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The Influence of Participatory Ergonomics Synergy with Guided Inquiry Learning Model on Boredom, Fatigue and Science Learning Outcomes in Junior High Schools

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Abstract: The inquiry learning model certainly has shortcomings in its implementation, one of which is controlling student activities and success. This model is difficult to observe students who are not participating in groups doing experimental activities. This causes uneven delivery of material for students individually. Therefore, it is necessary for this learning model to be synergized with a participatory approach. One approach that can be used is the Participatory Ergonomics Approach. This study aims to determine whether there is a difference in the effect of the synergy of participatory ergonomics with guided inquiry learning models with conventional learning on junior high school students' eye fatigue, to determine whether there is a difference in the effect of the synergy of participatory ergonomics with guided inquiry learning models with conventional learning on junior high school students' boredom in learning, to determine whether there is a difference in the effect of the synergy of participatory ergonomics with guided inquiry learning models with conventional learning on junior high school students' science learning outcomes, and to determine whether there is a difference in boredom, fatigue and science learning outcomes of students who are taught using the participatory ergonomics approach with guided inquiry models with conventional learning for junior high school students. This type of research is a quasi-experimental researchs. This study uses a quantitative approach. The design of this study uses the Nonequivalent Pretest Posttest Control Group Design. The data in this study are in the form of learning interest questionnaire scores and learning outcome test scores which are analyzed using the MANOVA test. The results of this study indicate that: a significant value of 0.000 ($p < 0.05$) was obtained, a significant value of 0.000 ($p < 0.05$) was obtained, a significant value of 0.000 ($p < 0.05$) was obtained.

Keywords: Boredom and learning outcomes; Fatigue; Synergy of participatory ergonomics

Introduction

Education in Indonesia has challenges in creating the next generation of the nation. The desired generation is capable of independence, a tough attitude and is able to face competition in the era of revolution 4.0 and demographic bonus opportunities. Indonesia has a prediction of getting a demographic bonus in 2045. Based on the National Development Planning (BAPPENAS) through that period, the number of people in productive age is 65% of the total population. The demographic bonus of the Republic of Indonesia is a

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savings of human resources that have the potential to be developed into development capital. The demographic bonus is expected to be Indonesia's capital as a golden generation in 2045. The management of the demographic bonus is determined by education, so that it can be started as early as possible to create the expected generation. Education is most commonly believed in the role of schools to overcome these challenges. Schools are used as containers or institutions that have facilities including: tables, chairs, classrooms, whiteboards, LCD projectors and so on, while for infrastructure there are educators or teachers who are used as student facilitators in learning. This is in accordance with Law (UU) RI No. 20 of 2003, concerning the National Education System Chapter 1 Article 3 states that National education functions to develop abilities and shape the character and civilization of a dignified nation in order to educate the life of the nation, aiming to develop the potential of students to become human beings who believe in and fear God Almighty, have noble morals, are healthy, knowledgeable, capable, creative, independent, and become democratic and responsible citizens (Idawati et al., 2025; Yusnan, 2022; Dina et al., 2020).

Learning can take place if the facilities and infrastructure can be implemented properly and adjusted to the learning conditions related to the applicable curriculum. The curriculum that will be implemented at the Junior High School (SMP) level in 2024 is an independent curriculum with a Full day school system. In implementing this curriculum, it is followed by a Full day school learning system. This school system has been implemented in Indonesia and is based on the Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 23 of 2017 concerning school days contained in Article 2 paragraph 1 which reads "School days are carried out for 8 (eight) hours in 1 (one) day or 40 (forty) hours for 5 (five) days in 1 (one) week". The implementation of the full day school system is to be used by students to carry out intracurricular, co-curricular, and extracurricular activities (Primasatya & Imron, 2021).

