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Fit Model on Science Teacher Performance Variables on Student's Science Learning Achievement with Structural Equation Modeling (SEM)

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This study aims to determine the positive direct effect of teacher performance on student's science learning achievement. This research includes quantitative research with the data used is the data of Trends International Mathematics and science study (TIMSS) 2011 grade eight from the database of the Education Assessment Center, Research and Development Agency of the Ministry of Education and Culture of Indonesia. The population in this study were all Indonesian students who took part in the 2011 TIMSS survey. Population research. In the 2011 TIMSS survey, Indonesia involved 5795 students and 259 teachers in Indonesia who teach science from 153 schools in junior high schools or equivalent. The data collection technique used was documentation. Data analysis using Structural Equation Modeling (SEM) with lisrel 9.1. The results of the study show that: (1) there are variables that make up the teacher performance variable, (2) there is a direct positive influence between the teacher performance variable and the student's scientific achievement variable including the cognitive domains knowing,applying and reasoning. Thus, a fit model was obtained between the teacher performance variables as the latent variable on the student's science learning achievement variables and there was a direct positive effect between the teacher performance variables on student's science learning achievement.

Keywords: *teacher performance, achievement, science*

Introduction

Results Indonesia's science learning achievement is very low. This is shown from international surveys, for example the *Trend of International Mathematics Science Study* (TIMSS) which is often followed by Indonesia every 4 years, Indonesia always gets a low rank compared to other countries. Natural Sciences (IPA) is one of the subjects that are directly related to the real life of students. This is in accordance with the opinion of Samatowa (2011) which is quoted by (Nahdi, Yonanda, & Agustin, 2018) that science is a subject that discusses natural phenomena that are arranged systematically based on the results of experiments and human observations.

Students' science learning achievement is not only determined by intrinsic factors but also by extrinsic students. One of the extrinsic elements that affect student achievement is the teacher. Previous research stated that the involvement of school teachers has a significant effect on student performance (Wadesango, 2012) and other studies show that there is a significant effect of professional teachers on student achievement (Bakar, 2018). Meanwhile, according to Mulyasa (2013), teacher performance assessment is related to the effectiveness of learning which includes various aspects, both related to *input* , process and *output* . According to him, teacher performance in learning is related to the teacher's ability to plan, implement and assess learning, both related to the process and results. Therefore, the teacher as the manager in the class determines the good or bad of the resulting learning achievement.

The performance of science teachers is influenced by teacher mastery of science subject matter, mastery of science teacher methods and strategies in teaching, science teacher skills in conducting assessments and evaluations in order to control the course of learning (MB. Wahyu Rejeki Handayani, 2014). Meanwhile, teachers are also required to carry out professional development. Teacher professional development is carried out as a form of teacher empowerment to improve teacher performance (Risdiantoro, 2021). Resources in this case is the infrastructure used by teachers in teaching also influence student achievement (Puspitasari, 2016). The success of teachers in learning activities is also supported by the completeness of learning resources in schools so that they can be used in learning (Sawianti et al., 2019).

This study further examines teacher performance which is focused on teacher professional development, preparation of science topics to be taught, learning methods, resources and assessments used by science teachers when teaching are latent variables including teacher performance that will affect students' science learning achievement. This study aims to (1) confirm the variables that make up the teacher performance variable, (2) find out whether there is a direct positive effect between the teacher performance variable and the student science achievement variable including the cognitive domains of *knowing* , *applying* and *reasoning* . The following questions will be discussed in this research:

- What variables make up the teacher's performance?
- Is there a direct positive influence between teacher performance variables and students' science learning achievement variables which include the cognitive domains of *knowing*, *applying* and *reasoning* ?

