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Measurement of Teacher Competence

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ABSTRACT

The quality of in-service and the preparation of pre-service teachers significantly impact education systems. However, existing literature lacks a structured framework for objectively measuring teacher competencies at a national level. This study aims to address that gap by developing a conceptual framework to assess teacher competence through a mathematical model. We propose a Teacher Competence Measurement by assigning numerical values to key competency components — academic achievements, pedagogical skills, and professional experience. This model quantifies teacher effectiveness and provides a systematic tool for evaluating in-service teachers in secondary schools in Mongolia. The findings contribute to enhancing teacher assessments and professional development strategies.

Keywords: Teacher Competence Measurement, Quantitative Assessment, Competency Modeling, Teacher Performance Evaluation

INTRODUCTION

Teacher competency is a crucial determinant of educational quality. Various factors, such as teaching skills, subject specialization, professional development, and classroom effectiveness, impact learning outcomes. Despite national qualification frameworks standardizing teacher requirements, an objective, numerical method to measure teacher competence remains underdeveloped.

This study aims to design a quantitative measurement tool for teacher competence by leveraging mathematical modeling. We hypothesize that:

1. Teacher competence consists of distinct measurable components.
2. Each component can be assigned numerical values based on defined parameters.
3. A mathematical model can establish correlations among these components, allowing standardized evaluation.

By formulating a Teacher Competence Measurement, we looked into providing a framework that enhances teacher assessment methodologies.

LITERATURE REVIEW

Historical approaches to teaching assessment evolved from Socratic dialogue (5th century BC) to structured qualification frameworks in the 21st century, including professional qualities of teaching and teacher competence (Government du Quebec, 2002). The teacher's competence and teaching quality strongly influence education service outcomes. The benefit of the education function key is variable (Juerges, 2004). The variable is a leading, defined factor; the learner's grade and school efficiency (Rowe, 2003).

Indeed, school education is the basis of adjusted existence in reforming national micro and macroeconomics and continuously develops on-the-job training. The Organization for Economic Cooperation and Development (OECD) defined the source of education as teacher competence and the quality of teaching (OECD, 1986, 1989, 1993). The OECD examined 23 cases of innovation tools in Mathematics, Natural Science, and technology. The study found that six main variables strongly affect (shock) education innovation. The OECD and international education bodies unequivocally emphasize teacher quality as a primary factor influencing student outcomes (Atkin, 1998). However, most studies focus on qualitative assessments, lacking an objective numerical model for competency measurement.

Key studies highlight essential teacher competencies, including pedagogical knowledge, subject expertise, communication skills, and professional experience. Understanding educational theories and methodologies (Shulman 1987) is one of the essential teacher competencies and pedagogical knowledge includes main sections such as content knowledge, curriculum knowledge, and didactic knowledge. Luvsandorj. Ts and others (2003) considered the result of the study that is focused on identifying education reform trends such as content, methodology, communication, and compassion competencies. In 2013, thirty-six countries joined the Collaboration in the European Qualification Framework and developed a framework that includes eight levels of competencies. This international collaboration underscores the global impact of the work being done in this field.

Graham Donaldson, who explored the teacher framework of Balkan countries (2012), emphasized that the national framework of teacher competence is a tool for systemizing and unifying/standardizing entrepreneurs' distinct requirements, interests, and aspirations as well as various viewpoints and innovations. Australia has designed its qualification framework for educators, which consists of 10 qualification levels and five qualification degrees, and each level and degree maintains various knowledge, skills, competencies, and content capacity (Australian Qualification Framework Council, 2013). Similarly, India has developed its national qualification framework, which consists of ten indicators such as procedural, professional knowledge, professional skill, essential skills, and responsibilities (Ministry of Finance, India, 2013). South America also has developed and complied with minimum requirements for teacher education qualification (The Department of Higher Education and Training, 2011).

In the case of our country Mongolia, the local government is working on the design and implementation of the national vocational education and training field qualification frameworks, which consist of ten categories. Despite the acknowledgment of these efforts and initiatives, no standardized numerical assessment tool exists. This study builds upon previous research to design a quantitative evaluation system for teacher competence.

METHODOLOGY

This study involved 50 secondary school teachers from Amgalan Complex School, Ulaanbaatar. The participants specialized in various subjects, including technology, science, foreign languages, and physical education. The sample included 7 male and 43 female teachers, with varying levels of academic qualifications.

Competency Measurement Framework

Based on our studies, four key competencies were identified and grouped together:

1. **Content Competence** – Subject knowledge and academic qualifications.
2. **Methodical Competence** – Pedagogical skills and instructional strategies.
3. **Communication Competence** – Interaction with students, peers, and engagement methods.
4. **Compassion Competence** – Empathy, mentoring, and student satisfaction.

