JURNAL SAINS PSIKOLOGI

Volume 14, Number 1, March 2025
pp. 27-38
http://dx.doi.org/10.17977/um023v14i12025p27-38

Confirmatory Factor Analysis to Measure Teachers' Emotional Scale in Digital Technology Classroom

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Article Information

Submitted date	15-10-2024
Revised date	25-02-2025
Accepted date	26-02-2025

Keywords:
confirmatory factor analysis;
teachers' emotional scale;
measurement scale;
digital competence of teachers.

Abstract

Digital technology is changing the educational landscape, requiring teachers to adapt to the changes. Integration of digital technology into the classroom requires teachers to master technology while handling various digital accesses. Teachers' emotions are an important aspect that requires readiness to handle stress and adapt to the 21st-century learning environment. This research aims to conduct a confirmatory factor analysis to measure the scale of teachers' emotions in digital technology classrooms. The research design used was a cross-sectional survey. The respondents were teachers of the Guidance and Counseling Study Program who were members of the in-service teacher education program at Universitas PGRI Adi Buana Surabaya for the 2023–2024 Academic Year, totaling 66 people with an average work period of five years. The research instrument used a scale of teacher emotions in the digital technology classroom consisting of 28 items with loading factor values between .598 and .846. Data analysis used CFA. The findings showed goodness of fit between the RMSEA, CMIN/DF, TLI, and CFI indices because they met four suitability criteria. The research contributes to developing a valid scale of teacher emotionality in technology classrooms. The implications of the research are to provide practical solutions for educational institutions and policymakers to better support teachers in navigating the emotional landscape in technology classrooms. At the same time, the limitations of the research lie in the small sample size and limited focus.

Kata kunci:
analisis faktor konfirmatori;
skala emosional guru;
skala pengukuran;
kompetensi digital guru.

Abstrak

Teknologi digital mengubah lanskap pendidikan, menuntut guru untuk beradaptasi dengan perubahan. Integrasi teknologi digital ke dalam kelas menuntut guru untuk menguasai teknologi sekaligus menangani berbagai akses digital. Emosi guru merupakan aspek penting yang menuntut kesiapan untuk menangani stres dan beradaptasi dengan lingkungan belajar abad ke-21. Penelitian ini bertujuan untuk melakukan analisis faktor konfirmatori untuk mengukur skala emosi guru di ruang kelas teknologi digital. Desain penelitian yang digunakan adalah survei *cross-sectional*. Responden adalah guru Program Studi Bimbingan dan Konseling yang tergabung dalam PPG Daljab di Universitas PGRI Adi Buana Surabaya Tahun Akademik 2023–2024, berjumlah 66 orang dengan masa kerja rata-rata lima tahun. Instrumen penelitian menggunakan skala emosi guru di kelas teknologi digital yang terdiri dari 28 *item* dengan nilai *loading factor* antara 0,598 dan 0,846. Analisis data menggunakan CFA. Temuan menunjukkan kesesuaian antara indeks RMSEA, CMIN/DF, TLI, dan CFI, karena memenuhi empat kriteria kesesuaian. Penelitian ini berkontribusi untuk mengembangkan skala emosionalitas guru yang valid di ruang kelas teknologi. Implikasi dari penelitian ini adalah untuk memberikan solusi praktis bagi lembaga pendidikan dan pembuat kebijakan untuk lebih mendukung guru dalam menavigasi lanskap emosional di ruang kelas teknologi. Sementara itu, keterbatasan penelitian terletak pada ukuran sampel yang kecil dan fokus yang terbatas.