Literature Review

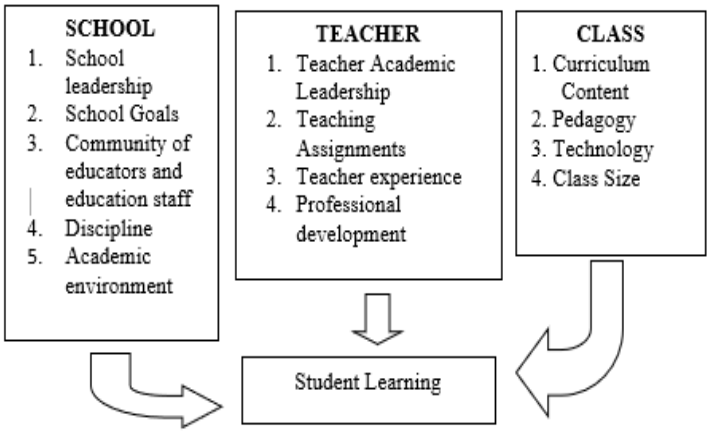
TIMSS Science Learning Achievement

The trend in the International Mathematics and Science Studies (TIMSS) assessment framework is one of the most recent and perhaps the simplest to classify cognitive domains under three categories as knowing, applying, and reasoning (Mullis & Martin, 2017). According to the 2011 TIMSS framework, the ability test in science/IPA subjects includes two domains, namely the content domain and the cognitive domain. The content domain consists of 4 components, namely biology, chemistry, physics and earth science. The percentages for TIMSS in 2011 are 35% biology, 20% chemistry, 25% physics and 20% earth science. Meanwhile, the cognitive domain consists of 3 components, namely *knowing* 35%, applying 35%, and reasoning 30%. The first domain or domain, *knowing* includes facts, procedures, and science concepts that students need to know, while the second domain, *Applying* focuses on students' ability to apply knowledge and conceptual understanding to a science problem. Finally, the third domain, reasoning , goes beyond the solution of routine science problems to cover unfamiliar situations, complex contexts, and multi-step problems.

Teacher Performance

Teacher performance appraisal according to Mulyasa is related to the effectiveness of learning which includes various aspects, both related to *input* , process and *output* . According to him, teacher performance in learning is related to the teacher's ability to plan, implement and assess learning, both related to the process and results (Mulyasa, 2013). Teacher performance plays a very important role in improving the quality of schools. Because the quality of the school will affect the knowledge of students through the training and talents of a teacher. According to Mayer et. all (Priansa, 2014) that there are 13 indicators of school quality related to the knowledge of students who are grouped into 3 major groups, namely schools, teachers and classes. The 13 indicators can be seen in Figure 1 below:

Figure 1. School Quality Indicators (Priansa, 2014).

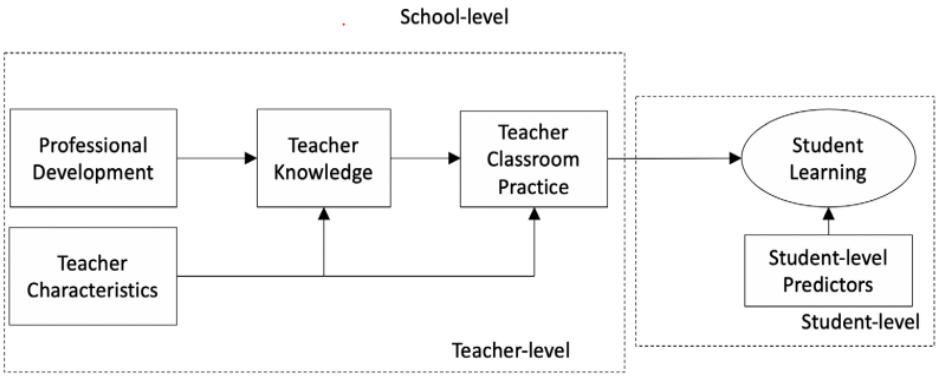


Based on Figure 1 above, the learning of students depends on the 3 components above, namely the school, the teacher and the class. The teacher component consists of four indicators, namely: teacher academic leadership, teaching assignments, teacher experience, and professional development .

Teacher Professional Development

Professional development can be defined as a career-long process in which educators refine their teaching to meet the needs of students (Putri & Imaniyati, 2017). Teacher professional improvement has an effect on teacher performance (Risdiantoro, 2021). The professional development of teachers will have an impact on students (Kasmawati, 2020). Teacher professional development can be related to what teachers do. This can also be seen in Figure 2 below:

Figure 2. The theoretical framework of professional development (Yang et al., 2020)



Based on Figure 2 above, the participation of teachers' professional development will affect teacher knowledge and then affect the teacher's practice in the classroom in learning and will ultimately affect student learning. According to Putri and Imaniyati (2017) there are several indicators of teacher professional development, namely: (1) Following information on the

development of science and technology that supports the profession through various scientific activities, (2) Developing various learning models, (3) Writing scientific papers, (4) Making tools visual aids/media, (5) Participating in qualification education, (6) Participating in curriculum development activities .