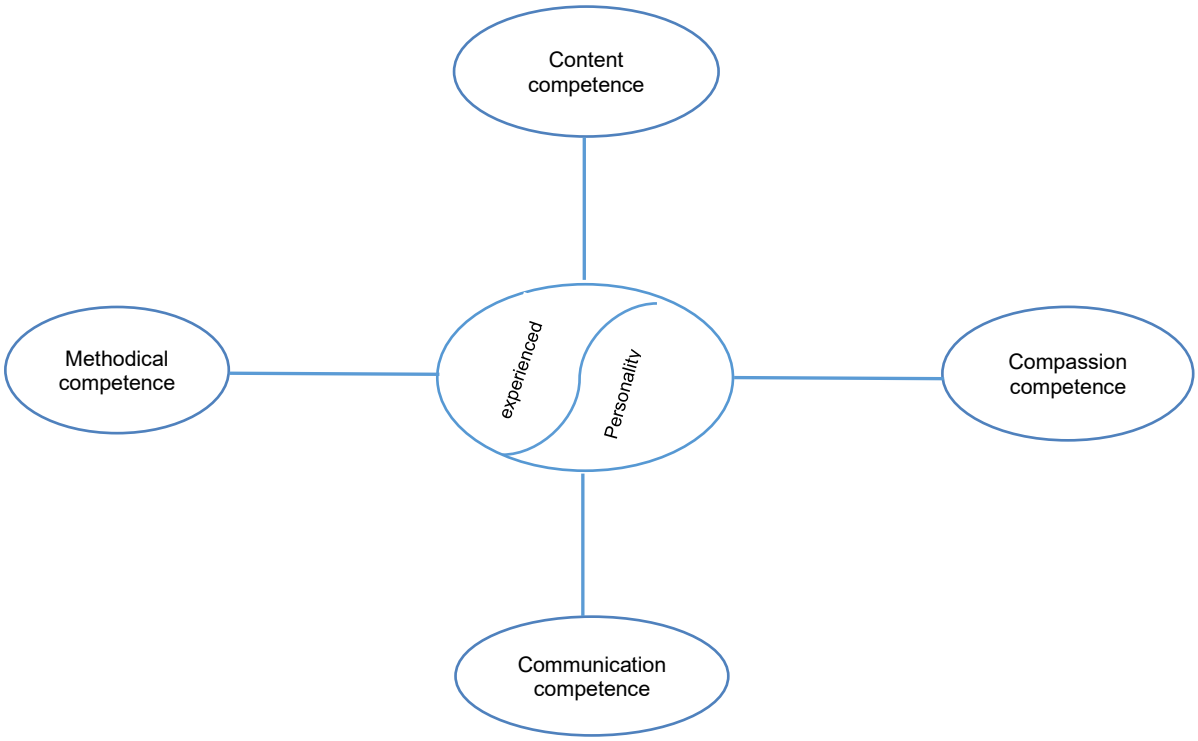

Figure 1. Competency Measurement Framework

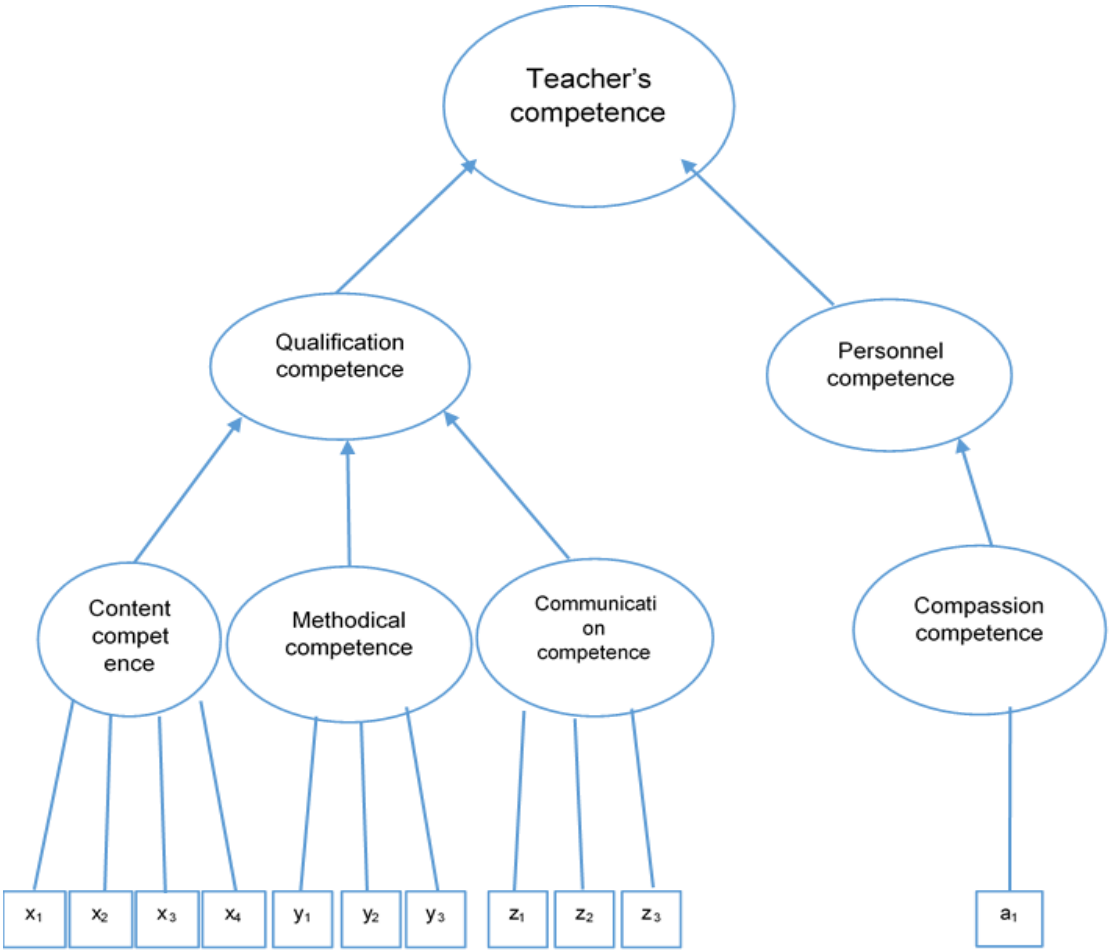

Figure 2. Teacher competence standard

Each competency was assigned a numerical value based on academic records, performance evaluations, and student feedback surveys. Using statistical analysis (T-tests, ANOVA, regression models) in SPSS and AMOS software, we developed a correlation model for teacher competence.

Teacher competence (y) is reckoned as a linear correlation of its content (x_1), methodical(x_2), communication (x_3), and compassion (x_4) competence. In this case, the Teacher Competence Measurement was formulated as:

$y=a\times x_1+ b\times x_2+ c\times x_3+ d\times x_4$.

Where:

Y = Overall teacher competence score
X_1 = Communication Competence
X_2 = Methodical Competence
X_3 = Content Competence
X_4 = Compassion Competence

The coefficients were determined through regression analysis, ensuring statistical significance.

Data Processing and Analysis

For the teachers involved in the study, competence mean was 83.72 (standard deviation of 5.496); of male teachers was 83.29 (standard deviation of 7.342); female teacher's communication competence mean was 85.49 (standard deviation of 6.695); methodical competence mean of male teachers was 81.14 (standard deviation 5.210); methodical competence mean of female teachers was 86.37 (standard deviation 5.394); content competence mean of male teachers was 79.43 (standard deviation 4.392); content competence mean of female teachers was 86.16 (standard deviation 4.392) compassion competence mean of male 80.57(standard deviation 4.315), compassion competence mean of female teachers 81.95 (standard deviation 4.220). Moreover, you can see the communication methodical, content, and compassion competencies from the chart below (Chart 1).

