in terms of classroom and time management. This improvement in quality indicates that the questions and opinions raised by students are beginning to move toward higher cognitive levels according to Bloom's Taxonomy, although they have not yet fully reached the analysis and evaluation levels [11]. This study shows that in chemistry instruction, cooperative learning models effectively improve students' oral communication skills [15].

The quality of written communication skills including accuracy of content, clarity of language and reasoning, completeness of responses, and writing conventions was analyzed based on the results of written assignments in four student worksheet activities in the analysis section. All three groups were able to answer the questions well, although there were differences among the groups. Overall, the written communication quality of the three groups was ≥ 66,67%, which falls into the good category [16]. This indicates that NHT-based worksheets are capable of training students to communicate experimental results in writing in a structured and scientific manner [3].

Table 6. The Quality of Students' Written Communication Skills

Skills	Group score (%)			Criteria
	1	2	3	
Quality Writing Skills	74,36	79,49	88,77	Good

In terms of cognitive learning outcomes, 12 students who took the posttest achieved mastery

with scores of ≥75. This 100% mastery rate is closely linked to the high level of student engagement and the quality of student communication during the learning process. These results suggest that when student communication and engagement are strong, cognitive learning outcomes also improve [17]. In the NHT model, the Heads Together phase mechanism, which requires all group members to understand the answer together, encourages a more comprehensive mastery of concepts, as each student not only learns for themselves but also ensures the understanding of all their groupmates [11].

CONCLUSION

This study successfully developed NHT-based worksheets to train students' communication skills on the topic of reaction rates, which met all three feasibility criteria. In terms of validity, the LKPD was categorized as valid and highly valid in both content and construct validity. In terms of practicality, 85,71% of the student response questionnaire items fell into the highly positive response category, supported by a 92,35% of relevant student activities. In terms of effectiveness, the frequency of asking questions in session 1 was 33,3%, while in session 2 it was 41,6%, while the frequency of expressing opinions in session 1 was 50%, and in session 2 it was 58,3%, meeting the fairly good criterion. The quality of questions in session 1 was 36,1%, and in session 2, 41,6%, while the quality of opinions in session 1 was 41,67%, and in session 2, 44%, meeting the fairly good criteria. The quality of written communication from all three groups reached ≥ 66,67%, meeting the good criterion, and the classical mastery rate was 100% for the posttest with a score of ≥75. This demonstrates that the developed worksheets can be used by teachers for discussion-based chemistry instruction.

An issue to consider for future research is that the time allocated for discussion was insufficient. Therefore, further research requires adjustments to time management to optimize the full potential of these worksheets.

ACKNOWLEDGMENTS.

Appreciation is also extended to all validators and the staff of Ngoro State High School, Jombang, who assisted in the implementation of the pilot test for this research.

REFERENCES

1. Nababan, K. 2024. *Pembelajaran Kimia Abad ke-21*. Surakarta: Tahta Media Group
2. Hijrathaen, C., Savalas, L. R., and Ariani, S. 2025. Analisis Kesulitan Belajar Siswa Kelas XI MAN 1 Lombok Tengah Pada Mata Pelajaran Kimia. *Chemistry Education Practice*, Vol. 8, No. 2, pp. 252–256.
3. Nilam, H. S., and Yenti, E. 2023. Analisis Keterampilan Komunikasi Siswa pada Materi Ikatan Kimia. *Journal of Natural Science Learning*, Vol. 13, No. 1, pp. 33–42.
4. Muchlis, and Wulandari, I. S. 2020. Implementation of Cooperative Learning Model Type of TPS Based SAVI to Complete Student Learning Outcome. *Journal of Chemistry Education Reseach*, Vol. 4, No. 2, pp. 71–76.
5. Puspitasari, L., and Muchlis. 2021. Implementation of Cooperative Learning Model NHT to Train Students Communication Skill in Acid Base Matter. *Journal of Chemistry Education Research (JCER)*, Vol. 5, No. 1, pp. 12–21.
6. Selvianti, F., Wijaya, M., and Sulastry, T. 2021. Penerapan Model Pembelajaran NHT dengan Pendekatan Ilmiah untuk Meningkatkan Aktivitas Belajar Siswa SMA Negeri 2 Pancarijang Kabupaten Sidrap pada Materi Pokok Ikatan Kimia (Research pada Kelas X MIA 3). *ChemEdu (Jurnal Ilmiah Pendidikan Kimia)*, Vol. 2, No. 1, pp. 10–18..
7. Dewi, R., and Diansah, I. 2022. Pengembangan (LKPD) Berbasis Problem Based Learning (PBL) pada Materi Klasifikasi Makhluk Hidup. *AL-Ikmal: Jurnal Pendidikan*, Vol. 1, No. 1, pp. 78–91
8. Agetania, N. L. P., Wulandari, I. G. A. A., Astiti, K. A., Marlinda, N. L. P. M., and Murpratiwi, S. I. 2024. Pelatihan dan Pendampingan Guru dalam Penyusunan LKPD Sebagai Bahan Ajar untuk Menunjang Pembelajaran di SD Negeri 5 Penarukan. *Proceeding Senadimas Undiksha*, Vol. 9, pp. 1187–1193.