Science Topic Preparation

In classroom learning, the teacher must plan what will be done in the classroom, including what material or topic will be taught to students. Teacher planning in learning must also be prepared, especially the material or topic to be taught. From simple concepts to more complex concepts. Preparation of topics or lessons to be taught is of course adjusted to the learning objectives to be (Puspita Dewi & Sumardi, 2017) (Indri, 2017). The teacher must prepare the topic or subject matter because it is related to the teacher demonstrating the learning. Therefore, the teacher must be able to master the material or subject matter to be taught and always develop his abilities which in the end are able to demonstrate what he teaches didactically. then it should mean that the teacher must prepare it well in order to master the learning material (Indri, 2017).

Teaching method

Teaching or learning methods can be interpreted as the method chosen by educators to optimize the teaching and learning process that aims to achieve the expected learning objectives (Khaeriyah et al., 2018). While the learning method is the method or stages used in the interaction between students and educators to achieve the learning objectives that have been determined in accordance with the material and mechanism of the learning method (Afandi et al., 2013). The learning method chosen by the teacher will have a major effect on the level of achievement of learning objectives (l *earning outcome)* (Nurhasanah, 2019).

Resource

In improving the quality of learning in the classroom, teachers are also required to use resources that must be used when teaching. The resources used can be in the form of learning media, the source books used, equipment, technology, for example computers. The use of media provides benefits in the learning process. This was stated by Arsyad in (Rohaeti, LFX, & Padmaningrum, 2009), among others: (1) Clarify the presentation of messages and information so that the learning process becomes smoother and improves learning outcomes; (2) Increase student motivation, by directing students' attention so as to enable students to learn on their own according to their abilities and interests; (3) The use of media can overcome the limitations of the senses, space, and time; (4) learners will have the same experience about an event, and allow direct interaction with the surrounding environment.

In this study, researchers used the resources used in the 2011 TIMSS instrument related to teachers in the use of text books, workbooks or worksheets, *science equipment and materials*, computer software for science instructions and reference materials.

Assessment

Assessment can also be interpreted as a collection of data that has been obtained through measurements in the form of tests and non-tests about a lesson (Teluma & Rivaie, 2019). Assessment is also related to the activities carried out by the teacher to provide various continuous and comprehensive information about the process and learning outcomes that have been achieved by students (Agustin, Ambyar, Aziz, 2021). Assessment is also defined as a joint effort between teachers and students to develop knowledge and skills (Scott, Scott, & Webber, 2016).

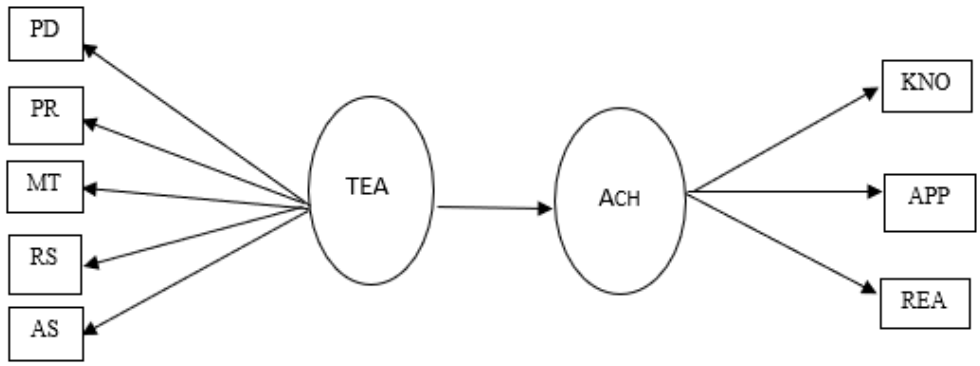
Assessment or evaluation techniques must also be one that teachers must prepare in teaching. Teacher preparation in teaching has seven factors, namely: preparation for the situation, preparation for students, preparation in learning objectives, preparation for the lesson to be taught, preparation for using teaching methods, preparation for using learning media, and preparation in the type of evaluation technique. (Puspita Dewi & Sumardi, 2017).