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INTRODUCTION

Digital technology has changed the educational landscape, requiring teachers to adapt to changes in teaching. Classrooms that utilize digital technology are characterized by various internet-connected learning devices such as computers, smartphones, and open learning resources that facilitate a more interactive and dynamic learning environment. The integration of digital technology into the classroom not only changes the teaching and learning process but also requires teachers to develop new competencies in mastering digital devices and platforms. This shift emphasizes the importance of digital literacy that teachers must master in order to navigate digital technology, to create engaging and effective learning experiences (Akintayo et al., 2024; Vaskov et al., 2021; Wu et al., 2021; Zhao et al., 2021). Thus, the challenges in digital transformation are significant. Teachers face the dual task of mastering new technologies while also handling various digital accesses among students (Pradana & Mayasari, 2023; Zizikova et al., 2023). This inequality risks hampering digital learning initiatives in accommodating diverse teaching needs (Alenezi & Akour, 2023; Bogdandy et al., 2020; Khalil et al., 2023; Msila, 2022).

One important aspect that needs to be considered in this context is teacher emotions. Teacher emotions can affect student performance in the classroom, including when using learning technology. Teachers confident in their digital technology competencies tend to use teaching effectively. Meanwhile, teachers who feel anxious are reluctant to adopt new teaching tools (Hanifah et al., 2023; Milawati & Sholeh, 2020; Molotsi et al., 2023; Sánchez-Cruzado et al., 2021). Emotional competence includes the ability to manage one's and other's emotions, which is very important for teachers when facing the challenges of integrating digital technology into teaching practices. Previous studies have shown that teachers with high emotional competence are better prepared to handle stress and adapt to the demands of the 21st-century learning environment, which is increasingly dependent on technology (Defrianti & Iskandar, 2022; Frenzel et al., 2018; Nisa et al., 2023). Research by Rosdi et al. (2020), Scherer et al. (2018), Valente and Lourenço (2020), shows that innovation in digital technology classes has revived research interest in understanding teachers' emotional experiences in the classroom. Teachers with good digital technology integration skills accompanied by the ability to present positive emotions tend to be able to communicate subject matter to students better (Albion et al., 2015; Pekrun et al., 2002). Meanwhile, teachers' concerns about digital competence in teaching tend to be caused by fears of losing control when integrating new technologies into the classroom (Johler et al., 2022).

Although teacher emotions are recognized as important, research that addresses this area, particularly through confirmatory factor analysis to measure teacher emotion scales in digital technology-based teaching practices, is still limited (Frenzel et al., 2018; Ma et al., 2023; Owens & Hudson, 2021; Reinhold et al., 2021). This research is important because it explores an area not widely explored in the existing literature. Previous studies on teacher emotions have focused on various aspects of educational technology integration, such as decision-making processes and teacher perceptions of technology use. In contrast, research on emotional aspects and teacher responses in digital technology classrooms has not been conducted (Ma et al., 2023). To address this, it is interesting to develop and

validate a confirmatory factor analysis model to measure teacher emotion scales in digital technology classrooms. The selection of confirmatory factor analysis (CFA) in the context of measuring teacher emotions in technology-based learning is considered because CFA is very rigorous in testing the latent structure of a construct by formulating a theoretical model that explains how emotional dimensions are interrelated and contributes to an overall construct (Danişman et al., 2016).

The CFA approach aligns with the educational research landscape, where there is increasing recognition of the importance of emotional constructs in classroom teaching practices. Previously, studies of the teacher emotion scale showed good reliability in assessing teachers' joy, anger, and anxiety factors through CFA to validate the three-factor model, indicating that the teacher emotion scale is effective in capturing teachers' various emotional experiences in educational settings (Frenzel et al., 2018). Similarly, studies of the Teacher Emotion Regulation Scale and the Language Teacher Emotion Regulation Inventory also emphasized the importance of CFA in validating the factor structure of the scales, confirming their reliability and validity (Ma et al., 2023).

Considering the above description, this research aims to conduct a CFA to measure the scale of teachers' emotions in digital technology classrooms. Through the identification and validation of the emotional dimensions experienced by teachers, a better understanding of teachers' emotional experiences in technology classrooms and how these experiences affect the integration of technology into teaching will be obtained. Thus, the findings of this research will contribute to the development of a scale of teachers' emotions in technology classrooms and provide an empirical basis for assessing teachers' emotional dimensions in the context of digital teaching.

