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The effect of science process skills of students argumentation skills

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Abstract: This study aims to compare students' learning skills in each class and students' argumentative abilities in each class and to determine the effect of students' science process skills on students' argumentation abilities. This type of research uses the mixed method with an explanatory design. The samples of this study were 70 students of class 11 science, with the sampling technique of simple random sampling. The results of data analysis using parametric statistics t-test (2-tailed) obtained sig value 0.034 < 0.05, so it can be said that the students' argumentative abilities in XI A and IPA B are different, and for the variable science process skills, the sig. is 0.043 < 0.05 so that each class's science process skills are different. The results of the regression test obtained the results of the sig value of 0.025 in class XI A and class XI B obtained a sig value 0.030, where the value of sig < 0.05 which means that science process skills affect the students' argumentation skills. The study confimr that the improvement of scientifict skills will make student better in conveying arguments.

Keywords: Crocodile Physics, Golabz, RLC series circuit, virtual laboratory.

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INTRODUCTION

Knowledge and skills and increasing self-capacity can be obtained at the education level. Education is essential in forming quality human beings through science education to achieve scientific literacy for all students (Kuehn et al., 2019; Reinsini et al., 2021; Utaminingsih et al., 2018). The purpose of education is to form humans with knowledge and skills so that it becomes one of the priorities in development in the era of globalisation. A teacher must have various competencies and professional skills (Hayati et al., 2019; Pahlevi et al., 2018; Taofiq et al., 2018; Zuhara et al., 2019). Education consists of several components that are integrated to form a system which is a learning process for each student to develop the abilities that exist in him so that he can make humans understand, understand, behave well, and be more mature (Aulia et al., 2019; Berlyana & Purwaningsih, 2019; Wati & Anggraini, 2019; Yilmaz & Ayaz, 2021). One of the lessons at the educational level that is important to learn is physics learning.

Physics learning begins to be studied at the junior high school level but is only external and leads to physics at the high school level. All levels of education, including universities, need to apply innovative learning to develop the quality of learning physics, a critical science related to matter and energy (Abidin et al., 2019; Fidan & Tuncel, 2021; Widyaningsih & Yusuf, 2020). The concepts and principles of physics are used for various daily activities such as transportation technology, communication, energy production, exploration, and space exploration, where the teacher has delivered the material and also the practice, which is carried out in the laboratory (Astalini et al., 2019; Fidan & Tuncel, 2021; Sari et al., 2019). The number of physics questions concerning mechanics, heat, light, optics, electricity, magnetism, radiation, elasticity, etc. that need to be solved directly or offline is an obstacle that makes students more difficult in solving physics problems (Abtokhi et al., 2021; Demirci & Akcaalan, 2020; Khandagle, V & Chavan, 2017). For this reason, the teacher as a facilitator in providing and conveying knowledge must be maximal.

Students' understanding of physics learning material can be seen from how students can argue in the learning process following the 2013 curriculum, which focuses on students being able to think at a higher level. Argumentation skills play an essential role for students were supporting students to be able to carefully consider information and reasons about situations is very important to prepare students to be able to effectively make decisions about problems in society (Noroozi et al., 2020; Öztürk & Doğanay, 2019; Songsil et al., 2019). Written argumentation is a complex skill to master, and in practice, the use of reason and logic is required to establish truth claims (Akbaş, 2021; Phongphio, 2021; Rodriguez-Hernandez & Silva-Maceda, 2021). In presenting arguments, students must be able to state based on criteria and aspects of scientific argumentation skills such as data evidence, support, and justification of claims (Alindra et al., 2020; Jumadi et al., 2021; Ping et al., 2020). Students' scientific process skills must be able to present arguments appropriately.

Students' science process skills in physics subjects can be obtained through laboratory practicum. Science process skills are essential in science learning as the most powerful tool to be applied in acquiring knowledge about the world and organising scientific knowledge (Ozkan & Umdu Topsakal, 2021; Puspita, 2019; Sideri & Skoumios, 2021). Science process skills are an essential component of cognitive skills; namely, the mastery of science process skills by students can make it easier for students to understand abstract concepts if they learn through concrete objects and are carried out by students themselves through direct learning experiences (Irwanto et al., 2019; Kurniawan et al., 2019; Zainuddin et al., 2020). Thus, science process skills become the principal capital for students in studying science which can support the mastery of science concepts (Duda et al., 2019; Molefe & Aubin, 2021; Şahintepe et al., 2020). As explained, science process skills are indispensable in advancing science and everyday life.

