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Advancing Collaborative Competence: Instrumentation Development and Integration Strategies for Effective Learning

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Abstract

Collaboration skills are one of the 21st-century skills that are important to develop for stu-dents because they are life tools needed when continuing their studies in school, engaging in society, and in the world of work. As a result, teachers must facilitate students' collaboration skills and measure them. Valid, reliable, and effective instruments are needed to measure students' collaboration skills. This study aims to develop an instrument to measure students' collaboration skills. This research uses a 4-D development model of defi-ning, designing, developing, and Disseminating. At the define stage, it was found that many teachers still needed instruments to measure collaboration skills and determine indicators of collaboration skills. The design results obtained are collaboration instruments in learning. These consist of 9 indicators: contribution, time management, problem-solving, working with others, investi-gative techniques, quality of work, focus on tasks, readiness, and monitoring group effecti-veness. Next, scoring is determined. The instrument was validated by experts and tested in 2 trials. The first trial was conducted at SMAM 7 and SMAM 3 Surabaya in class XI. Vali-dity results stated that the instrument was very valid. The results of trials using the IBSC learning model show that the instrument is reliable and considerably effective in measuring collaboration skills. The novelty of this study resulted in a collaborative instrument worthy of use both theoretically and empirically.

Keywords: collaborative competence, empowering education, instrumentation development, integration strategies

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1. Introduction

Collaboration skills are essential for students to develop because they function as tools in life. Collaborative skills include 21st-century skills demanded in the current global era (Scott, 2015; Hakkinen, 2016). Collaboration skills are needed when students continue their studies in the community or work (Arends, 2012). Students must develop collaboration skills (Permendikbud No. 20 of 2016; 21st-century skills). Therefore, in learning, it is essential to help students develop collaboration skills (NRC, 2011; Care & Griffin, 2015; Scott,

2015). Permendiknas No. 58 of 2014, states that collaboration skills need to be integrated into learning, including in learning Biology. Collaboration skills are one of the skills that must be trained in the "Kurikulum Merdeka" in Indonesia, as stated in the Minister of Education and Culture Regulation Number 22 of 2022 concerning the Strategic Plan of the Ministry of Education and Culture for 2020-2024.

Through collaboration, an attitude of empathy and concern for others will be built in students(Aini et al., 2020; Vance & Smith, 2019). Through collaboration, students who have low abilities will be able to achieve the expected learning goals because collaboration will involve active participation of students to achieve common goals with high positive dependence (Andrini & Yusro, 2021; Burns, M., Pierson, E., & Reddy, 2014; Jones & Vall, 2014).

Collaboration skills in the context of self-directed learning using the Merdeka Curriculum in Indonesia emphasize students' abilities to collaborate, share ideas, and support each other in achieving learning objectives effectively (Arung et al., 2023). Students are encouraged to actively participate in the learning process, both individually and in groups, utilizing available resources (Muhibbin et al., 2020; Putri et al., 2022). Additionally, the Merdeka Curriculum promotes the development of creativity, innovation, and self-responsibility in learning. Through this approach, students are expected to cultivate their collaborative skills, such as effective communication, leadership, and the ability to work in teams (Khusnani et al., 2023). With a focus on self-directed learning, students are directed to become critical and independent thinkers while still being capable of collaborating with others to achieve optimal learning outcomes in line with the spirit of the Merdeka Curriculum (Aditama et al., 2022).

When a teacher wants to practice collaboration skills, the teacher needs to know about the collaboration skills that students have (Care et al., 2015; Read write think, 2005). Thus, the teacher must be able to measure these skills (Hinyard et al., 2019; Sato, 2011, 2014). An instrument of collaboration is needed. Therefore, this research is fundamental because teachers can use the results of the instruments developed to measure their students' collaboration skills. This study aims to develop instruments to measure students' collaboration skills, providing a novel contribution that aligns both theoretically and empirically (Christidamayani & Kristanto, 2020).

2. Method

The type of research is development research, namely developing instruments to measure collaboration skills. The type of instrument produced is an observation sheet of collaboration skills. This development is based on the 4-D development model (four-D Models) developed by Thyagarajan (Aini et al., 2020). The 4-D development model consists of Defining, Designing, Developing, and Disseminating. However, this research is limited to the development stage.

At the define stage, the authors define collaboration skills and determine indicators of collaboration skills through literature studies. Thus, appropriate indicators are obtained to measure collaboration skills. At the design stage, the authors designed a collaboration skill instrument and determined the score and scoring rubric to be used as a measuring tool (Nieveen, N., Mc. Kenney And Van D., 2007). Furthermore, for the developed stage, the authors tested the validity and reliability of the instrument and tested it on

students to see its effectiveness in measuring collaboration skills. The research instrument used was a validation sheet to validate the collaboration skills instrument. Trials on students in learning using the IBSC (Investigation Scientific Collaboration) learning model to see the level of reliability of the instrument, as well as to measure the effectiveness of the instrument in measuring collaboration skills (Suharti et al, 2020). The reason for using the IBSC model to test the collaboration instruments that were being developed is because this learning model facilitates training in collaboration skills. This skill is trained through the second phase, the investigation collaboration sharing task, and the fourth phase, the investigation collaboration jumping task. In these two phases, teachers are asked to act as facilitators to facilitate cooperation between students by fostering positive dependence between students according to the learning steps in these two phases.