METHODS

This research design is a survey and cross-sectional research, which focuses on the variables of teacher emotions in digital technology classes by surveying over a certain period. The research data was collected using a simple random sampling technique on teachers who are members of the In-Service Teacher Professional Education Program (*Program Pendidikan Profesi Guru Dalam Jabatan* [PPG Daljab]) at the Guidance and Counseling Study Program, Universitas PGRI Adi Buana Surabaya, in the 2023–2024 Academic Year who have taught in digital technology classes, namely 66 teachers with an average work period of five years.

Data collection using an adaptation of the teacher emotion scale in digital technology classes, referring to the teacher emotion theory from Frenzel et al. (2016) and Pekrun (2006), which measures dimensions of (1) positive emotions and (2) negative emotions in the context of interacting with students, colleagues, and institutions and in decision-making according to the teaching profession. The steps for measuring the construct of the teacher emotion scale in digital technology classes include translation, back-translation, adaptation, and scale scoring. Validity testing using CFA, where the loading of the latent variable factor is more than .50 (valid).

As previously mentioned, this research was conducted on teachers who were members of the PPG Daljab invited to participate. After expressing their willingness as voluntary respondents, the teacher emotion scale was distributed online to measure their emotional experiences in teaching in digital technology classes. Once all the scale items were completed, the materials were collected for analysis to answer the research objectives.

Data analysis was carried out using CFA to test the factor structure and validity of the teacher emotion scale in digital technology classes. The analysis included determining the fit of the suggested factor model to the data and investigating the factor loadings and correlations between several emotional dimensions, including positive emotional dimensions (pleasure, hope, pride) and negative emotions (anger, anxiety, shame, hopelessness, and boredom).

