Mathematics teacher performance based on student’s perception and learning achievement by applying structural equation modeling approach

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Abstract. The purpose of this study was to obtain a model of students’ perceptions on the level of performance of mathematics teachers and to describe the relationship of pedagogical, professional, social and personal competencies to students’ final test (UAS) grade by applying Structural Equation Modeling data analysis techniques. It is a statistical analysis technique applied to construct and to evaluate statistical models which form of causal models. The population of this study was all junior high school students in Merauke City, Papua. The study sampling technique was proportional random sampling continued to simple random sampling. The number of samples obtained was 436 students. The data was collected by distributing questionnaires of students’ perceptions of mathematics teachers consisting of 31 items. The questionnaires form a Likert scale. Based on the analysis, it obtained the model final test grade $= 0.317 \text{pedagogical} - 0.085 \text{professional} + 0.059 \text{personal} - 0.138 \text{social} + e33$. The study concludes that pedagogical and personal competencies influence the students’ final test grades as well as each of the indicator. To improve student learning achievement, mathematics teachers need to enhance their pedagogical and personal competencies.

1. Introduction

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The main factor determines the quality of education is a teacher. The teacher is at the forefront of creating the quality of human resources as well as the spearhead of learning process success. As mandated in Law Number 14 of 2005, chapter 1 verse 1 concerning teachers and lecturers states that "Teachers are professional educators with the main task of educating, teaching, guiding, supervising, training, assessing, and evaluating students in early childhood education in formal education, elementary and secondary education ".

Furthermore, based on the Regulation of the Minister of National Education of the Republic of Indonesia number 16 of 2007 concerning Academic Qualification Standards and Teacher Competence, explains that the Teacher Competency Standards addressing on four main competencies such as pedagogic, personal, social and professional competencies.

Mathematics is a basic science that extremely requires more serious attention, particularly in the globalization era. Mathematics is one of the important and constantly studied subjects from the level of elementary school to higher education [1]. Mathematics education requires very serious handling from elementary to university level and continues to be monitored and developed the quality and quantity.
referring to the future. Therefore, to measure the progress of the mathematics learning process of education, it needs to be evaluated.

In a learning system, evaluation is one of the important components and stages which teachers must consider to determine the learning effectiveness. The evaluation result provides feedback for teachers to improve learning programs and activities. According to QCA, feedback is the mean by which teachers enable children to close the gap in order to take learning forward and improve children’s performance. The teacher might apply the feedback as a tool to assist students to improve their learning activities and improve their performance. It provides suggestions and improvements so that teachers are motivated to improve the performances and quality of the teaching process [2]. However, the evaluation itself should be considered the student’s need rather than the evaluation [3].

The implementation of learning monitoring and evaluation at the school level is carried out through the Teacher Performance Assessment (TPA) program. Teachers are required to prepare themselves especially in several aspects within the scope of their pedagogical and professional competencies. Several aspects are designing activities, implementation including the disclosure, core and closure activities, and evaluation. As teachers are a direct conduit to students and their performance, targeting the development of teacher competency is an avenue worth exploring [4].

In the learning process, there is a direct interaction between teacher and student. The success of learning depends on the ability of the teacher to facilitate and develop learning interactions. In this case, students experience their own interaction process with the teacher, listen and observe the learning process that takes place in the classroom. As Fraser and McRobbie said that Information about personal experience in the classroom provides more useful information to school personal charged with designing classroom interventions for individual students [5]. So the success and failure of the learning process is revealed by the students. Thus, the assessment of students’ perceptions and grades on the teacher performance might be considered in order to obtain a credible evaluation to formulate policies as an effort to improve the quality of learning and education services according to school needs.

In order to evaluate and improve mathematics teacher performance to support classroom learning, the highest officeholders’ role, especially the Principal is important. By applying Structural Equation Modeling (SEM) data analysis techniques, factor variables or observed variables were tested to determine a series of relationships between several variables. In this study, the variables are teacher competencies such as pedagogical, professional, social and personal competencies and student final test grades.

2. Method
The research applied survey method with the ex-post-facto procedure, which is the previous data carried out further questioned with correlational techniques. The research population was all junior high school students in Merauke City. The study sampling technique was proportional random sampling continued to simple random sampling by selecting the name of the respondents to be sampled in a drawing. The number of samples obtained was 436 students who could represent junior high school students in Merauke City. The sample selection criteria were all students who have studied at least one semester.

