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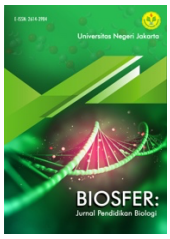

Enhancing science communication skills biology in students through the number head together

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ABSTRACT

The teaching of science communication skills at the high school level can be effectively accomplished through lessons that are oriented not only towards the development of cognitive skills, but also towards the acquisition of hands-on communication skills. The present study employs an experimental research design to investigate the impact of NHT-type cooperative learning on students' science communication skills. This study employs an experimental design comprising an class and a control class. The study population comprised students at X MIPA UPT SMAN 2 The X MIPA 3 class was designated as the experimental class, while the X MIPA 7 class served as the control class. Sampling was conducted using a randomised system. The data employed in this study were derived from two sources: primary data collected via the science communication skills rubric and secondary data obtained through observation of student and teacher activities. The data collection instrument was a science communication skills observation sheet that had previously been tested for validity and reability. The data were analysed using the Friedman test, which revealed significant differences in students' science communication skills between the control and experimental classes at each meeting ($p < 0.05$). Similarly, the Wilcoxon test demonstrated a significant difference between the control and experimental classes at each meeting ($p < 0.05$). The findings of this study suggest that further research should be conducted at a larger scale to gain a more comprehensive understanding of the rubric of science communication skills.

INTRODUCTION

Education in the 21st century is faced with being able to prepare a generation that has competitiveness (Boholano, 2017; Yulianda Putri Rahmawati & Mohammad Salehudin, 2021). This era is faced with various challenges and rapid changes, thus requiring resources that are qualified and competitive (Rakhmawati et al., 2024; Scott, 2015). The Partnership for 21st century skills has identified the skills that need to be possessed in this era, one of which is communication skills (Cahit Erdem et al., 2019; Gordon & Martin, 2019)

Communication skills are the ability of individuals to convey and receive information scientifically and effectively both orally and in writing (Malik & Ubaidillah, 2021). This skill is very important because it makes it easier to convey theories, interpret graphs and images, and so on (Cici Mayani et al., 2023). This skill also allows a person to convey ideas and information clearly and effectively, as well as understand the messages received from others. science communication skills consist of 4 aspects, namely: 1) Conveying thoughts and ideas systematically, both through oral and written communication. 2) using polite, clear, and communicative language. 3) convey ideas or main ideas scientifically (Malik & Ubaidillah, 2021). The development of these skills can be done through science learning at school.

Science learning is designed to help students understand scientific concepts, develop thinking skills, problem-solving and communication skills through the scientific method. The development of communication skills in learning is very important to increase students' self-efficacy and also prepare students to face the challenges of the future masses. Communication skills help students to convey ideas clearly, work together in teams, and build positive interpersonal relationships.

Some studies show that communication skills still need to be developed (Alpusari et al., 2019; Fitriah et al., 2020). The low communication skills of students are caused by several things, namely: students lack of confidence (Fitriah et al., 2020), lack of basic communication skills (Raptou et al., 2017), and the selection of inappropriate learning methods. This is also in line with the results of observations that have been made at SMAN 2 The problems found that: 1) students' communication skills have not been developed optimally, as evidenced by the presentation in front of the class, students lack confidence; 2) students are less active in communicating with fellow students during discussion; 3) in the learning process students are less motivated to develop their communication skills. The necessity for this research arises from the fact that numerous studies have been conducted to assess science communication skills within the NHT model. However, there is a paucity of studies that have investigated the impact of communication skills at each meeting of the NHT.

Effective biological science communication entails engaging the public through clear messaging, face-to-face interaction, and an understanding of audience needs, as elucidated in the case studies and practical tips presented in the guide. Biology is a science that can stimulate learners to develop effective communication skills. The ability to communicate scientific information effectively is a crucial skill in the field of science. This will facilitate the conveyance of theories, the interpretation of graphs and images, and so forth. In general, high school students still have difficulty in communicating both orally and in writing to convey their ideas (Anon n.d.; Ariyansyah and Nurfathurrahmah 2022; Cici Mayani, Djohar Maknun, and Mujib Ubaidillah 2023; Dimas Geovana, Budhi Akbar, and Supardi Supardi 2022; Haka et al. 2022; Limbong and Mnurung 2022; Sabila, Pertiwi, and Sintawati 2023; Sam and Rahayu 2022; Sekarningrum, Shoffa, & Soemantri 2023; Troy et al. 2022; Winanti & Amalia 2022).