RESULTS

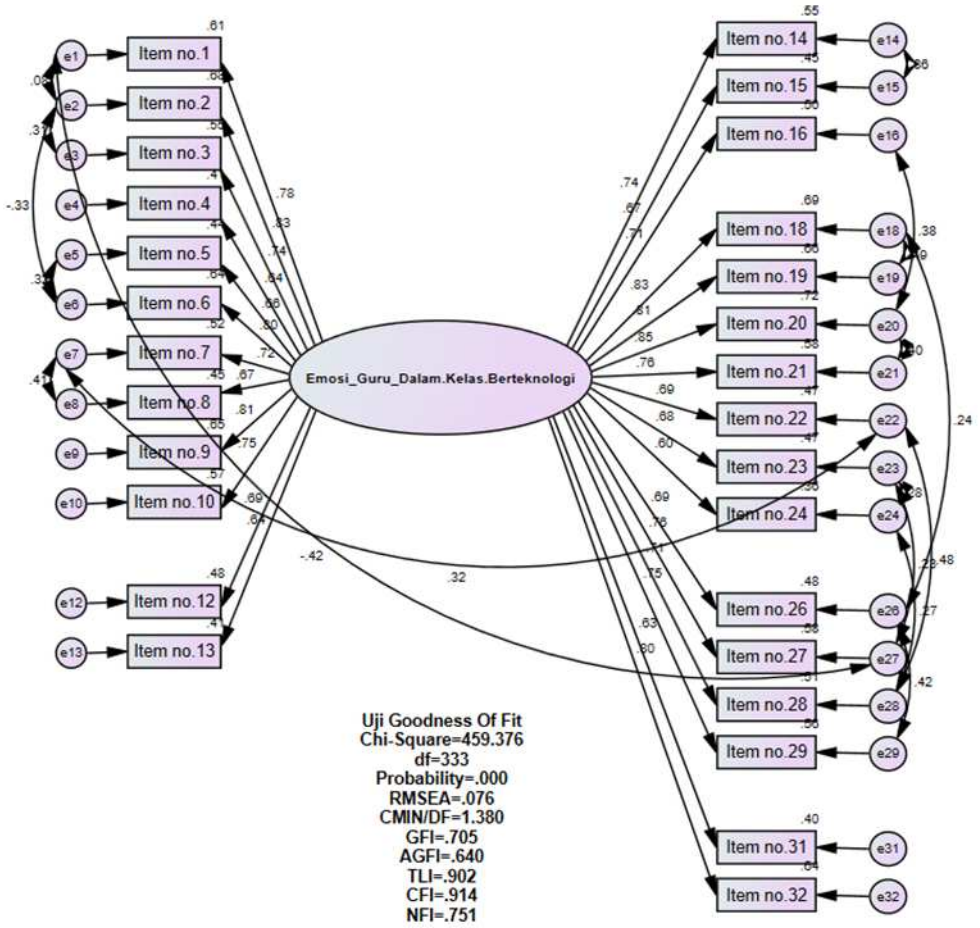

Figure 1.
Measurement Model of Teacher Emotion Scale in Technology Classroom With 28 Items

The results of the measurement model estimation for the CFA of the teacher emotion scale in the technology class after the model revision in Figure 1 above using the maximum likelihood estimation method in AMOS are summarized in Table 1. The estimation results of the measurement model for the CFA of the teacher emotion scale in the technology class after the revision of the model in Figure 1 above using the maximum likelihood estimation method in AMOS are summarized in Table 1. The model revision was carried out to improve the model's goodness of fit through modification indices in the model for the CFA of the teacher emotion scale in the technology class. After ensuring that the exogenous variable indicators are the constructs of the variables, the next step is to find out the loading factor values of each indicator of the teacher emotion scale variable in the technology class.

The calculation results, the RMSEA, CMIN/DF, TLI, and CFI indices, provide fit indices that follow the recommended limits, indicating a good fit value. Meanwhile, chi-square, GFI, AGFI, and NFI still do not meet the recommended limits. From the various fit indices, it can be concluded that the measurement model on the proposed construct is a fit or fairly good fit because it has four goodness of fit criteria.

Table 1.
Model Fit Index on CFA of Teacher Emotion Scale in the Technological Classroom

Goodness of Fit Index	Cut-off Value	Model Results	Description
χ^2 –chi-square of estimate model		459.376	Expected value is small
df		333	
χ^2–significance probability (p-value) probability level	≥ .05	.000	Bad fit
RMSEA	≤ .08	.076	Good fit
CMIN/DF	≤ 2.00	1.380	Good fit
Goodness of Index (GFI)	≥ .90	.705	Bad fit
Adjusted Goodness of Index (AGFI)	≥ .90	.640	Bad fit
Tucker-Lewis Index (TLI)	≥ .90	.902	Good fit
Comparative Fit Index (CFI)	≥ .90	.914	Good fit
Normed Fit Index (NFI)	≥ .90	.751	Bad fit

The next stage of testing is construct validity. The construct validity test ensures that the indicator is a construct of the studied latent variable. This construct validity test ensures that the indicator is a unit in each construct of the teacher emotion scale variable in the technology class (Ali et al., 2022; Moesarofah et al., 2023). If the critical ratio value is twice the standard error, then the indicator has met the convergent validity assumption. Alternatively, other metrics, such as whether the indicator's probability value is less than .05, can be calculated. Table 2 displays the output findings from AMOS to confirm that the indicator meets these two conditions.

Table 2.
Loading Factor Value of Constructs Standardized Regression Weights
(Group Number 1–Default Model)

			Estimate Loading Factor	Decision
Item.14	←	Emotions_Teacher_In.Class.Technology	.740	Valid
Item.15	←	Emotions_Teacher_In.Class.Technology	.670	Valid
Item.16	←	Emotions_Teacher_In.Class.Technology	.709	Valid
Item.18	←	Emotions_Teacher_In.Class.Technology	.829	Valid
Item.19	←	Emotions_Teacher_In.Class.Technology	.813	Valid
Item.20	←	Emotions_Teacher_In.Class.Technology	.846	Valid
Item.21	←	Emotions_Teacher_In.Class.Technology	.763	Valid
Item.22	←	Emotions_Teacher_In.Class.Technology	.688	Valid
Item.23	←	Emotions_Teacher_In.Class.Technology	.685	Valid
Item.24	←	Emotions_Teacher_In.Class.Technology	.598	Valid
Item.26	←	Emotions_Teacher_In.Class.Technology	.693	Valid
Item.27	←	Emotions_Teacher_In.Class.Technology	.760	Valid
Item.28	←	Emotions_Teacher_In.Class.Technology	.714	Valid
Item.29	←	Emotions_Teacher_In.Class.Technology	.748	Valid
Item.31	←	Emotions_Teacher_In.Class.Technology	.630	Valid
Item.32	←	Emotions_Teacher_In.Class.Technology	.802	Valid

