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The Influence of the Team-Based Learning Model on Students' Procedural Knowledge Learning Outcomes in Information and Communication Technology Subjects

Siti Rofiqoh[1] *, Etistika Yuni Wijaya[1], Puji Rahayu Ningsih[1], Laili Cahyani[1], Luluk Mauli Diana[1]

[1] Informatics Education Study Program, Trunojoyo Madura University, Bangkalan
Jl. Raya Telang, Kamal, Bangkalan, Jawa Timur, Indonesia-69162

*Corresponding author: sitirofiqoh232@gmail.com Doi: https://doi.org/10.24036/invotek.v24i2.1194

Abstract

Improving students' learning outcomes in terms of procedural knowledge in the subject of Information and Communication Technology (ICT) remains a significant challenge in the field of education. This is due to the limitations of traditional teaching methods, which are less effective in promoting active student engagement and are not optimal in developing critical thinking and problem-solving skills. To address this issue, this study aims to explore the implementation of the Team-Based Learning (TBL) model as an innovative instructional strategy that focuses on teamwork and active participation in the learning process. The TBL model is designed to enhance both conceptual understanding and procedural skills through group discussions, individual and team quizzes, and real-world applications. This study employs a quasi-experimental design involving two groups: an experimental group that applies the TBL model and a control group that uses conventional teaching methods. The results indicate that the implementation of TBL significantly improves students' procedural knowledge, encourages active interaction between teachers and students, and receives positive feedback from learners. These findings highlight the great potential of TBL as an effective approach to improving the quality of ICT learning in schools.

Keywords: Learning Model, Team-Based Learning, Learning Outcome, Procedural Knowledge, ICT.

1. Introduction

In the current information era, technological advancements have permeated every aspect of human life, significantly impacting various fields, especially education. Changes in many aspects of life are closely linked to developments in information and communication technology, with a primary focus on enhancing the quality and quantity of educational experiences. In 21st-century learning, significant shifts have emphasized the importance of equipping students with essential skills to develop superior human resources. Among these skills, the 4Cs—Communication, Collaboration, Critical Thinking and Problem Solving, and Creativity and Innovation—are fundamental. However, although the 4Cs are highlighted as vital competencies in 21st-century education, detailed analysis regarding their implementation or outcomes is often lacking. The high demands of the 21st century for creating quality human resources have led to profound changes in human life. Consequently, individuals in this era are expected to possess innovative skills and strong character [1]. 21st-century education requires a paradigm shift in the learning process, focusing on 21st-century skills to prepare students with relevant and competitive abilities. This era is characterized by technological advancements and rapid progress in various fields [2]. Fundamentally, 21st-century learning is a product of societal evolution over time [3]. The Ministry of Education and Culture emphasizes that the 21st-century learning paradigm prioritizes students' ability to access information from diverse sources, critically identify and analyze problems, and effectively collaborate to find solutions [4]. To achieve these objectives, education now demands students to master complex knowledge and diverse skills, including higher-order thinking, job-specific

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competencies, and proficiency in using information, media, and technology [5]. While 21st-century learning aims to systematically develop students' potential and instill positive character traits, it is crucial to clearly demonstrate how the 4Cs are analyzed and integrated into learning outcomes. The 21st-century approach positions teachers not only as guides but also as facilitators providing access to alternative learning resources, such as the internet and various educational media [6]. his shift underscores the importance of practical evaluation and analysis of how the 4Cs are developed and applied within educational contexts.

The Minister of Education and Culture's regulation regarding educational assessment standards states that the core competencies that students must possess in the realm of knowledge include understanding various dimensions of knowledge, including procedural knowledge. Procedural knowledge is knowledge that includes a sequence of steps in carrying out a task or activity [7]. Procedural knowledge refers to knowledge that is centered on mastering skills, algorithms, techniques and methods for understanding learning material [8]. Procedural knowledge does not only include students' skills and expertise in writing down steps or a sequence of actions to resolve problems. Moreover, students are also expected to understand that the subsequent completion steps are the consistency of the processing stages [9]. This understanding requires the skill or ability to carry out calculations using appropriate steps (algorithms), as well as knowing when these steps are appropriate to use. In addition, knowledge of the appropriate time and how to use it is required, as well as the skills to carry it out flexibly, accurately and efficiently.