The instrument to be used must be declared fit to implement it. Feasibility is determined based on the results of the instrument validity test. Meanwhile, the instrument's effectiveness is measured based on the results of trials on students in classroom learning using the IBSC model. The effectiveness is seen based on the T-test results, which state a significant difference between the initial (pretest) and final (posttest) collaboration scores. Next, the average n-Gain value is looked at to determine the effectiveness of the increase. The criteria consist of less effective (the average n-Gain is less than 30), quite effective (average n-Gain between 30-70), and very effective (average n-Gain value more than 70). Trials were conducted twice at SMAM 7 Surabaya (2 classes) and SMAM 3 Surabaya (3 classes) in class XI.

3. Result and Discussion

Researchers adapted opinions from the International Reading Association (Read write thing, 2005) and (Care et al., 2015) to assess collaborative skills from the definition results. Collaboration skills are identified based on aspects/indicators: 1) contribution, 2) time management, 3) problem solving, 4) working with others (Working with others), 5) research techniques 6) quality in work, 7) focus on the task, 9) preparedness and 10) monitoring group effectiveness.

At the design stage, each indicator's score is determined. Each indicator is assigned a score of 1 to 4 with different statements (Read write think 2005 and Griffin & Care, 2015). Here is one aspect: the contribution is divided into four statements with a score of 1 to 4 from the standard rubric of ability to collaborate (Read write think 2005 and Griffin & Care (2015).

As an example of an assessment for the Working with other indicator below.

The 1st statement is given a score of 1:
"*Rarely listens to, shares with, and supports the efforts of others. Often he is not a good team player.*"

The 2nd statement is given a score of 2:
"*Often listens to, shares with, and supports the efforts of others, but sometimes it's not a good team member.*"

The 3rd statement is given a score of 3:
"*Usually listens to, shares with, and supports the efforts of others. Does not cause "waves" in the group.*"

The 4th statement is given a score of 4:
"*Almost always listens to, shares with, and supports the efforts of others. Tries to keep people working well together.*"

Based on these two standard rubrics, a rubric is then made to measure the adapted collaboration skills, as shown in Table 1.

Table 1. Collaboration Skills Rubric Design

Indicators	Score			
	1	2	3	4
Contribution	In large or small group discussions, do not give ideas and do not participate.	In large or small group discussions, only one idea is given once, and only one time contributed in participating.	In large or small group discussions, ideas are only given two times. And not often (only two times) contributed in participating.	In large or small group discussions, they often (more than 2 times) give ideas that become a reference in the discussion. Able to lead discussions and often (more than 2 times) contribute to participation
Time management	Not doing the assignment caused the group to extend the time limit for its work..	The task was completed but was late > 3 minutes from the specified time. This caused the group to extend the time limit for its work.	Tasks completed but late < 3 minutes from the specified time. So it doesn't cause the group to extend the deadline for its work.	Complete tasks on time or finish before the deadline so that it never causes the group to extend the deadline for its work.
Problem-solving	There is no effort to find and answer problems and give all tasks to others.	Rarely (only once) tried to find answers to problems and use solutions initiated by others.	Often (only two times), people try to find answers to problems, but the solutions found result from the development from other people's ideas.	Very often (more than two times), make an apparent effort to find and provide own ideas for answers.
Working with others	Not listening to other people's opinions or not helping others and not participating in group work.	Rarely (only once) listens to other people's opinions and rarely (only once) helps others due to difficulties in group work.	Often (only 2 times) listens to other people's opinions and often (only 2 times) helps others, but does not make it easier in group work.	Very often (more than 2 times) listens to other people's opinions well and very often (more than 2 times) helps others, making it easier to work in groups.
Research techniques	Provide work that would normally need to be inspected or repaired by someone else to ensure quality	Rarely seeks multiple sources (only focuses on 2 sources) and records information, but not detail	Often searches for various sources (only focused on 3 sources) and always records information, but not in detail	Very Often searches for multiple sources (focused on more than 3 sources) and always records information in detail
Quality in Work	Does not seek multiple sources (focusing on only one source) and does not record information.	Provide work that occasionally needs to be checked or corrected by other group members to ensure quality	Delivering good quality work	Doing work of the highest quality

Indicators	Score			
	1	2	3	4
Focus on the Task	Rarely focuses on tasks and what needs to be done. Enabling others to do the work Focusing on the task and what needs to be done.	Other group members sometimes have to grumble, insist, remind this person to stay on duty.	Focus on tasks and what needs to be done most of the time. Other group members can count on this person.	Consistently stay focused on the task and what needs to be done. very independent,
Preparedness and	Often forgets materials/materials needed or rarely ready to start work	Almost always has the materials needed with him but occasionally needs to calm down and get to work	Almost always brings the materials needed to class and ready to work	Bring the materials needed to class and always ready to work
Monitoring group effectiveness	Rarely monitors group effectiveness and doesn't work to make it more effective	Occasionally monitors group effectiveness and works to make the group more effective	Regularly monitor group effectiveness and work to make the group more effective	Regularly monitor group effectiveness, and make suggestions to make it more effective