Efforts can be made to overcome these problems by applying the cooperative learning model of number head together (NHT) type. Cooperative learning is learning that places the teacher as a facilitator and guide to achieve learning objectives. One of the cooperative learning that can be applied is NHT-type cooperative learning. NHT is a learning model that involves students finding out the topics studied by giving different numbers. The application of NHT in learning has advantages in each of its stages, including providing opportunities for students to express their opinions and for each group member to share information. In addition, this learning trains students to think and be active in learning. This learning also increases student creativity because it makes students more active in conveying ideas and opinions so that it involves all students in the effort to complete the task and increases individual responsibility for their group. Based on the background that has been described, the purpose of this study is to see the effect of the NHT-type cooperative learning model on the development of science communication skills of high school students.

METHODS

Research Design

This research is a qualitative study using the quasi-experiment method (Sugiyono, 2017). This research design uses a two-group design research design. The research was conducted from September to October 2023. The following is Table 1 of the two-group design research design.

Table 1.
Research Design

Before	Rubric Treatment	After
O1	X1	O2
O3	X2	O4

Source: (Sugiyono, 2017)

Description:
O1 = Before Treatment Experimental class
O2 = After the experimental class treatment
O3 = Before treatment control class
O4 = after treatment control class
X1 = Experimental class rubric treatment
X2 = Control class rubric treatment

Population and Samples

The research population was X MIPA UPT SMAN 2 class students totaling 317 students. Determination of the sample in this study using a random sampling technique. Research samples X MIPA 3 class as an experimental class and X MIPA 7 class as a control class. The number of students in each class was 35 students

Instrument

The data collection instrument used in this study is an observation sheet of science communication skills. Science communication skills rubric referring to Ramadhani et al, (2023).

Procedure

This research procedure starts from the preparation stage. This stage prepares data collection instruments, conducts interviews at school, prepares learning devices that are in accordance with the NHT-type cooperative learning model, and validates the instruments and learning devices to be used. The second stage is the implementation stage. This stage is carried out through the application of the learning model. Before the treatment with the NHT-type cooperative learning model, the experimental class at the first and second meetings had not been given treatment, then the researchers provided treatment in the form of a learning process with the NHT-type cooperative learning model during the third to fifth meetings. At the sixth meeting when implementing learning activities, students' science communication skills will be seen as well as after treatment with the NHT-type cooperative learning model. The third stage is the data analysis stage.

Data Analysis Techniques

The data analysis techniques used in this study are descriptive statistical analysis and inferential analysis. This study hypothesizes is a correlation between the efficacy of science communication skills and the implementation of the NHT learning model. Descriptive statistical analysis using the SPSS 22.0 for Windows program. Inferential statistical analysis using the Friedman test and Wilcoxon test.

RESULTS AND DISCUSSION

The data obtained in this study are data on students' science communication skills in biology subjects at senior high school. In this study, treatment was given in the form of using the Number Head Together (NHT) type cooperative learning model in the experimental class in class X MIPA 3, while the control class was not given treatment because it used a learning model that was in accordance with the teacher's lesson plan.

Based on Table 2, there were 35 students of class X in SMAN who were observed for six meetings. Descriptively, the difference in science communication ability scores from the first meeting to the sixth meeting can be analysed using Friedman test with the following results.

Table 2.
Differences in Science Communication Skills in the Experiment Class

Meeting	Minimum	Maximum	Mean	Std. Deviation	α
1st Meeting	2.00	6.00	3.771	0.973	
2nd Meeting	2.00	10.00	4.800	1.694	
3rd Meeting	0.00	8.00	4.600	1.850	0.000
4th Meeting	0.00	9.00	4.286	2.444	(α<0.05)
5th Meeting	2.00	11.00	6.143	2.002	
6th Meeting	11.00	22.00	15.143	2.819	

Table 2 shows the results of the analysis of differences in science communication skills obtained a significance value of 0.000 (α <0.05). The results of this analysis indicate that there is a difference in the average communication skills from the first meeting to the sixth meeting. A comparison of science communication skills for each meeting can be further analyzed with Wilcoxon test. Table 3: Differences in science communication skills at each meeting.