Methodology

Conceptual Model

The conceptual model of the research variables used in this study are all aspects derived from teacher performance (TEA) including aspects of professional development (PD), preparation of science topics (PR), teaching methods (MT), resources (RS) and assessment (AS). and science learning achievement (ACH) which includes aspects of knowing (KNO), applying (APP) and reasoning (REA). The research conceptual model is given in Figure 3.

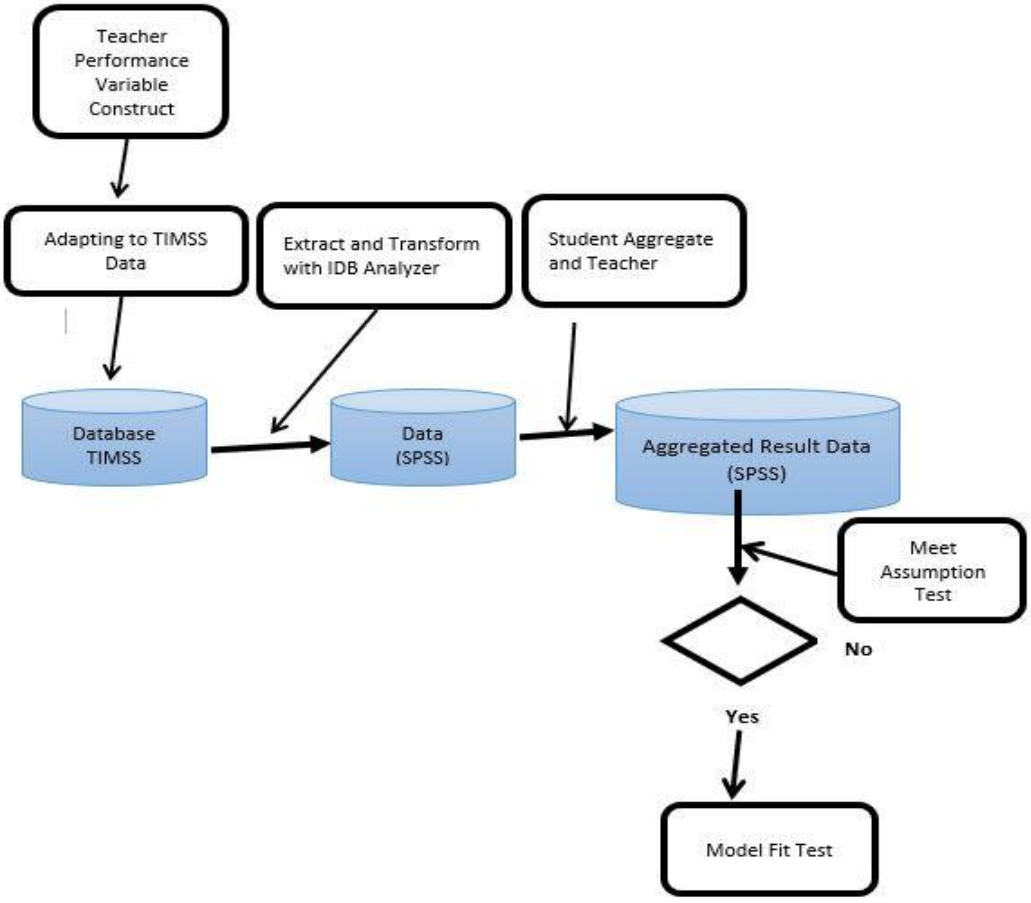
Figure 3. Conceptual Model



This research approach includes confirming the teacher performance variables and then connecting the influence of the latent variable teacher performance on students' science learning achievement variables including knowing, applying and reasoning using data from the appropriate Association For The Evaluation of Educational Achievement (IEA) instrument

. In general, the researcher carried out the stages in the research, starting from constructing the theory of teacher performance variables and then adjusting it with TIMSS data taken from the 2011 TIMSS database *log file* from the server of the Education Assessment Center, Research and Development Agency, Ministry of Education and Culture of the Republic of Indonesia. Then extract the data, only the data needed in the research is taken and transforms the data using IDB Analyzer into spss form. Furthermore, in the form of SPSS, an aggregate is made between student data and teacher data. Then proceed with testing a number of test assumptions of the requirements for the next stage. If it meets the structural model fit test using *Structural Equation Modeling* (SEM) with *Confirmatory Factor Analysis* (CFA) *first order* and *second order* analysis using Lisrel 9.1. The Research Design Chart can be seen in Figure 4 below:

