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Submission date: 28-Jun-2023 03:04PM (UTC+0800)
Submission ID: 2123842901
File name: 3222-Article_Text-5891-1-10-20230223.pdf (263.73K)
Word count: 7587
Character count: 44033

European Journal of Humanities and Educational Advancements (EJHEA)
Available Online at: https://www.scholarzest.com
Vol. 4 No. 2, February, 2023
ISSN: 2660-5589

DEVELOPMENT MODEL OF MATHEMATICS TEACHER COMPETENCY IN VOCATIONAL HIGH SCHOOLS

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Article history:

Received: December 11th 2022
Accepted: January 11th 2023
Published: February 20th 2023

Abstract:

Competence is a person's ability and sense of responsibility a person demonstrates in the duties or works performed to produce quality outcomes. The present works seeks to analyze the internal factors that can formulate a model for developing the competence of mathematics teachers and how much impact these internal factors have on increasing the competence of mathematics teachers. This study was designed as an *ex post facto* study. The data were collected from a proportionally randomized sample of 90 mathematics teachers in Vocational High Schools. They were interviewed from July to October 2022. The data obtained were analyzed using the Structural Equation Model procedure. The results of the study show that the variables characteristic, motivation, and independence affect mathematics teachers' competence as shown by the following coefficients: 0.32, 0.87, and 0.25 significant at α = 0.05. Cumulatively (R2), the influence of characteristics, motivation, and independence on mathematics teachers' competence is 84%, and the remaining 16% is the influence of other variables outside this study.

Keywords: Mathematics teacher competence, characteristics, motivation, independence

INTRODUCTION

The duties and responsibilities of a teacher are to create changes in students' behavior, knowledge, skills, and attitudes so that students become human beings with character, personality, creativity, and innovation to achieve a decent life. Professional teachers are teachers who are able to carry out their main tasks and functions as educators, mentors, and teachers and develop learning curricula according to the abilities of teachers and students.

Teacher professionalism can be achieved by increasing the quality of competence possessed. Competence is an individual's ability to demonstrate specific activities in a work environment that is carried out with full responsibility so that the individual can complete the role and work properly (Calafato & Kevin, 2022).

According to Artacho et al. (2021), a teacher's competence can contribute to the formation of students' character, so teachers must be active, creative, innovative, and have high-integrity role models at school. According to Blomeke et al. (2022), teacher competence is shown through developing a learning curriculum which is the academic responsibility of a teacher to achieve learning objectives.

Professional teacher activities require competency standards according to the teacher's area of expertise. According to the Law of the Republic of Indonesia Number 14 of 2005 concerning Teachers and Lecturers, the main competency standards of a teacher consist of; pedagogical, personality, social, and professional competencies. Pedagogic competence is the teacher's ability to manage students by managing students' character, mastering learning theory, developing curriculum, conducting educational learning, communicating effectively, and conducting learning evaluations (Boe et al., 2022).

The teacher's personality competence reflects a mature, authoritative, wise attitude and becomes a role model for students who can motivate student achievement in the learning process (Lidyasari, 2014). Social competence is the ability of a teacher as a social being to develop attitudes that are inclusive, objective, communicative, and non-discriminatory in every learning process so that teachers can be accepted in the school and community environment (Rodriguez, 2021). According to Koberstein and Anke (2022), professional competence is the teacher's ability to master the material and substance of the learning curriculum based on structure and scientific methodology.

Merdeka Belajar curriculum is a curriculum that makes students the center of learning and teacher the facilitators, so it is hoped that there will be a paradigm shift in the process of utilizing technological innovations that make learning goals from learning products to fun and democratic learning process. Changes in the learning paradigm can be carried out through managing teacher competence, one of which is increasing teacher competency in the mathematics learning process, which places students as subjects, not as learning objects, planting the

impression that mathematics is easy and fun, learning strategies from monotony to more varied, realistic and integrated, as well as the use of relevant media following the topic and learning objectives..

In fact, mathematics teachers' competence at Vocational High Schools could be more optimal in transferring mathematical knowledge to students in the Province of Gorontalo. Mathematics teachers are still patterned on the old paradigm in using learning tools, such as; materials, media, and learning models that are still teacher-centered. The mathematics teacher has not provided concrete examples of various mathematical formulas following developments in the work environment and events experienced by students, so the process of learning mathematics is boring for students.

The competence of the mathematics teacher who is not optimal is closely related to the teacher's character, motivation, and independence in managing the mathematics learning process, which makes students the center of learning. The character, motivation, and independence of teachers who are not optimal are influenced by the level of education and training attended by the teacher and the existence of classroom management that does not consider the number of students and the ability of the teacher at each learning hour (Slemp et al., 2020).

Based on the reality on the ground, it is necessary to study the competence of mathematics teachers in Vocational High Schools through the management of various factors that influence the character, motivation, and independence of teachers in developing a mathematics learning process that is centered on students and following developments in the business world and the industrial world. The results of this study are expected to contribute to educational institutions, especially in preparing Vocational High School graduates who are ready to compete in the business and industrial world.

RESEARCH METHODOLOGY

Research Model

The research model employed ex post facto, which asses events that have occurred or assessments of factual conditions in the field. The research variables include independent variables (X) (teacher characteristics, teacher competence, teacher motivation, and teacher independence) and dependent variables (Y) (mathematics teacher competence).

