An analysis of STAD cooperative learning implementation and its effect on the collaborative skill in solving the problems of addition and subtraction

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Abstract: Collaborative skill is needed in 21st century era. However, there is an indication that the learning model has not been able to improve the collaborative skill. This research was intended to analyze the implementation of Student Team Achievement Division (STAD)-based learning instruments and its effect on the students' collaborative skill in solving the problems of addition and subtraction. A mixed research model was used in this research. The triangulation design which combined both quantitative and qualitative researches. As many as 28 students of class 3A were targeted as the control class and 28 students of class 3B as the experimental one. The data was collected by filling out questionnaire, observation, validation sheet, test, documentation as well as pretest and posttest. The results revealed that the percentage of students' collaborative thinking skills in the control class after being implemented by STAD-based learning instruments covered of 57% of cooperation, 62% of responsibility, 60% of compromise, 59% of communication and 65% of flexibility. Whilst, the experimental class got better than the control class as it consisted of 83% of cooperation, 79% of responsibility, 76% of compromise, 80% of communication and 78% of flexibility. The scores obtained from independent sample t-test of post-test showed that there was a significant difference between the control class and the experimental class with a sig (2-tailed) value of 0.003 (p = <0.05). It can be concluded that the implementation of STAD-based learning instruments was able to improve the collaborative abilities of elementary school students in solving the addition and subtraction problems.

1. Introduction
The rapid development of mathematics and technology in the 21st century impacted human life, especially the education, so developing the new skills to keep up with the development is needed. The achievement of 21st century skills in education is done by improving the quality of learning, and helping the students develop their participation, having the emphasis on project or problem-based learning, encouraging the student in communication and collaboration. In fact, the students find mathematics as a difficult subject since it requires higher order thinking to solve math-related problems. Actually, the abstract mathematical concept comes from the reality on daily basis whose essences are taken to be generalized into the abstract formula. Addition and subtraction are parts of mathematics. Addition is the basic operation of arithmetic by adding two numbers into a single number. Whilst the subtraction is the opposite of addition. Addition and subtraction are denoted by symbols a/b/c in which a is hundreds and b is tens and c is unit. The types of addition and subtraction consist of: the addition with saving and non-saving techniques; whilst the subtraction is done by using the borrowing and non-borrowing techniques.
The researcher conducted the research by asking the students to count the addition and subtraction of various types in one question. During the process, there were some children who kept silent because they found it difficult, embarrassed to ask questions, and some did not even know how to do it since they forgot or did not pay attention to the previous explanation, because the learning process that students have so far has been more about "learning about things" than "learning how to be"[1]. They paid less attention and was not actively involved as they felt bored during the explanation. There were only one or two children who dared to ask. It proved that the students' collaborative abilities in counting addition and subtraction were still low.

Student-Teams Achievement Division (STAD) Cooperative learning is a learning activity where students work in small groups to help each other solve problems [2]. Cooperative learning is one of the simplest types of cooperative learning. Slavin [6] states that the STAD (Student Teams-Achievement Division) learning model is a variation of cooperative learning that encourages students to encourage and help each other to master the skills taught by the teacher. There is not much differences of STAD cooperative learning compared to the learning done by teachers in general, but the cooperative learning makes the students work in groups to complete the material and group appreciation is also included. In STAD, they are divided into several groups consisting of 4-5 people of various abilities, genders, and ethnicities. STAD models must be heterogeneous consisting of men and women [2], come from various ethnic groups, have high and moderate abilities.

According to Trilling and Fadel [4], collaborative skill covers the collaboration activities with other people to achieve common goals. The teacher has to monitor these activities while implementing the collaborative activities in the classroom. However, the teacher must be place himself as the group member as well as the student who are seeking knowledge. The activities done collaboratively include: forming groups, setting goals, managing time, brainstorming and solving conflicts within groups. Forming groups refers to how someone is able to form a group so that each member plays an active role in group work. Setting goals refers to how the group is able to set goals which will be achieved during the process of group work. Managing time refers to how the group is able to manage the time provided so that the goals are achieved on time. Brainstorming means that each group member is able to play an active role in expressing opinions to achieve the group success, as well as being able to solve the conflicts during the group work; both conflicts come from the internal and external side of the group.