The current research is in line with previous research, which examines students' process skills in science learning with the research findings, namely providing information about some of the advantages and disadvantages of science textbooks that teachers can use in planning to teach (Sideri & Skoumios, 2021). In line with current research, previous research is on students' science process skills, with the findings that science process skills have a positive and significant correlation with creativity (Zainuddin et al., 2020). Previous and current research differ in the variables associated with students' science process skills. Namely, the current research examines students' argumentation skills as measured by students' science process skills in Physics subjects with elasticity and Hooke's law.

In line with previous research by Riwayani et al. (2019) know that in physics, the students' argumentative ability is still relatively low. Another research by Rahman et al. (2018) found that students' scientific argumentation skills are still relatively low. The average quality of students' scientific arguments is at levels 1 (unsupported) and 2 (phenomenological). He also said that scientific argumentation ability is crucial in preparing scientifically literate students. So, in line with previous research, this research was conducted.

This study was in line with research by Ping (2020), which provides significant improvement in argumentation and science process skills of biology who experience the MADI approach in practical biology. The subsequent research that is in line with the current research is carried out by Perdana et al. (2020). The difference is that previous studies researched biology subjects, so this study was conducted to measure the effect of students' science process skills on students' argumentation skills in physics subjects with elasticity and Hooke's law.

The importance of this research is that it is known that the current educational curriculum requires students to have skills and high-level thinking, one of which is science process skills and students' ability to argue as an effort to face the increasingly advanced era of globalisation. So science process skills and the ability to argue are essential to research. The purpose of this research is to determine the science process skills and argumentation ability of high school students in class XI in physics with elasticity and Hooke's law material, to know the difference between the argumentation ability and science process skills of students, and to know the effect of science process skills on students' argumentation ability. In classes XI A and XI B. The problem statements in this study are as follows:

1. How are the science process skills and argumentation skills of high school students in elasticity and Hooke's law?
2. Are there differences in senior high school students' argumentation and science process skills?
3. Do science process skills influence the argumentation ability of senior high school students?

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METHODS

This type of research uses Mixed Methods with an explanatory sequential research design. A mixed-method research method combines quantitative and qualitative research methods (Hermawan, 2019). Sequential explanatory design and qualitative and quantitative data collection were carried out in two stages, with the main emphasis on quantitative methods assisted by qualitative methods (Fibrianti, 2021; Jalinus et al., 2021).

The population in this study were students of class XI science at one of the Senior High schools in Jambi City. The sample of this research was classified into two classes, XI A and XI B, with a total sample of 70 students. Sampling using a simple random sampling technique. The simple random sampling technique is characterised by each element from the entire population having an equal chance of being selected, and by using this technique, the sample members are easily and quickly obtained (Sugeng, 2022; Usman & Akbar, 2022).

This study used research instruments in the form of essay questions on elasticity and Hooke's law with eight essay questions. This question measures students' argumentation skills using a four-Likert scale. Then to measure the students' scientific process ability, an instrument in the form of an observation sheet on physics, elasticity and Hooke's law subjects was assessed by four observers in each class using a four Likert scale. The scale consists of 4 points (4 for Excellent, 3 for Good, 2 for Fair, and 1 for Very Bad). The results obtained from the essay questions and observation sheets are reinforced by interviews with teachers who teach these subjects. The indicators of students' abilities in this study are provided in Table 1.

Table 1. Indicators of students' argumentation ability

Variable		Indicator	Question Items Number
Students' argumentation ability		Claim	A1, A2
		Data	A3, A4
		Warrants	A5, A6
		Backing	A7, A8
Science Process Skills	Basic	Observation	P1, P2, P3, P4, P5
		Communication	P8, P9, P10, P11, P12
		Measure	P13, P14, P15, P16
	Integrated	Creating Data Tables	P33, P34, P35, P36
		Doing Experiments	P28, P29, P30

Moreover, the category of students' argumentation is provided in Table 2.