Operational formulas for measurement equation models and structural equation models are created in accordance with the structural equation model to determine the effect of independent variables on the dependent variable. The formulas are described as follows:

A. Measurement model equation:

Measurement of characteristic variables:

$X_{1.1} = \lambda_1 X_1 + \delta_1$
$X_{1.2} = \lambda_2 X_1 + \delta_2$
$X_{1.3} = \lambda_3 X_1 + \delta_3$
$X_{1.4} = \lambda_4 X_1 + \delta_4$
$X_{1.5} = \lambda_5 X_1 + \delta_5$

Measurement of motivational variables:

$X_{2.1} = \lambda_6 X_2 + \delta_6$
$X_{2.2} = \lambda_7 X_2 + \delta_7$
$X_{2.3} = \lambda_8 X_2 + \delta_8$
$X_{2.4} = \lambda_9 X_2 + \delta_9$
$X_{2.5} = \lambda_{10} X_2 + \delta_{10}$
$X_{2.6} = \lambda_{11} X_2 + \delta_{11}$

Measurement of independence variables:

$X_{3.1} = \lambda_{12} X_3 + \delta_{12}$
$X_{3.2} = \lambda_{13} X_3 + \delta_{13}$
$X_{3.3} = \lambda_{14} X_3 + \delta_{14}$
$X_{3.4} = \lambda_{15} X_3 + \delta_{15}$

4. Measurement competency variables:

$Y_{1.1} = \lambda_{16} Y_1 + \varepsilon_1$
$Y_{1.2} = \lambda_{17} Y_1 + \epsilon_2$
$Y_{1.3} = \lambda_{18} Y_1 + \epsilon_3$
$Y_{1.4} = \lambda_{19} Y_1 + \epsilon_4$

B. Equation of the structural model of teacher competence:

$Y = \gamma_1 X_1 + \gamma_2 X_2 + \gamma_3 X_3 + \zeta_1$

Based on the measurement equation model and the structural equation model, the variables in this study are described in Table 1

Table 1. Variables and sub variables of the measurement equation model and structural equation model

Variable	Sub variable	Notation
Exogenous latency		
Teacher Characteristics	Age	$X_{1.1}$
	Years of service	$X_{1.2}$
	formal education	$X_{1.3}$
	Functional training	$X_{1.4}$
	Number of math lessons hours	$X_{1.5}$
Teacher Motivation	Self potential development	$X_{2.1}$
	Student recognition	$X_{2.2}$
	Teacher Salaries	$X_{2.3}$
	The need for achievement	$X_{2.4}$
	The need for affiliation	$X_{2.5}$
	The need for power	$X_{2.6}$
Teacher Independence	Emotional independence	$X_{3.1}$
	Intellectual independence	$X_{3.2}$
	Economic independence	$X_{3.3}$
	Social independence	$X_{3.4}$
Endogenous Latent		
Teacher Competency	Pedagogic competence	$Y_{1.1}$
	Personal competence	$Y_{1.2}$
	Social competence	$Y_{1.3}$
	Professional competence	$Y_{1.4}$

Population and Sample

Research Population

The study's population is mathematics teachers with the total of 215 individuals at public (58) and private (40) Vocational High Schools in Gorontalo Province. The population is described in Table 2.

Table 2. Population size of mathematics teachers in Gorontalo Province

Regency/City	Number of Mathematics Teachers (individuals)
Gorontalo Regency	55
Bone Bolango Regency	32
Boalemo Regency	26
Pohuwato Regency	21
North Gorontalo Regency	33
Gorontalo City	48
Total Province of Gorontalo	215

Research Sample

The study's unit of analysis is the mathematics teachers. A "proportional random sample" method was used to select a sample from a list of available names of mathematics teachers at the aforementioned school in Gorontalo Province. In addition, by employing the Slovin formula (Sevilla, 1993), the sample size for math teachers with an error rate of 8% is:

$$n = \frac{N}{1 + N(e)^2} \qquad n = \frac{215}{1+215\ (0.08)^2} = 90 \text{ people}$$

$$ni = \frac{Ni}{N} xn$$

Note: n = sample size
N = population size
e = standard error
ni = stratum i sample size
N_i= stratum i population size

The sample size of the study can be used to proportionally determine the sample size of mathematics teachers in each regency/city in Gorontalo Province, as stated in Table 3's explanation.

No	Regency/City	Sample size (people)
1	Gorontalo Regency	23
2	Bone Bolango District	13
3	Boalemo County	11
4	Pohuwato Regency	9

5	North Gorontalo Regency	14
6	Gorontalo City	20
Total		90

Data collection was carried out through structured interviews with respondents using a questionnaire. Further, in order to support the primary data, secondary data was collected from the affiliated institution, such as the district/city education office and the Gorontalo Province education office.

The data analysis employed is Structural Equation Model analysis with the LISREL (Linear Structural Relationships) program to describe the variables according to their indicators (measurement model) and to explain the causality relationship between variables (structural model).