In the implementation of learning, it is inseparable from the role of the teacher as the center of the implementation of learning, which of course must convey learning with all the creativity they have, also related to the time cuts of the curriculum project being held. This causes teachers to be able to carry out effective and efficient teaching time and what is taught must of course improve learning outcomes related to teaching materials. The delivery of learning materials has also been in various forms, namely with LKS books, printed books, and using power point media. The use of power point generally helps teachers in explaining the material to be conveyed, but the descriptions presented contain many full explanatory sentences or Power text. Based on research (Mira & Putri, 2022), it states that the use of power point media has little effect on student learning outcomes. During learning using power point media, students are less effective in learning and students do not understand the material displayed and the results found are that learning outcomes are less stable. The number of students who fall into the lowest category in their learning outcomes before using Power Point media is 50% and after this power point media is implemented it becomes 60%. Students who are sufficient in learning before the implementation are 7%, but after the power point media is implemented, student learning outcomes are 25%. For students in the high category before the application of power point media was 15%, now after the application of power point media it has become 40%. The results of this study concluded that the use of Power point media accompanied by sound, animation effects has not been effective in the learning process. Students' difficulty in dominating learning due to teachers explaining thoroughly and students' lack of interest in asking or answering questions provided by the teacher (Svanes & Andersson-Bakken, 2023).

This error occurs due to the teacher's limited creativity regarding how to teach and use the lecture learning method by utilizing power point learning media, prioritizing students to take notes and listen. In the use of power point learning media, of course, it is assisted by the presence of an LCD (Liquid Crystal Display). The use of LCD facilities is a supporting force for schools for the success of the learning process, especially in displaying learning images. An uncomfortable seating position between the distance between the screen and students can cause a feeling of continuous tension which causes eye muscle fatigue. Eye fatigue is eye or visual tension caused by the use of the sense of sight in work that requires the ability to see for a long time and uncomfortable viewing conditions. In addition to the non-ergonomic viewing distance between the use of the LCD and students, monotonous learning also stimulates loss of concentration and boredom in students. Boredom arises because the activities carried out do not attract students to concentrate or occur monotonously. Low student participation is also another factor in boredom, namely Students only listen without responding or asking questions about the material being taught (Fadlila et al., 2022; Jiang, 2020; Citrawathi et al., 2019). The delivery of material and combined with the use of interactive learning media Power point certainly uses a learning approach. One approach that is still used is the Scientific Approach.

Learning that uses a scientific approach with the 5M steps used in the 2013 Curriculum has been designed in such a way that students are active in constructing concepts, laws and principles that they have discovered through the stages of observing, asking, trying, reasoning and communicating these steps are called the 5M steps in the Scientific approach. However, in reality learning with a scientific approach (5M) has not yet run optimally. This is supported by the results of a preliminary study of 40 ninth grade students of SMP Dharma Wiweka Denpasar, the average value in learning was 60.35, which means that the average value does not meet the KKM IPA value of 78. This is supported by problems related to the learning process, namely the influence of boredom in learning with an average score of 67.89 (slightly bored) and eye fatigue caused by the use of teaching media is generally given at 50.59 (slightly tired) so that if it is allowed to continue, student boredom will end up being very bored and the condition of the eyes will become tired. The inquiry learning model is one of the learning models that encourages students to be actively involved in the learning process (Hamid et al., 2023; Suyatmo et al., 2023; Adauyah & Aznam, 2024). The inquiry learning model has a series of learning activities that emphasize student activity in having learning knowledge in discovering material concepts based on the problems presented. One of the inquiry models used for junior high school students is the guided inquiry model (Rahmatika et al., 2022; Tabun et al., 2019).

The guided inquiry learning model also emphasizes critical and logical thinking skills to solve a problem through teacher guidance. The main characteristic of inquiry learning is the existence of questions or problems that encourage students to find answers through practicums or experiments (Nurlaila & Lufri, 2021; Eristya & Aznam, 2019; Achmad et al., 2023). The inquiry learning model certainly has shortcomings in its implementation, one of which is controlling student activities and success. This model makes it difficult to observe students who do not participate in groups carrying out experimental activities. In groups, of course, there are some students who participate in learning activities actively and passively. This passivity arises from burdening group assignments on certain children, this causes the delivery of material to be uneven for students individually. Therefore, it is necessary to synergize this learning model with a participatory approach. One approach that can be used is the Participatory Ergonomics Approach (Burgess-Limerick, 2018; Suhartini et al., 2022; Widyawati et al., 2019). The reason for synergizing the guided inquiry learning model with the participatory ergonomics approach is to complement the shortcomings of the usual guided inquiry learning model. The participatory ergonomics approach is now widely used in the learning process related to health quality (Adnyana & Citrawathi, 2019; Abdollahpour & Helali, 2022; Citrawathi & Adnyana, 2018).

