PERIÓDICO TCHÊ QUÍMICA
ARTIGO ORIGINAL

O EFEITO DA IMPLEMENTAÇÃO DA AUTOAVALIAÇÃO NOS PROCESSOS CIENTÍFICOS NAS ATITUDES CIENTÍFICAS E OS RESULTADOS DA APRENDIZAGEM DE FÍSICA, CONTROLANDO O CONHECIMENTO INICIAL

THE EFFECT OF THE IMPLEMENTATION OF SELF ASSESSMENT WITH SCIENCE PROCESSES ON SCIENTIFIC ATTITUDES AND PHYSICS LEARNING OUTCOMES BY CONTROLLING INITIAL KNOWLEDGE

PENGARUH IMPLEMENTASI ASESMEN DIRI BERMUATAN PROSES SAINS TERHADAP SIKAP ILMIAH DAN HASIL BELAJAR FISIKA DENGAN MENGONTROL PENGETAHUAN AWAL

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RESUMO

Introdução: Diversos estudos demonstram que a autoavaliação contendo processos científicos aplicados na aprendizagem de física afetará a atitude científica e os resultados de aprendizagem de física dos alunos. Verificou-se também que o conhecimento inicial também contribui para determinar o nível de atitudes científicas e os resultados de aprendizagem de física dos alunos. No entanto, o conhecimento inicial precisa ser controlado para que o efeito puro da autoavaliação no aprendizado da física nas atitudes científicas e nos resultados do aprendizado da física seja conhecido. **Objetivos:** Este estudo examinou o efeito da implementação da autoavaliação com processos científicos sobre as atitudes científicas e os resultados da aprendizagem de física, controlando o conhecimento inicial. **Metodos:** Esta pesquisa foi conduzida com uma abordagem quase experimental para 143 alunos do primeiro ano do ensino médio com especialização em ciências na cidade de Singaraja (Indonésia) utilizando um projeto de grupo independente de fator único com o uso de covariável. A amostra da pesquisa foi escolhida por meio da técnica de amostragem aleatória em múltiplos estágios. Os instrumentos utilizados foram um questionário de atitude científica, o teste de conhecimento inicial e o teste de resultado do aprendizado de física. Os dados foram processados por meio de análise de covariância multivariada. **Resultados e Discussões:** Os resultados mostraram que houveram diferenças nas atitudes científicas e nos resultados de aprendizagem dos alunos que realizaram o aprendizado de física com a autoavaliação contendo o processo de ciências e dos alunos que realizaram o aprendizado da física com a avaliação convencional após controlar seus conhecimentos iniciais, de forma independente ou simultaneamente. O conhecimento prévio dos alunos contribuiu para as atitudes científicas em 22,8% e para os resultados do aprendizado de física em 19,4%. **Conclusões:** concluíu-se que a autoavaliação contendo processos científicos na aprendizagem de física afetou as atitudes científicas e os resultados da aprendizagem ao controlar o conhecimento inicial.

Palavras-chave: *autoavaliação, processo científico, atitude científica, resultados de aprendizagem de física, conhecimento inicial.*

ABSTRACT

Background: Various studies show that self-assessment containing scientific processes applied in physics learning will affect the scientific attitude and the physics learning outcomes of the students. It is also found that Initial knowledge also contributes to determining the level of scientific attitudes and the physics learning outcomes of physics. However, initial knowledge needs to be controlled so that the pure effect of self-assessment in learning physics on scientific attitudes and learning outcomes of physics is known. **Aim:** This study examines the effect of the implementation of self-assessment with science processes on scientific attitudes and physics learning outcomes by controlling initial knowledge. **Methods:** This research was conducted with a quasi-experimental approach to 143 1st grade high school students majoring in science in Singaraja City using a single factor independent group design with the use of covariate. The sample of the research was chosen by using a multistage random sampling technique. The instruments used were the scientific attitude questionnaire, the initial knowledge test, and the physics learning outcome test. The data were processed using multivariate covariance analysis. **Results and Discussion:** The results showed that there were differences in scientific attitudes and learning outcomes of students who took physics learning with self-assessment containing the science process and students who took physics learning with the conventional assessment after controlling their initial knowledge, either independently or simultaneously. The prior knowledge of the students contributed to scientific attitudes by 22.8%, and to physics learning outcomes by 19.4%. **Conclusions:** it can be concluded that self-assessment containing scientific processes in physics learning affected scientific attitudes and learning outcomes by controlling initial knowledge.