Adapted from IRA (Read write think, 2005) and (Care et al., 2015)

The collaboration skills observation sheet instrument is valid and reliable and is quite effective in measuring collaboration skills. This is based on the mode of the average value of all aspects of the validity of the collaboration skills instrument from the results of the assessment of 3 validators with an average mode score of 4, which means it is very valid. Meanwhile, reliability and effectiveness are obtained from the results of trials in learning using the IBSC model. The results stated that all indicators of collaboration skills were declared reliable and quite effective, based on the statistical analysis results of the following pretest and posttest data in trials I and II.

ed out in learning at SMAM 7 Surabaya using the IBSC model. The data on the completeness of the collaboration skills from the results of the first trial are presented in Table 2.

1. Results of Trial I Collaboration Skills in Learning

To see the effectiveness of the collaboration instrument developed, a trial I was carri-

Table 2. Proportion of Pree Test and Posttest Completeness on Student Collaboration Skills in Trial I

No Subject	Pre Test	Posttest	n-Gain Skor (%)
1	44.45	88.89	80.00
2	44.45	88.89	80.00
3	44.45	77.76	58.96
4	77.76	100.00	100.00
5	44.45	77.76	59.96
6	22.23	88.89	85.71
7	22.23	77.76	71.43
8	22.23	66.67	57.14
Total	**322.25**	**666.55**	**584.8**
Average	**40.28**	**83.32**	**73.1**

Based on Table 2, it can be seen that the entire proportion of completion of the collaboration skills pretest results is below the minimum completeness category, namely 75% and the average mastery of student collaboration skills is 40.28. This shows that no students have a complete category in student collaboration skills that are measured at the beginning. While the proportion of mastery of final collaboration skills/posttest, students with a proportion of post test more than 75% in trials I, is 87.5 % and the average mastery of student collaboration skills is 83.32, above the minimum mastery category of 75%.

To strengthen the effectiveness of the instrument in measuring student collaboration skills in learning using the IBSC learning model, a statistical test was carried out using the t-test on the data on the proportion of mastery of pretest and posttest of student collaboration skills and N-Gain analysis (Tabel 2). Previously the data was tested for distribution with the Kolmogorov test. Based on the Kolmogorov test results, the data is stated to be normally distributed because a significance value of 0.200 > 0.05 is obtained. Furthermore, the initial data/results of the pretest and posttest were tested using the t-test. The results of the t-test are shown in Table 3.

Table 3. Paired Samples Test

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest - Posttest	-3.75000	1.38873	.49099	-4.91101	-2.58899	-7.638	7	.000

The results of the t-test showed a significance value of 0.000 <0.05, which means that there was a significant difference between the proportions of pretest and posttest of students' collaboration skills in the trial class I. Next, we looked at the correlation between the pree and posttest results.

Table 4. Paired Samples Correlations of Trial I

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	8	.616	.104

The results of the correlation test between the pree test and post test of student's Collaboration skill mastery proportion values in class trial I, showed no correlation between the pretest and pos test Collaboration skill mastery proportion values, because the significance value of the correlation between the two was 0.104 > 0.05. (Table 4)

The results of the class I trial n-Gain analysis are shown in Table 4. Based on the analysis of the Tryout class's n-Gain value, I obtained an average n-Gain value of 73.1 %. This shows that the collaboration instrument is quite effective in measuring collaboration skills in learning using the IBSC learning model

2. Results of Trial II Collaboration Skills in Learning

To further strengthen the trial results, trial II was carried out in learning with 3 repetitions of classes at SMAM 3 Surabaya using the IBSC model. The results of Collaboration Skills mastery on the three replications in trial II are presented in Table 5

Table 5. Proportion of Pree Test and Posttest Completeness on Student Collaboration Skills in Trial 2

No subject	Replication 1 (IPA 1)		Replication 2 (IPA 2)		Replication 3 (IPA 3)	
	Pre	Post	Pre	Post	Pre	Post
1	55.57	77.79	11.12	88.90	66.68	100
2	33.34	77.79	22.23	77.78	44.45	88.90
3	33.34	77.79	44.45	66.67	66.68	100
4	33.34	66.68	55.57	66.67	55.57	77.78
5	22.23	55.57	11.13	55.57	33.34	77.78
6	22.23	88.90	33.34	66.68	33.34	77.78
7	33.34	88.90	33.34	77.79	33.34	88.89
8	22.23	66.68	44.45	77.79	33.34	77.78
9	22.23	66.68	44.45	66.68	44.45	66.68
10	33.34	66.68	44.45	77.79		
Total	**311.18**	**733.46**	**344.52**	**722.75**	**422.27**	**755.55**
Avarage	**31.1**	**73.4**	**34.5**	**72.3**	**46.9**	**83.9**

Based on Table 6, there is an increase in the mastery of collaboration skills in students in trial II in the three replication classes. To strengthen the instrument's effectiveness in measuring student collaboration skills, measurements were taken in learning using the IBSC learning model. Then a t-test was carried out on the data on the proportion of mastery of pree test and pos test of students' collaboration skills and n-Gain analysis. Previously, The pretest and posttest data on student collaboration skills in the three classes were tested for homogeneity of variance.

