Strengthening Buffer Solution Learning Activities with Numbered Heads Together Models Equipped with a Combined Hand Out –Augmented Reality

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Abstract. This study aims to determine the comparison of the effect between the Numbered Heads Together (NHT) model equipped with Handout-AR and NHT model equipped with Microsoft PowerPoint on student learning activities on the buffer solution. The research sample was determined using the Cluster Random Sampling technique. The study data were obtained using documentation and observation techniques. The documentation technique was used to obtain data on the students’ midterm test results. The observation technique was used to obtain the data on the scores of student learning activities. The study data were analyzed using the Mann Whitney test. The results show that the application of the NHT model equipped with Handout-AR has a better effect on student learning activities on buffer solution material than the application of the NHT model equipped with Microsoft PowerPoint. These results are supported by the results of the Mann Whitney test and the average score of student learning activities from the two experimental classes. The data analysis using the Mann Whitney test produces asymp. Sig. 2-tailed value (0.000) greater than the significance level/α (0.050). The NHT/Handout-AR class has an average score of learning activities (87.6) which is greater than the NHT/ Microsoft PowerPoint class (68.4).

1. Introduction
Chemistry is one subject in the 2013 curriculum that is formally given to senior high school students in Indonesia. The characteristics of the material in chemistry learning tend to be conceptual, abstract, complex, and hierarchical. Every basic concept of chemistry underlies even more complex chemical concepts, requiring the ability to understand the relationship of one concept to another. An incorrect understanding of a concept may lead to the formation of incorrect understandings of other concepts [1].

Buffer solution is one of the materials in chemistry learning that requires a good conceptual understanding. The complexity of the buffer solution concept is related to other chemical concepts, such as the concept of chemical equilibrium and acid-base. Good mathematical skills are also needed in learning buffer solution. The characteristics of such material often make students think that the buffer solution is a difficult material [2,3].

Based on the results of interviews with several twelfth-grade students at SMA Negeri 2 Boyolali, buffer solution is one of the difficult materials. This was confirmed by one of the chemistry teachers in the school. He said that most students still scored below the standard on the buffer solution material. He
added that the low student learning outcomes were partly due to the students’ lack of understanding of concepts and mathematical skills. The inactivity of students in the learning process is also one reason for the low outcomes in the buffer solution material.

Student learning activities are an essential principle in the learning process because increasing student learning activities has a positive effect on improving student learning outcomes [4,5,6]. The teacher as a facilitator must be able to reduce their dominance in learning. Students must always be involved in the learning process to optimize students’ learning activities and experiences, hoping that student learning outcomes will also be more optimal.

Teachers must also be able to apply appropriate learning models so that student learning activities can be optimized. One model that can be applied by teachers is Numbered Heads Together (NHT). This model is one type of cooperative learning model developed to encourage student involvement in studying the material learned and to check their understanding of the content of the material [7]. Several studies have shown that NHT can significantly increase student activities and learning outcomes in chemistry learning [8], including the buffer solution material [9,10,11], the periodic system of elements [12], atomic structure [13], salt hydrolysis [14], and colloids system [15].

The syntax of NHT begins with numbering students assigned to groups (3-5 students per group). The teacher then gives assignments or asks questions (questioning) to the students to be discussed/thought about together (Heads together) in each group. The discussion activities are carried out within a certain period. After the discussion, the teacher mentions one number randomly. The student whose number is called must report the results of the discussion in front of the class (answering) while others are asked to pay attention and provide responses or questions. After no responses or questions are submitted, the teacher can end the lesson by concluding together with the students [7, 16].

In addition to the application of an appropriate learning model, the use of appropriate learning media is important to enable students to better learn the buffer solution material. According to Daryanto [16], learning media is anything that can be used to convey messages in the form of learning materials to students so that students' thoughts and feelings can be encouraged to carry out learning activities to achieve the learning objectives. Learning media that can be used by teachers include Microsoft Powerpoint and Combined Handout-Augmented Reality (Handout-AR).