Keywords: *self-assessment, science process, scientific attitude, learning outcomes of physics, initial knowledge*

ABSTRAK

Latar Belakang: Berbagai penelitian menunjukkan bahwa penilaian diri yang mengandung proses ilmiah yang diterapkan dalam pembelajaran fisika akan mempengaruhi sikap ilmiah dan hasil belajar fisika siswa. Ditemukan juga bahwa pengetahuan awal juga berkontribusi untuk menentukan tingkat sikap ilmiah dan hasil belajar fisika siswa. Namun, pengetahuan awal perlu dikontrol sehingga efek murni penilaian diri dalam belajar fisika pada sikap ilmiah dan hasil belajar fisika dapat diketahui. **Tujuan:** Penelitian ini meneliti efek dari pelaksanaan penilaian diri dengan proses sains pada sikap ilmiah dan hasil pembelajaran fisika dengan mengendalikan pengetahuan awal. **Metode:** Penelitian ini dilakukan dengan pendekatan kuasi-eksperimental kepada 143 siswa SMA kelas 1 jurusan SAINS di Kota Singaraja dengan menggunakan satu faktor desain kelompok mandiri dengan penggunaan kovaat. Sampel penelitian dipilih dengan menggunakan teknik multistage random sampling. Instrumen yang digunakan adalah kuesioner sikap ilmiah, tes pengetahuan awal, dan tes hasil belajar fisika. Data diproses menggunakan analisis kovarians multivariat. **Hasil dan Diskusi:** Hasil penelitian menunjukkan bahwa ada perbedaan sikap ilmiah dan hasil belajar siswa yang mengambil pembelajaran fisika dengan penilaian diri yang berisi proses sains dan siswa yang mengambil pembelajaran fisika dengan penilaian konvensional setelah mengendalikan pengetahuan awal mereka, baik secara mandiri atau bersamaan. Pengetahuan siswa sebelumnya berkontribusi pada sikap ilmiah sebesar 22,8%, dan hasil pembelajaran fisika sebesar 19,4%. **Kesimpulan:** Dapat disimpulkan bahwa penilaian diri yang mengandung proses ilmiah dalam pembelajaran fisika mempengaruhi sikap ilmiah dan hasil belajar dengan mengendalikan pengetahuan awal.

Kata kunci: *asesmen diri, proses sains, sikap ilmiah, hasil belajar fisika, pengetahuan awal*

1. INTRODUCTION:

1.1 Background

The biggest challenge in the era of industrial revolution 4.0 is accelerating technological changes that affect every life aspect. In the 21st century, the industrial revolution with massive changes in various fields eliminates the boundaries between the physical, digital, and biological worlds (Gandasari *et al*., 2020).

It takes strategic maturity as well as mental strength to be able to compete in global competition. In this case, education needs to make breakthroughs in various innovations to create a smart, qualified, and competitive generation (Wan et al., 2020). The national education system faces very complex challenges in preparing human resources to compete in the era of globalization (Malik, 2019).

To prepare human resources who can compete in globalization, a quality education system is needed. Quality education functions to develop capabilities and shape the character and civilization of a nation with dignity in order to educate the people's life, develop the potential of students to become human beings who believe and fear the Almighty God, have a noble character, are healthy, knowledgeable, capable, creative, independent and become a democratic and responsible citizen.

The low quality of Indonesia's human resources in global competition is a challenge in education. Students must be able to achieve various competencies with the application of Higher Order Thinking Skills or HOTS (Pratama and Retnawati, 2018).

These competencies include critical thinking, creative and innovative thinking, communication skills, collaboration skills, and confidence. These five factors are the character targets attached to the evaluation system and are part of the skills of the 21st century (Suarni, 2019).

The results of the Trends in International Mathematics and Science Study (TIMSS), the Program for International Student Assessment (PISA), the results of the National Physics Examination of Buleleng Regency High School students for the 2018/2019 academic year, findings of the low level of student science process skills and findings related to research on the scientific attitudes of the students show that there are problems with science process skills, physics learning outcomes and student scientific attitudes. The factors that determine learning outcomes, process skills, and scientific attitudes include teachers, learning, assessment, students, and the environment. (Jain and Prasad, 2018). These factors must always be considered in achieving learning objectives. The most dominant factors affecting learning outcomes and scientific attitudes are learning and assessment factors.

The concerns of education experts, supported by the results of the two international studies above, should be used as a basis for reorienting the learning process (Gürses *et al*., 2015). Many factors cause the low ability of our students. One of the contributing factors is that students are generally less trained to work on real life problems. This situation is not in line with the characteristics of TIMSS and PISA questions, whose substance is contextual, which demands reasoning, argumentation, and creativity in solving them (Muszyński, 2020).

In the learning process, students are also required to have direct experience to develop their skills. By using process skills in learning, there will be interactions between the concepts/principles/theories that have been found (Kurniawati, 2019). With these interactions, the attitudes and values required for scientific discovery will emerge. These values include: conscientious, creative, diligent, tolerant, responsible, critical, objective, diligent, honest, open, and disciplined (Mulyeni et al., 2019).

Direct experiences as learning experiences can be used to develop science process skills (Zeitoun and Hajo, 2015). Through direct experience, one can become more deeply involved in the process. One of the other dominant factors considered to influence scientific attitudes and physics learning outcomes is the assessment used by the teacher in assessing the process and learning outcomes of physics learning. In the learning cycle, assessment is one of the stages whose role is very important and cannot be ignored.

The assessment model that is suitable for learning with a scientific approach is an authentic assessment. It is strongly relevant to scientific approach as this type of assessment can depict an increase in the learning outcomes of the students, either in the context of observing, reasoning, experimenting, building networks, or others (Sabri *et al*., 2019).