There were two kinds of data as primary and secondary data. The primary data was collected from the main examinee. Data collection techniques were carried out by distributing questionnaires on students’ perceptions of the performance of mathematics teachers consisting of 31 questions in the form of a Likert scale with ordered response option: (1) Very Poor/ Much Lower/ Never. (2) Poor/ Slightly Lower/ Rarely. (3) Fair/ About the Same/ Sometimes. (4) Good/ Higher/ Most of the Time. (5) Very Good/ Much Higher/ Always. The secondary data was collected from junior high school mathematics teachers in Merauke City.

There are five research variables applied to provide an overview of the evaluation of mathematics teacher performance in the learning process for one semester such as final test grade and pedagogical competence, professional, personal, and social competencies.

Data analysis applied Structural Equation Modeling (SEM). SEM is one of the multivariate analysis which tested the correlation of complex variables. Generally, this analysis is applicable for studies whose plenty of variables [6]. Kline [7] said that SEM applies several models to represent correlation among
observed variables to provide quantitative test of hypothesis. Particularly, SEM assists to analysis several theoretical models and to provide correlation of constructed variables. SEM is applied to construct and test the statistic model. The model forms causal model. Figure 1 presents the SEM’s procedures [8].

![Figure 1. SEM’s procedures](image)

SEM analysis applied Software AMOS Version 23, Microsoft office excel 2013 dan SPSS version 21. AMOS is an applicable software and fairly popular in analyzing SEM data.

3. Result and discussion

3.1 Results

The results of the study consisted of path construction, conversion of the path into the structural equation, selection of input matrix and estimation, the goodness of fit (GOF), and model interpretation.

3.1.1 Path construction. Path construction aimed to determine the correlation among the variables. There were some stages, such as designing structural model, correlating latent variables both endogen and exogen, and designing of measurement model with manifest variables. Figure 2 provides a correlation between indicator and latent variables used in this study.

![Figure 2. Input graphic of path](image)
3.1.2 Conversion of Path into structural equation. Based on Figure 2, the study obtained structural equation. The structural equation represents the effect among pedagogical, professional, social and personal competencies to students' final test grade

\[ Y = \rho_{y1} P_g + \rho_{y2} P_{ro} + \rho_{y3} P_{ri} + \rho_{y4} S_{os} + \rho_{y} \varepsilon_1 \]  

... (1)

3.1.3 Selection of input matrix and estimation. Standard estimation model of AMOS applied maximum likelihood (ML) estimation. ML estimation requires:

1) Large sample size

In this study, the total of respondents was 436. This number was categorized as a large sample size.

2) Multivariate data normally distributed

Normally distributed testing was presented by Critical Ratio (CR) value, based on skewness and kurtosis. If the CR value is between range - 2.58 to 2.58 (±2.58) at a significance level of 1% (0.01), it could be concluded that the data were normally distributed both univariate and multivariate.

The results of the normality test with AMOS software version 23 obtained a CR value of 2.344. Based on this value, it concluded that the data addressed the multivariate normal assumptions.

3) The hypothesized model is valid

The model was hypothesized based on the theory. According to the value of the validity output presented in the standardized regression weight table, it obtained there were no variable values with below 0.5. Consequently, the variables presented in the model reached out valid assumptions.

Based on the results of data processing, at the initial output model, there were still a number of indicators that contained a loading factor value of less than 0.5. Thus, that the indicators were discarded from the data.