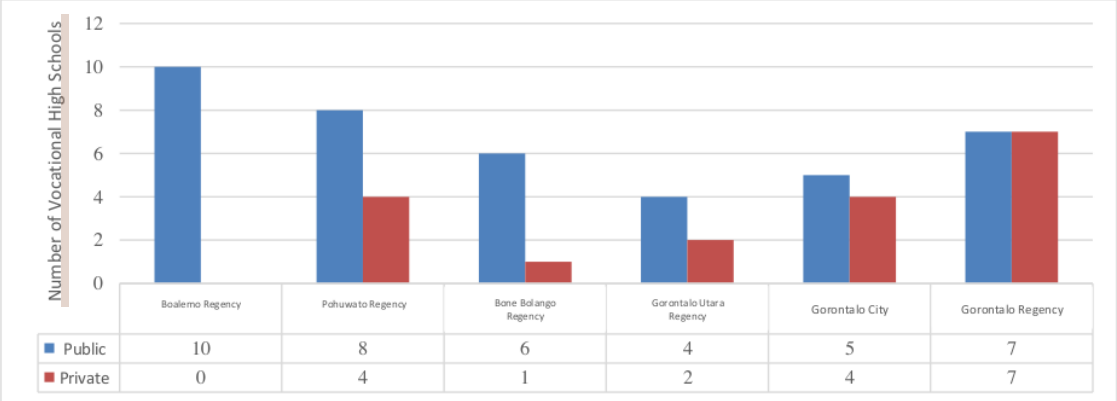
Several Goodness-of-Fit-Test (GFT) model suitability measures were used in the model measures. A structural model is indicated as suitable or fit if it meets three types of GFT, namely: (1) chi-square test p-count ≥ 0.05, (2) Root Means Square Error of Approximation (RMSEA) ≤ 0.08, and (3) Comparative Fit Index (CFI) ≥ 0.90.

Structured interviews with respondents utilizing a questionnaire were used to collect the data. Secondary data was gathered from associated organizations, such as the district/city education office and the Gorontalo Province education office, to supplement the primary data that was directly gained from the respondents

FINDING AND DISCUSSION

General Conditions of Vocational High Schools

Vocational High School is defined as formal education unit that organizes vocational education at the secondary education level that prepares students to work in particular fields. The number of Vocational High Schools in Gorontalo Province is presented in Figure 1.



Source: BPS Gorontalo Province, 2021.

According to Figure 1, there are 58 public and private vocational high schools in the Gorontalo Province. Boalemo Regency has the most public vocational high schools, with a total of 10 schools, while Gorontalo Regency has the most private vocational high schools, with a total of 7 schools. According to the study's findings, vocational high schools train students in a variety of expertise so they can compete in the business and industrial worlds.

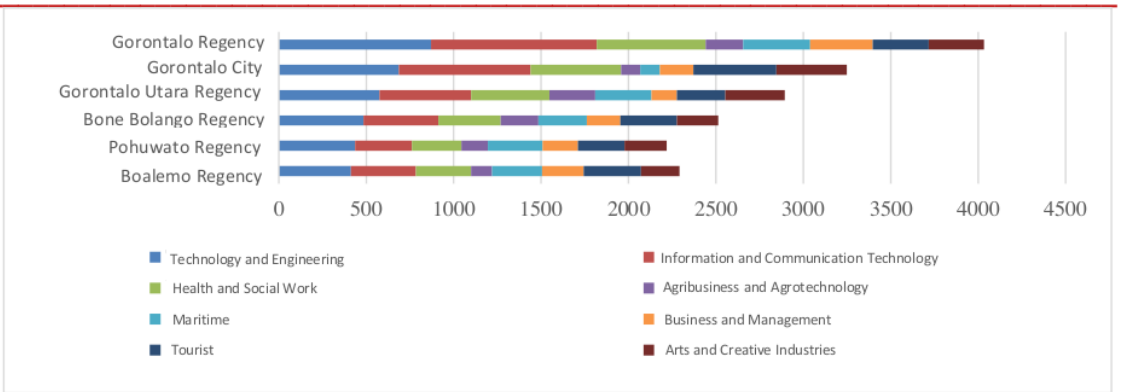
The results of this study are in line with the results of research from Zeng et al. (2022) which concluded that Vocational High Schools prepare students to be independent through the skills acquired while attending education so that they can create jobs and be able to compete in the world of work.

This research findings are in line with Zeng et al. (2022) research's which concluded that Vocational High Schools prepare students to be independent through the skills acquired in school, thus, they are able to create employment and be competitive in the workforce.

State of Expertise in Vocational High Schools

The field of expertise in Vocational High Schools is a field of interest in a study that becomes the students' competency expertise in a school. There are 8 (eight) fields of expertise for said school in Gorontalo Province: technology and engineering, information and communication technology, health and social work, agribusiness and agrotechnology, maritime, business and management, tourism, arts, and creative industries. The enthusiast in the expertise field is described in Figure

Figure 2 depicts interest in the field of expertise at Vocational High Schools in the Gorontalo Province



Source: Processed Research Data, 2022.

According to research findings in Figure 2, there will be 17,200 students enrolled in vocational high schools in Gorontalo Province for the 2022–2023 school year. The expertise fields with high student interest include Tourism expertise with 1993 individuals (11.59%), Health and Social Work with 2543 individuals (14.78%), Information and Communication Technology with 3350 individuals (19.48%), Technology and Engineering with 3466 individuals (20.15%), and the Arts and Creative Industries with 1757 individuals (10.22%). While the expertise fields with low interest are expertise in Maritime, Business, and management, as well as Agribusiness and Agrotechnology.