The participatory ergonomics approach is an approach method that aims to develop student learning activities to be more dynamic in anticipating learning facilities that are not conducive (Gumasing & Castro, 2023; Anjum, 2020). In participatory ergonomics learning, students are allowed to stretch each learning activity, namely in the form of dynamic movements carried out during learning, not only being in one place but they move around looking for the information they need. Based on this description, students' boredom and eye fatigue need to be considered because they will indirectly contribute to student learning outcomes. The application of the participatory ergonomics approach that is synergized with the guided inquiry learning model can have implications for more productive student conditions which are marked by increased concentration and enthusiasm for learning. Learning conditions will return to being conducive and effective which will make it easier to achieve learning objectives and improve student learning outcomes.

Method

The type of research used in this study is a quasi-experiment. This study uses a quantitative approach. The design of this study uses the Nonequivalent Pretest Posttest Control Group Design which can be seen in Table 1.

Table 1. Research Design

Group	Sampling	Pre-test	Treatment	Posttest
Control	R	O1	X1	O2
Experimental Group	R	O3	X2	O4

This design consists of two groups, namely the experimental group and the control group. This study uses several data collection instruments, namely: The instrument used to measure science learning outcomes is in the form of an objective test consisting of pretest and posttest questions; The instrument used to determine student fatigue and boredom in learning is in the form of a questionnaire. The study was conducted at SMP Dharma Wiweka Denpasar in class IX C as the experimental class and class IX I as the control class. The questionnaire instrument for measuring eye fatigue and boredom in learning is based on five Likert scales and consists of 18 and 26 positive-negative question items and learning outcome tests are filled in and tested on students in the control and experimental classes, each totaling 39 people in one class. The questions made are based on the material of inheritance of traits and Biotechnology.

Result and Discussion

The results of the study are in the form of descriptive test results, normality tests, variance homogeneity tests, collinearity tests and finally after other tests are appropriate, the Manova test will be carried out. The descriptive test is expressed in the form of average data and standard deviations and the differences given in the data found. The data described are in the form of eye fatigue, boredom in learning and student learning outcomes between the control and experimental groups. Eye fatigue data was obtained based on the results of the questionnaire in the form of statements in the form of positive and negative statements and taken before learning took place and after learning took place stated in the form of an average which can be seen in Table 2.

Table 2. Description of Eye Fatigue

Group	Average	Standard Deviation	Information %
Experimental Group (Pretest)	47.65	7.482	Different 16.67
Control Group (Pretest)	57.18	7.497	
Experimental Group (Posttest)	46.00	7.229	Different 20.19
Control Group (Posttest)	57.64	5.143	
Difference in eye fatigue (Experimental group)	1.65	0.253	Different 60.60
Eye fatigue difference (control)	0.46	2.354	

Based on Table 2, it is known that it can be explained that the average eye fatigue before learning in the experimental group was 47.65 (eye fatigue in the slightly tired category) with a standard deviation of 7.482 and the average eye fatigue before learning in the control group was 57.18 (eye fatigue in the tired category) with a standard deviation of 7.497 (16.67% difference). The average eye fatigue after learning in the experimental group was 46.00 (eye fatigue in the slightly tired category) with a standard deviation of 7.229 and the average eye fatigue in the control group after learning was 58.64 (eye fatigue in the tired category) with a standard deviation of 5.143 (20.19% difference). The average difference in eye fatigue in the experimental group was 1.65 with a standard deviation of 0.235 and the average difference in eye fatigue in the control group was 0.46 with a standard deviation of 2.354 (60.60% difference). Meanwhile, for the results of the description test of learning boredom, data was obtained based on the results of the questionnaire in the form of positive and negative statements and taken before learning took place and after learning took place, as can be seen in Table 3.

