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PAPER

K-12 Teacher Perceptions of LMS Usage in Online Teaching and Information Technology Support: Post COVID-19 Pandemic

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ABSTRACT

This study examines K-12 teachers' technology acceptance through their perceptions of Google Classroom in the aftermath of the COVID-19 pandemic. A correlational survey, adapted from the Technology Acceptance Model, analyzed the relationships between functionality, usability, IT support, perceived usefulness (PU), perceived ease of use (PEOU), attitudes towards use (ATU), behavioral intention to use (BI), and actual usage (AU). An end-user questionnaire was used to assess PK-12 teachers' perceptions of IT support in terms of Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty. Structural equation modeling (SEM) revealed statistically significant relationships between PU, PEOU, ATU, and BI. BI showed a small but significant relationship with AU. Mixed relationships were observed between functionality, IT support, and usability with PU and PEOU. Pearson correlations indicated significant links between PEOU and BI. Qualitative findings highlighted challenges such as academic dishonesty, technology-related issues, and teacher-specific barriers during emergency online teaching. This study provides insights to guide educational leaders in addressing teacher challenges and improving online learning, particularly in emergency contexts.

KEYWORDS

online K-12 education, technology acceptance, usability, IT support, perceived ease of use (PEOU), behavioral intention (BI), structural equation modeling (SEM)

1 INTRODUCTION

The onset of the COVID-19 pandemic triggered widespread school closures, forcing both teachers and students to transition to online learning. These emergency changes exposed many educators to the challenges of online instruction for the first time, including issues related to connectivity, academic integrity, test security, and student engagement. Despite these hurdles, teachers and students adapted by persevering through extreme circumstances. This period of emergency

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online learning provided K-12 teachers with a unique opportunity to use Learning Management Systems (LMS) such as Google Classroom, gaining significant insights into their perceptions of educational technology. The growth of online learning created an opportunity for schools and teachers to learn the most effective aspects of this type of instruction to enhance student achievement. This correlational research study aims to capitalize on these experiences while gathering key data on technology usage and acceptance to aid K-12 schools in improving their online learning strategies. This study builds on the foundation work of Davis [12] by expanding on the original Technology Acceptance Model (TAM) components and introducing additional constructs of functionality (novelty and stimulating), usability (perspicuity and efficiency), and IT support (reliability, responsiveness, competence, security, and product portfolio) in the modified version of the TAM. These constructs provide a more nuanced understanding of the factors that influence technology acceptance along with the TAM components of perceived ease of use, perceived usefulness, attitudes towards use, and behavioral intention (BI) to use [16].

The significance of this study is in its focus on K-12 teacher technology acceptance of an LMS, an area that has seen limited research post-COVID-19. Most prior studies were conducted before the pandemic [25], during the pandemic [13], after the pandemic [33], or at the collegiate level [1, 15]. These studies offer limited insights into teachers' perceptions of using LMS in conjunction with IT support that is a salient contextual feature that influences the end users' propensity to adopt a technological tool in routine instructional practices. A recent meta-analysis of teacher technology acceptance found that training, technical support, and institutional backing are among the strongest external predictors of technology adoption, alongside TAM variables [29]. The inclusion of the modified TAM constructs and IT support, with a concerted focus on assessing differences between elementary, middle, and high school K-12 educators, distinguishes this study as unique and worthwhile. To the best of the researcher's knowledge, no other study integrates the TAM constructs in the context of K-12 education with functionality, usability, and end-user experiences of IT support, making this study a strong contribution to the body of research. This study is also crucial for identifying challenges in online assessment and barriers to effective implementation. The insights gained from this study will be valuable for school leaders attempting to support their teaching staff in the event of future emergencies that may require online instruction.

1.1 Study purpose

The purpose of the study is to assess the influence of post-pandemic perceptions (TAM constructs), user experiences (functionality and usability) of K-12 teachers and their perspectives of IT support on utilizing an LMS (Google Classroom) in their instructional practices.

1.2 Research questions

1. How do the modified TAM constructs (teachers perceived ease of use, perceived usefulness, attitudes toward use, and BI to use) influence K-12 teachers' actual system usage of Google Classroom LMS?

2. How do the IT support experiences of K-12 teachers influence their BI to use the Google Classroom system?
3. How does the functionality and usability of the Google Classroom LMS influence K-12 teachers' BI to use it?