Authentic assessments tend to focus on complex or contextual tasks, enabling students to demonstrate their competencies, including attitudes, knowledge, and skills. Educators can use the authentic assessment results to plan programs for improvement, enrichment, or counseling services (Taufina and Chandra, 2018). Also, authentic assessment results can be used as materials to improve the learning process that meets educational assessment standards.

One of the authentic assessments that fit the constructivism paradigm is self-assessment (Ratminingsih et al., 2018). Self-assessment is an assessment technique in which students are asked to assess themselves concerning the process and level of achievement of their learning (Kunandar, 2015). Self-assessment is an assessment carried out by students in assessing activities or work carried out by themselves. The role of assessment in learning is basically to identify the gaps between the achievements achieved and the expected achievements and provide opportunities for students to overcome these gaps (Wride, 2017).

The use of assessment is not just knowing the achievement of learning outcomes, what is more, important is how the assessment can improve the ability of students in the learning process. Assessment is carried out through three approaches, (1) assessment of learning, (2) assessment for learning, and (3) assessment as learning (Hidayati, 2017).

Self-assessment as an assessment as learning functions as a formative assessment during the learning process (Sadeghi and Rahmati, 2017). In its implementation, self-assessment involves students actively in these assessment activities. Assessment as learning is an assessment process carried out by educators that allow students to see their learning achievements and progress to determine learning targets (Earl and Katz, 2006).

Self-assessment containing scientific processes is very urgent to be applied. This is in order to transform the assessment in the measurement of the scientific process. PISA has identified three major dimensions of scientific literacy, namely the science process, science content, and the context of science application. The scientific process refers to the mental processes involved when answering a question or solving a problem, such as identifying and interpreting evidence and explaining conclusions (Bahar and Aksüt, 2020).

The scientific process is the application of the scientific method in understanding, developing, and discovering science (Darling-Hammond et al., 2020). The scientific process is very important for every student to use the scientific method in developing science, and it is hoped that they will acquire new knowledge/develop the knowledge they already have (Mehtap *et al*., 2020).

Self-assessment containing the scientific process provides opportunities for students to carry out their learning activities according to their needs, abilities, and interests and opportunities for self-reflection and the application of the scientific process itself. These opportunities provide a very broad space for students to improve learning outcomes and scientific attitudes. Thus, self-assessment containing scientific processes in physics learning can affect scientific attitudes and learning outcomes of physics.

Luque's finding was that self-assessment improved the skills of their students during the learning process. Students will have good classroom abilities and in the family environment (Luque and Mendoza, 2019). The research results from Pantiwati also state that self-assessment in learning can increase metacognitive awareness, which will have implications for the competence of the students (Pantiwati and Husamah, 2017).

The study of a literature review of 37 empirical studies in the last decade (2008-2018), which aims to investigate the contribution of the self-assessment of the students to increased learning motivation, increased academic achievement, development of independent learning, and increased self-esteem, found that most of the studies that concluded that the self-assessment of the students contributes positively in improving the quality of learning (Papanthymou and Darra, 2018).

Apart from assessment as an external factor, the learning process is also influenced by internal factors such as interest, motivation, intelligence, self-concept, cognitive style, initial knowledge, and others. Internal factors related to scientific attitudes and physics learning outcomes are initial knowledge. Initial knowledge is the knowledge that students have before the learning process in the classroom, obtained through informal learning or daily experiences and formal learning at school at a previous level. Initial knowledge is an asset for students in learning activities because learning activities are a vehicle for negotiating meaning between teachers and students regarding learning materials (Juhji and Nuangchalerm, 2020).

Based on the above description, it can be assumed that self-assessment containing scientific processes applied in physics learning will affect the scientific attitude and the physics learning outcomes of the students. Initial knowledge also contributes to determining the level of scientific attitudes and the physics learning outcomes of the students. Initial knowledge is an internal factor that influences the scientific attitudes and physics learning outcomes of the students. Initial knowledge needs to be controlled so that the pure effect of self-assessment in learning physics on scientific attitudes and learning outcomes of physics is known.

To prove this assumption, a study was conducted to examine the effect of self-assessment with scientific processes in learning physics on scientific attitudes and learning outcomes by controlling initial knowledge.

1.2 Research Problems

Following the background of the problem, the formulation of the research problems is as follows. 1) Are there differences in scientific attitudes and physics learning outcomes between students who take physics learning with self-assessment with scientific processes and students who take physics learning with conventional assessment individually? 2) Are there differences in scientific attitudes and physics learning outcomes between students who take physics learning with self-assessment with scientific processes and students who take physics learning with the conventional assessment after controlling their initial knowledge either individually or simultaneously? 3) How big is the contribution of the initial knowledge of the students to the scientific attitudes and physics learning outcomes of students?

1.3 Research Significance

Theoretically, the results of this study are expected to provide empirical support for the effectiveness of self-assessment with scientific processes in improving the scientific attitudes and learning outcomes of the students. This empirical evidence will strengthen the theory, concepts, and practices of self-assessment as a learning assessment.

Its theoretical value for education is that the results of this study can be used as a theoretical reference, which can be further developed in further studies, thereby increasing insight into the field of assessment.

The results of this study are expected to contribute ideas in order to develop the repertoire of science in education and improve the quality of natural science education, especially physics. The practical value of this research can be used by educational experts and practitioners, especially concerning the use of assessment models to improve physics education quality.