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The collaborative process refers to an adaptive system process whose different opinions from various parties produce a consensus, put their efforts in mapping a model which describes how collaborative process occurs. According to this model, the collaborative process covers various stages, they are face-to-face dialogue, trust-building, commitment to the process, shared understanding, and the intermediate outcome is formed then. This stage becomes a cycle on how the learning process occurs. If one wants to learn, he must be accompanied by a partner, thus collaborative skill An increase in Critical Thinking and Collaborative skills can be seen from the increase in the total score of students each cycle [5]. The indicators of Collaborative Skills according to [4].

| No | Indicator | Sub-Indicator |
|----|-----------|--------------|
| 1  | Collaboration | Effective collaboration within group Respectful collaboration within diverse group |
| 2  | Responsibility | Shared-responsibility in collaborative work Having initiative and able to manage oneself |
The students with low collaborative skills were proved by the lack of students’ learning activities of Grade 3 at SDN Tanggul Wetan 01 and it made their learning outcomes of Mathematics was not satisfying, as the completeness standard criteria (KKM) of Mathematics is 70.

The students' collaborative skills in solving the addition and subtraction problems were still low. It was shown by the observation results on the students’ learning activities and outcomes as they did not fulfil the collaborative indicators. The learning activities done by the students in class were classified as the incapability to interpret, analyze, inference and evaluate. In addition, they focused on the teacher's explanation and had no worksheets to lead them to be active and find their own concepts. Moreover, the learning outcomes obtained from the results of previous tests were low as there were only a quarter of 28 students obtained scores above 70 (KKM) whilst the others varied below the KKM.

The suitable alternative to this problem was by developing the learning instruments in the form of LKPD. LKPD referred to a printed teaching material whose contents were the materials, summaries and instructions of learning implementation done by the students. A good LKPD had to meet the criteria of valid, practical and effective. Student Worksheet (LKPD) developed was in accordance with STAD cooperative learning. The developed LKPD was adjusted to the syntax of STAD learning model. By implementing STAD-based LKPD, the students were expected to have an active participation and solve problems collaboratively.

This research was intended to determine whether or not there was a process on the development of mathematics learning instruments based on Student Teams-Achievement Divisions (STAD) cooperative learning and its effect on the students' collaborative skills in solving the addition and subtraction problems.

2. Research Methods
The researcher applied triangulation design mixed method in analyzing the collaborative skills in solving the addition and subtraction problems by implementing collaborative-based learning. The triangulation design in mixed method research was used to collect the quantitative and qualitative data, combine the data and use the results to understand the research problem. The triangulation design is shown in Figure 1. And the experimental process is drawn in Table 2.

| Table 2. Pre-test and post-test control group design. |
|-----------------------------------------------------|
| Class | Pre test | Treatment | Post test |
|-------|----------|-----------|-----------|
| Experimental (3A = 28) | T₁ | X | T₂ |
| Control (3B = 28) | T₁ | - | T₂ |
2.1 Population
The research area is the center of research implementation. The research subjects chosen were the students of grade 3 at SDN Tanggul Wetan 01, Tanggul-Jember. As many as 28 students were in the experimental class and 28 students were in the control one. This research was carried out in the even semester of 2020/2021 academic year. The sampling technique used was purposive sampling method based on utility considerations, class 3A which became an experimental class covering 11 boys and 17 girls was given STAD learning, and class 3B which involved 15 males and 13 women as the control class was given cooperative script learning model.

2.2 Instruments
The instruments used in this research were: tests, observation, questionnaires and interview. The pre-test and post-test were in the form of an essay. Observation was done during the teaching and learning activities to observe the learning process clearly and accurately. The questionnaire contained the statements with closed answers by using the linkert scale of five categories, they were excellent (score 4), good (score 3), good enough (score 2), not good (score 1), and poor (score 0). During the interview, the open questionnaire was used as the students’ worksheets.

This research was done to make them easier in counting the addition and subtraction on various types. "Associating Operation Technique" was used to count the different addition and subtraction. The technical steps used to sort the different addition and subtraction were from "Associating Operation Technique". The examples are presented as follows:
For example, 78 + 86, 234 + 252, 78 - 23, 134 - 78. The strategies used are as follows:
2.3 Data collection and analysis

Data collection was conducted using pre-test and post-test in the experimental class and control class. In addition, the researcher also conducted observations and interviews with the research subjects. Pre-test and post-test results were used for quantitative analysis using the t-test, while the observations and interviews results were used for qualitative analysis. Quantitative data were analyzed using inferential statistics, while qualitative data were analyzed descriptively. The results of inferential statistics analysis were frequency, mean, and standard deviation. And for different tests, the researcher used an independent sample t-test to test the difference between the experimental class and the control class with a significance level of 0.05. Quantitative analysis was done statistically using SPSS 23.