Chart 1. Basic performances of statistics.

Criteria	Mean	Std. Deviation	N
Communication competence	85.18	6.754	50
Methodical competence	86.06	5.373	50
Content competence	85.22	5.804	50
Compassion competence	81.76	4.216	50

We tested using the Independent samples test method whether teachers' competencies distinctively depended on their gender. Communication competence t=-0.797(48), p=0.429; methodical competence t=-0.505(48), p=0.615; content competence t=-3.613(48), p=0.001; compassion competence t=-0.801(48), p=0.427. Hereof we have observed that there are no gender differences in teachers' competencies.

Therefore we analyzed using the ANOVA method if there was a correlation between the competencies, communication competence was F=1.995, p=0.045; methodical competence was F=0.345, p=0.993; content competence was F=1.332, p=0.237; compassion competence was F=0.834, p=0.665. Also, we found out that the competencies were not correlated to the teacher's standing.

Content, methodical, communication, and compassion competencies have direct and strong correlations to an individual teacher's competence. In addition, four competencies were related to the teacher's competence on the coefficient of determination (R^2)

Chart 2. Result of determination examination

R Square	F Change	Sig. F Change	Durbin-Watson
0.997	3800.530	.000	1.825

We designed a model to reckon with and assess teachers' competence, factor analyze correlation, and quantitative correlation. Herein, we used the AMOS program and expressed a path model to show non-measurable variables.