Currently, the problem that is often encountered is the lack of students' skills in solving problems during the learning process. One of them is in information and communication technology subjects, especially those related to procedural knowledge. In the current educational environment, students are required to memorize rather than understand and apply it. Students are often given material without being encouraged to understand or apply their knowledge. Thus, they face challenges when trying to apply theoretical knowledge in real life situations. The main reason behind this is students' less than optimal involvement in the learning process, which causes passivity and a decline in their academic performance. This observation was proven in research conducted in class

The low procedural knowledge learning outcomes at State Vocational High School 1 Kwanyar are caused by several factors, including the learning method delivered by the teacher which is realized to be less interactive and tends to be conventional, as well as an evaluation system that is not up to standard, and the teacher's approach to students also influences the low procedural knowledge learning outcomes. Several other factors are due to the limited devices used during the learning process so that students feel bored and their focus is diverted to other activities such as talking with friends or playing on their cellphones.

Based on the results of the interviews obtained, it can be concluded that the use of conventional learning at State Vocational High School 1 Kwanyar is still considered less than optimal in transferring learning. The learning model used is considered inadequate, where the model used is centered on the lecture method and tends to be monotonous, making students feel bored when learning takes place and tend to be passive. The impact of using conventional learning is that students at State Vocational High School 1 Kwanyar in information and communication technology subjects have low minimum completion criteria (KKM) scores. Therefore, in this very advanced technological era, experts are trying to overcome the problems faced by students in understanding the material being taught. They look for ways so that learning can take place effectively and adaptively to changes and technological developments faced by students today [10].

One effort to optimize classroom learning is to use innovative learning models. One of them is by using a Team-Based Learning model. Team-Based Learning (TBL) is a teaching method where students work in groups to study course material. TBL is a unique and effective small-group learning model. TBL combines the power of teamwork and social learning, and is supported by accountability structures and planned teaching sequences, to help you achieve significant results [11]. The main goal of Team-Based Learning is to create a platform where students can actively engage and apply subject concepts through various learning activities [12]. Team-Based Learning (TBL) is an active learning strategy that involves applying knowledge through a series of activities that involve individual work, team work and direct feedback [13]. A learning framework is a method that can be applied to create learning documents that are more interesting and effective, and can increase student participation in understanding and consistent application in solving everyday problems [14]. Team-Based Learning is seen as a viable

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method for improving academic performance in educational environments. Various research findings show that TBL is not only successful in improving student learning outcomes and achievement but also contributes to creating a more dynamic classroom atmosphere, where students are more actively involved in discussions.

This is confirmed by several previous studies including Lakshamana is said that there is a significant difference in learning outcomes between the experimental class and the control class, with the average score of the experimental class applying the Team-Based Learning model being higher than that of the control class [15]. Carolina said that there was an increase in learning outcomes by implementing the Team-Based Learning model [16]. Firmansyah is stated that the Team Based Learning model has an impact on learning outcomes [17]. Therefore, the implementation of this model can influence students' procedural knowledge learning outcomes

Based on several previous studies, the team-based learning model has been shown to have an impact on students' learning outcomes. However, this research has a different focus from previous research. This research focuses on aspects of learning outcomes related to students' procedural knowledge. It is expected that the application of the team-based learning model will offer deeper insights into the implementation of a more effective learning process, especially in relation to procedural knowledge.

2. Method

The research type used in this study is quantitative research with an experimental method. The experimental method is one of the strategies in quantitative research used to measure the effect of independent variables (treatment) on dependent variables (outcomes) in an environment that can be manipulated or controlled. The experimental design used in this study is a quasi-experimental design, which is an extension of the true experimental design. In this design, there is a control group, but it does not fully function to control external variables that may influence the implementation of the experiment [18].

In quasi-experimental research design, there are two types: Time-Series Design and Non-equivalent Control Group Design. This study uses the Non-equivalent Control Group Design, which shares similarities with the pretest-posttest control group design, as both designs involve collecting data through pretests and posttests for the experimental and control groups. This process aims to understand the initial conditions and observe changes after the treatment. The difference in the Non-equivalent Control Group Design lies in the selection of experimental and control groups, which is not done randomly.