For education experts, the practical value is that the results of this research can be used as an empirical reference that can be developed in the form of further studies and research to gain insight into the field of learning and evaluation in physics. For practitioners, the practical value is that the results of this study can be applied in the learning process to improve the quality of physics learning in high schools.

2. MATERIALS AND METHODS:

The hypotheses of this study are as follows. 1) There are differences in scientific attitudes and physics learning outcomes between students who take physics learning with self-assessment with scientific processes and students who take physics learning with conventional assessment either individually or simultaneously, 2) There are differences in scientific attitudes and physics learning outcomes between students who take physics learning with self-assessment containing scientific processes and students who take physics learning with the conventional assessment after controlling initial knowledge either individually or simultaneously, 3) Initial knowledge contributes to the scientific attitudes and physics learning outcomes of the students.

This research was conducted at public high schools in Singaraja City, Buleleng Regency, Bali. The schools that implemented the 2013 curriculum include Public High Schools no 1,2,3, and 4 Singaraja. The selection of the schools was based on affordability and feasibility considerations. Affordability is easy to access so that the smooth running of research can be guaranteed. Feasibility is an opportunity to realize experimental learning. Also, no similar research has been conducted at the research site.

This research was conducted with a quasi-experimental approach in high school students in Singaraja City using a single factor independent group design using covariate. The experimental design matrix is shown in Table 1.

Table 1. Experimental Design Matrix

Assessment (A)					
(A_1)			(A_2)		
X	Y_1	Y_2	X	Y_1	Y_2
.	.	.	.	.	.
.	.	.	.	.	.

Explanation:

A_1 : Self-assessment containing a scientific
A_2 : process
X : Conventional
Y_1 : Assessment

Y_2	Initial Knowledge Scientific Attitude Physics Learning Outcomes

The research procedure was carried out in three stages: the initial stage, the experimental stage, and data collection, and the final stage. This study involved 143 1st grade high school students majoring in science as the research sample, drawn by a multistage random sampling technique. Data collection using instruments: 1) scientific attitude questionnaire with a reliability coefficient of 0.887; 2) physics learning outcomes test with a reliability coefficient of 0.618, and 3) the initial knowledge test with a reliability coefficient of 0.837.

The treatment variable in this study was self-assessment containing the scientific process. The class designated as the experimental group followed the physics learning with self-assessment containing the scientific process. The class designated as the control group took the physics lesson with a conventional assessment.

Hypothesis testing used multivariate covariance analysis with the help of the SPSS 23.0 program. Hypothesis testing used a significance level α = 0.05. The prerequisite testing for data analysis conducted before testing the hypothesis includes testing for normality of data distribution, multivariate normality, homogeneity of group variance, regression linearity, the meaning of regression lines, the similarity in the slope of regression direction, and multicollinearity.

3. RESULTS AND DISCUSSION:

3.1 Description of Research Data

The data described in this study are scientific attitudes and physics learning outcomes resulting from the treatment between the application of self-assessment containing scientific processes and conventional assessment in learning physics by controlling initial knowledge.

The recapitulation of research data is presented in Table 2.

Based on the data in Table 2, the results of the analysis are as follows. 1) The average initial knowledge of students who took physics learning with process-loaded self-assessment was M = 20.85 and Sd = 2.73 were in the high category, 2) The average initial knowledge of students who took physics learning with conventional assessment was M = 19.75 and Sd = 2.66 were in the high category, 3) The average scientific attitude of students who took physics learning with self-assessment containing scientific processes was M = 169.56 and Sd = 9.98 were in the high category , 4) The average scientific attitude of students who took physics learning with conventional assessment was M = 153.89 and Sd = 11.55 were in the high category, 5) The average physics learning outcomes of students who took physics learning with self-assessment the science process was M = 65.17 and Sd = 11.78 were in the high category, 6) The average physics learning outcomes of students who took physics learning with conventional assessment were M = 56.07 and Sd = 10.03 were in the category enough.

3.2 Data Analysis Requirements Testing Results

3.2.1 Data Normality

The data normality test was carried out to determine whether the frequency distribution of the scores on each variable was normally distributed or not (Candiasa, 2011). This study tested the normality of data distribution using the Kolmogorov-Smirnov technique through the SPSS 23.0 program. The results are presented in Table 3.

Table 3. Data Normality Test Results

Data Groups	Sig.	α	Conclusion
X_1	0.072	0.05	Normal
X_2	0.088	0.05	Normal
Y_{11}	0.200	0.05	Normal
Y_{21}	0.200	0.05	Normal
Y_{12}	0.087	0.05	Normal
Y_{22}	0.200	0.05	Normal

3.2.2 Multivariate Normality Test

The multivariate normal distribution test is used to determine whether the data is multivariate normally distributed or not. The multivariate normality test is carried out by calculating the Mahalanobis distance for each observation point with its average (Leys et al., 2018).