			Estimate Loading Factor	Decision
Item.1	←	Emotions_Teacher_In.Class.Technology	.778	Valid
Item.2	←	Emotions_Teacher_In.Class.Technology	.825	Valid
Item.3	←	Emotions_Teacher_In.Class.Technology	.739	Valid
Item.4	←	Emotions_Teacher_In.Class.Technology	.641	Valid
Item.5	←	Emotions_Teacher_In.Class.Technology	.664	Valid
Item.6	←	Emotions_Teacher_In.Class.Technology	.798	Valid
Item.7	←	Emotions_Teacher_In.Class.Technology	.719	Valid
Item.8	←	Emotions_Teacher_In.Class.Technology	.668	Valid
Item.9	←	Emotions_Teacher_In.Class.Technology	.808	Valid
Item.10	←	Emotions_Teacher_In.Class.Technology	.753	Valid
Item.12	←	Emotions_Teacher_In.Class.Technology	.691	Valid
Item.13	←	Emotions_Teacher_In.Class.Technology	.638	Valid

Based on the loading factor values in Table 2 for the teacher emotion scale variable in the digital technology class, all loading factor coefficient values for each variable indicator are more than .60 or an average of .70. Furthermore, Hair (2010) stated that the valid criteria in CFA analysis are if the loading factor is more than 30. In addition, the number of samples N = 60–70 is allowed in the CFA test if the loading factor reaches an average coefficient of .65–.70. Thus, the findings of this research with a sample size of N = 66 and a loading factor value > .60 are concluded to be valid. This means that all indicators in the teacher emotion scale variable in the digital technology class are the same indicators studied and show that there is a strong relationship between the indicators and the latent construct (Hung et al., 2021).

DISCUSSION

The results of the measurement model estimation for the CFA of the teacher emotion scale in the digital technology class after the model revision show that the RMSEA, CMIN/DF, TLI, and CFI indices are appropriate and follow the recommended limits, namely showing good fit values. Meanwhile, the chi-square, GFI, AGFI, and NFI indices still do not meet the recommended limits (Figure 1). However, from the various fit indices, it can be concluded that the measurement model for the proposed construct already has a fairly good fit because it has four goodness of fit criteria (Moesarofah et al., 2023). In assessing the fit index of the measurement model, it is important to consider the various fit criteria used to assess the adequacy of the model. According to Byrne (2016), Kline (2023), Schreiber et al. (2006), and Tafarini et al. (2022), if the proposed measurement model meets four or more suitability criteria, it can be concluded that the model shows a satisfactory level of suitability, thus ensuring the validity of the measured construct. The good fit value indicates that the teacher emotion scale successfully measures the construct of teacher emotions accurately, especially regarding the positive emotion dimension in the use of digital technology in the classroom (Brown, 2015; Naylor & Nyanjom, 2021). The results of this research consistently support the research of Pekrun (2006), Frenzel et al. (2016), and Hagenauer et al., (2015), that teacher emotions significantly impact various aspects of education, including student engagement and interpersonal relationships between teachers and students. According to Pekrun's emotion theory, various emotions (joy, hope, pride, anxiety, anger, and shame) significantly affect motivation, engagement, and academic performance (Goetze, 2023; Klassen et al., 2013; Shao & Parkinson, 2024). In digital learning, emotional dynamics are more prominent when teachers face challenges and opportunities in online learning.