Table 2. Categories of students' argumentation ability

Category	Interval
	Students' argumentation ability
Poor	8 – 14
Fair	15 – 20
Good	21 – 26
Excellent	27 – 32

In addition, the category of observation sheets for students' science processes is provided in Table 3.

Table 3. Category descriptions of students' science process skills

Category	Indicator				
	Basic			Integrated	
	Observation	Communication	Measuring	Creating Data Tables	Doing Experiments
Poor	5.0 – 8.75	5.0 – 8.75	4 – 7	4 – 7	3.0 – 5.25
Fair	8.76 – 12.5	8.76 – 12.5	8 – 10	8 – 10	5.26 – 7.5
Good	12.6 – 16.25	12.6 – 16.25	11 – 13	11 – 13	7.6 – 9.75
Excellent	16.26 – 20.0	16.26 – 20.0	14 – 16	14 – 16	9.76 – 12.0

The data was obtained in the form of quantitative and qualitative data. Where quantitative data were obtained from observation sheets for students' science process skills and essay questions on

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students' argumentative abilities, which were strengthened by the results of interviews with teachers in charge of physics subjects at the schools studied. Quantitative data analysis uses statistics, namely descriptive statistics and parametric inferential statistics. Quantitative data was analysed using descriptive statistical analysis and parametric inferential. Descriptive analysis is presented in tables of frequency, percentage, mean, median, min and max and for descriptive parametric inferential in the form of t-test and regression test. Before the parametric test is carried out, the data must meet the assumption test requirements; namely, the data is typically distributed and linear. Then the normality test is carried out with the provisions of the sig value. > 0.05 means that the data is usually distributed, and for the linearity test, the condition is that the value of Sig. < 0.05 means that the data is linear. A t-test was carried out to determine the effect of a variable on other variables using a parametric regression test, which is the basis for making decisions if the value of Sig. < 0.05, then it has an effect. For qualitative data analysis, the Miles and Huberman model was used, where the analysis process consists of three stages: data reduction, data display, and drawing conclusions and verification (Helmis, 2020).

The research begins with school licensing to conduct research after obtaining permission; research can be carried out and questionnaires and interviews with teachers. After the data is obtained and collected, data analysis is carried out to obtain results and draw conclusions. The procedure in this study follows the diagram in Figure 1.

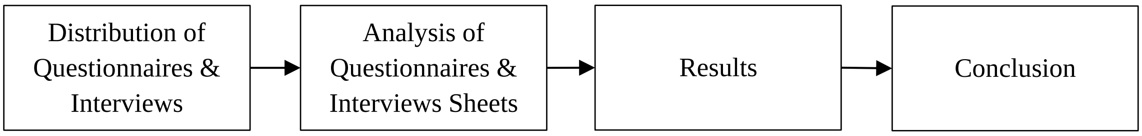

Figure 1. Research procedure

RESULTS AND DISCUSSION

The results of the data analysis that have been obtained are processed using statistical sciences. The first data processing analysis is descriptive statistics. The results of descriptive statistics for each indicator of students' science process skills and students' argumentative ability variables in physics subjects with elasticity and Hooke's law are presented and can be seen in Table 4.

Table 4. Students' argumentative abilities

Class	Category	Interval	F	%	Mean	Med	Min	Max
XI A	Poor	8 – 14	0	0.00	22.2	23.0	15.0	29.0
	Fair	15 – 20	10	27.8				
	Good	21 – 26	23	66.7				
	Excellent	27 – 32	2	5.60				
XI B	Poor	8 – 14	0	0.00	24.0	24.0	20.0	29.0
	Fair	15 – 20	3	8.60				
	Good	21 – 26	25	71.4				
	Excellent	27 – 32	7	20.0				

Based on Table 4, it is known that the argumentation ability of students in class XI A is dominant in the good category with a percentage of 66.7% and an average value of 22.2. Class XI B is more dominant in the good category with a percentage of 71.4% with an average value of 24.0, so the argumentation ability of students in class XI B is more significant than XI B. Furthermore, a descriptive statistic of students' science process skills on observation indicators in elasticity and Hooke's law material is provided in Table 5.