9. Permata, I.D., Roza, Y., and Maimunah. 2021. Analisis Kesesuaian antara LKPD dengan Model Pembelajaran. *Naturalistic: Jurnal Kajian Penelitian dan Pendidikan dan Pembelajaran*, Vol. 5, No. 2, pp. 764–773.

10. Nazhifah, F. R., Dewi, R. S., and Taufik, M. 2025. Keterampilan Kolaborasi Dan Komunikasi dalam Implementasi Model Pembelajaran Kooperatif Tipe STAD pada Kelas V SD Negeri Balaraja III. *JERUMI: Journal of Education Religion Humanities and Multidiciplinary*, Vol. 3, No. 2.

11. Arends, R. I. 2012. *Learning to Teach (9th ed.)*. New York: McGraw-Hill.

12. Sugiyono. 2015. *Metode Penelitian Pendidikan: Pendekatan Kuantitatif, Kualitatif, dan R&D*. Bandung: Alfabeta.

13. Suwandi, V. K., and Muchlis. 2020. Penerapan Model Pembelajaran Kooperatif Tipe NHT Materi Larutan Elektrolit dan Non Elektrolit Melatihkan Keterampilan Komunikasi. *Unesa Journal of Chemical Education*, Vol. 9, No. 3, pp. 334–343.

14. Thiagarajan, S., Semmel, D. S., and Semmel, M. I. 1974. *Instructional Development for Training Teachers of Exceptional Children*. Indiana: Indiana University.

15. Haqiqi, F., and Rusmini, R. 2022. Penerapan Multi Model untuk Melatihkan Keterampilan Komunikasi Siswa pada Materi Asam Basa di SMA Negeri 1 Bangsal Mojokerto. UNESA *Journal of Chemical Education*, Vol. 11, No. 2, pp. 158–167.

16. Hendrasari, N., and Mitarlis. 2020. Penerapan Model Pembelajaran Kooperatif Tipe TPS untuk Melatihkan Keterampilan Berkomunikasi Peserta Didik pada Materi Asam Basa. *Unesa Journal of Chemical Education* Vol. 9, No. 3, pp. 290-298.

17. Siregar, L. H. 2023. Meningkatkan Prestasi Belajar Siswa melalui Model Pembelajaran Berdasarkan Masalah (Problem Based Learning) pada Mata Pelajaran Kimia di Kelas XI IPA 6 SMA Negeri 19 Medan. *Ability: Journal of Education and Social Analysis*, Vol. 4, No. 2, pp. 55–64.

18. Septyaningrum, A., and Lestari, W. 2023. Validitas Perangkat Pembelajaran Project-Based Inquiry Science Terintegrasi Pendidikan Lingkungan untuk Meningkatkan Kemampuan Berpikir Kritis. *Jurnal Ilmu Pendidikan dan Pembelajaran*, Vol. 2, No. 1, pp. 1–16.

19. Ashudik, and Yonata, B. 2018. Keterampilan Komunikasi Siswa Kelas XI SMA Negeri Bangsal Mojokerto melalui Model Pembelajaran Kooperatif Tipe NHT pada Materi Pokok Kesetimbangan Kimia. *Unesa Journal of Chemical Education*, Vol. 7 No. 3, pp. 399-406.

20. Masgumelar, N. K., and Mustafa, P. S. 2021. Teori Belajar Konstruktivisme dan Implikasinya dalam Pendidikan. *GHAITSA: Islamic Education Journal*, Vol. 2, No. 1, pp. 49–57.

21. Danial, M., and Sanusi, W. 2020. *Penyusunan* Lembar Kegiatan Peserta Didik (LKPD) Berbasis Investigasi bagi Guru Sekolah Dasar Negeri Parangtambung II Kota Makassar. *Prosiding Seminar Nasional Lembaga Penelitian dan Pengabdian kepada Masyarakat*, pp. 615–619.

22. Palupi, D. I., Rahmani, E., Yusnita, E., Gustina, H., Pertiwi, H., and Priyanti, N. 2023. Mengenal Model Kooperatif Numbered Head Together (NHT) untuk Pembelajaran Anak Usia Dini. *Edukasia: Jurnal Pendidikan dan Pembelajaran*, Vol. 4, No. 1, pp. 21–28.

23. Ibrahim, M. 2014. *Model Pengembangan Perangkat Pembelajaran menurut Jerold E. Kemp & Thiagarajan*. Surabaya: PSMS PSS Unesa.