The research design used is the nonequivalent control group design as shown in Table 1.

Table 1. Research Design

O1	X	O2	Experimental Class
O3		O4	Control Class

Description:

- O1 : Questions about pretest for class eksperimen before treatment by implementing modern Team-Based Learnig.
- O3 : Pretest questions for control class structure without treatment.
- X : Treatment.
- O2 : The posttest questions of the experimental class include treatment by applying modern standard learning.
- O4 : Control class posttest questions without treatment.

The population in this study were all students of class 11th Grade TKJ (Computer and Network Engineering) Vocational High School 1 Kwanyar, consisting of 2 classes. The samples studied were class 11th Grade TKJ (Computer and Network Engineering) A students as the experimental class and class 11th Grade TKJ (Computer and Network Engineering) B students as the control class. Where in each class there are 26 students.

The instrument used to measure the effectiveness of the Team-Based Learning model consists of learning outcome test questions aligned with procedural knowledge indicators, including pretest and

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posttest. Before being implemented as pretest and posttest questions, the instrument was validated and tested for reliability. Additionally, the questions were analyzed to assess validity, reliability, difficulty level, and discriminating power using data from students who were not part of the research sample.

Procedural knowledge is also described as a series of steps performed systematically, starting from identifying the problem to reaching the solution stage. This process is highly dependent on the type of problem faced, so a deep understanding of how to address the problem through the established procedures is necessary. There are several indicators of procedural knowledge. These indicators can be seen in Table 2.

Table 2. Procedural Knowledge Indicators

Knowledge Dimensions	Indicator
Procedural Information	1. Identify procedures to solve problems 2. Aligning the chain of movements to solve the problem 3. Using signs or logos, conditions and techniques to brighten things up 4. Describe a document on how to resolve the incident that occurred

Data analysis techniques include prerequisite testing and hypothesis testing. Prerequisite tests include normality test, homogeneity test, linearity test and simple linear regression test. Then, to test the hypothesis, namely by using a significant test (t test), independent sample test and normalized gain test.

3. Result and Discussion

Data analysis was conducted after testing the learning assessment questions to evaluate their validity, reliability, difficulty level, and discriminative power. This process aligns with measurement theories that emphasize the importance of using valid and reliable instruments to ensure accurate assessment results. Similar studies, such as those conducted by [17] have also employed these evaluation methods to enhance the quality of their test instruments. By identifying valid and reliable questions, this study ensures that the pretests and posttests can accurately and precisely measure the intended procedural knowledge.

A recapitulation of the results of the learning outcomes test instrument can be seen in Table 3.

Table 3. Recapitulation of Trial Results for Learning Achievement Test Instruments

No. Question	Validity	Valid Question Reliability	The Power of Different Questions	Level Difficulty	Information
1.	Valid	0.8358 Very good	Enough	Easy	Used
2.	Valid		Enough	Currently	Used
3.	No valid		Bad	Currently	No used
4.	Valid		Enough	Easy	Used
5.	Valid		Enough	Easy	Used
6.	Valid		Good	Currently	Used
7.	Valid		Enough	Currently	Used
8.	Valid		Bad	Easy	Used
9.	Valid		Bad	Difficult	Used
10.	No valid		Bad	Currently	No used

Based on the test results data in Table 3, there are 8 questions that are used to select pre-test and post-test questions.

Analysis of pretest and posttest results for experimental class and control class. Pretest is used to measure students' abilities before treatment is carried out in the learning process. Meanwhile, the posttest is used to measure learning outcomes after receiving treatment in the learning process (Table 4).

Table 4. Pretest and Posttest Results for Experimental Class and Control Class

Class	Pretest Average	Posttest Average

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Experiment	51	80
Control	45	66

Based on Table 4, the average pretest score obtained by students in the experimental class is 51, while the average posttest score is 80. In contrast, the average pretest score in the control class is 45, and the average posttest score is 66. Thus, it can be concluded that the learning outcomes in the experimental class are higher compared to those in the control class.