Furthermore, data were reanalyzed and obtained the result as the second model presented in Figure 3. Figure 3 presents that there were not found the loading factor value less than 0.5. Thus, it concluded that the indicators applied in the study were valid.
3.1.4 Goodness of fit. Measure goodness of fit (GOF) is the main objective in SEM, which to determine the hypothesized model whether it 'fits' or matches the data sample. The following is a summary of the results of AMOS 23 output:

**Table 1. The goodness of fit measurement**

| Goodness of Fit Index | Cut off | Initial Model | Final Model | Description       |
|-----------------------|---------|---------------|-------------|-------------------|
| Prob. Chi-square      | Assump. | 0.000         | 0.001       | Model fit         |
| RMR                   | ≤0.05   | 0.055         | 0.049       | Fit               |
| RMSEA                 | ≤0.08   | 0.058         | 0.058       | Fit               |
| CMIN/DF               | ≤2.00   | 2.163         | 1.940       | Fit               |
| GFI                   | ≥0.90   | 0.848         | 0.854       | Marginal Fit      |
| CFI                   | ≥0.95   | 0.872         | 0.879       | Marginal Fit      |

Table 1 provides that the overall size of the goodness of fit model presents good results even though some of the sizes were categorized as marginal fit, which means we're not implied either good nor bad. Thus, it concluded that the model was accepted.
3.1.5 Model interpretation. The hypothesized model reached out several criteria needed. Therefore no need to modify the model. Table 2 presents, the estimated regression weight of each indicator on endogenous variables and endogenous variables on exogenous variables.

**Table 2.** Regression coefficient of each indicator on endogenous variables and endogenous variables on exogenous variables.

| Variable          | Path Coef. | Variable          | Path Coef. |
|-------------------|------------|-------------------|------------|
| Student's Final Test's | 0.317      | Pro 4             | 0.743      |
| - Pedagogical     | -0.085     | Pro 5             | 0.681      |
| - Professional    | 0.059      | Pro 6             | 0.661      |
| - Personality     | 0.138      | Pro 7             | 0.589      |
| pg 1              | 0.616      | Pro 8             | 0.593      |
| pg 2              | 0.535      | Pri 1             | 0.612      |
| pg 3              | 0.553      | Pri 2             | 0.63       |
| pg 4              | 0.612      | Pri 3             | 0.746      |
| pg 5              | 0.655      | Pri 4             | 0.703      |
| pg 6              | 0.637      | Pri 5             | 0.702      |
| pg 7              | 0.51       | Pri 6             | 0.645      |
| pg 8              | 0.621      | Sos 1             | 0.661      |
| pg 9              | 0.57       | Sos 2             | 0.53       |
| pg 10             | 0.635      | Sos 3             | 0.661      |
| pg 11             | 0.56       | Sos 4             | 0.578      |
| pro 1             | 0.522      | Sos 5             | 0.633      |
| pro 2             | 0.595      | Sos 6             | 0.659      |
| pro 3             | 0.693      |                   |            |

Additionally, it presents the correlation of each indicator within endogenous variables and endogenous variables on exogenous variables, and the correlation within endogenous variables and exogenous variables.
| Variables | Correlation Coefisien |
|-----------|----------------------|
| Pedagogical ↔ Social | 0.739 |
| Pedagogical ↔ Personal | 0.821 |
| Professional ↔ Personal | 0.850 |
| Personal ↔ Social | 0.870 |
| Pedagogical ↔ Professional | 0.899 |
| Professional ↔ Social | 0.824 |

Based on table 3 indicated that each competence provided positively impact to each other.

3.2 Discussion
Based on the results of data analysis, the correlation between the endogenous latent variables “final test grade” and exogenous latent variable “pedagogical, personal, social and professional competencies” as follows:

3.2.1 Generally, obtained structural mode was:

final test grade = 0.317 pedagogical - 0.085 professional + 0.059 personal - 0.138 social + e33

The regression coefficient between final test grade and pedagogical, and personal competencies was positive means that the final test grade was effected by pedagogical, and personal competencies. The pedagogical competences the most influence to the student’s final test grade.

The regression coefficient between final test grade and social and professional competencies was negative which means that if the final test grade was currently measured, the social and professional competencies could impact to the final test grade

3.2.2 Spesifically, the correlation between exogenous latent variables within the indicators explained as follow:

a) Pedagogical competence variable:
1) pg1 = 0.616 Pedagogical Competence + e1
2) pg2 = 0.535 Pedagogical Competence + e2
3) pg3 = 0.553 Pedagogical Competence + e3
4) pg4 = 0.612 Pedagogical Competence + e4
5) pg5 = 0.655 Pedagogical Competence + e5
6) pg6 = 0.637 Pedagogical Competence + e6
7) pg7 = 0.510 Pedagogical Competence + e7
8) pg8 = 0.621 Pedagogical Competence + e8
9) pg9 = 0.570 Pedagogical Competence + e9
10) pg10 = 0.635 Pedagogical Competence + e10
11) pg11 = 0.560 Pedagogical Competence + e11