Microsoft Powerpoint is a media in the form of a presentation program or application that is commonly used by teachers in learning. Although it is a type of software media, the use of this media still requires some supporting hardware, such as a computer/laptop and an LCD projector. The computer/laptop is used to create and operate the presentation program containing learning materials while the LCD projector is used to display the presentation program so that students can observe and pay attention directly. Teachers can pack up and display an attractive presentation using Microsoft Powerpoint media. The content of the presentation program can be the material in the form of text, images, graphics, sound, or animation/video, according to the characteristics of the material to be studied [17, 18].

The use of Microsoft Powerpoint media can attract and motivate students to participate in learning. The weakness of this media is it requires expensive hardware, resulting in many schools less able to provide supporting tools for the media. To start learning using Microsoft Powerpoint media also takes a relatively long time for preparation, reducing the effective learning time. The perspectives of the students will also be audio-visually limited by their sitting position. Besides, the student interactions with the media are not flexible, so the use of media depends on the teacher in learning.

Handout-AR is an advanced development of the printed media, handout. Handout media contains not only printed material in the form of text, graphics, charts, tables, symbols, or two-dimensional still images as in general but also markers or signs that can bring up three-dimensional images, animations, or learning videos through the use of AR application. The object is packaged virtually but can be displayed/visualized in the real world, making the user feel like seeing a real-life object. The visualization of virtual objects can be done using a smartphone [19].

The application of AR technology in printed media such as handouts allow students to interact directly with the learning media. Students will be interested in studying the media from various
perspectives so that learning is not monotonous, and students are motivated to follow learning well. The weakness of Handout-AR media lies in the use of supporting tools such as smartphones. The application of this media will be disrupted if the school regulations do not allow students to bring cellphones. However, the application of this media will remain disrupted if the students do not have smartphones or they have smartphones that do not comply with the prerequisite specifications [20].

Based on the background, this study was conducted to compare the effects of the application of the NHT model equipped with the Handout-AR and the NHT model equipped with Microsoft Powerpoint on student learning activities on the buffer solution material at SMA Negeri 2 Boyolali in the 2018/2019 academic year.

2. Research Method
This study was conducted at the XI science class of SMA Negeri 2 Boyolali in the even semester of the 2018/2019 academic year. The experimental method was used. The study population was comprised of all students of XI science class at SMA Negeri 2 Boyolali in the 2018/2019 academic year. The sample was determined using the cluster random sampling technique. Before determining the sample, the normality and homogeneity tests were carried out. After that, the average balance test was performed to determine the initial condition of the selected sample (balanced or not).

The sample used in this study consisted of two classes, namely Class XI Science 4 as the experimental class I, which received treatment in the form of learning using the NHT model equipped with Handout-AR, and Class XI Science 1 as the experimental class II, which received treatment in the form of learning using the NHT model equipped with Microsoft Powerpoint. The experimental class I consisted of 34 students while the experimental class II consisted of 33 students.

The data were collected using observation to assess student learning activities. There are four learning activities assessed, namely visual, oral, listening, and writing activities. The assessment was carried out by two observers using the observation sheet instrument. The scoring ranges from 1 to 4.

| Score Interval | Criteria       |
|----------------|----------------|
| 0 – 20         | Very inactive  |
| 21 – 40        | Inactive       |
| 41 – 60        | Quite active   |
| 61 – 80        | Active         |
| 81 – 100       | Very active    |

The observation instrument consists of ten indicators of student learning activities. The indicators of the visual activities include (1) paying attention to the material displayed in the learning media and (2) paying attention to fellow students who are giving presentations, expressing opinions or responses, and asking or answering questions. The indicators of the oral activities include (1) answering questions raised by teachers or fellow students and (2) asking questions about the material delivered by the teacher or fellow students during the presentation, (3) expressing opinions/responses during discussions or learning. The indicators of the listening activities are (1) listening to the delivery of material and explanations by the teacher and (2) listening to friends who are giving presentations, expressing opinions or responses, and asking or answering questions. The indicators on the writing activities include (1) taking note of the material, (2) writing the results of the discussion, and (3) working on the questions given by the teacher. The assessment criteria of student learning activities are as stated in Table 1.