Data from the preliminary and posttest results will be used for various prerequisite tests and hypothesis tests. Where the prerequisite tests include normality tests, linearity tests, and simple linear regression tests. Then, the function of the hypothesis test with a significant test (t test) of the third-order sampler and a normalized gain test.

3.1 Prerequisite Test

3.1.1 Normality Test

The Normality Test is carried out to find out whether the distribution of the data population is normal or not [19]. The method used in the normality test in this research is the Liliefors test (Table 5).

Table 5. Pretest Normality Test Results

Class	Pretest		Information
	L_{count}	L_{table}	
Experiment	0.0494	0.1699	$L_{count} \leq L_{table}$, data has normal distribution
Control	0.1402	0.1699	$L_{count} \leq L_{table}$, data has normal distribution

Based on the results of the normality test in Table 5, the results of the initial normality test of the experimental class were obtained with a L_{count} value of 0.0494 < L_{table} of 0.1699, then Ho was accepted and the data was declared to have normal distribution. Furthermore, the results of the initial normality test of the control class were obtained L_{count} 0.1402 < L_{table} 0.1699, so that Ho was accepted and it was stated that the data had normal distribution.

Table 6. Posttest Normality Test Results

Class	Posttest		Information
	L_{count}	L_{table}	
Experiment	0.1046	0.1699	$L_{count} \leq L_{table}$, data has normal distribution
Control	0.1551	0.1699	$L_{count} \leq L_{table}$, data has normal distribution

Based on the results of the normality test in Table 6, the results of the posttest normality test for the experimental class were obtained L_{count} = 0.1046 < L_{table} = 0.1699, so Ho was accepted and declared to have normal distribution. Furthermore, the results of the posttest normality test for the control class were obtained L_{count} = 0.1551 < L_{table} = 0.1699, so that Ho was also accepted and it was stated that the data had normal distribution. In this way, based on the results of the normality test, it can be concluded that the posttest data in the experimental class and control class are declared to have "normal distribution".

3.1.2 Homogeneity Test

The homogeneity test is carried out to find out whether the data in variable X and variable Y are homogeneous or not [19].

Table 7. Pretest Data Homogeneity Test Results

Class	S2	F_{count}	F_{table}	Information
Experiment	96.51	1.4503	1.9554	Ho is accepted = homogeneous data

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Based on the results of the homogeneity test of the preterst values of the experiment class and the control class in Table 7, the result obtained is $F_{count} = 1.4503 < F_{table} = 1.9554$ so that H_o is accepted and a conclusion can be drawn from the pretest data of the experiment class and the control class which are declared homogeneous.

Table 8. Posttest Data Homogeneity Test Results

Class	S2	F_{count}	F_{table}	Information
Experiment Control	63.14 87.06	0.7253	1.9554	Ho is accepted = homogeneous data

Based on the results of the homogeneity test of the posttest values for the experiment class and the control class in Table 8, the results obtained are $F_{count} = 0.7253 < F_{table} = 1.9554$ so that Ho is accepted and a conclusion can be drawn from the pretest data for the experiment class and the control class being declared homogeneous.

3.1.3 Linearity Test

The linearity test is used to determine whether there is a linear relationship between the based variable (X) and the bound variable (Y) [18]. The data that will be used for the linearity test is the preliminary and posttest data of the experimental class.

Table 9. Linearity Test Results

Formula	Mark
The number of squares of the regression [Jkrerg (a)]	165441.3846
Constant Value b	0.650
The number of squares of the regression [Jkrerg a (b/a)]	1018.15
Number of squared returns [Jkrers]	560,461
Average number of cura regressions [RJKrerg(a)]	165441.38
Average number of curvatures of regression [RJKrerg a (b/a)]	1018.15
Average number of squared returns [RJKrers]	23.353
Features	43.599
F_{table}	4.2597
Decision	Ha received = Linear Pattern Data

Based on the results of the linearity test on the previous and posttest values of the experimental class in Table 9, it was obtained that $F_{count} = 43.599 > F_{table} = 4.2597$, then Ha was accepted and H_o was rejected. So, it can be concluded that the initial and posttest data for the experimental class have a linear pattern. This means that the second variable has linear relationships and can be used in various simple linear regression test requirements.