Table 3.
Differences in Science Communication Skills at Experiment Class

Meeting	Mean	α
1st Meeting – 2nd Meeting	1.028	0.000
2nd Meeting - 3rd Meeting	-0.200	0.503
3rd Meeting – 4th Meeting	-0.314	0.513
4th Meeting – 5th Meeting	1.857	0.001
5th Meeting – 6th Meeting	9.000	0.000

Table 3 shows that from the first meeting to the second meeting there was a significant increase in science communication skills. This is indicated by the significance value of the Wilcoxon test of 0.000 (α<0.05). From the second meeting to the third meeting to the fourth meeting there was a slight decrease. The decrease in science communication skills was not significant as indicated by a significance value of 0.503 (α>0.05). The same thing also happened at the third meeting to the fourth meeting where there was a slight decrease but not significant as indicated by a significance value of 0.513 (α>0.05). From the fourth meeting to the fifth meeting, there was again an increase and was significant as indicated by a significance value of 0.001 (α<0.05). While at the fifth meeting to the sixth meeting, there was also the highest and most significant increase indicated by a significance value of 0.000 (α<0.05).

The success of improving students' science communication skills is supported by several facts of learning activities. The first stage, organizing students into several groups heterogeneously. At this stage, students are grouped into several groups and each group member is given a number. This grouping of students encourages increased learning motivation (Astuti, 2019; Sudewiputri & Dharma, 2021) the classroom atmosphere is fun and interactive. It has been posited that proficiency in speaking skills, or in this case communication, is directly proportional to the frequency of reading. This is because the more one reads, the greater the capacity to communicate information (Ariyansyah and Nurfathurrahmah 2022; Cici Mayani et al. 2023; Dimas Geovana et al. 2022; Sam & Rahayu 2022)

The second stage is problem discussion. Learners are given several problems according to the number of numbers. Learners will discuss the problems given and later will be responsible according to the number given. This stage will train active participation in group discussions(Simanungkalit, 2021), so that students have direct involvement in the learning process. This process trains science communication skills the ability to convey ideas through small groups(Wardani, 2010). The third stage is giving answers. At this stage, students will convey the results of the discussion that has been carried out with their group friends. Because NHT is one of the models that has flexible learning steps and provides an opportunity for each learner to convey their own thoughts according to the ideas they have abstracted themselves(Wen et al., 2020). At this stage, students will convey the results of the discussion

using polite, clear, and communicative language. This stage will also train students to convey ideas scientifically(Irawan et al., 2023).

The success of improving students' science communication skills is supported by the application of the NHT cooperative learning model applied to the learning process. The advantages of applying this learning model are able to increase students' learning motivation(Fiqry et al., 2024). This model also provides opportunities for students to exchange ideas(Sa'idah et al., 2022) so that communication skills between fellow students can be trained. The better the communication skills, the better the students' learning activities(Qodarsih et al., 2023). In addition, the NHT model can also develop collaboration skills (Dalimunte, 2023),an attitude of responsibility(Suhartini, 2018), and increase students' self-confidence(Mardiati Mardiati, 2018).

The results of previous studies also show that the application of the NHT learning model can improve students' science communication skills (Alisyah et al., 2022; Munawaroh et al., 2022; Novibriawan et al., 2021). However, the results of the study obtained at meetings 2-3 and meetings 3-4 decreased students' communication skills. This decline is influenced by several factors, namely students' lack of interest in participating in learning. This happens because students feel the learning process is less challenging. Science learning should be carried out interactively, inspiring, and challenging for students(Ayu Sri Wahyuni, 2022). A less conducive classroom environment is also a cause. The large number of students also has an impact on the effectiveness of the learning process. So that teachers are expected to be able to manage and condition the class to remain conducive(Elmi Masfufah et al., 2023; Havik & Westergård, 2020). The use of a monotonous learning model allows students to lose interest in learning(Dalimunte, 2023; Khairul Khalqi et al., 2023).The application of a varied learning model is also very important (Ponidi et al., 2021)

This research has revealed that students' science communication skills can be developed through cooperative learning by applying the NHT learning model (Najamudin 2022; Limbong and Mnurung 2022). The results of this study are expected to be used as a reference to apply biology learning on different topics and more samples. This is because the research was limited by time and sample.

Based on Table 4 below, the results of descriptive data analysis showed that 35 students of class X at SMAN were observed for six meetings. The difference in science communication skills scores from the first meeting to the sixth meeting can be analyzed using the Friedman test with the following results.