Table 3. Description of Learning Boredom

Group	Average	Standard Deviation	Information %
Experimental Group (Pretest)	69.97	7.264	Different 2.78
Control Group (Pretest)	71.95	6.537	
Experimental Group (Posttest)	63.69	6.367	Different 22.64
Control Group (Posttest)	82.33	5.774	
Difference in eye fatigue (Experimental group)	6.28	0.897	Different 66.30
Eye fatigue difference (control)	10.38	0.763	

Based on Table 3, it is known that the average boredom before learning in the experimental group was 69.97 (learning boredom in the rather boring category) with a standard deviation of 7.264 and the average boredom before learning in the control group was 71.95 (learning boredom in the rather boring category) with a standard deviation of 6.537 (a difference of 2.78%). The average boredom after learning in the experimental group was 63.69 (learning boredom in the rather boring category) with a standard deviation of 6.367 and the average boredom in the control group after learning was 82.33 (learning boredom in the boring category) with a standard deviation of 5.774 (a difference of 22.64%). The average difference in learning boredom in the experimental group was 6.28% with a standard deviation of 0.897 and the average difference in eye fatigue in the control group was 10.38 with a standard deviation of 0.763 (a difference of 66.30%). The results of the description of the learning outcome data obtained are presented in the form of averages, standard deviations, variances, minimum-maximum values and finding the gain score value from the Pretest-posttest given, then presented in Table 4.

Based on Table 4, it can be seen that the comparison of learning outcomes between students in the experimental group (guided inquiry learning model with participatory ergonomics approach) and the control group (guided inquiry learning model with scientific approach (5M)). The posttest data for the experimental group, the learning outcomes obtained ranged from 52 to 100 with an average value of 76.10. Meanwhile, for the learning outcomes of the control group, the student scores ranged from 28 to 96 with an average of 60.41. This illustrates that the learning outcomes of students in the experimental group with the guided inquiry learning model with participatory ergonomics approach are better than the learning outcomes of the control group with a scientific approach (5M). This can be seen from the gain value between the experimental group of 0.77 which is relatively high compared to the gain value of the control group of 0.56 which is relatively moderate. The normality test was conducted by testing the entire research data used to be normally distributed or not in the data distribution in two groups, namely the control group (guided inquiry learning model with the 5M approach) and the experimental group (guided inquiry learning model with the Participatory Ergonomics approach). The testing criteria used were that the data had a normal distribution with a significance figure generated greater than 0.05.

Table 4. Description of Science Learning Outcomes

Statistics	Learning outcomes					
			Experimental Class			Control Class
	Pretest	Posttest	Gn	Pretest	Postetst	Gn
Mean	27.38	76.10	0.77	26.46	60.41	0.45
SD	11.627	11.912	0.171	13.286	16.356	0.23
Variance	135.190	141.884	0.030	176.518	267.617	0.57
Maximum	52	100	1	52	96	0.92
Minimum	8	52	0.23	4	28	0.14

The summary results of the normality test can be seen in table 5. Based on table 5, it can be seen that the summary of the normality test of the data distribution shows that for the data of both groups, both on variables related to eye fatigue, boredom, learning outcomes and each difference has a significance value of > 0.05. This shows that the data studied is normally distributed. The homogeneity test of the variance is a test used to review whether the data studied is homogeneous or not. The data homogeneity test is carried out using Levene's Test of Equality of Error Variance. Data is stated to have homogeneous variance if the significance number is greater than 0.05.