The data on the scores of student learning activities were analyzed using SPSS 16 application. The data analysis was started by doing the prerequisite analysis tests, namely the normality test using the Shapiro-Wilk test and the homogeneity test using the Levene test. The data that meet the prerequisite tests can be analyzed using a parametric statistical test, namely the right-tailed t-test, while data that do not meet the prerequisite tests are analyzed using a non-parametric statistical test, namely the Mann Whitney test.
3. Results and Discussion

Referring to the NHT syntax, the learning process began with the delivery of objectives and an overview of the learning to be undertaken. After that, the teacher divided the students into several groups and assigned a number to each student according to the class attendance number. The division of the groups was based on the homogeneity of gender and the ability of students based on the results of the midterm test in the even semester. The numbering of each student aims to fulfill the learning syntax of the NHT model applied. The numbering was also done to allow the observer to observe and assess student learning activities.

After the numbering, the teacher gave several problems or questions to the students to be discussed in their respective groups. They discussed to find solutions or answers to the problems/questions. After that, the teacher mentioned one number. The students with the number mentioned presented the results of their group discussions in front of the teacher and other students. Other students listened and could provide feedback in the form of rebuttals, questions, or opinions. If there is no feedback from the students, the teacher provides a review or confirmation of the answers submitted and then concludes together with the students.

The experimental class I learned using a combined Handout-AR media while the experimental class II learned using the NHT model with Microsoft Powerpoint media. The use of different media in its application can have different effects in terms of student response and involvement during the learning process.

![Figure 1. Comparison of the Frequency Distributions of Scores of Student Learning Activities between Experimental Classes I and II.](image)

Based on the results of the assessment of student learning activities, the experimental class I obtains an average score of 87.6 with the highest score of 97.5 and the lowest of 72.5. The experimental class II obtained an average score of 68.4 with the highest score of 85 and the lowest of 52.5. The comparison of the scores of student learning activities from the two classes is displayed in Figure 1, while the results of the normality and homogeneity tests can be seen in Table 2.

| Class          | Significance (Sig.) | Decision   |
|----------------|---------------------|------------|
| Normality      |                     |            |
| Experimental I | 0.001               | No         |
| Experimental II| 0.080               | Normal     |
| Homogeneity    |                     |            |
| Experimental I | 0.129               | Homogeneous|
| Experimental II|                     |            |
Based on Table 2, the data on the scores of student learning activities for the experimental class I are declared abnormal because they have a significance value (0.001) which is smaller than the significance level ($\alpha = 0.050$). Therefore, the Mann Whitney test was used to test the hypothesis. The results of the hypothesis testing are shown in Table 3.

### Table 3. Results of Hypothesis Test on the Scores of Student Learning Activities

| Class          | Mean | Asymp. Sig. (2-tailed) | Decision  |
|----------------|------|------------------------|-----------|
| Experimental I | 87.6 | 0.000                  | $H_0$ is rejected |
| Experimental II| 68.4 |                        |            |

Based on Table 3, the hypothesis test using the Mann Whitney test produces Asymp. Sig. (2-tailed) smaller than the significance level ($\alpha = 0.050$), so $H_0$ is rejected. This means that NHT model with Handout-AR has a different effect on student learning activities compared to NHT model with Microsoft Powerpoint. Based on the average score of student learning activities from both classes, learning using the NHT model with Handout-AR has a better effect. This is evidenced by the average score of the experimental class I (87.6) which is greater than that of the experimental class II (68.4).

### Table 4. Comparison of Student Learning Activities Scores between Experimental Classes I and II

| No | Indicator                                | Mean Score |
|----|------------------------------------------|------------|
|    |                                          | Experimental Class I | Experimental Class II |
| 1  | Paying attention to learning media       | 3.97       | 2.94        |
| 2  | Paying attention to presentation activities | 3.56       | 2.64        |
| 3  | Answering questions                      | 3.21       | 2.55        |
| 4  | Asking questions                         | 2.71       | 2.36        |
| 5  | Expression opinions                      | 3.71       | 2.73        |
| 6  | Listening to teacher’s explanation       | 3.85       | 2.79        |
| 7  | Listening to friend’s opinion            | 3.62       | 2.36        |
| 8  | Taking note of the material              | 2.76       | 2.30        |
| 9  | Writing discussion results               | 3.79       | 2.94        |
| 10 | Working on the exercise                  | 3.88       | 3.76        |