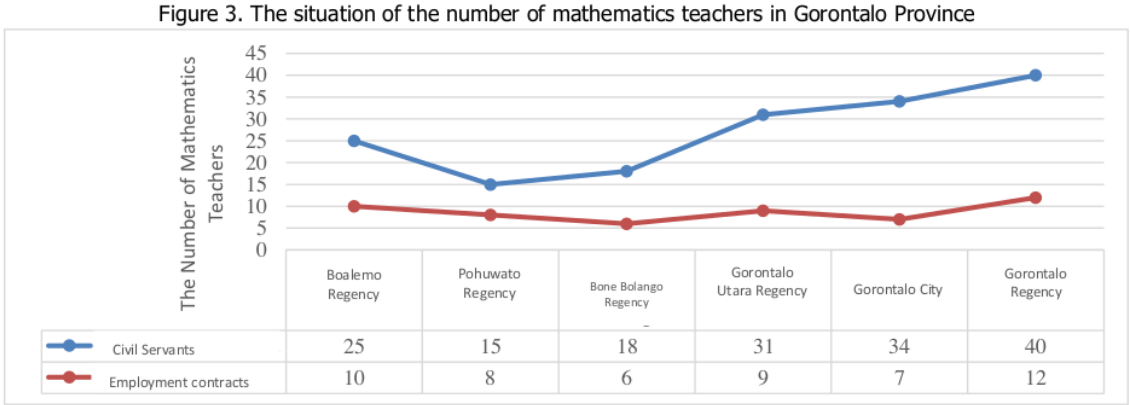
The research findings demonstrate that students have been interested in developing the Communication and Information Technology field since the era of the industrial revolution 4.0 Engineering and Information Technology, Health, and Tourism are needed to meet the needs of the business and the industrial world. On the other hand, the main expertise of students is supported by the fields of Business And Management, Maritime Affairs, Agribusiness, and Agrotechnology since this area of expertise are required to manage natural resources and industrial and office management.

The findings are in accordance with research findings by Erten et al. (2022) which concluded that in the business world and the industrial world, occupational health and safety expertise is required in an effort to prevent accidents that can cause harm to workers. Furthermore, research findings by Javaid et al. (2023) stated that the development of information and communication technology engineering in the industrial revolution 4.0 era requires a workforce that can collaborate between cyber and automation technology.

The Condition of Mathematics Teachers in Vocational High Schools

The number of mathematics teachers in Gorontalo. Mathematics teachers are professionals responsible for planning, carrying out the learning process, and assessing learning outcomes in mathematics subjects as well as guiding, training, and directing students. Teachers of mathematics must motivate students to learn mathematics by facilitating problem-solving and encouraging active learning, others than preparing and delivering the materials and formulas.

Figure 3. The situation of the number of mathematics teachers in Gorontalo Province



Source: Processed Research Data, 2022.

According to the research's findings, Figure 3 shows that there are 215 mathematics teachers in Gorontalo Province, including 163 Civil Servants (75.81%) and 52 Contract Employees (24.19%). This demonstrates that mathematics teachers in Vocational High Schools are under the responsibility of the state for the salary and benefits of teachers with the status of Civil Servants and the responsibility of the local government for the salaries and benefits

of teachers with the status of Contract Employees.

The findings are in line with the research findings from Dennis et al (2020) which concluded that teachers will be more active in developing the curriculum if the govermemt provide the teachers learning facilities and infrastructure, allowances. In addition, Ibrahim & Fawzia's research findings (2022) explain that teachers in carrying out their obligations need to be supported by the government's role in providing salaries as an effort to foster teacher motivation, independence, and competence to be more creative in developing a professional and innovative mathematics learning process.

Characteristics of Mathematics Teachers

Characteristics is defined as personal factors of an individual's life and environment such as: age, education, and psychological characteristics. According to Tinn (2021), characteristics are the primary traits of a teacher who play a role in finding new ideas to increase teacher professionalism. The characteristics of mathematics teachers are explained by age category, education level, education and training participation, years of service, and working hours. Characteristics will support the teachers competence who are ational, mental flexibility, and task-oriented in accepting innovation. The characteristics of mathematics teachers are described in Table 4.

Table 4. Characteristics of mathematics teachers in Gorontalo Province

Table 4. Characteristics of mathematics teachers in Gorontalo Province

Category	Number (individuals)	Percentage (%)
Age (years)		
30 – 35	53	25.58
36–41	48	22,33
42–47	43	20.00
48–53	38	17,67
58–63	31	14,42
Formal Education (years)		
Vocational High School (3)	21	9.77
Diploma (3)	42	19.53
Bachelor (4)	62	30.23
Masters (2)	51	23.72
Doctor (3)	36	16.74
Functional Training (Hours)		
Basic Training (30 - 80)	75	
Advanced Training (81 - 180)	47	34.88
Secondary Education and Training (181 - 480)	62	21.86
Higher Education and Training (481 - 640)	31	28.84
		14.42
Working Period (year)		
5 – 10	21	9.77
11 – 16	35	16,28
17–22	46	21.40
23 – 28	51	23,72
29 – 34	62	28,84
Number of Math Study Hours (Hours/Week)		
2 – 4	58	
5 – 7	76	26.98
8 – 10	81	35.35
		37.67

Source: Processed Research Data, 2022.