Table 5. Summary of Normality Test Results

Variable		Kolmogorov-Smirnov			Shapiro-wilk			Information
		Statistics	Df	Sig.	Statistics	Df	Sig.	
Eye fatigue (before learning)	Control class	0.10	39	0.20	0.98	39	0.92	normally distributed
	Experimental class	0.09	39	0.20	0.96	39	0.26	normally distributed
Eye fatigue (after learning)	Control class	0.08	39	0.20	0.96	39	0.26	normally distributed
	Experimental class	0.06	39	0.20	0.98	39	0.26	normally distributed
Difference in eye fatigue	Control class	0.10	39	0.20	0.97	39	0.43	normally distributed
	Experimental class	0.12	39	0.15	0.95	39	0.12	normally distributed
Boredom of learning (before learning)	Control class	0.11	39	0.19	0.97	39	0.64	normally distributed
	Experimental class	0.09	39	0.20	0.97	39	0.51	normally distributed
Boredom in learning (after learning)	Control class	0.09	39	0.20	0.97	39	0.64	normally distributed
	Experimental class	0.08	39	0.20	0.97	39	0.51	normally distributed
Difference in learning boredom	Control class	0.11	39	0.20	0.96	39	0.18	normally distributed
	Experimental class	0.07	39	0.20	0.95	39	0.57	normally distributed
Learning Outcomes (before learning)	Control class	0.11	39	0.20	0.95	39	0.14	normally distributed
	Experimental class	0.96	39	0.20	0.96	39	0.35	normally distributed
Learning Outcomes (after learning)	Control class	0.10	39	0,20	0.98	39	0.74	normally distributed
	Experimental class	0.09	39	0.20	0.97	39	0.46	normally distributed
learning outcome gap	Control class	0.12	39	0.12	0.97	39	0.53	normally distributed
	Experimental class	0.13	39	0.07	0.96	39	0.32	normally distributed

A summary of the results of the homogeneity test of variance is presented in Table 6. Based on the results of the homogeneity test of the significance level for data on eye fatigue, boredom in learning and science learning outcomes, it has a value of > 0.05 which can be seen for the significance value of eye fatigue of 0.121; boredom in learning of 0.432; and learning outcomes of 0.109. The purpose of the Collinearity Test is to find a relationship or correlation between eye fatigue, boredom in learning and science learning outcomes. If the data between the dependent variables has a high correlation (r > 0.8), then one of the variables is used as a covariate.

Table 6. Summary of Homogeneity Test

Variables	Levene statistics	df1	df2	sig
Eyestrain	2.464	1	76	0.121
Learning Boredom	0.599	1	76	0.432
Learning Outcomes	2.624	1	76	0.109

The data from the collinearity analysis can be seen in Table 7. Based on Table 7, it can be seen that the correlation value between the variables of eye fatigue, learning boredom and learning outcomes is 0.347 and 0.328. The correlation value obtained is smaller than 0.8 which indicates that the three variables do not have the same correlation, so it can be continued with the MANOVA test. In the hypothesis test in this study, there are four hypotheses. The statistical test used is the MANOVA (Multivariate Analysis of Variance) test. The following are the results of the first, second, third and fourth hypothesis tests. The first hypothesis tested states that there is a difference in the effect of participatory ergonomics synergy with guided inquiry learning models with conventional learning on junior high school students' learning boredom. To test this hypothesis, the test of between-subject effects is used. Students' eye fatigue will be different if the F value of each has a significance value of less than 0.05.

Table 7. Test Table Between Dependent Variables

		Eye Fatigue	Boredom	Learning outcomes
Eye Fatigue	Pearson Correlation	1	.599	-.347
	Sig. (2-tailed)		.000	.002
	N	78	78	78
Boredom	Pearson Correlation	.599**	1	-.328
	Sig. (2-tailed)	.000		.003
	N	78	78	78
Learning outcomes	Pearson Correlation	-.347	-.328	1
	Sig. (2-tailed)	.002	.003	
	N	78	78	78

The summary results of the test of between-subjects effects of eye fatigue can be seen in Table 8. Table 8 shows that eye fatigue in the source has an F value of 67.146 with a significance of 0.000 smaller than 0.05 ($p < 0.05$). Thus, H0 is rejected and H1 is accepted, so it can be concluded that there is a difference in the influence of the synergy of participatory ergonomics with guided inquiry learning models with conventional learning on junior high school students' boredom. The second hypothesis tested states that there is a difference in the influence of the synergy of participatory ergonomics with guided inquiry learning models with conventional learning on junior high school students' boredom. To test this hypothesis, the test of between-subject effects is used. Student boredom will be different if the F value of each has a significance value smaller than 0.05.