Based on Figure 1, most students in the experimental class I obtain the scores in the interval of 78.6 - 98.0 while the scores of most students in the experimental class are at the interval of 52.5 - 78.5. This indicates that the experimental class I has a higher learning activity score than the experimental class II. From the comparison of the average score obtained on each indicator (see Table 4), the experimental class I has a higher average score than the experimental class II for all indicators. This proves that the application of the NHT model equipped with Handout-AR has a better effect than the application of the NHT model equipped with Microsoft Powerpoint.

The results are related to the differences between the two types of multimedia used in this study. According to Smaldino [18], besides having to be able to combine several elements of media into a single system, multimedia-based learning media must also be able to provide opportunities for students...
to learn independently and repeatedly and flexible in use. Students must have the opportunity to use the media according to the desired perspective.

Based on its characteristics, Handout-AR media can encourage student involvement in the learning process better. It can provide flexibility to students to use it. Students can directly interact with the media with different perspectives as desired. The ability to incorporate virtual objects into a real-life environment of the Handout-AR media can also attract, encourage interest, and motivate students to be actively involved in the learning process [20].

4. Conclusion

Based on the results and discussion, it is concluded that the application of the NHT model with Handout-AR has a different effect on the student learning activities on the buffer solution material compared to the application of the NHT model with Microsoft Powerpoint. The application of the NHT model with Handout-AR has a better effect than that of the NHT model with Microsoft Powerpoint.

References

[1] Ross J, Guerra E, Gonzalez-Ramos S 2020 Chem. Educ. Res. Pract. 21 (1) 357-370
[2] Rodriguez J-G, Hensiek S, Meyer JR, Harwood CJ, and Towns MH 2018 J. Chem. Educ. 95 (10) 1816-1820
[3] Purpuniyanti M, Masykuri M, and Ulfa M 2019 J. of Phys: Conference Series 1318 (1) 012001.
[4] Maltese AV, Danish JA, Bouldin RM, Harsh JA, and Bryan B 2016 Int J Res Method Educ 39 (2) 208-226
[5] Brouet SA, Hupp AM. 2013 J Chem Educ 90 (10) 1349-1352
[6] Hume DL, Carson KM, Hodgen B, and Glaser RE 2006 J Chem Educ 83 (4) 662-667
[7] Maheady L, Michielli-Pendl J, Harper GF and Mallette B 2006 J Behav Educ 15 (1) 25-39
[8] Saraswaty S, Masykuri M and Utami B 2014 J. Pendidikan Kimia 3 (1) 86-94
[9] Hidayanurhayati, Sihaloho M and La Kilo, A 2018 J. Entropi 13 (2) 233-240
[10] Kusumawardani A, Utami B and Sukardjo JS 2015 J. Pendidikan Kimia 4 (4) 207-216
[11] Murti MMS, Redjeki T and Utomo SB 2014 J. Pendidikan Kimia 3 (4) 75-82
[12] Humaira, Saputro S and Setyowati WAE 2019 J. Pendidikan Kimia 8 (2) 299-305
[13] Retnani FY, Sukardjo JS and Utomo SB 2014 J. Pendidikan Kimia 3 (3) 57-65
[14] Ambawati T, Haryono and Sukardjo JS 2014 J. Pendidikan Kimia 3 (1) 58-64
[15] Antoro YD, Utomo SB, and Masykuri M 2016 J. Pendidikan Kimia 5 (3) 1-8
[16] Arends RI 2001 Learning to Teach Fifth Edition McGraw-Hill New York.
[17] Smith GC and Hossain MM 2017 J Chem Educ 94 (12) 1911-1917
[18] Walkowiak M and Nehring A 2016 J Chem Educ 93 (4) 778-780
[19] Yang S, Mei B and Yue X 2018 J Chem Educ 95 (6) 1060-1062
[20] Aliyu F and Talib CA 2020 J Crit Rev 7 (7) 854-859
[21] Riduwan 2013 Dasar-dasar Statistika [Basics to Statistics] Bandung Alfabet