3. Research Results and Discussion

The 4-D model development model by Thiagarajan et al (1974: 5)[11]This article aimed to examine the effect of STAD on students' collaborative thinking skills in solving addition and subtraction problems. This test involved control and experimental classes, in which each of them consisted of 28 students. To test this, an independent t-test was conducted on the post-test data of the control class and experimental class. Testing the effects and assumptions that must be met before the testing was done using SPSS. Validity test Question. Test the validity and reliability of the questions using 15 respondents. The validity test using SPSS 18 produces the following Table 3.

| Task 1 | Task 2 | Task 3 | Task 4 | Total |
|--------|--------|--------|--------|-------|
| Pearson Correlation | .442   | .331   | .110   | .718* |
| Pearson Correlation | .442   | 1      | .358   | .807**|

* p < 0.05
** p < 0.01

Figure 2. addition and subtraction development.
The question is said to be valid if the value is sig. <0.05. In the rightmost column we can check one by one that the sig. question 1 = 0.03, sig. question 2 = 0.000, sig. question 3 = 0.012, and sig. question 4 = 0.30. This means that all four questions are valid.

**Question Reliability Test**

The reliability test of questions using SPSS produces the following table:

**Table 4. Results of Question Reliability.**

| Reliability Statistics |
|------------------------|
| Cronbach's Alpha       |
| N of Items             |
|                        |
| .632                   |
| 4                      |

The question is said to be variable if the Cronbach's Alpha value is> 0.6. Because the Cronbach's Alpha value = 0.632, these questions are reliable. There were 2 things that must be fulfilled before testing the effect using independent t-test, namely the normality test and the homogeneity test. The first step was testing the normality of the pre-test data from the experimental class. The normality test in this article used the Shapiro-Wilk test. The selection of the Shapiro-Wilk normality test was based on the effectiveness of this test with n < 50. Based on the pre-test data of the experimental class students in the table below, the Sig. = 0.63. From this result, it can be seen that according to the Shapiro-Wilk normality test, the Sig. = 0.631 was greater than 0.05 or in other words 0.631> 0.05, so it can be concluded that the pre-test data were normally distributed.

**Table 5. The normality test of pre-test data of experimental class.**

| Tests of Normality |
|--------------------|
| Kolmogorov-Smirnova |
| Shapiro-Wilk       |
| Statistic          |
| df                 |
| Sig.               |
| Statistic          |
| df                 |
| Sig.               |
**a. Lilliefors Significance Correction**

* This is a lower bound of the true significance.

Furthermore, the researcher performed normality test of pre-test data from the control class. Based on the control class students’ pre-test data in the table below, the Sig. = 0.430. From this result, it can be seen that according to the Shapiro-Wilk normality test, the Sig = 0.430 was greater than 0.05, or in other words \(0.430 > 0.05\), so it can be concluded that the pre-test data were normally distributed.

After ensuring that the pre-test data for both classes were normally distributed, the next step was testing the homogeneity of the both classes’ pre-test data. The homogeneity test of the pre-test data for both classes was done using the Leavene Test. Based on the pre-test data of both classes in the table below, the Sig value was = 0.083. From this result, it can be seen that according to the Leavene Test homogeneity test, the value of Sig = 0.083 was greater than 0.05 or in other words \(0.083 > 0.05\), so it can be concluded that the pre-test data were homogeneous.

| Test of Homogeneity of Variances |
|----------------------------------|
| **Class**                         |
| Levene Statistic                 |
| df1     | df2     | Sig.     |
| 3.124   | 1       | 54       | .083     |

After the assumptions of normality and homogeneity were met, an independent t-test was then performed to determine whether the classes were equal or not. Based on the statistical descriptive table below, it can be seen that both classes had almost the same average score, in which the experimental class average score was 66.54 and the control class was 63.64.

| Descriptive statistics of both classes. |
|----------------------------------------|
| **Group Statistics**                   |
| N          | Mean       | Std. Deviation | Std. Error Mean |
| Class Experimental | 28 | 66.54 | 6.443 | 1.218 |
| Control     | 28 | 63.64 | 4.130 | .780  |

Furthermore, an independent t-test was performed to prove that both classes were equal. Hypothesis testing:
Table 8. Percentage of pretest results of the control class.

|                      | Independent Samples Test |
|----------------------|--------------------------|
|                      | Levene's Test for        |
|                      | Equality of Variances    |
|                      | t-test for Equality of   |
|                      | Means                   |
|                      |                         |
|                      | 95% Confidence Interval  |
|                      | of the Difference        |
|                      |                         |
| Sig.                 | Sig. (2-tailed)          |
|                      | Mean Difference          |
|                      | Std. Error Difference    |
|                      | Lower                   |
|                      | Upper                   |
| Equal variances      | .05                     |
| assumed              | 2.89                    |
|                      | 1.44                    |
|                      | -.00                    |
|                      | 5.79                    |
| Equal variances      | .05                     |
| not assumed          | 2.89                    |
|                      | 1.44                    |
|                      | -.01                    |
|                      | 5.80                    |