Each of regression coefficient was positive; specifically Pg5 was the highest among others. This indicated that in fact, the teacher taught core and basic competencies, as well as the learning indicators briefly and clearly in the learning disclosure. Meanwhile, Pg7 was the lowest among other coefficients. This indicated that to improve the final test grade, according to pedagogical competence, the teacher was necessary to pay attention the clarity of explanation in learning objectives, materials, and student’s questions in the classroom. Therefore, it is necessary for teachers focussed on lesson plans that they designed [9]. Particularly on the curriculum 2013 the teacher still obtained several difficulties [10].
b) Professional competence variable
1) pro1 = 0.522 professional competence + e12
2) pro2 = 0.595 professional competence + e13
3) pro3 = 0.693 professional competence + e14
4) pro4 = 0.743 professional competence + e15
5) pro5 = 0.681 professional competence + e16
6) pro6 = 0.661 professional competence + e17
7) pro7 = 0.589 professional competence + e18
8) pro8 = 0.593 professional competence + e19

Each regression coefficient was positive, particularly Pro4 was the highest among others. This indicated that according to professional competence, the teacher explained the material and topics systematically and clearly.

Meanwhile, Pro1 was the lowest among others. This indicated that to improve final test grade based on the professional competence, the teacher needed to pay attention to the timeliness of teacher attendance, to provide the learning process effectively and efficiently as well as the accordance between material and learning objectives.

c) Personal competence variable
1) per1 = 0.612 personal competence + e21
2) per2 = 0.630 personal competence + e22
3) per3 = 0.746 personal competence + e23
4) per4 = 0.703 personal competence + e24
5) per5 = 0.702 personal competence + e25
6) per6 = 0.645 personal competence + e26

Each regression coefficient was positive, particularly Per3 was the highest among others. This indicated that according to personal competence, the teacher’s wisdom was sufficient to solve the students’ difficulties.

Meanwhile, Per1 was the lowest among others. This indicated that to improve final test grade based on personal competence, the teacher should improve the confidence in teaching.

d) Social competence variable
1) soc1 = 0.661 social competence + e27
2) soc2 = 0.530 social competence + e28
3) soc3 = 0.661 social competence + e29
4) soc4 = 0.578 social competence + e30
5) soc5 = 0.633 social competence + e31
6) soc6 = 0.659 social competence + e32

Each regression coefficient of social competence variable was positive, particularly Soc6 was the highest among others. This indicated that according to social competence, the teacher treated the students objectively.

Meanwhile, Soc1 was the lowest among others. This indicated that to improve final test grade based on social competence, it was necessary for the teacher to communicate and interact to all school members including the students. In the process of educating and teaching activities, on the basis of right moral values, felicitous application of strategies of the impression management will help teachers to enhance the interpersonal communication and be more harmonious, smooth and successful [11]. The teacher should improve confidence in teaching. This might reduce the stigma of ‘cruel math teacher’ even more dismiss it. The students might get close and freely consult to improve the students’ competencies and final test grades.
e) Correlation within exogenous latent variables
According to table 3, the correlation within each exogenous latent variables was extremely high each whose more than 0.73. For instance, the correlation between pedagogical and professional competencies was 0.899. This could be a significant recommendation to improve the teaching and learning plans, and delivering the materials systematically and clearly to enhance the students’ final test grade and competencies. As Zakiyati [12] stated that there was a significant effect among professional and pedagogical competencies on student learning achievement.

4. Conclusion and suggestion
Based on the study findings, it concludes that pedagogical and personal competencies improve the students’ final test grades as well as each of the indicator. The most influential of competence is pedagogical competence. The way of the teacher to explain the core and basic competencies briefly and clearly is the most influence toward the pedagogical competence. The teacher ability in explaining the materials and topics systematically in the learning process is the most influence on professional competence. The teacher wisdom to overcome the decision such as solving the student’s difficulties is the most influence toward personal competence. Furthermore, the teacher’s justice in treating the student is the most influence toward social competence.

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