Table 8. Summary of Results of Test of Between-Subjects Effects of Eye Fatigue

Source	Dependent Variable	Type III Sum of Square	Df	Mean Square	F	Sig
Corrected Model Class	Eyestrain	2642.513a	1	2642.513	67.146	.000
	Learning Boredom	6776.013b	1	6776.013	183.463	.000
	Learning Outcome	4801.846c	1	4801.846	23.452	.000
	Eyestrain	209458.513	1	209458.513	5322.295	.000
Source	Learning Boredom	415808.013	1	415808.013	11258.175	.000
	Learning Outcome	363397.128	1	363397.128	1774.830	.000
Corrected Model	Eyestrain	2642.513	76	39.355		
	Learning Boredom	6776.013	76	36.934		
	Learning Outcome	4801.846	76	204.750		

Table 9. Summary of Results of Test of Between-Subjects Effects of Learning Boredom

Source	Dependent Variable	Type III Sum of Square	Df	Mean Square	F	Sig
Corrected Model Class	Eyestrain	2642.513a	1	2642.513	67.146	.000
	Learning Boredom	6776.013b	1	6776.013	183.463	.000
	Learning Outcome	4801.846c	1	4801.846	23.452	.000
	Eyestrain	209458.513	1	209458.513	5322.295	.000
Source	Learning Boredom	415808.013	1	415808.013	11258.175	.000
	Learning Outcome	363397.128	1	363397.128	1774.830	.000
Eror	Eyestrain	2642.513	76	39.355		
	Learning Boredom	6776.013	76	36.934		
	Learning Outcome	4801.846	76	204.750		

The summary results of the test of between-subjects effects of boredom can be seen in Table 9. Table 9 shows that boredom in learning on the source has an F value of 183.463 with a significance of 0.000 smaller than 0.05 (p <0.05). Thus, H0 is rejected and H2 is accepted, so it can be concluded that there is a difference in the influence of the synergy of participatory ergonomics with guided inquiry learning models with conventional learning on junior high school students' boredom in learning. The third hypothesis tested states that there is a difference in the influence of the synergy of participatory ergonomics with guided inquiry learning models with conventional learning on junior high school students' science learning outcomes. The summary results of the test of between-subjects effects on science learning outcomes can be seen in Table 10.

Table 10. Summary of Results of Test of Between-Subjects Effects Learning Outcomes

Source	Dependent Variable	Type III Sum of Square	Df	Mean Square	F	Sig
Corrected Model Class	Eyestrain	2642.513a	1	2642.513	67.146	.000
	Learning Boredom	6776.013b	1	6776.013	183.463	.000
	Learning Outcome	4801.846c	1	4801.846	23.452	.000
	Eyestrain	209458.513	1	209458.513	5322.295	.000
Source	Learning Boredom	415808.013	1	415808.013	11258.175	.000
	Learning Outcome	363397.128	1	363397.128	1774.830	.000
Eror	Eyestrain	2642.513	76	39.355		
	Learning Boredom	6776.013	76	36.934		
	Learning Outcome	4801.846	76	204.750		

Table 10 shows that the learning outcomes in the source have an F value of 23.452 with a significance of 0.000 less than 0.05 (p <0.05). Thus, H0 is rejected and H3 is accepted, so it can be concluded that there is a difference in the influence of the synergy of participatory ergonomics with guided inquiry learning models with conventional learning on the science learning outcomes of junior high school students. The fourth hypothesis tested states that there is a difference in boredom, fatigue and science learning outcomes of students who are taught with a participatory ergonomics approach with a guided inquiry model with conventional learning for junior high school students. To test this hypothesis, multivariate analysis of variance (MANOVA) is used. If all four have F values with a significance of less than 0.05, then H0 is rejected and H4 is accepted. A summary of the MANOVA test results is shown in Table 11.