Table 5. Students' science process skills on observation indicators

Class	Category	Interval	F	%	Mean	Med	Min	Max
XI A	Poor	5.0 – 8.75	0	0.00	14.9	15.0	10.0	20.0
	Fair	8.76 – 12.5	3	8.30				
	Good	12.6 – 16.25	24	66.70				
	Excellent	16.26 – 20.0	8	22.20				

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Class	Category	Interval	F	%	Mean	Med	Min	Max
XI B	Poor	5.0 – 8.75	0	0.00	15.17	15.0	10.0	19.0
	Fair	8.76 – 12.5	9	25.70				
	Good	12.6 – 16.25	18	51.40				
	Excellent	16.26 – 20.0	8	22.90				

Based on Table 5, it is known that the science process skills of students on the observation indicators in class XI A are dominant in the good category with a percentage of 66.7% as well as in class XI B are dominant in the good category with a percentage of 51.4% with the percentage of students in the poor category being 25.7%. So class XI A is superior. Furthermore, a descriptive statistical description of students' science process skills on communication indicators is seen in Table 6.

Table 7. Students' science process skills on communication indicators

Class	Category	Interval	F	%	Mean	Med	Min	Max
XI A	Poor	5.0 – 8.75	0	0.00	14.3	14.0	11.0	18.0
	Fair	8.76 – 12.5	9	25.70				
	Good	12.6 – 16.25	18	51.40				
	Excellent	16.26 – 20.0	8	22.90				
XI B	Poor	5.0 – 8.75	0	0.00	14.5	15.0	11.0	18.0
	Fair	8.76 – 12.5	7	20.00				
	Good	12.6 – 16.25	22	62.90				
	Excellent	16.26 – 20.0	6	17.10				

Table 6 shows that the students' science process skills on the communication indicators in class XI A are dominant in the good category with a percentage of 51.4%, with the percentage of students in the wrong category being 25.7%. Then in class XI B is dominant in the good category with 62.9%. So class XI B is superior. Furthermore, a descriptive statistical description of students' science process skills in measuring indicators is provided in Table 7.

Table 7. Students' science process skills on the indicators of Measuring

Class	Category	Interval	F	%	Mean	Med	Min	Max
XI A	Poor	4 – 7	0	0.00	11.7	12.0	8.0	16.0
	Fair	8 – 10	7	20.00				
	Good	11 – 13	22	62.90				
	Excellent	14 – 16	6	17.10				
XI B	Poor	4 – 7	1	3.90	11.3	11.0	7.0	15.0
	Fair	8 – 10	10	28.60				
	Good	11 – 13	21	60.00				
	Excellent	14 – 16	3	8.60				

Table 7 shows that the students' science process skills in measuring indicators in class XI A are dominant in the good category with a percentage of 62.9%. Then in class XI B is dominant in the good category with a percentage of 60.0%, and the percentage of students in the poor category is 28.6%. So class XI A is superior. Furthermore, a descriptive statistical description of students' science process skills on the indicators of making data tables is provided in Table 8.

Table 8. Students' science process skills on the indicator Creating Data Tables

Class	Category	Interval	F	%	Mean	Med	Min	Max
XI A	Poor	4 – 7	1	2.90	11.3	11.0	7.0	15.0
	Fair	8 – 10	10	28.00				
	Good	11 – 13	21	60.00				
	Excellent	14 – 16	3	8.60				
XI B	Poor	4 – 7	0	0.00	11.2	11.0	8.0	14..0
	Fair	8 – 10	10	28.60				
	Good	11 – 13	24	68.60				
	Excellent	14 – 16	1	2.90				

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Table 8 shows that the students' science process skills on the indicators of making data tables in class XI A are dominant in the good category with a percentage of 62.9%. Then in class XI B is dominant in the good category with a percentage of 60.0% and the percentage of students in the bad category 28.6%. So class XI A is superior. Furthermore, a descriptive statistical description of students' science process skills on indicators for conducting experiments is provided in Table 9.