According to the study's findings in Table 4, mathematics teachers in vocational high schools are at a productive age. As a result, the teachers readily accept innovation and change the paradigm of the mathematics learning system, which encourages students to be more creative and innovative in their understanding and use of mathematical learning. Most mathematics teachers are in the 36-41 year category (22.33%), meaning that mathematics teachers generally have physical and potential performance in guiding, directing, and motivating students to understand and apply mathematic according to learning objectives.

This study's findings are consistent with those of Insulander et al. (2019), who argue that math teachers who are productive in age will be more creative and dynamic in using innovative techniques, materials, and learning media in order to improve students' mathematical comprehension and skills.

Education plays a role in developing the capacity of human resources, this orientation emphasizes the importance of education to increase individual productivity and professionalism in an organization. According to the findings in Table 4, the formal education of mathematics teachers at Vocational High Schools ranges from high school to doctoral degrees (S3). There total of 62 individuals (30.23%) mathematics teachers at Vocational High Schools have Bachelor's

degrees. This indicates that the level of undergraduate education is crucial for enhancing the capacity and competency of a teacher's human resources, thereby motivating teachers to implement scientific innovations that can improve the quality of the mathematics learning process.

This research findings are in accordance with research from Okolie et al. (2021), who found that the purpose of undergraduate education is to educate students with skills in research, community service, and the capacity to develop the downstream potential of science and technology for industry and business. Additionally, according to the findings of Cheung & Cheuk's (2022) research, the objective of undergraduate mathematics education is to improve students' knowledge, skills, and attitudes regarding the use of information and communication technology for mathematics learning, entrepreneurship, and the ability to manage educational institutions

Education and training are the creation of an adaptive and applicable work environment in which human resources can acquire knowledge, skills, and change of attitude so that expertise and skills are developed according to the work's demand. The research findings shown in Table 4 describe the education and training that mathematics teachers have attended, ranging from 30 to 640 hours of education and training at the basic to advanced levels. A total of 75 (34.88%) mathematics teachers at Vocational High Schools have completed 30 to 80 hours of basic education and training. This demonstrates that mathematics teachers in said schools are competent in teaching and implementing the mathematics curriculum according to their fields of competence.

The study's findings are consistent with Calavia et al.'s (2023) research, which explains that basic education and training attempts to prepare teachers to cope with occupations that have not been mastered in the classroom environment based on their fields of expertise. Moreover, according to Nutov et al. (2021), basic education and training for teachers function to provide basic skills and expertise to teach and guide students according to the teachers' level of work.

Work period or experience is an accumulated process of working process, training, implementing, and deciding to embrace an innovation in one's life and can have a favorable effect in improving performance to achieve organizational objectives. The results of the research in Table 4 explain that the tenure of mathematics teachers in Vocational High Schools ranges from 5 – 34 years. Further, there are as many as 62 (28.84%) math teachers have worked for 29-34 years, indicating that math teachers have experience in teaching and guiding in the field of mathematics in supporting students' primary skills in Vocational High Schools.

This research findings are in accordance with Sanmerier et al. (2002), which indicates that a teacher's tenure demonstrates competency while working as a teacher, particularly in developing the learning process and guiding students. Next, Prediger's research findings (2022), concluded that tenure is the period of time that teachers have used in teaching and guiding, changing the students' behavior.

The number of lesson hours is a certain period of time in teaching, both in class and in the laboratory. The number of study hours is determined by the teacher's ability to manage the learning process. The findings in Table 4 explain that the number of teaching hours for mathematics teachers in Vocational High Schools ranges from 2 – 10 hours of lessons. As many as 81 (37.67%) math teachers have study hours between 8-10 hours. This demonstrates that mathematics teachers in vocational high schools seek their best attempt to strengthen the mathematics learning process, which is supported by the teacher's ability to effectively and efficiently manage classes and laboratories.

The findings are in line with Buchbinder & Sharon's research (2020), which concludes that the management of the mathematics learning process is part of the implementation of planned mathematics lessons in accordance with abilities. Additionally, according to Haser et al.'s (2022) research findings, the number of study hours for mathematics teachers is the time requirement used by teachers in teaching mathematics in accordance with lesson plans and the suitability of the number of students.

MATHEMATICS TEACHER COMPETENCY MODEL

The competence of mathematics teachers was analyzed with the parameters of the structural equation model, as described in Figure 4.

Figure 4. Estimation of all parameters of the structural model of mathematics teacher competence