Figure 4. Research Design Chart



Population and sample

The population in this study were all Indonesian students who took part in the 2011 TIMSS survey. Population research. In the 2011 TIMSS survey, Indonesia involved 5795 students

and 259 teachers in Indonesia who teach science from 153 schools in junior high schools or the equivalent for grade eight.

Data Collection Tool

The data used is TIMSS 2011 data from the database of the Education Assessment Center, Research and Development Agency of the Ministry of Education and Culture of Indonesia which comes from the Association For The Evaluation of Educational Achievement (IEA) . So the researchers used secondary data that was processed by researchers according to research needs.

Data analysis

Data analysis used confirmatory factor analysis (CFA) with first order and second order and to see the positive direct effect of latent variables on teacher performance on science learning achievement using SEM with lisrel 9.1.

Results And Discussion

Structural Model Design Description of latent variables and their manifest variables are as follows:

The exogenous latent variable of teacher performance (TEA) has five manifest variables (indicators), namely, professional development as stated by the PD, topic preparation stated by the PR, teaching methods stated by MT, resources stated by RS, and assessments stated by the teacher. declared by the AS.

The endogenous latent variable of students' science learning achievement has three manifestation variables (indicators), namely the cognitive domain of "knowing" which is expressed by KNO; "apply" with the APP; and "reasoning" with REA. After evaluating the measurement model on the respondents, the teacher's performance on students' science learning achievement used was overall valid and reliable. So that the appropriate structural model for this research is obtained, which is as shown in Figure 5 below:

Figure 5. *Path diagram* of teacher performance variables and science learning achievement based on *Standardized Loading Factor*

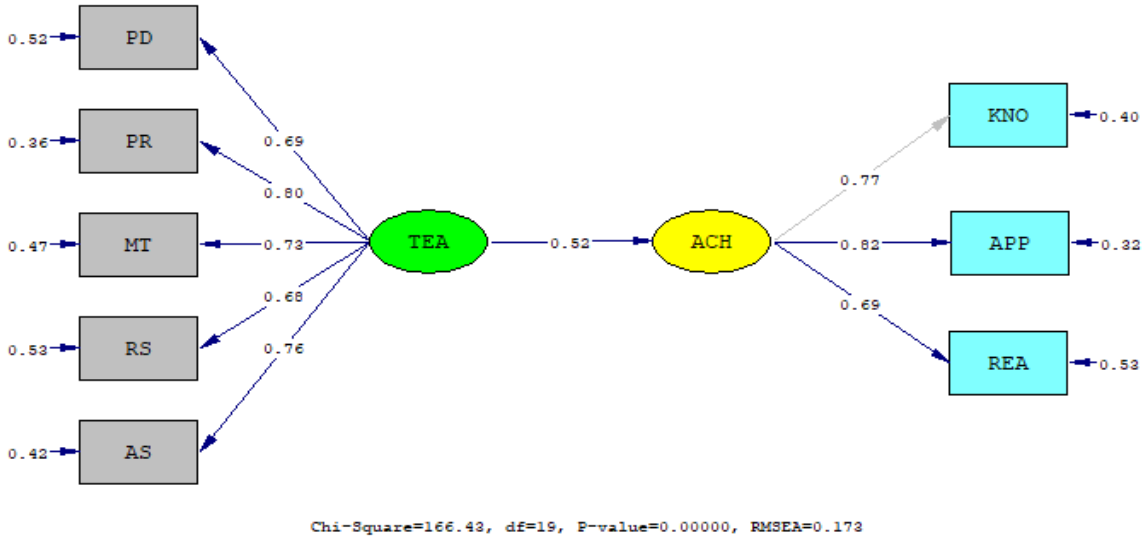
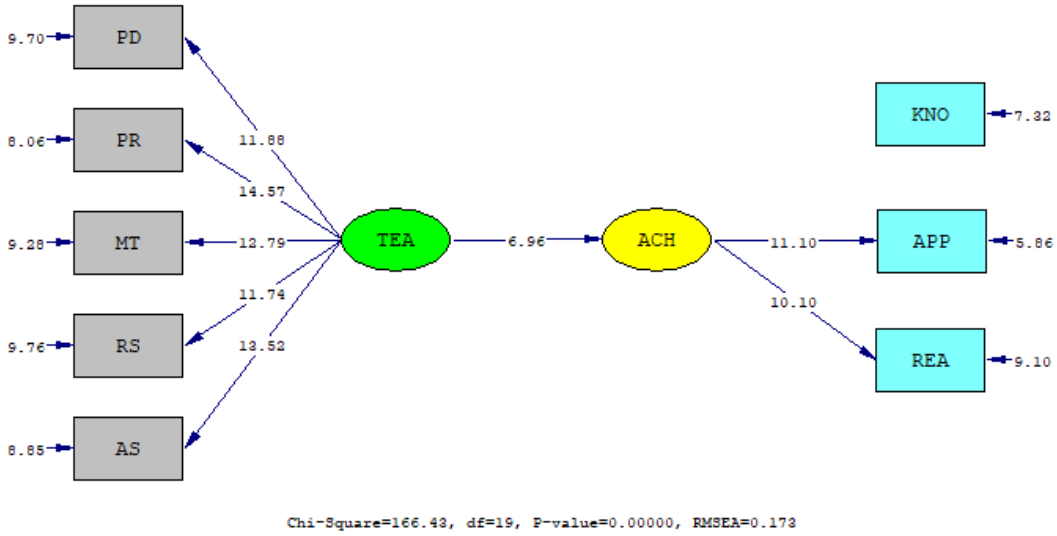