Based on Table 2, it can be seen that the entire proportion of completion of the collaboration skills pretest results is under the minimum completeness category, namely 75% and the average mastery of student collaboration skills is 40.28. The results of the variance homogeneity test stated that the three classes were homogeneous because the significance value was 0.302 > 0.05. Likewise, with the homogeneity test results, the posttest data's value is homogeneous. This shows that the instrument is empirically reliable in measuring collaboration skills.

The data normality test results for each trial II replication class have normal data distribution because the significance values obtained successively in replication classes I, II, and III are 0.133, 0.178, 0.71, which are all > 0.05. The t-test is then carried out. The t-test results for each replication are shown in Tables 6, 8, and 10.

a. T Test Results in Class of Replication I of Trial II (XI IPA 1)

The pretest and posttest data from the results of trial II replication I were then tested for statistical differences using the t-test after it was stated that the data were normally distributed. The summary results of the t-test analysis for replication class I in trial II are shown in Table 6.

Table 6. Paired Samples Test

		Paired Differences					T	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pretest – Posttest	-3.80000	1.39841	.44222	-4.80036	-2.79964	-8.593	9	.000

Based on the results of the t-test, a significance value of 0.000 <0.05 was obtained, which means that there was a significant difference between the proportion of pretest and posttest of the collaboration skills of students of replication class I in trial II.

Table 7. Paired sample correlations of class replication I of trial II

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	10	-.100	.783

The results of the correlation test between the values of the proportion of mastery of collaboration skills for trial II in class of replication I, showed that there was no correlation between the values of the proportion of mastery of pree test and post test of student's collaboration skills, because the significance value of the correlation between the two was 0.78 > 0.05

a. T-Test Result in Class of Reflication II Trial II (XI IPA 2)

The pretest and posttest data from the results of trial II and reflication II were then tested for statistical differences using the t-test after it was stated that the data was normally distributed. The summary results of the t-test analysis for replication class II in trial II are shown in Table 8.

Table 8. Paired Samples Test

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pretest – Posttest	-3.40000	1.71270	.54160	-4.62519	-2.17481	-6.278	9	.000

The results of the t-test for trial II replication class II, obtained a significance value of 0.000 <0.05, which means that there is a significant difference between the proportion of pretest and posttest of students' collaboration skills in trial II on replication class II.

Table 9. Paired Samples Correlations in Class of Reflication II of Trial II

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	10	-.143	.693

The results of the correlation test between the values of the proportion of mastery collaboration skills in trial II in replication class II showed that there was no correlation between the values of the proportions of the pretest and posttest collaboration skills mastery, because the significance value of

the correlation between the two was 0.259 > 0.05.

b. T Test Result in Class of Reflication III of Trial II (XI IPA 3)

The pretest and posttest data from trial II and replication III results were then tested for statistical differences using the t-test after it was stated that the data was normally distributed. The summary results of the t test analysis for replication class III in trial II are shown in table 8.

Table 10. Paired Samples Test

		Paired Differences					T	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest – Posttest	-3.33333	1.00000	.33333	-4.10200	-2.56467	-10.000	8	.000

The results of the t test in class of replication III trial II, obtained a significance value of 0.000 <0.05, which means that there was a significant difference between the proportion of pree test and pos test of students' collaboration skills in trial II, class of replication III. To see the effectiveness of improving students' collaboration skills as a result of the trial, an n-Gain test was. To see the effectiveness of improving students' collaboration skills as a result of the trial, an n-Gain test was conducted

c. Analysis of n-Gain Value in Class of Replication I of Trial II (XI IPA 1)

The results of the n-Gain analysis in a class of replication I trial II are shown in Table 11.

Table 11. Result Description n-Gain

			Statistic	Std. Error
N_Gain_Skor	Mean		60.2370	5.20478
	95% Confidence Interval for Mean	Lower Bound	48.4630	
		Upper Bound	72.0110	
	5% Trimmed Mean		60.3167	
	Median		57.1400	
	Variance		270.897	
	Std. Deviation		16.45895	
	Minimum		33.33	
	Maximum		85.71	
	Range		52.38	
	Interquartile Range		21.43	
	Skewness		.337	.687
	Kurtosis		-.167	1.334

The analysis results of the n-Gain value analysis in the class of replication II trial I obtained an average n-Gain value of 60.24. This shows that the collaboration Instrument is quite effective in measuring collaboration skills in learning by using the IBSC learning model in trial II class of replication I.

d. Analysis of n-Gain Value in Class of Replication II of Trial II (XI IPA 2)

The results of the n-Gain analysis in clas of replication II of Trial II are shown in table 12.