Table 4.
Differences in science communication skills in the control class

Meeting	Minimum	Maximum	Mean	Std. Deviation	α
Meeting 1	1.00	5.00	2.89	1.157	
Meeting 2	1.00	5.00	3.06	1.110	
Meeting 3	0.00	6.00	2.94	1.259	0.000
Meeting 4	0.00	6.00	3.23	1.285	(α<0.05)
Meeting 5	0.00	7.00	3.17	1.774	
Meeting 6	0.00	20.00	9.46	4.168	

The p-value of 0.000 indicates that there is a highly significant difference in students' science communication skills from meeting 1 to meeting 6. This means that the NHT method exerts a different influence at each meeting, with a noticeable change in students' science communication skills. The results of the Friedman test showed that there was a significant difference in the development of students' science communication skills at each meeting. This means that the application of the Number Head Together (NHT) method is effective in improving these skills over time, especially in the final meetings.

This improvement in communication skills may not be immediately apparent in the early meetings, but it is increasingly evident in subsequent meetings, especially in the last meeting, which is also supported by the results of the Wilcoxon test which shows a significant increase between the 5th and 6th meetings. analysis results can be seen in Table 5.

Table 5.
Differences in science communication skills in the experimental group and the control group

Meeting	Mean	α
Meeting 1 – Meeting 2	0.235	0.357
Meeting 2 – Meeting 3	0.141	0.648
Meeting 3 – Meeting 4	0.152	0.124
Meeting 4 – Meeting 5	0.184	0.885
Meeting 5 – Meeting 6	0.536	0.000

The Wilcoxon test is a non-parametric test used to compare two paired conditions in non-normally distributed ordinal or interval data. In this context, the Wilcoxon test is used to see if there is a significant difference in students' science communication skills from one meeting to the next.

From the first meeting to the fifth meeting, there was no significant change in students' science communication skills. The p-value was always greater than 0.05, indicating that the difference between the meetings was not large enough to be considered significant.

However, at the 6th meeting, there was a very significant increase in communication skills. This could indicate that the Number Head Together (NHT) method may take several meetings before its effects are truly visible, with the best results appearing in the last meeting. The results of the data analysis showed a p-value of 0.000, which indicates a highly significant difference in students' science communication skills from meeting 1 to meeting 6. This indicates that the Number Head Together (NHT) method had a consistent and significant impact on students' science communication skills during the study period.

Sayekti (2024); Septikasari and Frasandy (2020) They found that the NHT method was effective in improving science communication skills with significant changes at the final meeting. They noted that this skill improvement was mainly due to the active interaction encouraged by the NHT method, which requires students to actively participate in group discussions.

This finding is supported by the implementation of interaction strategies that encourage students to engage in discussions and explain their ideas to classmates. This is in line with the results of your data analysis, which showed an increase in science communication skills from meeting to meeting. The improvement can be explained by having more opportunities to practice communication in a group setting. This finding is consistent with the results of my study, where a significant improvement in communication skills occurred between meetings 5 and 6. This suggests that the NHT method may take time to show its full effect, which is consistent with the findings (Sabila et al. 2023)**.**

Taher (2023) observed that the improvement in communication skills occurred gradually, with a greater impact on students with lower initial skills. Your results show a greater improvement at the final meeting, which is consistent with their findings that the impact of the NHT method can increase over time. the NHT method helps students build confidence in speaking in front of the class and improve collaboration skills. Their research shows that NHT helps students with low communication skills because it provides a clear structure for speaking and collaborating. This also explains your findings, where the analysis results showed a significant improvement in communication skills from meeting 1 to meeting 6, especially at the final meeting. The structure provided by NHT allows students to improve over time.

Roche et al. (2021); Taher (2023) They reported that the NHT method improved collaborative and communication skills significantly in the final session. Your findings, with a significant increase between meetings 5 and 6, support this result, suggesting that the effects of the NHT method may be more visible in the final session when students are more familiar with the method. The results of this study also proved that students' communication skills improved due to the structured interaction within the group.

Their research suggests that collaborative and communication skills are interrelated, and improvements in one area can have a positive impact on the other. The results of your study support these findings, as the data analysis showed that communication skills improved significantly in each meeting. This could be due to the continuous and structured interaction provided by the NHT method. My research findings are consistent with previous studies, which show that the NHT method is effective in improving students' science communication skills. The significant increase from meeting to meeting indicates that this method allows students to gradually develop their communication skills, in line with what was reported (Supena, Darmuki, and Hariyadi (2021)**.** The shortcomings of this study are due to the relatively limited time frame for data collection. A significant challenge is the time constraints

inherent to the learning process, which is often disrupted by competing demands on students' time, such as extracurricular activities.

CONCLUSION

The NHT method has a significant impact on students' science communication skills, especially at the final meeting. This finding provides additional evidence that the application of the NHT method can lead to significant improvements in communication skills if applied consistently and adequately over some time.

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