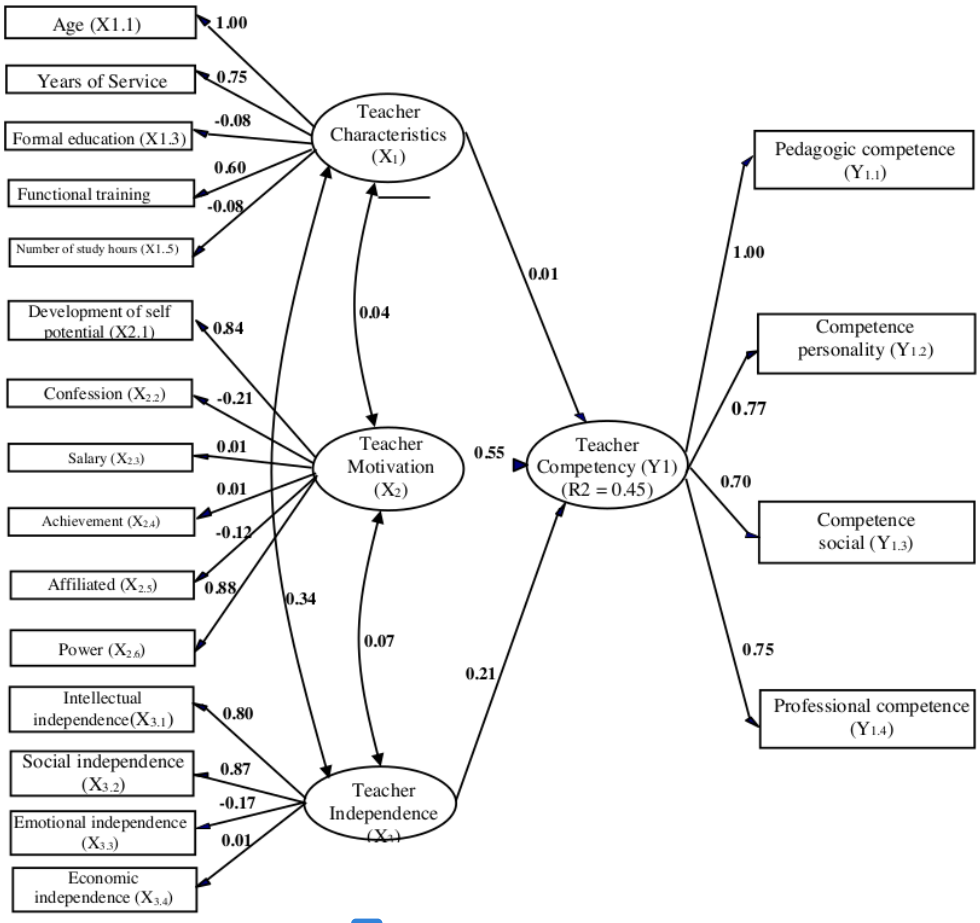
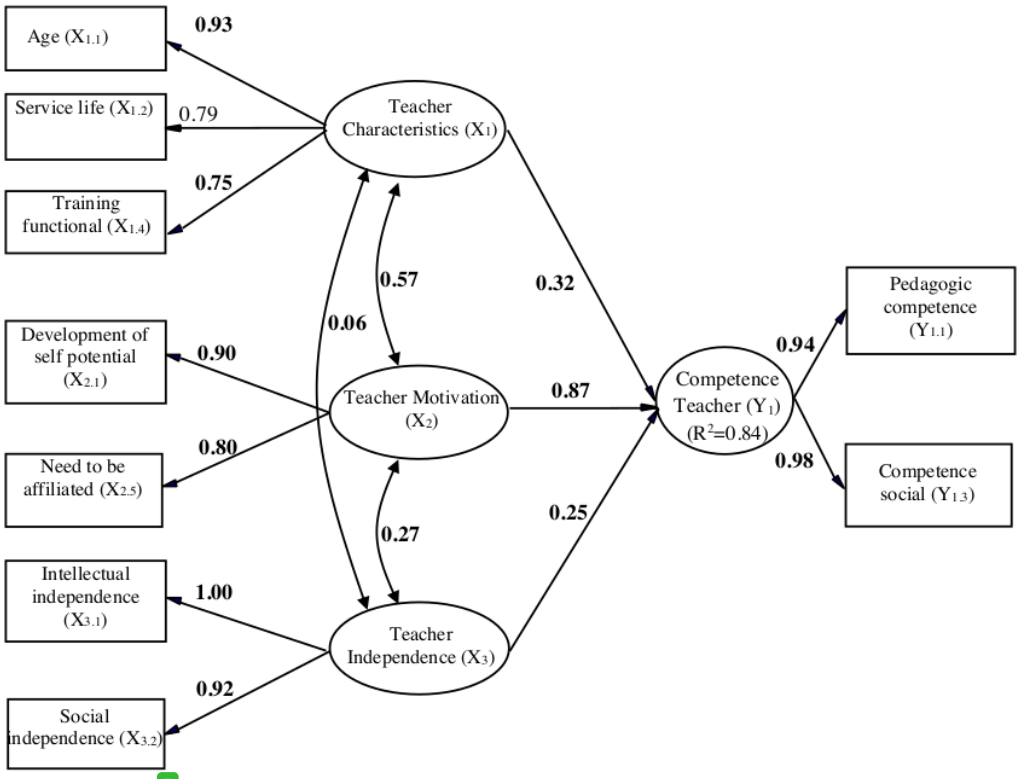


Figure 4 reveals the p-value = 0.00000 <0.05, the Root Mean Square Error of Approximation (RMSEA) value = 0.143 > 0.08, and the Comparative Fit Index (CFI) value = 0.62 <0.91, meaning that the model those tested were unable to estimate the population covariance matrix or the results of the estimation of model parameters could not be applied to the study population. Thus the results of the model suitability test in Figure 4 show that the measurement model does not fit the data, the model needs to be repaired.