Table 12. Result Description N-Gain in Replication Class II

			Statistic	Std. Error
N_Gain_Skor	Mean		56,0000	5.68853
	95% Confidence Interval for Mean	Lower Bound	42.1916	
		Upper Bound	67.9284	
	5% Trimmed Mean		54.9278	
	Median		55.0000	
	Variance		323.594	
	Std. Deviation		17.98872	
	Minimum		25.00	
	Maximum		87.50	
	Range		62.50	
	Interquartile Range		27.86	
	Skewness		.145	.687
	Kurtosis		.078	1.334

The analysis of the n-Gain value in the Trial II class of replication II obtained an average N-Gain value of 56%. This shows that the collaboration instrument is quite effective in measuring collaboration skills in learning using the IBSC learning model in the trisl II, class of replication II.

e. Analysis of n-Gain Value in Class of Replication III of Trial II (XI IPA 3)

The results of the n-Gain analysis in replication class III Trial II are shown in Table 13.

Table 13. Result Description n-Gain in Replication Class III

			Statistic	Std. Error
N_Gain_Skor	Mean		71.8522	6.94121
	95% Confidence Interval for Mean	Lower Bound	55.8458	
		Upper Bound	87.8587	
	5% Trimmed Mean		72.0580	
	Median		66.6700	
	Variance		433.624	
	Std. Deviation		20.82363	
	Minimum		40.00	
	Maximum		100.00	
	Range		60.00	
	Interquartile Range		36.67	
	Skewness		.035	.717
	Kurtosis		-.931	1.400

The analysis of the n-Gain value in the Trial II of class replication III obtained an average n-Gain value of 71.85 %. This shows that the collaboration instrument is quite effective in measuring collaboration

skills in learning using the IBSC learning model in the trial II, class replication III.

by Anova, to see the difference in the impact of applying the IBSC learning model, the results are shown in table 14. Furthermore, the n-Gain data of class replication I, II and II in trial II were tested.

Tabel 14. ANOVA Test Results

N_Gain	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1386.221	2	693.111	2.043	.150
Within Groups	8819.410	26	339.208		
Total	10205.632	28			

The results of the ANOVA test obtained a significance value of 0.150 > 0.05, this indicates that the IBSC model has the same impact on improving student collaboration skills.

Based on data on the proportion of mastery of pre-test collaboration skills in the trial class, I showed that all proportions of mastery of student collaboration skills were below the minimum mastery criterion of 75% with the average mastery of student collaboration skills of 40.27. This means that there are no students who have completed the criteria for collaboration skills to be measured. Based on the data on the proportion of posttest completeness and the collaboration skills of the students in the trial, I showed that the number of students who had completed it was 87.5% (7 of the 10 students observed). Class completeness is more than 80%, with the average posttest mastery of student collaboration skills being 83.31. Indicators that have not reached mastery class 80% of all students observed are indicators 2 (71.4%) and 9 (1.25%).

The results of the data representation of collaboration skills in trial I in the form of graphs as shown in Figure 1.

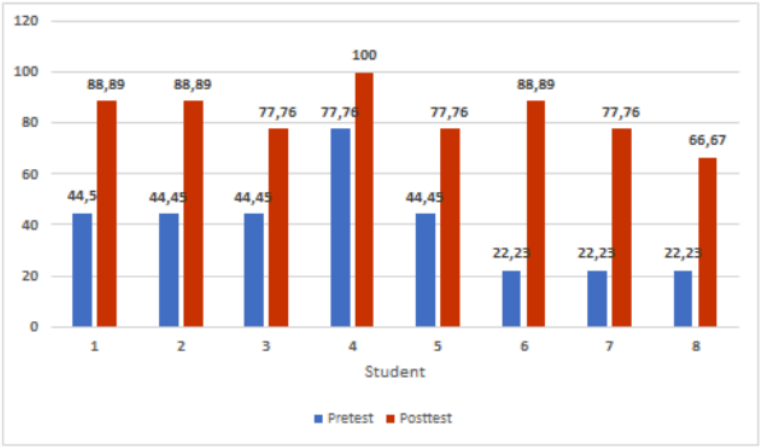

Figure 1. Graph of the Pretest and Posttest Collaboration Skill Mastery of the Students in the Trial I

The results of statistical tests using the t-test on the proportion of mastery of pretest and posttest of student collaboration skills (Table 3) obtained a significance value of 0.000 <0.05, which means that there is a significant difference between the proportion of pretest and posttest mastery of student collaboration skills. There is no correlation

between the value of the proportion of mastery of pretest and posttest of student collaboration skills because it was found that the significance value of the correlation between the two was 0.104 > 0.05 (Table 4). The results of the n-Gain analysis of the trial class I (Table 5) obtained an average N-Gain value of 73.1%. This shows that the IBSC learning model fairly effectively influences students' collaboration skills in trial I.

The proportion of mastery of pretest collaboration skills in replication classes I, II, and III trial III (Table 6) shows that all proportions of pretest of student collaboration skills in replication classes I, II, and III are under the minimum criteria of 75% and the average mastery of student collaboration skills in class of replication I, II and III respectively were 31.1; 34.42 and 42.22 %. This means that no students completed the communication skill criteria measured at the beginning for replication classes I, II, or III.