H₀: There is no difference in the experimental class and the control class
H₁: There are differences in the experimental class and the control class
Based on the table below, the Sig. (2-tailed) value was = 0.340. Based on the Sig. (2-tailed) value, it can be seen that Sig. (2-tailed) > 0.05 or in other words 0.340 > 0.05, so it can be concluded that H₀ was accepted and H₁ was rejected. Based on this, it can be said that there was no significant difference between the experimental class and the control class.

Next, the distribution of students’ collaborative skills from the control class and the experimental class based on the students' pre-test results as follows:

![Percentage of collaborative skills of the control class](image1)

![Collaborative skills of the control class](image2)

Figure 3. Percentage of pretest results of the control class.
The distribution of collaborative skills of control class students based on the pre-test results

Based on the test results above, it can be concluded that both classes were homogeneous. From the results, both classes had the same ability to do the given assignments. The experimental class was given treatment in the form of LKPD based on STAD and exploring collaborative skills, while the control class studied using conventional method. After that, post test data were collected in the form of several essay questions to test the effect of STAD on collaborative skills. Before testing the post test data to test the effect of STAD on collaborative skills, the normality and homogeneity of post-test were performed first. Based on the post test data of the experimental class students in the table below, the Sig. = 0.673. From this result, it can be seen that according to the Shapiro-Wilk normality test, the value of Sig = 0.673 was greater than 0.05, or in other words 0.673 > 0.05, so it can be concluded that the post test data were normally distributed.

Table 9. Normality test of post test data of experimental class.

| Tests of Normality          | Kolmogorov-Smirnov* | Shapiro-Wilk         |
|-----------------------------|---------------------|----------------------|
|                             | Statistic df Sig.   | Statistic df Sig.    |
| Post-test of experimental class | .133 28 .200*       | .973 28 .673         |
| Post-test of control class  | .129 28 .200*       | .948 28 .177         |
| a. Lilliefors Significance Correction | * This is a lower bound of the true significance. |

Furthermore, the researcher performed post-test data normality test of the control class. Based on the control class students’ post test data in the table below, the Sig. = 0.177. From this result, it can be seen that according to the Shapiro-Wilk normality test, the value of Sig = 0.177 was greater than 0.05, or in other words 0.177 > 0.05, so it can be concluded that the post test data were normally distributed.

After ensuring that the post-test data for the classes were normally distributed, the next step was to test the homogeneity of the post-test data of both classes. The homogeneity test of the post test data of both classes was done using the Leavene Test. Based on the post test data of both classes in the table below, the Sig value = 0.626. From this result, it can be seen that according to the Leavene Test homogeneity test, the value of Sig = 0.626 was greater than 0.05 or in other words 0.626 > 0.05, so it can be concluded that the post test data were homogeneous.
After the assumptions of normality and homogeneity were met, an independent t-test was then performed to determine the effect of STAD on collaborative thinking skills. Based on the table below, it can be seen that both classes had a significantly different average value, the experimental class average score was 73.29 and the control class was 69.39.

The assumptions for normality and homogeneity of post test data had been fulfilled. The final step for testing the effect of STAD on collaborative thinking skills was testing the effect using an independent t-test.

Hypothesis testing:
H₀: There is no effect of STAD on collaborative thinking skills
H₁: There is an effect of STAD on collaborative thinking skills
Based on the table below, the Sig. (2-tailed) value was = 0.006. Based on the Sig. (2-tailed) value, it can be seen that Sig. (2-tailed) <0.05 or in other words 0.006 <0.05, so it can be concluded that H₀ was rejected and H₁ was accepted. Based on this, it can be said that STAD had an effect on collaborative skills.
From Table 12, it can be seen that the result of t-test showed sig. (2-tailed) was 0.00 (p<0.05), so it was significant. It indicates that the implementation of STAD significantly affected students’ collaborative skills in solving problem of addition and subtraction.

![Percentage of collaborative skills of control class](image1.png)

**Figure 5.** Percentage of pretest results of the control class.

The distribution of students’ collaborative skills in class was based on the result of post-test. It showed that the students’ collaborative skills in the control class were categorized as excellent by 0%, good by 15%, good enough by 46%, not good by 35%, poor 4%, while for the experimental class was excellent by 30%, good by 46%, good enough by 15%, not good by 9%, and poor by 0%. Both results can be seen in Figure 5 and Figure 6. It shows that the experimental class outperformed the control class.