Table 11. Manova Test Results

Variable	Effect	Value	F	Hypothesis Df	Error Df	Sig
Learning	Pillai’s Trace	0.791	93.423b	3.000	74.000	.000
	Wilks’ Lambda	0.209	93.423b	3.000	74.000	.000
	Hotteling’s Trace	3.787	93.423b	3.000	74.000	.000
	Roy’s Largest Root	3.787	93.423b	3.000	74.000	.000

Based on Table 11, it can be seen that the F value = 93.423 with a significance value of Pillai's Trace, Wilks' Lambda, Hotteling's Trace, and Roy's Largest Root is 0.000, the value is smaller than the significance level of 0.05 (p <0.05) thus H0 is rejected and H4 is accepted. So it can be concluded that there are differences in boredom, fatigue and science learning outcomes of students who are taught with a participatory ergonomics approach with a guided inquiry model with conventional learning for junior high school students. Based on the results of the homogeneity test of the significance level for data on eye fatigue, boredom in learning and science learning outcomes, it has a value of > 0.05 which can be seen for the significance value of eye fatigue of 0.121; boredom in learning of 0.432; and learning outcomes of 0.109. The purpose of the Collinearity Test is to find a relationship or correlation between eye fatigue, boredom in learning and science learning outcomes. If the data between the dependent variables has a high correlation (r > 0.8), then one of the variables is used as a covariate. The data from the collinearity analysis can be seen in Table 7 below. Based on Table 11, it can be seen that the F value = 93.423 with a significance value of Pillai's Trace, Wilks' Lambda, Hotteling's Trace, and Roy's Largest Root is 0.000, the value is smaller than the significance level of 0.05 (p <0.05) thus H0 is rejected and H4 is accepted. So it can be concluded that there is a difference in boredom, fatigue and science learning outcomes of students who are taught with a participatory ergonomics approach with a guided inquiry model with conventional learning for junior high school students.

Based on the results of the data analysis, there is a difference in eye fatigue between students who use a guided inquiry learning model with a participatory ergonomics approach (experimental group) and a scientific approach (control group). Descriptively through the results of the analysis it was obtained that the approach used participatory ergonomics can reduce eye fatigue in students in learning compared to the learning approach using scientific, this can be seen in Table 2. The learning approach using the scientific approach (5 M namely observing, asking, trying, reasoning and communicating) is not far from using the dominance of using LCD projectors to provide direction to students related to the material being studied through written form and images, not only that the use of LKPD is more often done in groups by trying to find information via cellphones and done by one group with one observation report result. The depiction of material via LCD projector with the use of PPT (Power Point) that is not appropriate, such as the size of the writing is too small, the selection of the basic color of the writing, the size of the image makes it difficult for students to stimulate the vision of objects is also supported by sufficient lighting in the study room (Nieuwenhuysen, 2000). In addition, the long distance with the vision and height of the students who sit do not adjust to the order of the table, resulting in excessive eye accommodation to see objects near or far for a long period of time (Biswas et al., 2024).

However, on the contrary, for student learning with a guided inquiry learning model with a participatory ergonomics approach, there is a decrease in eye fatigue. This indicates that there is a response to reducing the use of LCD projector screens in learning. Learning is formed by dividing the table into several discussion areas so that the shape of the table is formed according to the group that is divided. In this learning, students use LKPD by printing and reducing the opening of LKPD on their cellphones (Nurkhasanah & Rohaeti, 2024; Hendrawan et al., 2019). In learning using a participatory ergonomics approach, the position of the table with the screen for introducing material or the board used for learning direction is arranged and adjusted in groups. The influence of using LKPD which is used in personal/individual form and printed makes it easier for students to read and research properly what is sought from learning problems and is completed in groups (Clair-Thompson et al., 2018). The implementation of learning with the inquiry learning model with a participatory ergonomics approach and a scientific approach shows a visible difference in the paired t-test presented in Table 3 with a significance value before and after learning of 0.0001 which states that both learning approaches have a significant different effect on student boredom (Xie, 2021; Imsa-ard, 2024; Citrawathi et al., 2020).