Kusnendi (2008) states that, if an invalid indicator is found in the model, then the indicator is removed from the measurement model. That is, the measurement model is corrected and the factor weight coefficient is re-estimated. An indicator is said to be valid and reliable in measuring its latent variables if: (1) statistically the coefficient of the weighted factor is real at an error rate of α = 0.05, and (2) the magnitude of the estimated coefficient of the weighted factor of each standardized indicator is not less than 0 .40 or .50. Thus the improvement of the model that is not fit refers to both of these things. After repairing the model, a fit model was found based on the estimation of the parameters of the structural model of the mathematics teacher's competence and the t-statistical t-count of the parameters of the mathematics teacher's competency structural model as shown in Figure 5.

Figure 5 shows the p-value = 0.073 > 0.05, the Root Mean Square Error of Approximation (RMSEA) = 0.050 <0.08 and the Comparative Fit Index (CFI) value = 0.95 > 0.91. This means that the tested model is capable of estimating the population covariance matrix or the results of estimating model parameters can be applied to the study population, thus the results of the model fit test show that the measurement model is fit with the data. Figure

5. Parameter estimation of the structural model of mathematics teacher competence



Chi-Square = 71.12, df = 55, *p*-count = 0.073, RMSEA = 0.050, CFI = 0.95

After analyzing the variables that affect a mathematics teacher's competency, a structural model of the competency is discovered, as illustrated in Figure 5. This figure depicts the track of influence between the variables, and the structural model equation can be formulated as follows:

$Y = 0.32X_1 + 0.87X_2 + 0.25X_3$

Overall the analysis result demonstrates the relationship and influence between variables/sub variables in the mathematics teacher competency model which is summarized in Table 5.

Table 5. Decomposition of the influence between variables/sub-variables of the mathematics teacher competency model

The relationship between variables/sub variables			Influence Direct	Indirect	Total	*t count*
Teacher characteristics	→	**Teacher competence**	**0.32**	**-**	**0.32**	**2.59**
Teacher characteristics	→	Pedagogic		0.19	0.19	3,13
Teacher characteristics	→	Social		0.16	0.16	2.95
Teacher motivation	→	**Teacher competence**	**0.87**	-	**0.87**	**3,33**
Teacher motivation	→	Pedagogic	-	0.51	0.51	5,16
Teacher motivation	→	Social	-	0.43	0.43	4,44
Teacher independence	→	**Teacher competence**	**0.25**	**-**	**0.25**	**2,23**
Teacher independence	→	Pedagogic	-	0.14	0.14	2.39
Teacher independence	→	Social	-	0.12	0.12	2,31

Description: t 0.05 table = 1.96

The equation of the measurement model and the structural equation model as shown in Figure are described as follows:

A. Measurement model equation

1. Loading on teacher characteristic variables (X_1):

$X_{1.1} = 0.93\ X_1$

$X_{1.2} = 0.79\ X_1$

$X_{1.4} = 0.75\ X_1$

2. Loading on teacher motivation variables (X_2):

$X_{2.1} = 0.90\ X_2$

$X_{2.5} = 0.80\ X_2$

3. Loading on teacher independence variables (X_3):

$X_{3.1} = 1.00\ X_3$

$X_{3.2} = 0.92\ X_3$

4. Loading on the mathematics teacher competency variable (Y):

$Y_{1.1} = 0.94\ Y$

$Y_{1.3} = 0.98\ Y$

B. Structural model equation for Mathematics Teacher Competency:

$Y = 0.32X_1 + 0.87X_2 + 0.25X_3$

The Impact of Characteristics on Mathematics Teacher Competence

The findings in Table 5 reveals that the characteristic variables significantly affect the mathematics teacher's competency. This means that the characteristics are able to determine the quality of the mathematics teacher's competence with an effective coefficient of 0.32 which is significant at α = 0.05. The influence of characteristics on mathematics teachers' competence appears in the quality of mathematics teachers' pedagogic competence and social competence. This indicates that if there is an increase in one characteristic unit, it will increase the pedagogical competence of mathematics teachers by 0.19 units and, at the same time, increase the social competence of mathematics teachers by 0.16 units.

The findings explicate the increase in pedagogical competence because mathematics teachers are very good at managing students' character, mastering mathematics learning theory, conducting educational learning according to the curriculum, communicating effectively, and evaluating mathematics learning well while increasing social competence because mathematics teachers always develop attitudes that are inclusive, objective, communicative, and non-discriminatory in every process of learning mathematics so that teachers can be accepted in the school and community environment.

The findings in line with the results of research from Boe et al. (2022), which explain that pedagogical competence is the teacher's ability to manage students in the form of managing students' characters, mastering learning theory, developing curriculum, conducting educational learning, communicating effectively, and carry out learning evaluations. Furthermore, the results of research from Rodriguez (2021) explain that social competence is the ability of a teacher as a social being to develop attitudes that are inclusive, objective, communicative, and non-discriminatory in every learning process so that teachers can be accepted in the school and community environment

The Impact of Motivation on Mathematics Teacher Competence

The research findings in Table 5 reveals that the motivation variable directly has a significant effect on the competency of the mathematics teacher, this means that motivation can determine the quality of mathematics teacher competence with an effective coefficient of 0.87 which is significant at α = 0.05. The influence of motivation on mathematics teacher competence appears in the quality of the pedagogic competence and social competence of mathematics teachers. This indicates if there is an increase in one unit of motivation, it will increase the pedagogic competence of the mathematics teacher by 0.51 units and, at the same time, increase the social competence of the mathematics teacher by 0.43 units.