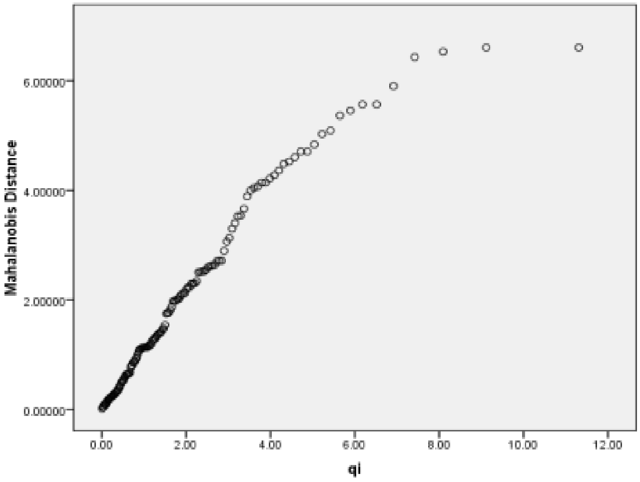

Figure 1. Scatter Plot of Normality Multivariate

The correlation coefficient obtained from the calculation was 0.972 with a sig value <0.05. It means that there was a significant correlation. The scatter-plot means that the data comes from a multivariate normally distributed sample.

3.2.3 Homogeneity of Group Variance

The homogeneity test of the group variance was carried out to ensure that the differences in the dependent variable were not caused by differences within groups but differences between groups. The homogeneity test of variance was carried out on the data group of the prior knowledge scores of the students in learning physics, the scientific attitudes scores of the students, and the physics learning outcomes of the students.

In this study, the variance homogeneity test was carried out in two stages, namely: 1) testing the homogeneity of group variance with the Levene test to test the variance homogeneity of the two data groups, namely: between the experimental group and the control group individually, and 2) homogeneity testing. The covariance variance matrices were carried out using Box's test of equality of covariance matrices, aiming to test the homogeneity of group variance simultaneously, namely the group of data on scientific attitudes and student learning outcomes of physics. These data sets must satisfy the assumption that each group has the same variance. All tests use the help of the SPSS 23.0 program.

The statistical hypotheses tested were $H_0 : \sigma_1^2 = \sigma_2^2$ dan $H_1 : \sigma_1^2 \neq \sigma_2^2$. Criteria for acceptance or rejection of Ho: if the resulting significance value was more than the specified significance number, namely 0.05, then Ho was accepted, and in other conditions, Ho was rejected. Accepting Ho means that the variance between groups was homogeneous, and rejecting Ho means that the group variance was not homogeneous. Based on the analysis of group variance homogeneity with the Levene's and Box's M Test, the following summary results were obtained.

Table 4. Homogeneity Test Results

No	Data Groups	F	Sig.
1	X	0.034	0.854
2	Y_1	0.397	0.530
3	Y_2	3.238	0.074
4	$\begin{pmatrix} Y_1 \\ Y_2 \end{pmatrix}$	1.144	0.330

Referring to the analysis results in Table 4, the significance figures generated for each data group were all more than 0.05. It means that the data group of the prior knowledge scores of the students in learning physics, the data group of scientific attitudes scores of the students, the data group of the physics learning outcomes scores of the students, and the data group of the scientific attitudes and physics learning outcomes of the students had homogeneous variances.

3.2.4 Regression Linearity Testing

One of the prerequisites for multivariate covariance analysis is the linear influence of covariates on dependent variables. For this reason, it was testing the linearity of covariate regression on dependent variables. Regression linearity testing was carried out to ensure a linear relationship between the variables tested so that it is appropriate to be used as the variables in the study. The regression linearity test was carried out on the covariables of the prior knowledge in learning physics of the students against the variables of scientific attitudes and the covariables of the prior knowledge of the students in learning physics to the variables of physics learning outcomes.

The statistical hypothesis tested was Ho : $\beta = 0$ and H1 : $H_1 : \beta \neq 0$. The test criterion accepts Ho, which states that the regression is linear at the significance level (α) = 0.05 if the test results show that the F value was on the deviation from linearity that had a significance number of more than 0.05. It means that the covariable of the prior knowledge of the students in learning physics and the variable of the scientific attitudes of the students, the covariable of the initial knowledge of the students in learning physics, and the physics learning outcomes of the students was a form of linear regression relationship.

The significance value was obtained from the calculation results at the value of F deviation from linearity more than 0.05, so that Ho was accepted. It means that the regression between the covariables of the prior knowledge of the students in learning physics and the variables of the scientific attitudes of the students, the regression between the covariables of the prior knowledge of the students in learning physics, and student variables learning outcomes in physics had a linear relationship.

3.2.5 Testing the Meaning of Regression Directions

Testing the meaning of the regression direction was carried out to test whether the X covariate had a significant effect on the Y variable. The test for the meaning of the regression direction was carried out by testing the regression coefficient $Y = \beta_2 X + \beta_1 + \varepsilon$, using the F test. The statistical hypothesis tested is $H_0 : \beta_2 = 0$ dan $H_1 : \beta_2 \neq 0$.

From the analysis, it can be concluded that the significance number at the F linearity value was less than 0.05 so, that Ho was rejected. Thus, it can be concluded that the covariate of the prior knowledge of the students in learning physics had a significant linear effect on scientific attitudes, and the covariate of the prior knowledge of the students in learning physics had a significant linear effect on physics learning outcomes.