3.1.4 Simple Linear Regression Test

After carrying out a linearity test which suggests the results of data with a linear pattern, a simple linear regression test is also carried out to estimate the value of the dependent variable (Y) which is influenced by the dependent variable (X).

Table 10. Simple Linear Regression Test

Data	Mark
Constant b	0.650
Constant a	46,714
Eq	Y = 46.714+0.650X
$\bar{X}$	50.9

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$\bar{Y}$	79,769
R	0.803

Based on a simple linear regression test in Table 10, a constant value of 46.714 was obtained and a constant value of b was 0.650. The simple linear regression equation obtained is based on the resulting result Y= 46.714+0.650X. From this simple linear regression equation, there are several things that can be analyzed:

- The constant a = 46.714, recommends that the estimated value in learning be carried out without using modern basic learning methods, so the learning outcomes are estimated to be 46.714. Meanwhile, if modern Team-Based Learning is applied, it is estimated that the learning outcomes of students in the experiment class, namely class.
- The constant b = 0.650, suggests increasing student learning outcomes for each lesson by using modern Team-Based Learning.

Based on Table 10, Also obtained a value of 50.9 and a value of 79.769. In addition, a correlation value (r) of 0.803 was obtained. The terserburt correlation value is in the form of a positive number, meaning that it supports a positive relationship between the modern application of Team-Based Learning and the learning outcomes of students' procedural knowledge in the cognitive domain. The complete calculation results of the simple linear regression test can be seen in Table 10.

The simple linear regression equation Y = 46.714+0.650X can be seen in the following graph (Figure 1).

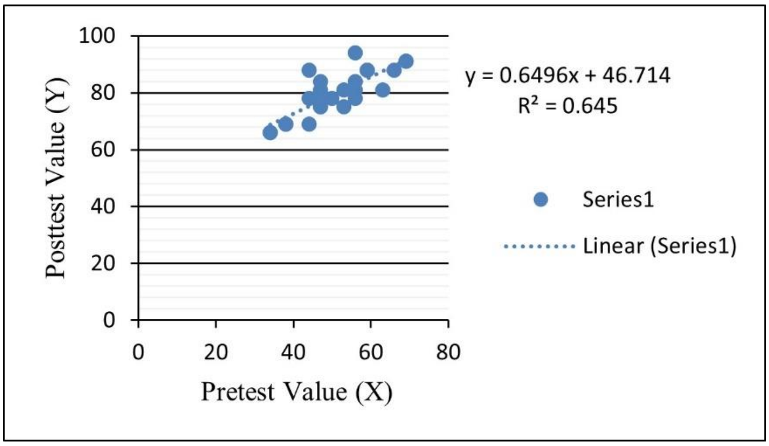

Figure 1. Graph of Simple Linear Regression Equation.

Based on Figure 1 above, it can be concluded that the student learning outcomes without using modern basic learning are 46,714. After the treatment was given by using the modern term base calculation, there was an increase of 0.645, which means that the regression line has a positive linear relationship. So it can be concluded that the results of learning students' procedural knowledge in the experimental field class and after being given treatment will increase the level of Y = 46.714 + 0.645.

3.2 Hypothesis Testing

3.2.1 Significant Test

After carrying out the prerequisite test, the next step is to carry out a hypothesis test by using a significant test (test sampler independent test). This test was carried out to find out whether modern terram-based learning has a significant influence on students' procedural knowledge learning outcomes in the cognitive domain or not [19]. The data used for this hypothesis test are posttest on the control class and experimental class.

Table 11. Significant Test Results

Significant Level	T_{count}	T_{table}	Information
0.05	5.8246	2.0639	H_o Rejected

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Based on a significant test with a significance level of 0.05 in Table 11, a value of t_{count} of 5.8246 and t_{table} of 2.0639 was obtained. From these two value, the results of the $t_{count} > t_{table}$ calculation result, so that the null hypothesis (H_o) is rejected and the alternative hypothesis (H_a) is accepted. So, it can be concluded that there is a significant influence from modern Team-Based Learning on students' procedural knowledge learning outcomes.