Teachers in digital classes often experience anxiety due to the rapid transition to online learning, while teachers' digital skills do not support these demands. Furthermore, classroom anxiety causes emotional exhaustion for teachers in managing and maintaining a positive attitude in front of students (Elliot & Pekrun, 2007; Fix et al., 2020; Liu et al., 2024; Shin & Ryan, 2017; Solheim, 2019; Wang & Song, 2022). The above opinion is in line with the research of Carcausto et al. (2020), which shows that teachers often report feelings of uncertainty and fear in engaging students in virtual formats. Negative emotions (anger, anxiety, shame, hopelessness, and boredom) reflect challenges and stress when adopting technology (Iacolino et al., 2023). These emotions can stem from inadequate training, technical difficulties, or fear of failure. A study by Hadlington and Scase (2018) showed that teacher frustration in using technology can lead to negative emotional experiences, which hinder effective teaching. Furthermore, Wang and Song (2022) noted that teachers' mental health has a significant impact on teachers' emotional climate in the classroom in creating a supportive learning environment.

A synthesis of several works of literature relevant to the explanation above shows that a validated emotion scale can help identify teachers' emotional experiences in teaching practice. Positive emotions indicate that teachers feel satisfaction and optimism when using technology in the classroom, which results in a pleasant learning process. For example, Wu et al. (2021) found that positive academic emotions significantly predicted technology acceptance among teachers. In addition, Awofala et al. (2017) and Meyer and Turner (2006) emphasized that teachers' positive attitudes toward technology are closely related to their self-efficacy and willingness to integrate technology into teaching practices, affecting students' responses to technology in the classroom.

Thus, new insights based on the results of this research indicate that the development of a teacher emotion scale must be adjusted to the context of digital technology use. The valence of positive and negative emotions in technology-based learning needs special attention. When teachers integrate technology into their teaching, they may experience a variety of emotions, ranging from enthusiasm and joy to frustration and anxiety (Fernández-Batanero et al., 2021). Technology can enhance learning through multimedia resources, facilitate communication, and personalize instruction. On the other hand, the use of technology also poses new emotional challenges and complexities for teachers to continue updating their digital skills (Richards, 2022; Shi et al., 2023).

Seeing the discussion description, this research contributes to developing a valid teacher emotion scale in a technology-enabled classroom. This research provides an empirical basis for understanding how teachers' emotional experiences influence their attitudes, beliefs, and behaviors toward integrating technology into teaching and learning in the classroom (Ventouris et al., 2021). Thus, the scale of teacher emotions in the digital technology classroom that was developed can be a useful tool to assess the emotional dimensions of teachers in the context of digital teaching. The implications of this research are to provide practical solutions for educational institutions and policymakers to better support teachers in navigating the emotional landscape in the technology classroom, such as providing teachers with comprehensive training not only on the technical aspects of digital devices but also on strategies to manage emotional challenges that may arise. Meanwhile, the limitations of this research lie in the small sample size and limited focus, so caution is needed in generalizing the results. Future research needs to use a longitudinal research design to examine the dynamics of teacher emotions when integrating technology into teaching practices (Shi et al., 2023).

CONCLUSION

This research's findings indicate that the Teacher Emotions in Digital Technology Classes scale is a valid instrument for measuring teacher emotions in technology-based learning. This research contributes to developing educational psychology instruments, particularly in the context of technology

integration in education. It can be used to evaluate and support teachers' emotional well-being in digital learning environments. The measurement model estimation for the CFA of the scale shows that the RMSEA, CMIN/DF, TLI, and CFI indices meet the recommended thresholds, indicating a good fit. The results highlight that teacher emotions—both positive and negative—significantly influence motivation, engagement, and performance in digital teaching and learning. Teachers often experience anxiety due to the rapid transformation of learning and a lack of digital skills. At the same time, negative emotions such as anger, shame, and despair emerge from challenges in technology adoption. Conversely, positive emotions like hope and pride are associated with technology acceptance and teaching effectiveness. Given these findings, future research could explore teacher emotions through longitudinal studies to provide a broader and deeper understanding of their role in education.

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