3.2.6 Testing Alignment of Regression Lines

Testing the alignment of the regression lines was carried out to determine whether the coefficient of the regression line direction of the covariate effect on the dependent variable of each sample group was parallel. From the calculation results, the F-count value for the alignment of the regression lines of the prior knowledge of the students in learning physics and the scientific attitudes of the students was 0.527, and a significance value was 0.881. Because the significance value obtained was more than 0.05, Ho was accepted. There was no difference in the slope of the regression line of the prior knowledge of the students in learning physics and the scientific attitudes of students from the self-assessment group containing the scientific process and the conventional assessment group.

Similarly, the alignment of the regression lines of the prior knowledge of the students in learning physics and the physics learning outcomes of the students showed the F-count value of 1.800 with a significance value of 0.062. The significance figure obtained was more than the significance figure set at 0.05. It means that Ho was accepted or there was no difference in the slope of the regression line of the initial knowledge of the students in learning physics and the physics learning outcomes of the students from the group formed by the assessment. Thus, the regression line of the initial knowledge in physics learning and the physics learning outcomes of the students from all groups in this study were parallel.

3.2.7 Multicollinearity

Multivariate covariance analysis requires that two or more dependent variables do not have a high correlation. For this reason, multicollinearity testing was carried out. The multicollinearity test of data was carried out to ensure that the two dependent variables could be used as different criteria. Multicollinearity testing in this study was carried out on the variables of the scientific attitudes of the students and the physics learning outcomes of the students with the help of the SPSS 23.0 linear regression program by looking at the collinearity value of variance inflation factor (VIF). The dependent variables have multicollinearity if the VIF value is more than 10.

Based on the linear regression analysis results, the VIF value= 1.00 or the tolerance value= 1.00, with a significance less than 0.001. Because the VIF value was less than 10, the dependent variable was the scientific attitude of the students. The physics learning outcomes of the students did not experience multicollinearity, so it could be used as a criterion individually and simultaneously.

All the requirements related to the multivariate covariance analysis as above had been fulfilled, so that inferential analysis in the context of testing the research hypothesis using the Manakova statistical technique could be continued.

3.3 Hypotheses Testing

To test the effect of self-assessment with scientific processes in physics learning both individually and simultaneously on scientific attitudes and physics learning outcomes by controlling initial knowledge using multivariate covariance analysis. The recapitulation of the analysis results is presented in Tables 5 and 6.

Based on the recapitulation of the results of data analysis, the results of testing the research hypothesis can be described as follows: (1) there was a significant difference in scientific attitudes and learning outcomes between students who took physics learning with self-assessment with scientific processes and students who took physics learning with conventional assessment (2) there were significant differences in scientific attitudes and learning outcomes of physics between students who took physics learning with self-assessment with scientific processes and students who took physics learning with the conventional assessment after controlling initial knowledge both individually and simultaneously (3) initial knowledge students in learning physics contributed significantly to 22.8% of the scientific attitudes of the students and 19.4% to the physics learning outcomes of the students.

3.4 Discussion of Research Results

This study proved that physics learning with self-assessment containing scientific processes positively affected the scientific attitudes and learning outcomes of the students.

Theoretically, these findings indicate that physics learning with self-assessment with scientific processes positively affected the scientific attitudes and learning outcomes of the students. The scientific attitude and physics learning outcomes of the students were influenced by the type of physics learning assessment. The learning process tended to follow the type of assessment applied. If the assessment used required an understanding of the concept, the learning process was also based on understanding it. The interactions of the students in learning were also adjusted to the demands of the assessment. Their interactions in the learning process largely determined the learning outcomes of the students.

Learning physics with self-assessment containing scientific processes would improve the scientific attitudes of the students. With an improved scientific attitude, learning outcomes would also increase. In contrast to physics learning with conventional assessment, it was less demanding to develop the scientific attitudes of the students.

In conventional assessment, the opportunity for students to carry out their learning activities according to their needs, abilities, and interests, as well as opportunities for self-reflection from self-evaluation and feedback, were not available in conventional assessments. Even though these opportunities provided a very broad space for the students to spur their achievement to excel, these assessments were commonly used worldwide for time and cost-efficiency. The assignments and performance of the students tended to be ignored and were not considered a more meaningful alternative assessment model. Pure multiple-choice tests contributed less to learning and were therefore not appropriate for all assessments conducted in schools. The conventional assessment model could not measure the actual ability of students because it only focused on a few aspects, so it did not provide opportunities for students to demonstrate their respective abilities and strengths.

Empirically, the results of this study are supported by Zi Yan's research, which concluded that the physics learning outcomes of students assessed by self-assessment were higher than those of the physics learning outcomes of the students assessed by conventional assessment (Yan, 2020). The results of this study are also in line with Juhji's findings that components in science learning such as respect for evidence and facts, desire to change paradigms, critical thinking, diligent, optimistic, creative, honest, responsible, open-minded, objective, tolerance, careful at work, and positive thinking so that it is always developed in learning activities. A good scientific attitude will significantly affect the knowledge of the students, as indicated by a correlation coefficient of 0.842 (Juhji and Nuangchalerm, 2020). The findings of this study are also in line with Stavros A. Nikou that there has been a significant increase in the learning achievement of low achieving students. Who participated in the mobile and computer-based self-assessments. The positive effect of using computers and mobile devices in learning also increased the motivation of the students. It can be used as a promising alternative to complement paper and pencil-based assessments (Nikou and Economides, 2016).