The proportion of the posttest of students' collaboration skills in replication class I of trial II, which has been completed is 50% of the number of students observed. This means that the mastery of the class is less than 80%, with an average mastery of student collaboration skills of 73.4%. Indicators that did not reached class mastery 80% of all students observed are indicator 2 (30%) indicator 6 (30%) and indicator 9 (1.25%). The results of data representation of collaboration skills in replication class I trial II in the form of bar graphs as shown in Figure 2.

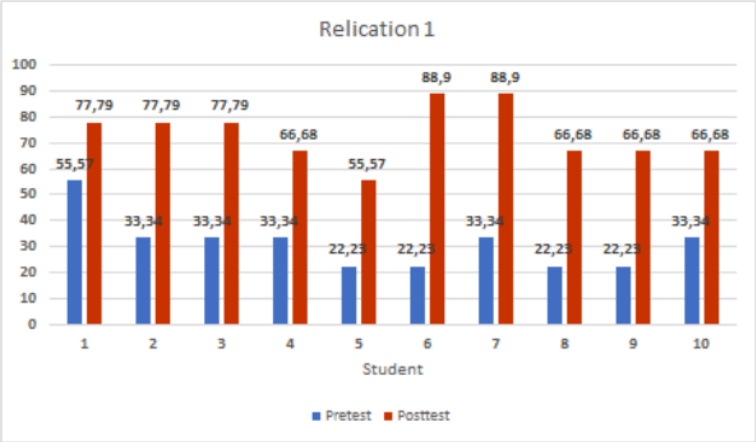

Figure 2. Graph of Pretest and Post Test Collaboration Skill Mastery of Students in Class of Replication 1, Trial II

The proportion of the posttest of students' collaboration skills in class replication II trial II shows the number of students who have completed 50% of the number of students observed. This means that the mastery of the class is less than 80%, with an average mastery of student collaboration skills of 72.3%. Indicators that did not reach class mastery in 80% of all students observed are indicator 2 (30%), indicator 6 (40%), and indicator 9 (1.25 %).

The results of data representation of collaboration skills in class of replication II, of trial II in the form of graphs as shown in Figure 3.

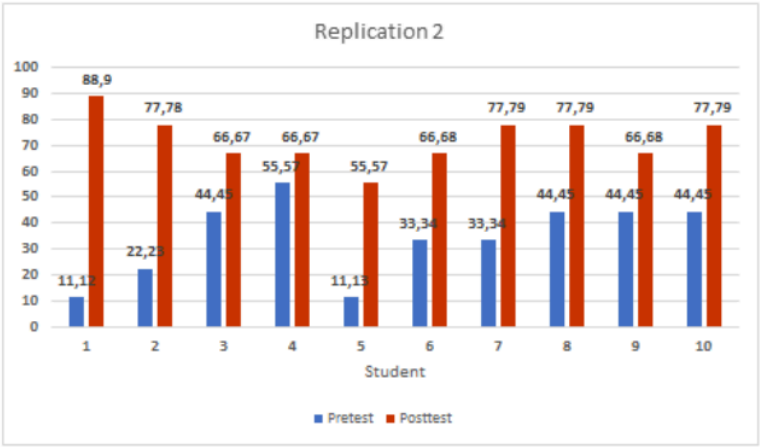

Figure 3. Graph of Pre Test and Post Test Collaboration Skill Mastery of Students in Class of Replication II, Trial II

The proportion of the posttest of the collaboration skills of students in class of replication III, trial II showed that the number of students who had completed was 88.9 % of the number of students observed. This means that the mastery of the class is more than 80%, with an average mastery of student collaboration skills of 83%. Indicators that have not reached mastery class 80% of all students observed are indicator 6 (55.6%) and indicator 9 (22.2%)

The results of data representation of collaboration skills in class of replication III of trial II in the form of bar graphs as shown in Figure 4.

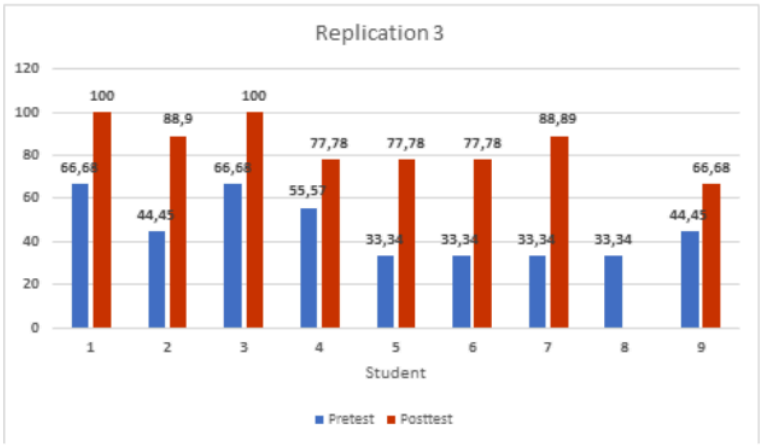

Figure 4. Graph of Pre Test and Post Test Collaboration Skill of Students in Class of Replication III, Trial II

The results of the T-test analysis for replication classes I, II and III in trial II (Table 2; Table 3 and Table 4) in each replication class obtained a significance value of 0.000 <0.05. This means there is a significant difference between the proportion of pretest and posttest of the collaboration skills of students of replication class I, II and III in trial II.