3.2.2 Normalized Gain Test

The normalized gain test is used to understand the increase in student learning outcomes and learning implementation procedures using the modern learning process [20]. In this test, the data used are the results of the preliminary and posttest results of the experiment class.

Table 12. Normalized Gain Test Results

Category	Respondent	Amount
Tall	3, 5, 7, 18, 22, 26	6
Medium	1, 2, 4, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19, 20, 21, 23, 24, 25	20
Low		-
Fixed		-
An abort occurred		-
N-Gain Test	N-Gain	Category
	0.588	Medium

Based on the results of the Normalized Gain test in Table 12, it can be seen that of the 26 students in the experimental class, 6 students have a learning increase in the "high" category and 20 students have an increase in the "medium" category. In addition, the average normalized gain test value is 0.588 in the "medium" category. In this way, it can be concluded that the results of the normalized gain test suggest that student learning outcomes have increased significantly to around 0.588.

Based on the hypothesis test with a significant test, the results obtained were that the t_{count} value was 5.8246 and t_{table} value was 2.0086. Because t_{count} is greater than t_{table}, H_o is rejected and Ha is accepted. So, it can be said that modern teram based learning has a significant influence on students' procedural knowledge learning outcomes in class 11th Grade TKJ (Computer and Network Engineering) Virtual Local Area Network material at Vocational High School 1 Kwanyar. Furthermore, in the normalized gain test, the results were obtained that 6 students in the experimental field class were in the "High" category and 20 students were in the "Serdang" category. The resulting average value of the normalized gain test is 0.588 with the "Serdang" interpretation.

The influence of modern Team-Based Learning on student achievement can be seen through learning outcomes. The questions used for the learning outcomes test include indicators of procedural knowledge. Indicator 1 on procedural knowledge is located on questions number 2, 6 and 7, Indicator 2 on procedural knowledge is located on questions number 3, 5 and 10, Indicator 3 on procedural knowledge is located on questions number 4 and 8 and Indicator 4 on procedural knowledge is located on questions number 1 and 9. Students' learning achievements are impressive through pre-test and post-test in the experimental class and control class. While the regional group received the treatment, students in the experimental class and the control class carried out preparations to improve students' initial abilities. After being given treatment, students then carry out post-test to understand student learning outcomes in the cognitive domain. The treatment given differs between the experimental class and the control class, where the experimental class is given treatment by implementing modern learning based programming in the learning process. Meanwhile, in the learning control class, learning is carried out using conventional models.

A student's score is declared straight if the student reaches the low minimum completion criteria (KKM) score set by the school, namely 70. As many as 81% of the 26 students in the final course class got a posttest score in the "complate" category. Of all the students registered, 21 students have achieved a complete score, while 5 other students have yet to reach the low minimum completion criteria (KKM). Meanwhile, in the control class only 8 students out of 26 students got a complete score on the posttest results. In this way, it can be said that the learning process in the experimental group with the application

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of modern Team-Based Learning has a significant influence on the achievement of students' procedural knowledge learning outcomes.

4. Conclusion

This study shows that the Team-Based Learning (TBL) model has a significant impact on students' procedural knowledge learning outcomes, particularly in virtual local area network (VLAN) material. The significance test reveals a t-value (5.8246) greater than the table value (2.0086), leading to the rejection of the null hypothesis (H_o) and acceptance of the alternative hypothesis (H_a). Additionally, the normalized gain test with an average of 0.588, categorized as "Medium," indicates a moderate improvement in students' procedural knowledge learning outcomes. This study is limited to class 11th Grade TKJ (Computer and Network Engineering) students at Vocational High School 1 Kwanyar and the short duration of the intervention.

This research contributes by demonstrating the effectiveness of the TBL model in enhancing procedural knowledge learning outcomes in ICT subjects, particularly in *Virtual Local Area Network* material, and its potential for application in teaching strategies in other educational contexts. These findings also imply that the implementation of TBL could be expanded to improve student engagement and learning outcomes across various subjects and educational environments. Further research is recommended to investigate the long-term effects of TBL on procedural knowledge and to broaden the study to other institutions and subjects to gain a deeper understanding of the generalizability of these findings.

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