The finding that learning physics with self-assessment containing a scientific process had a positive effect on scientific attitudes and learning outcomes after the prior knowledge of the students in learning physics was controlled, meaning that differences in scientific attitudes and learning outcomes between experimental and control classes were solely due to the treatment given, namely self-assessment containing a scientific process. Learning physics with a combination of scientific approaches and self-assessment, students could build their knowledge, plan and monitor their development as expected. Through self-assessment, learners could see their strengths and weaknesses, and then this deficiency became the goal of improvement. Thus, students were more responsible for the learning process and the achievement of learning goals. Self-assessment had a positive impact on students, including (1) it could foster the self-confidence of the students, (2) students were aware of their strengths and weaknesses because in the assessment process, they had to reflect on their abilities, and (3) could encourage, accustom and train students to act objectively and honestly. It was what contributed to strengthening the scientific attitudes of the students.

Self-assessment containing scientific processes was meaningful because students could feel their learning progress, feel that they had greater autonomy, feel that they were doing useful activities for themselves, and not just do the teacher's assignment. Thus, self-assessment is an element of metacognition that plays a very important role in the learning process because through self-assessment, students can find out what is known and know what is not yet known. This self-assessment containing a scientific process reinforces the efforts to achieve increased the learning outcomes of the students.

The controlled variable in this study is initial knowledge. This initial knowledge variable needed to be controlled because this variable was suspected of affecting scientific attitudes and learning outcomes of physics in the treatment process. Therefore, the scientific attitude and physics learning outcomes obtained in this study were purely due to the treatment process by controlling the initial knowledge variable.

The prior knowledge of the students is an important consideration to be netted before starting learning. Regarding the initial knowledge of the students, when the negotiation of meaning took place, the received information changed slowly from the general context into the specific context of science. It was linked to various activities that would spur students to continue to seek and find. Therefore, the success of the teacher in learning would be determined by the identification of the initial knowledge of the students. The physics initial knowledge of the students could be in the form of knowledge about the discovery process and physics products consisting of the concepts, principles, and laws of physics.

The initial knowledge about discovering physics products of the students would be very influential when in the learning process there were process activities to find physics products. The process of finding a physical product was carried out by a scientific process or scientific method. The scientific process to find physical products required a scientific attitude that included curiosity, respect for facts or evidence, a willingness to change views, and critical thinking. In finding physics products based on the initial knowledge of these findings, students would be able to develop scientific attitudes. The initial knowledge of physics products of the students would be very influential when there are activities to describe and apply physics products in the learning process. The activity of describing and applying physics products based on prior knowledge about these products could improve learning outcomes in physics, especially in the cognitive domain.

Thus, this initial knowledge is a good predictor of the interest and achievement in physics lessons of the students. It indicates that initial knowledge is a variable that deserves to be controlled to determine the effect of purer self-assessment with scientific processes on the scientific attitudes and physics learning outcomes of the students.

Empirically, the results of this study reinforce the results of research conducted by Liang Yi Li that students who had high initial knowledge had a more positive scientific attitude and showed higher learning outcomes than students with low initial knowledge (Li, 2019).

3.5 Implications of Research Results

The results of this study provide the following implications. (1) Implications of the results of this study on the curriculum in physics learning. Implementing the 2013 Curriculum in physics learning in schools should be understood not only as adjustments to the material substance and curriculum format with the demands of development, but a paradigm shift towards a physics learning approach oriented towards self-assessment as a reference for students' graduation. This change in orientation had implications for the expansion of assessment methods and techniques. Physics teachers must be able to choose the right type of assessment in physics learning with the material being taught because one of the determinants of scientific attitudes and students' learning outcomes is the assessment applied by the teacher during the learning process. Suppose a teacher can apply learning strategies well, master the material proficiently, and select and use learning assessments appropriately and carefully. In that case, student success in learning will be achieved as well. Self-assessment containing scientific processes has an important role in improving students' learning outcomes. Assessment is an integral part of the learning process. Selection of self-assessment containing appropriate scientific processes can improve students' scientific attitudes to learning so that it will lead to improving the quality and learning outcomes of students. (2) The implication of the results of this study for learning strategies is that teachers should design learning strategies that can facilitate students to construct their knowledge through authentic and meaningful experiences. With self-assessment containing scientific processes, students will monitor their level of knowledge, learning, abilities, thoughts, actions, and strategies based on scientific procedures. Learning strategies are designed to provide opportunities for students to actively participate in learning. In learning, students build their knowledge through students' interaction with the environment. The learning strategy developed also considers students' initial knowledge to improve scientific attitudes and students' learning outcomes. (3) Implications of the results of this study on learning assessment. Self-assessment containing scientific processes should be developed and implemented, in line with the findings of this study, and in order to improve the quality of physics learning, as well as to improve scientific attitudes and physics learning outcomes, one alternative that teachers can do is to multiply and expand the use of process-loaded self-assessment science in physics learning, both in the learning process and in assessing students' physics learning outcomes. Through self-assessment, students can see the strengths and weaknesses, and then this deficiency becomes the goal of improvement. Thus, learners are more responsible for the learning process and the achievement of learning goals. Self-assessment is meaningful because students can feel their learning progress, feel they have greater autonomy, feel that they are doing something useful for themselves, not just doing the assignment of the teacher. Conventional assessments should only be carried out for certain things so that physics learning is more meaningful. Self-assessment containing scientific processes has advantages in revealing students' potential in problem-solving, reasoning, and communication in written and oral form. Self-assessment containing a scientific process must be based on the assessment of the rater's observations of himself. Therefore, self-assessment containing scientific processes is very well used to assess students' abilities and reflect student learning success. The habit of using self-assessment with a scientific process will stimulate students to create scientific attitudes, which in turn will improve the quality of learning and student learning outcomes. Self-assessment containing scientific processes should be developed and improved for physics learning, especially physics learning at the high school level. It has been proven to be able to improve scientific attitudes and students' physics learning outcomes. In contrast to the learning process with the conventional assessment. The learning process with conventional assessment tends to place students as objects filled with problems. It impacts decreasing the ability of students to solve the problems faced so that scientific attitudes and learning outcomes are not good.