Based on the results of the correlation test between the values of the proportion of mastery of collaboration skills in the trial II in class of replication I, II and III, it shows that there is no correlation between the values of the proportion of mastery of Collaboration skills at the beginning and at the end (Table 8; Table 10 and Table 12). This shows that the increase in the proportion of mastery of collaboration skills in replication classes I, II, and III is not parallel.

Based on the analysis of the n-Gain values in Trial II of replication classes I, II and III, the average n-Gain values in repeat classes I, II and III were 60.24% each; 56%; 71.85%. This shows that the value of students' skills increases quite effectively after they are trained in learning through the IBSC model. This means that the IBSC learning model can help students develop collaboration skills (Abdulrazzaq, 2022; Maharani et al., 2021)

The IBSC (Investigation Scientific Based Collaborative) learning model can train student collaboration because in the IBSC learning model there are sharing task collaborative investigation activities and jumping task joint investigations (Supriyanto et al., 2022). These two phases of learning activities are scientific collaborative investigation activities to solve problems (Suharti et al, 2020)—characteristics of the problems that will be resolved in stages, starting from academic issues to authentic problems. Through sharing tasks and jumping tasks, students must collaborate in solving problems (Sato, 2014). For collaboration between students, the teacher facilitates positive dependence between students. The teacher acts as a facilitator and guide when students work in groups by fostering a sense of empathy in students with high abilities towards students with low skills, and fostering courage in students with low abilities to ask for help from students with high abilities, so that communication and collaboration occurs between students (Blau et al, 2020; Moreno, 2010; OEDC, 2013). In this way, learning interactions occur through communication and collaboration between students when solving problems (Nurkhairo Hidayati, Siti Zubaidah, 2020; Santoso et al., 2021; Zubaidah, 2016).

The results of the Anova test to see the difference in the assessment of collaboration skills in the three classes of replication in trials II based on the n-Gain value, obtained a significance value of 0.15 > 0.05 (Table 14). This shows that the collaborative observation sheet instrument developed is reliable. Therefore, it is appropriate to be used to assess students' collaboration skills.

4. Conclusion

The collaboration instrument developed consists of 9 indicators: Time management, Problem-solving, Working with others, Research techniques, quality of work, Focus on the task, Preparedness, and Monitoring group effectiveness. For measurement, each indicator is given a score of 1-4. The collaboration instrument was declared valid and reliable. The results of empirical trials show that collaboration in the instrument effectively measures collaboration skills after training using the IBSC learning model. The IBSC learning model can be used to train student collaboration, which is measured using a collaboration instrument developed because it has a learning phase that asks the teacher to facilitate positive student dependency. As a result, collaboration occurs. The validity and reliability of the collaboration skills instrument show that it is feasible to measure collaboration skills anywhere, anytime, and by anyone who wants to measure them.

5. References

Abdulrazzaq, A. H. (2022). Teacher Appraisers' Perceptions of Teacher Appraisal. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *4*(3), 233–245. https://doi.org/10.23917/ijolae.v4i3.18779

Aditama, M. G., Shofyana, M. H., Muslim, R. I., Pamungkas, I., & Susiati, S. (2022). Peningkatan Kompetensi Guru dalam Project Based Learning melalui Temu Pendidik Daerah. *Buletin KKN Pendidikan*, *4*(1), 90–98. https://doi.org/10.23917/bkkndik.v4i1.18215

Aini, M., Narulita, E., & Indrawati. (2020). Enhancing Creative Thinking and Collaboration Skills through ILC3 Learning Model: A Case Study. *Journal of Southwest Jiaotong University*, *55*(4). https://doi.org/10.35741/ISSN.0258-2724.55.4.59

Andrini, V. S., & Yusro, A. C. (2021). Blended Learning Model in a Distance Learning System to Increase 4C Competence (Creativity, Critical Thinking, Collaboration, and Communication). *Journal of Educational Science and Technology (EST)*, *7*(3), 236–244. https://doi.org/10.26858/est.v7i3.21278

Arends, R. . (2012). *Learning to Teach* (9 th). Mc. Graw Hill Companies.

Arung, F., Murthado, F., & Boeriswati, E. (2023). Merdeka Belajar: the Real Learning Needs of Students, Teachers, and Institutions Related to Demands for Independent Learning Innovation. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *5*(2), 120–135. https://doi.org/10.23917/ijolae.v5i2.20370

Blau IShamir-Inbal THadad S. (2020). Digital collaborative learning in elementary and middle schools as a function of individualistic and collectivistic culture: The role of ICT coordinators' leadership experience, students' collaboration skills, and sustainability. *Journal of Computer Assisted Learning*, *36*(5), 672–687. https://doi.org/10.1111/jcal.12436

Burns, M., Pierson, E., & Reddy, S. (2014). Working together: How teachers teach and students learn in collaborative learning environments.No Title. *International Journal of Instruction, 7*(Working together: How teachers teach and stu), 17–32.