Table 9. Students' science process skills on indicators of conducting experiments

Class	Category	Interval	F	%	Mean	Med	Min	Max
XI A	Poor	3.0 – 5.25	1	2.90	8.3	8.0	5.0	12.0
	Fair	5.26 – 7.5	12	34.40				
	Good	7.6 – 9.75	15	42.90				
	Excellent	9.76 – 12.0	7	20.00				
XI B	Poor	3.0 – 5.25	0	0.00	8.4	8.0	6.0	12.0
	Fair	5.26 – 7.5	10	28.60				
	Good	7.6 – 9.75	18	51.40				
	Excellent	9.76 – 12.0	7	20.00				

Table 9 shows that students' science process skills on the indicators of conducting experiments in class XI A are dominant in the good category with a percentage of 42.9%, and the percentage of students in the bad category is 34.4%. Then in class XI B, dominant in the good category with a percentage of 51.4%. So class XI B is superior.

The analysis of the assumption test data consists of normality test, homogeneity test and linearity of argumentation ability and science process skills. The requirements of parametric statistical tests in the form of t-test and regression tests were fulfilled, as seen in Table 10.

Table 10. Normality test

Variable	Class	Sig.	Distribute
Argumentation skills	XI A	0.200	Normal
	XI B	0.178	Normal
Science process skills	XI A	0.200	Normal
	XI B	0.200	Normal

Based on Table 10 above, the Kolmogorov-Smirnov test obtained the normality test with a significance value > 0.05. It can be concluded that the data is normally distributed—the results of the homogeneity test as seen in Table 11.

Table 11. Homogeneity test

Variable	Class	Sig.	Distribute
Argumentation Ability	XI A	0.320	Homogenous
	XI B	0.228	Homogenous
Science process skills	XI A	0.250	Homogenous
	XI B	0.240	Homogenous

Based on Table 11, the homogeneity test results are obtained, namely the significance value > 0.05. It can be concluded that the data used in this study is homogeneous. Then, Table 12 shows the linearity test analysis of students' argumentative abilities and science process skills.

Table 12. The linearity tests

Variable	Class	Sig.	Distribute
Argumentation Ability	XI A	.033	Linear
	XI B	.022	Linear
Science Process Skills	XI A	.020	Linear
	XI B	.025	Linear

Based on the Table 12 linearity test, it is known that the Deviation from the linearity value of Sig. < 0.05, it can be obtained that the variable data of ability to argue and science process skills in each data class are linear. Thus, the data obtained meet the normally distributed, homogeneous and linear

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requirements. Then it can be continued to test the hypothesis in the form of a t-test and regression test. The results of the t-test of the argumentation ability and science process skills are provided in Table 13.

Table 13. the t-test of students' argumentative abilities and science process skills

Class	Variabel	Sig. (2-tailed)
XI A XI B	argumentation ability	0.034
XI A XI B	Science process skills	0.043

Based on the description in table 14, the results of the t-test of students' argumentative abilities and science process skills in class XI A and XI B material on elasticity and Hooke's law obtained the value of Sig. (2-tailed) < 0.05 so that it can be said that the argumentation ability of students in XI B and IPA 1 is different, and for the variable science process skills, students get a sig. value. (2-tailed) < 0.05 so that students' science process skills in each class are different. Furthermore, a regression test between the argumentation ability and science process skills of students is provided in Table 14.

Table 14. Regression test of students' argumentative abilities and science process skills

Variable	Class	Sig.
Science Process Skills* Students' Argumentation Skills	XI A	.025
	XI B	.030

Based on table 14, it can be seen that the value of Sig. < 0.05 so that students' science process skills affect the ability to argue in classes XI A and XI B on elasticity and Hooke's law.