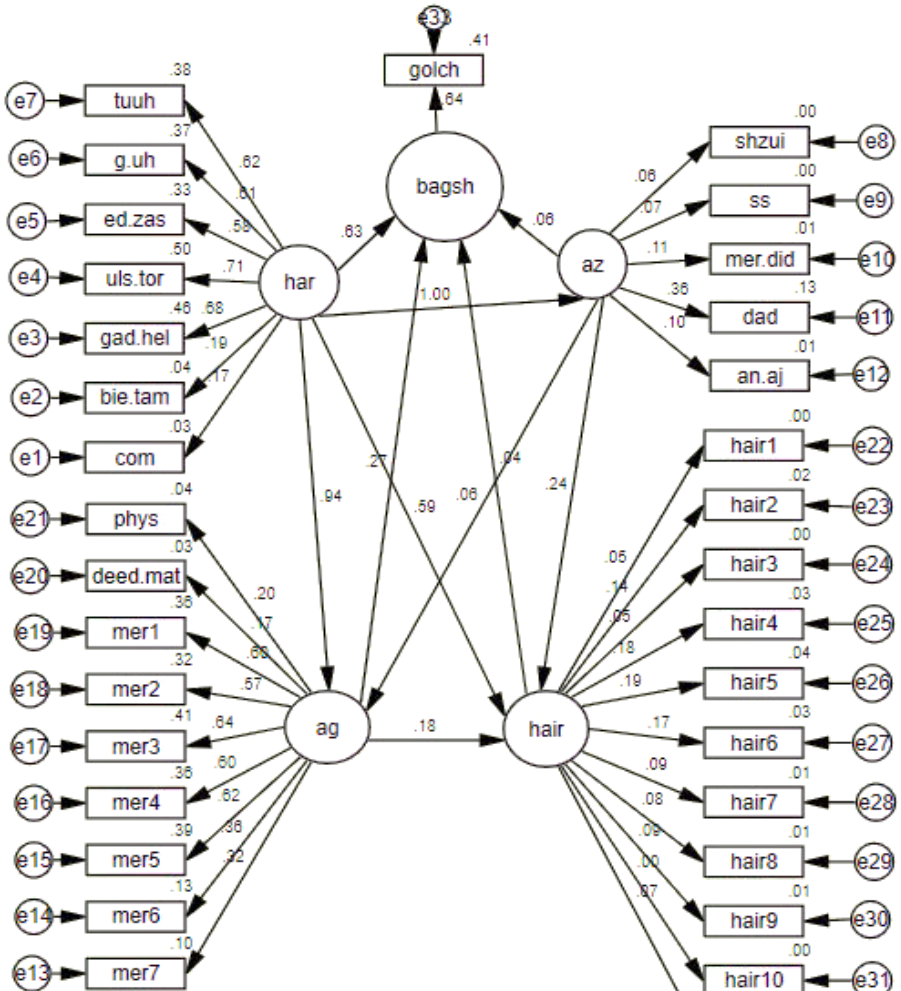

Figure 3. Correlation sketch of teacher competence set

Finally, we studied the correlation between teacher's competence in communication, methodical, and compassion competencies and designed a mathematical model of their correlation. (2)

$$Y=0.310x_1 + 0.608x_2 + 0.597x_3 + 0.199x_4 \quad (2)$$

Here is the equation of Y expressing the Grade Point Average (GPA) of teachers, x_1 - communication competence, x_2 - methodical competence, x_3 – content competence, x_4 – compassion competence. Equation coefficient (0.310, 0.608, 0.597, 0.199) tetrad was defined as dimension vector, and (x1, x2, x3, x4) were found in the teacher's data; they were defined as teacher's vector. The teacher's competence is the dot product of dimension and the teacher's vector.

FINDINGS

The study's findings include developing a method for measuring teacher competence based on individual teachers and collection of various data on their teaching approaches at the national secondary school, as well as measuring teacher competencies and techniques for using the measurement.

Teacher competence scores ranged from 79.43 to 86.37, with no significant gender-based differences.

Correlation analysis revealed a strong relationship between content knowledge and overall competence, reinforcing the importance of subject expertise.

Regression results confirmed the model's validity, making it a reliable tool for evaluating teacher effectiveness.

DISCUSSION

This study provides a structured mathematical approach to teacher assessment, offering an alternative to subjective evaluations. The Teacher Competence Measurement can be integrated into national teacher qualification frameworks to standardize assessments and improve professional development strategies.

IMPLICATIONS:

- Policymakers can use the model to enhance teacher certification processes.
- Schools can implement the tool to identify competency gaps and provide targeted training.
- Further research can refine the model by incorporating additional competency variables.

CONCLUSION

This study developed a quantitative measurement model for assessing teacher competence, introducing the Teacher Competence Measurment. By systematically quantifying competencies, this tool provides an objective, scalable approach to evaluating and enhancing teacher quality. Future research should explore cross-national applications to adapt the model to diverse educational systems.

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