Care, E., Griffin, P., Scoular, C., Awwal, N., & Zoanetti, N. (2015). *Assessment and teaching of 21st century skills: Methods and approach* (P. Griffin & E. Care (eds.)). Springer.

Christidamayani, A. P., & Kristanto, Y. D. (2020). The Effects of Problem Posing Learning Model on Students' Learning Achievement and Motivation. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *2*(2), 100–108. https://doi.org/10.23917/ijolae.v2i2.9981

Hinyard, L., Toomey, E., Eliot, K., & Breitbach, A. (2019). Student Perceptions of Collaboration Skills in an Interprofessional Context: Development and Initial Validation of the Self-Assessed Collaboration Skills Instrument. *Evaluation and the Health Professions*, *42*(4), 450–472. https://doi.org/10.1177/0163278717752438

Jones, H. M. B., & Vall, O. C. (2014). Preparing special educators for collaboration in the classroom: Pre service teachers' beliefs and perspectives. *International Journal of Special Education*, *29*(1), 1–12.

Khusnani, A., Husein, R., Jufriansah, A., Welly Jenni Thalo, O., Dewi Rahmawati, K., Fitri, M., & Aurora Adina, C. (2023). Identification of Understanding of Disaster Preparedness in the School Environment. *Indonesian Journal on Learning and Advanced Education*, *5*(3), 233–248. https://doi.org/10.23917/ijolae.v5i3.229

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Maharani, S., Nusantara, T., As'ari, A. R., & Qohar, A. (2021). Exploring the computational thinking of our pre-service mathematics teachers in prepare of lesson plan. *Journal of Physics: Conference Series*, *1783*(1). https://doi.org/10.1088/1742-6596/1783/1/012101

Moreno, R. (2010). *Educational Psychology*. Jhon Wiley & Sonc, Inc.

Muhibbin, A., Prasetiyo, W. H., Saputra, R. C., Sari, W. N., Fatmawati, Y. I., Pramudika, R. G., Nashiroh, A. L., Hariyanti, H., Sawitri, N. W., & Saputri, A. I. (2020). Penguatan Generasi Cerdas, Kreatif, dan Berkarakter bagi Siswa, Guru, dan Tendik MIM Janti Klaten. *Buletin KKN Pendidikan*, *2*(2), 50–55.

Nieveen, N., Mc. Kenney And Van D., A. (2007). *Educational Design Research*. Routledge.

Nurkhairo Hidayati, Siti Zubaidah, E. S. et al. (2020). Cognitive learning outcomes Its relationship with communication skills and collaboration skills through digital mind mapsintegrated PBL. *International Journal of Information and Education Technology*.

OEDC. (2013). *Collaborative Problem Solving Framework*. OEDC Publishing.

Putri, A. H., Samsudin, A., Purwanto, M. G., & Suhandi, A. (2022). Examination of Conceptual Change Research Over A Decade: A Bibliometric Analysis Using Science Mapping Tool. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *4*(3), 171–190. https://doi.org/10.23917/ijolae.v4i3.18249

Read write think. (2005). Collaborative Work Skill Rubrik. *Internatioanl Reading Association/Ncte*.

Santoso APrimandiri PZubaidah S et al. (2021). Improving student collaboration and critical thinking skills through ASICC model learning. *Journal of Physics: Conference Series*, *1806*(1). https://doi.org/10.1088/1742-6596/1806/1/012174

Sato, M. (2011). *Dialog dan kolaborasi di sekolah menengah pertama, praktek learning community,*. Depdiknas, Depag dan Jica.

Sato, M. (2014). *Mereformasi Sekolah: Kosep dan Praktek Komunitas Belajar* (Indonesian). The International Development Centre of Japan Inc.

Suharti, Peni., Ibrahim, M., Rahayu, Y. S. (2020). Proceedings of the International Conference on Research and Academic Community Services (ICRACOS 2019). In S. Matul Imah, Elly. Atweh, Bill. Chendra W. (Ed.), *Validity of investigation based scientific collaboratif (IBSC) learning model to facilitate student's communication and collaborative skills* (pp. 172–176). Atlantis Press.

Supriyanto, S., Munadi, S., Daryono, R. W., Tuah, Y. A. E., Nurtanto, M., & Arifah, S. (2022). The Influence of Internship Experience and Work Motivation on Work Readiness in Vocational Students: PLS-SEM Analysis. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *5*(1), 32–44. https://doi.org/10.23917/ijolae.v5i1.20033

Vance, E. A., & Smith, H. S. (2019). The ASCCR Frame for Learning Essential Collaboration Skills. *Journal of Statistics Education*, *27*(3), 265–274. https://doi.org/10.1080/10691898.2019.1687370

Zubaidah. (2016). *Keterampilan Abad Ke-21: Keterampilan Yang Diajarkan Melalui Pembelajaran. Isu-isu Strategis Pembelajaran MIPA Abad 21.* STKIP Persada Khatulistiwa Sintang.

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