The results of interviews with teachers revealed that schools have adequate laboratories to carry out practical activities. Based on interviews conducted with teachers, students were enthusiastic when doing practicum, but only for some students. One of the teachers in physics in class XI IPA also said that the existence of experimental or practicum activities could increase students' science process skills such as observing, measuring, analysing, making hypotheses etc. Then as for the results of interviews with students, it is known that they do practicums at school only on specific materials, and before doing practicums, the tutor teacher gives directions first to minimise errors. According to one student in class XI IPA SMAN 11 Jambi City, he thought that doing practicum made it easier for him to understand and convey the concepts and principles he was learning and could increase his skills in doing science activities.

Furthermore, students also assume that with the practicum, they can argue with the data and evidence obtained. Moreover, by having these skills, students can obtain data and evidence to strengthen the arguments they convey during the learning process. Students' argumentation skills are needed to make learning activities more active. The teacher, as a facilitator in the running of learning activities in the classroom, provides direction before the practicum. Facilities and infrastructure such as laboratories and experiment tools are needed.

This research is in line with previous research examining students' science process skills which found that the blended learning strategy is more significant in improving science process skills than conventional learning strategies (Harahap et al., 2019). The difference is in previous studies examining students' science process skills in biology subjects. So that in the current study, an update was carried out that examined students' science process skills in physics subjects with elasticity and Hooke's law learning materials.

This research is also in line with previous research on scientific process skills. The findings show that applying science process skills-based learning improves the critical thinking skills of junior high school students (Pradana et al., 2020). The difference between previous and current research is that previous research measured the influence of science process skills on critical thinking skills. While in this study, an update from previous research measures the influence of students' science process skills on students' argumentation abilities. With the results of data analysis, it is stated that students' science process skills affect students ability to argue.

Previous research is in line with current research, which discusses the ability to argue, namely with the aim of research to determine the level of scientific argumentation ability in chemistry subjects

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for grade 11 students, especially in logical thinking. In addition, there is a statistically significant difference ($p < 0.05$) in the scientific argumentation skill level due to gender in favour of female students (Al-Ajmi & Ambusaidi, 2019). The difference in the current research is measuring the argumentation ability of 11th-grade students on Hooke's law material in physics. The study's results, namely the ability to argue, can be influenced by the science process skills possessed by students. Furthermore, each class has a different ability to argue.

The current research is in line with previous research, which examined the science process skills of high school students with the research results. The results were the percentage of science process skills of high school students in Bukit Kecil and Ilir Barat I Palembang sub-districts. The results of the percentage of science process skills of high school students in Bukit Kecil Subdistrict, Palembang are indicators of observing with a percentage of 68.18%, grouping 66.29%, interpreting 61.74%, predicting 73.48%, formulating a hypothesis of 42.04%, planning an experiment 43.94%, and communicating 51.89%. The results of the percentage of science process skills for high school students in Ilir Barat I Palembang are observing indicators with a percentage of 75.98%, grouping 77.21%, interpreting 62.43%, predicting 75.43%, formulating hypotheses 49.31%, planning experiments 53,72%, and communicating 49.03% (Elvanisi et al., 2018). The difference in this previous study was only up to the comparison test and had not connected science process skills with other variables. So the researcher updated and generalised from previous research by measuring the effect of science process skills on students' argumentation ability in grade 11 physics subject matter of elasticity and Hooke's law.

The meaning of this research for scientific development is as a future reference for teachers in carrying out their duties and obligations in teaching so that they can be a reference in taking further action on a problem faced by students. The novelty of this research is that the variables analysed are analysed by regression and T-test of students' science process skills on students' argumentation abilities in physics subjects, elasticity and Hooke's law. It is hoped that students' science process skills can be further honed so that they can have a positive impact on students' argumentation skills. The limitations of this study are that it only examines five indicators of students' science process skills consisting of 3 fundamental and two integrated indicators. Recommendations for further research are that further research can be carried out by measuring the ability to argue on other subjects. Moreover, it can provide generalisations in further research.

CONCLUSION

Students' argumentation ability and science process skills in each class are different. Furthermore, students' science process skills influence students' argumentation skills, where students can provide reinforcement based on existing data and evidence. With better students' science process skills, students will be more reliable in presenting the data and facts found. Recommendations for further research are that further research can be carried out by measuring the ability to argue on other subjects. Moreover, it can provide generalisations in further research.

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