In addition, there is a difference in the average boredom score from the scientific approach, which increased before and after by 12.61%, while for the learning approach with participatory ergonomics before and after learning, it decreased by 8.98%. This shows that the guided inquiry learning model with a participatory ergonomics approach is better than using the scientific approach (5M) (Sulistyani et al., 2022). The scientific approach (5M) requires students to pay attention first to the teacher's presentation on the LCD projector screen, the dominance of finding solutions to problems with groups without going through other activities and of course there is a dominance of working in groups of one or two people causing boredom due to monotonous activities (Tempelaar & Niculescu, 2022). The decrease in boredom in the participatory ergonomics approach is caused by several learning activities or activities carried out in groups (Kruk & Zawodniak, 2020; Liu et al., 2022), but still carrying out learning tasks independently through practicums that are made differently (Kristina et al., 2021; Dishon-Berkovits et al., 2024; Camerini et al., 2023). This aims to ensure that each student can focus and work together in solving problems and reduce the occurrence of monotonous activities so as to prevent fatigue and boredom.

Demonstrations carried out by some types of students regarding what is being learned and done will optimize motivation for the expected results and the tasks given can be made by choosing the appropriateness of filling out the LKPD with the understanding obtained through friends in the group with the aim of completing the independent tasks (Sutajaya et al., 2020). If learning is adjusted to comfort and freely for activities, it will be influenced by his psychological state. his psychological state tries to achieve a goal but is not realistic with his characteristics will result in students running out of energy, time and losing motivation to achieve these goals until boredom occurs (Griadhi et al., 2018; Sutajaya et al., 2020; Mustika et al., 2016). Based on the data analysis that has been done, the learning outcomes in Table 4 for students with a scientific approach (5M) have an average before learning of 26.46 and after learning of 60.41, so there is an increase of 56.19%. While for students with a participatory ergonomics approach before learning, it is 27.38 and after learning of 76.10, so there is an increase of 64.03%. This indicates that the guided inquiry learning model with a participatory ergonomics approach model is better than the scientific approach (5M). The application of a participatory ergonomics approach to these learning outcomes involves students as a whole (Sormunen et al., 2022; Avsec & Jagiełło-Kowalczyk, 2021; Davies et al., 2023). Individual student involvement can increase student activity in learning with decreased eye fatigue and boredom in learning can support more comfortable, concentrated and relaxed learning activities.

In learning using this approach, it provides a learning atmosphere with the achievement of students' thinking power and absorption of memory is achieved optimally so that complete and meaningful knowledge in dealing with problems that arise. Participatory ergonomics learning changes students' habits which are generally passive and monotonous to become active, passive and dynamic and able to express learning findings well (Moslander & Jacobs, 2022; Chellappa, 2025; Syafar et al., 2024).

Conclusion

From the research results obtained that it was concluded that there were differences in the influence of participatory ergonomics synergy with guided inquiry learning models with conventional learning on junior high school students' boredom with an F value of 67.146 with a significance of 0.000 smaller than 0.05 ($p < 0.05$) at a significance level of 5%. There were differences in the influence of participatory ergonomics synergy with guided inquiry learning models with conventional learning on junior high school students' boredom with an F value of 183.463 with a significance of 0.000 smaller than 0.05 ($p < 0.05$) at a significance level of 5%. The learning outcomes using the participatory ergonomics synergy learning approach with guided inquiry learning models with conventional learning were different and the results were better using participatory ergonomics synergy than conventional. It is also known that among the research variables there are differences in boredom, fatigue and science learning outcomes of students who are taught using a participatory ergonomics approach with a guided inquiry model with conventional learning for junior high school students.

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