Figure 6 *Path diagram* of the variables of teacher performance and science learning achievement based on *T-value*



Based on **Figures 5 and 6**, the results of factor loading and t-value can be recapitulated in table 1 below:

Table 1. Results of *factor loading* and T-Value variable teacher performance and science achievement

No	Variable	factor load	t-value
1	KNO	0.77	-
2	APP	0.82	11.10
3	REA	0.69	10.10
4	PD	0.69	11.88
5	PR	0.80	14.57
6	MT	0.72	12.79
7	RS	0.68	11.74
8	AS	0.76	12.52

Based on table 1 above, all variables or dimensions for teacher performance and student science learning achievement have *factor loading* is entirely 0.32 , and the t-value is above 1.96. It can be stated that the variables of teacher performance and science learning achievement are valid. Furthermore, to see the suitability of the model, it can be seen based on the *goodness of fit criteria.* As for the recapitulation *of goodness of fit* The *factor loading* of teacher performance and science learning achievement from Lisrel's output is as shown in table 2 the following:

Table 2 Goodness of Fit variable Teacher performance (TEA) on student science achievement (ACH)

criteria	***Cut off value***	**Model results**	**Evaluation**
Chi-Square	0	166.43	Expected small
Probability	0.05	0.00000	not good
RMSEA	0.05 – 0.08	0.173	not good
RMSR	< 0.08	0.062	good
NFI	0.9	0.91	good
CFI	0.9	0.92	good
IFI	0.9	0.92	good
GFI	0.9	0.90	good
RFI	0.9	0.90	good
AGFI	0.9	0.81	Marginal fit
PGFI	0.6	0.45	not good

In Table 2 above, it is known that the resulting probability value is less than 0.05; RMSEA also meets the criteria of being less good because it is more than 0.08. Meanwhile, RMSR, NFI, CFI, IFI, GFI, and RFI are in good category because the value obtained exceeds the *cut*

off value of more than 0.9. Meanwhile, AGFI is categorized as marginal fit while PGFI with not good category. In general, from the table above, several *goodness of fit criteria* are considered sufficient to assess the feasibility of a model, so that it has been fulfilled as a fit model criteria. According to Hair et.al as quoted Latan (2012) the use of 4-5 *goodness of fit criteria* is considered sufficient to assess the feasibility of a model. Furthermore, *Construct Reliability* and *Variance Extracted* can be seen in table 3 below.