![Collaborative skills of the experimental class](image2.png)

**Figure 6.** Percentage of pretest results of the eksperimental class.

The distribution of the observation result toward students’ activities by using research-based learning. Based on Figure 7, students who involved in the observation were 28 students. It was found that the highest score of observation criteria was excellent by 29%. It means that during the implementation of STAD, students were actively involved in solving problem, and 47% of students achieved good level, the rest of 20% was on the level of good enough, not good, and poor. It can be concluded that STAD worked very well in the learning process of addition and subtraction material and thus able to improve students’ collaborative skills. Furthermore, we also observed the results of the students' worksheets on the post-test. The following is the examples from the students. The students’ test result was categorized as collaborative. Based on the examples of the following LKPD, students who have good ability were able to describe the mathematics symbol and produced coherent answer. They can find the easiest
technique but they could not finish the task earlier than students who have excellent collaborative skills. They were able to analyze the questions but unable to give explanation. The following is the best group work in doing STAD cooperative based-LKPD

**Figure 7.** The results of student worksheets SE_022 in the implementation of STAD.

In this step, students’ addition and subtraction determined the part of what is known from the problem as mentioned above. Each group began doing the task based on the teacher’s instruction, then they determined the problem that must be solved. Next, students presented their answers and used observation technique. From their work, it was found that each group consisted of 4 members. Whereas, S_12 was not good working with the similar steps and unable to develop AOT as well as using the old technique. S_15 was good enough because he succeed develop several part of AOT, S_20 was good and able to analyze the question but unable to explain it, and S_22 was excellent in comparison to other students because he could give correct explanation and answers.

Based on the syntax of STAD, students were encouraged to identify the operation result and discuss it based on the implementation of STAD as well as solving the problem of addition and subtraction. The addition and subtraction by S_20 and S_22 has determined the operation result of AOT, therefore they could solve the problem related to AOT.

The researcher conducted interview with E_12 to know their perception about the implementation of STAD. The student was chosen because they got the highest collaborative skills criteria. The result of the interview is as follow:

**Researcher**: What kind of problem that have you learned today?

**Student**: Today, I learned about addition and subtraction problems using flat counting way...
Researcher : What do you know about addition and subtraction?
Student : addition is combining two groups (set) and subtraction is taking of a new group
Researcher : Can you mention the types of addition and subtraction?
Student : Sure, the type of addition consists of addition without the storing technique and addition using the storing technique, while the type subtraction consists of deductions without borrowing techniques and deductions without borrowing techniques.
Researcher : What do you think about the different calculation technique used in addition and subtraction?
Student : Before knowing the technique, I found it difficult to carry out a calculation in addition and subtraction.
Researcher : Why did you think so?
Student : Because the calculation used different technique.
Researcher : You mentioned “before knowing the technique”, Why did you say that?
Student : Because now I know that there is an easy way to calculate by using different technique.
Researcher : Are you sure that you can easily calculate by using different technique?
Student : Yes, I am pretty sure with my answer.
Researcher : What kind of method did you use to calculate?
Student : I used "Associating Operation Technique".
Researcher : How can you prove that "Associating Operation Technique" ease you in carrying out calculation on different addition and subtraction?
Student : The prove is that I can calculate different things quickly and correctly.
Researcher : Well, what can you conclude from different calculation?
Student : I conclude that different calculation is easier by using "Associating Operation Technique", especially when we learned it in group and used the worksheet provided by the teacher yesterday. We can easily remember this material because it taught us to discover the answer by ourselves.
Researcher : To be more convinced, could you please explain the steps of different calculation by using flat counting technique?
Student : Sure, First, read the problem, we can start calculate from the very last number. Second, add or subtract the middle number and then add or subtract the very first number.
Researcher : If you find the same problem, could you solve it easily?
Student : Yes, I think so

The portrait phase of students’ collaborative skills is as follow.

Figure 8. Student collaborative process stage portrait of collaborative high criteria.

4. Conclusions
Based on the result of the research and the discussion, it can be concluded that: first, STAD based learning had significant effect on students’ collaborative skills in addition and subtraction material. It was proven that the result from the experimental class which used STAD model showed higher collaborative skills than the control class. Therefore, it can be claimed that STAD improved students’ collaborative skills. Second, STAD based learning ease students in understanding concepts in solving problem of addition and subtraction which was found difficult beforehand. The difficulty was due to the lack of students’ activeness in employing collaborative skills to solve daily problems. Therefore, it future researcher is suggested to use STAD model to improve students’ collaborative skills.

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