(4) Implications of research results on the prior knowledge of the students. The prior knowledge of the students in learning physics contributes to the scientific attitudes and to physics learning outcomes of the students. It shows that initial knowledge will affect the academic abilities of the students. The amount of initial knowledge will determine the amount of effort made to achieve success. Students' initial knowledge of physics can be in the form of knowledge about the discovery process and physical products, consisting of the concepts, principles, and laws of physics. Early knowledge is very important to be extracted and used to direct learning activities. It means that the initial knowledge, which is an internal factor of students, should be considered because it influences the learning outcomes of the students.

4. CONCLUSIONS:

Based on the hypothesis testing results, it can be concluded that self-assessment containing scientific processes in physics learning affected scientific attitudes and learning outcomes by controlling initial knowledge. In more details, it can be concluded as follows: (1) there were significant differences in scientific attitudes and learning outcomes of physics between students who took physics learning with self-assessment with scientific processes and students who took physics learning with conventional assessment, either individually or independently. Simultaneously, (2) there was a significant difference in scientific attitudes and simultaneous physics learning outcomes between students who took physics learning with self-assessment with scientific processes and students who took physics learning with conventional assessment by considering the effect of initial knowledge, both individually and simultaneously, (3) students ‘prior knowledge in learning physics contributed significantly to the scientific attitudes and the physics learning outcomes of the students.

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Table 2. *Recapitulation of Research Data*

Statistics	**A_1**			**A_2**		
	X	**Y_1**	**Y_2**	**X**	**Y_1**	**Y_2**
Lots of Data	71	71	71	72	72	72
Amount of Data	1480	12039	4627	1422	11080	4037
Max Score (ideal)	28	210	100	28	210	100
Min Score (ideal)	0	42	0	0	42	0
Maximum Score	27	191	85	26	190	77
Minimum Score	15	145	36	14	128	35
Interval	12	46	49	12	62	42
Average	20.85	169.56	65.17	19.75	153.89	56.07
Median	21	170	65	20	155	57
Mode	20	175	72	19	162	64
Standard Deviation	2.73	9.98	11.78	2.66	11.55	10.03
Variance	7.45	99.68	138.74	7.09	133.51	100.57

Explanation:

A_1 : Learning physics with self-assessment containing scientific processes

A_2 : Physics learning with conventional assessment

X : Students' initial knowledge in learning physics

Y_1 : Students' scientific attitude

Y_2 : Students' physics learning outcomes

Table 5. Recapitulation of Manova and Manakova Analysis Results

Difference Test			
Effects		F-*Wilk's Lambda*	Sig.
Assessment		7.724	0.001
Assessment	Scientific Attitude	75.479	0.000
	Learning Outcomes	24.766	0.000
Assessment + Initial Knowledge Control		43.292*	< 0.001
Assessment + Initial Knowledge Control	Scientific Attitude	69.084*	0.000
	Learning Outcomes	18.189*	0.000

Test of Significance of Differences				
Effects		Mean Difference	F Value	Significance
Assessment		-	7.724	0.001
Assessment	Scientific Attitude	13.708	75.479	0.000
	Learning Outcomes	7.314	24.766	0.000
Assessment + Initial Knowledge Control		-	43.292	< 0.001
Assessment + Kontrol Pengetahuan awal	Scientific Attitude	15.703**	69.084	0.000
	Learning Outcomes	9.100**	18.189	0.000

* Residual F Value

** Corrected Mean Value

Table 6. Recapitulation of Analysis of the Contribution of Covariates to Bound Variables

Regression	R	R^2	R^2 Adjustments	F	Sig.
$X – Y_1$	0.460	0.211	0.206	40.161	< 0.001
$X – Y_2$	0.427	0.183	0.177	33.498	< 0.001