Based on table 3 above, shows the price of *Construct Reliability* (CR) and *Variance Extracted* (VE) above 0.7 and 0.5, respectively. According to Hair et.al in Wijanto (2007)that a construct has good reliability if the value of *Construct Reliability* (CR) 0.70 and the value of *Variance Extracted* (VE) 0.50. Thus, it means that the teacher performance model variable on students' science learning achievement is a variable that has good reliability because it is above CR 0.70 and VE value 0.50, so it can be said that all latent variables are reliable.

Table 3 Calculation of Construct Reliability and Variance Extracted Variables teacher performance and student science learning achievement

Calculation of Construct Reliability and Variance Extracted						
Variabel	Indikator	*factor loading* (λ)	λ^2	*Measurment error* ($1-\lambda^2$)	Construct Reliability (CR)	Variance Extracted (VE)
	KNO	0.77	0.5929	0.4071	0.9075	0.5520
ACH	APP	0.82	0.6724	0.3276		
	REA	0.69	0.4761	0.5239		
	PD	0.69	0.4761	0.5239		
	PR	0.80	0.6400	0.3600		
	MT	0.72	0.1800	0.4816		
TEA	RS	0.68	0.4624	0.5376		
	AS	0.76	0.5776	0.4224		
	∑	5.93	4.4159	3.5841		
Total	(∑ λ)2	35.1649				
	(∑λ)2+ error	38.749				
	(∑λ2)+ error	8				

Hypothesis Testing

Hypothesis testing is obtained from testing based on calculations using *Lisrel 9.1 software* presented in Figures 3 and 4, where the overall value of the conceptual model of this testing research is based on hypothesis testing of the *path coefficient* value and t- *value.* Based on the results of the hypothesis presented in Figures 3 and 4 as well as in Table 1, testing the hypothesis that the magnitude of the direct influence of the teacher performance variable (TEA) on science learning achievement is 0.52 with a t-value of 6.96, because the *t-value* ± 1.96 then Hypothesis 0 is rejected, so it can be explained that there is a direct effect of the teacher performance variable (TEA) on the science learning achievement variable (ACH). That is, in this study the latent variable of teacher performance (TEA) with its indicators significantly affects the latent variable of student science learning achievement (ACH) with its indicators. The coefficient is positive so it can be concluded that the influence of the teacher's performance factor is positive. This means that the higher or better the teacher's performance, the student's science learning achievement will increase.

Discussions

This study aims to confirm the constituent variables of teacher performance as latent variables and determine the positive direct effect of teacher performance on student achievement in science subjects at grade eight of Junior High School or its equivalent in Indonesia.

The results of this study indicate that the variables of teacher performance include professional development, preparation of science topics, teaching methods, resources used by teachers when teaching and assessment are variables that make up teacher performance. Meanwhile, learning achievement in science subjects in TIMSS covers the cognitive domains of knowledge, application and reasoning. This study also shows that there is a direct positive effect between the latent variable of teacher performance and science learning achievement. This study supports previous findings that teacher content knowledge and changes in teacher practice both have statistically significant effects on student achievement (Polly et al., 2015). The results of this study also complement and expand knowledge about the results of previous studies (Fauth et al., 2019). Previous findings have also shown that traits of professional development, specialization, educational qualifications, and teaching experience among mathematics teachers were found to have varying degrees of impact on achievement (Alharbi et al., 2020).

Based on the research, some of the limitations that occur may be more considered for future researchers to improve and refine them. Some of these limitations include: Researchers cannot control research directly either in terms of respondents or others because the data is taken from existing data so researchers are not directly involved in determining the data. The factors that affect teacher performance in this study only consist of five variables, namely professional development, preparation of science topics, teaching methods, resources used by teachers when teaching and assessment, while there are many other factors that affect teacher performance.

CONCLUSION

The contribution of teachers in producing students who excel in science cannot be ignored. Therefore, it is important for teachers to improve their performance. Teacher performance includes participation in professional development, preparation of science topics to be taught, teaching methods, resources and assessment. There is a direct positive relationship between teacher performance and student science achievement covering the cognitive domains of knowing, applying and reasoning. However, there may be many other factors included in teacher performance that can be considered important by teachers that affect science achievement. Therefore, this paper suggests exploring in detail the most influential factors to improve students' science achievement in terms of increasing the achievement of knowing, applying, and reasoning.

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