The findings explain that the increase in pedagogical competence is because mathematics teachers are motivated to attend formal education, education, and training and try to develop the process of learning mathematics in Vocational High Schools according to the independent learning curriculum. While increasing social competence because mathematics teachers are motivated to be accepted by students in the school and community environment, try to progress and succeed in carrying out the mathematics learning process, and always try to participate in every school activity.

This research's findings align with Sufian Burhan et al. (2014), which explain that each individual is motivated by innate needs from birth, which makes the individual satisfied with his needs to survive. Furthermore, the results of research from Currie et al. (2022) concluded that motivation is the driving force in directing employees and organizations so that they want to work together, work effectively, and be integrated to achieve self-satisfaction and organizational objectives.

The Impact of Independence on Mathematics Teacher Competence

The research findings in Table 5 depicts that the independence variable directly has a significant effect on mathematics teachers' competence. This means that independence can determine the quality of mathematics

teachers' competence with an effective coefficient of 0.25 which is significant at α = 0.05. This indicates that if there is an increase in one unit of independence, it will increase the pedagogical competence of mathematics teachers by 0.14 units and, at the same time, increase the social competence of mathematics teachers by 0.12 units. The influence of independence on mathematics teachers' competence can be seen in the quality of the pedagogic competence and social competence of mathematics teachers.

The reserch findings explain that the increase in pedagogical competence because mathematics teachers have independence in developing innovative methods, materials, and learning media to make it easier for students to know and understand mathematics lessons in their area of expertise, in contrast, increasing social independence. After all, mathematics teachers are able to be independent in growing self-confidence and giving meaning to students to understand mathematics according to their field of expertise in Vocational High Schools

The findings are in accordance with the research's findings from Lahdenpera et al. (2022), which explain that the independence of the pedagogic competence of mathematics teachers is determined by the teacher's ability to develop learning materials according to the abilities of students which is supported by increased innovation in mathematics learning media according to the learning curriculum. Furthermore, the results of research from Lihong et al. (2022) concluded that the social competency independence of mathematics teachers is based on the teacher's ability to give students confidence that mathematics lessons are very easy to understand because teachers are able to interpret mathematics subject matter according to students' areas of expertise.

THE IMPACT OF CHARACTERISTICS, MOTIVATION, AND INDEPENDENCE ON COMPETENCY OF MATHEMATICS TEACHERS

The results inidcated that the variable characteristics, motivation, and independence had a significant effect on the competency of the mathematics teacher with a coefficient of determination (R2) of 84% which was significant at α=0.05 (Table 3). This means that the three independent variables (X) together have a significant effect on the competency of the mathematics teacher (Y) by 84%, and the remaining 16% is the influence of other variables not included in this study.

The impact of characteristics on the competence of mathematics teachers is determined by three dimensions: the teacher's age, tenure, and functional education and training that the mathematics teacher has attended. This means that increasing age, years of service, and functional education and training will increase mathematics teachers' competence. While the other two dimensions of teacher characteristics, namely: formal education and the number of hours of mathematics lessons in this study, have an estimated factor weight coefficient of less than 0.40 which is not significant at α = 0.05. This means that the two dimensions are not valid in measuring mathematics teachers' competence in Vocational High Schools.

The impact of motivation on the competence of mathematics teachers is determined by two dimensions, which are the motivation for self-potential development and the motivation for affiliation. This means that increasing motivation for developing self-potential and the need for affiliation will increase mathematics teachers' competence. In contrast, the other four dimensions of teacher motivation, namely: student recognition, income, need for achievement, and need for power in this study, have less estimated factor weight coefficients. of 0.40 which is not significant at α = 0.05. This means that the four dimensions of motivation are not valid in measuring mathematics teachers' competence in Vocational High Schools.

The impact of independence on mathematics teachers' competence is determined by two dimensions: intellectual and social independence. Increasing intellectual and social independence will increase mathematics teachers' competence. In contrast, the other two dimensions of independence, namely emotional and economic independence in this study, have an estimated factor weight of less than 0.40 which is not significant at α = 0.05. This means that the four dimensions of independence are not valid in measuring mathematics teachers' competence in Vocational High Schools.

The findings are in line with the results of research from Roy et al. (2020) which explain that in the learning process in Vocational High Schools, in addition to requiring expertise to apply technological innovations, a teacher needs to have psychological factors, such as personality and independence which can motivate students to master discipline. Furthermore, the research results from Vries et al. (2022) concluded that teacher characteristics could influence student learning development, especially in understanding learning material adapted to the school environment and students' abilities.

CONCLUSION

Based on the findings and discussion, the internal factors that influence in formulating the competency development model for mathematics teachers in Vocational High Schools are: age, years of service, functional training, self-potential development, need for affiliation, intellectual independence, and social independence, which is a manifestation of the characteristics, motivation, and independence of teachers independence. Cumulatively (R2), the influence of characteristics, motivation, and independence has an 84% influence on mathematics teacher ability; the remaining 16% comes from an external factor

ACKNOWLEDGMENT

We would like to thank the Provincial Government of Gorontalo for the permits and the funds so that this research can be completed in the allocated time. We also want to thank vocational high school mathematics teachers who who participated in the study as the respondents

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