1.3 Barriers to LMS adoption and online teaching

The abrupt transition to online learning during COVID-19 unveiled significant barriers. Many educators felt inadequately trained for online teaching, particularly regarding LMS usage, as noted by [18]. Connectivity problems and lack of proper hardware impeded effective teaching [35]. Teachers also cited limited parental engagement as a challenge, particularly in younger grades, according to [34]. Online assessments raised concerns about academic honesty and accessibility [11]. These barriers highlight the need for targeted IT support and professional development to facilitate seamless LMS integration. A mixed-methods study was conducted in Portugal during the pandemic to further understand the difficulties teachers experienced during the sudden transition to online learning. The teachers who responded to the survey reported that their main difficulties in transitioning to online learning were work, conditions, and time management. Overall, the majority of the problems were related to the novelty of online teaching and its associated technologies [35]. A study conducted on K-12 teachers' experiences, feelings, and perspectives about online teaching during the COVID-19 lockdowns. Researchers used a mixed-methods design in which teachers completed a Likert survey (online teaching experiences, challenges, issues, and required support) along with follow-up interviews with a sub-set of teachers [2]. The survey results showed that approximately 80 percent of respondents felt they had the necessary skills and knowledge to be successful at online teaching. Approximately 66 percent reported that they wished to have more opportunities to learn about online teaching, and 60 percent had stress in virtual teaching. Conversely, 22 percent of respondents said that they struggled through online teaching. The main issues in online teaching discovered in interviews were related to struggles with student participation, lack of student technology, student well-being, lack of in-person communication with students, work-life imbalance, and struggles of working with new technology [2].

Another study illuminates many of the problems encountered by teachers during the COVID-19 pandemic [31]. Although perceived usefulness (PU) and ease of use remain central predictors of technology adoption, access to timely technical assistance, training, and infrastructure significantly enhances these perceptions and strengthens behavioral intention, whereas inadequate IT support acts as a key barrier to effective LMS implementation [29]. A qualitative study was conducted in which teachers were asked to share their experiences using emergency online learning during the COVID-19 pandemic. A total of 17 K-12 private school teachers in the Philippines were interviewed in an online semi-structured format. The challenges identified in online teaching were internet connectivity issues, unresponsive students, late submissions, and spending an inordinate amount of time grading assignments. Participants noted that internet connection problems, including unstable connections, caused students to miss important information and sometimes led to teachers' inability to appropriately teach their lessons. Teachers explained that unresponsive students negatively affected their ability to communicate with other students. There were long waiting times for responses from students [29].

This gap in communication caused teachers to struggle in the online learning environment. Late submissions were also mentioned as a problem because teachers struggled with holding students accountable while also maintaining fairness towards them. Teachers felt that students missed out on valuable learning experiences due to the online learning format. More specifically, hands-on activities such as labs were shut down, and teachers felt this caused learning deficits. A qualitative case study that was conducted in Turkey to explore primary school teacher perceptions of online learning during the COVID-19 pandemic had similar themes [34]. The findings were grouped into the four main categories of guidance and support, planning and teaching, technical issues, and the use of technological tools. Teachers perceived a lack of guidance and limited parental support for online teaching. They explained that professional learning sessions were offered by schools and that these sessions were helpful. However, they stated that they had trouble teaching online lessons because parents would often undermine them in the process. Technical issues ranged from microphone problems, phone problems, user ineptitude, screen size, and software errors. The use of technological tools was only a problem at the onset with no further problems in online learning after working through initial roadblocks [34].

A mixed-methods study had similar results [18]. A survey was emailed to 15,341 teachers in Mississippi and South Dakota. The survey had questions on teachers' distance learning experiences, as well as problems and strategies used during online instruction. Information was collected on the types of LMS that were used by teachers and the difficulties encountered by them [18]. The quantitative results showed that Google Classroom was by far the most utilized LMS. Canvas and Schoology were the next most popular LMS. The remaining respondents were split between numerous other LMSs. The qualitative results had five major areas of difficulty: students, remote teaching, technology, parental and home environments, and school administration. The student issues included contact and communication difficulties, participation and engagement deficits, and accountability. Teachers found interactions with students to be more difficult using online learning. Remote teaching problems included trouble finding and creating online resources and providing instructional support [17, 18]. Internet and computer access was another problematic area where some students had to drive to alternate locations for class because the home connections did not work. The lack of parental support and involvement was another problem area noted by teachers. Parents were inadequately prepared to assist their children in online learning and uncooperative when they were asked to assist the teachers. The school administration was also an issue where teachers felt that they were not given sufficient instructions, guidance, or support during remote learning. These studies highlight the need to examine the role of IT support to alleviate the internet and computer-based issues that were encountered by PK-12 teachers during the pandemic.

1.4 The role of IT support

Effective IT support is crucial for overcoming technical and usability challenges in LMS adoption. Studies have identified key components of IT support, such as professional development, which improves confidence and competence. A study surveyed 1,048 teachers working in public K-12 schools to examine the types of technology teachers use and how they use it to support student learning. The interview data showed that 45 percent of teachers referred to in-house and virtual support in the form of trained professional and administrator assistance in IT as extremely important to their success in integrating technology into their classrooms. Furthermore, they claimed that IT support in the form of a knowledgeable team of fellow teachers was integral to their successful technological integration and use [32]. Organizational support, including reliable and responsive technical assistance, fosters positive attitudes toward technology [46]. The incorporation of teacher and student feedback into LMS development enhances usability [9]. Furthering the study of IT support and technology integration or acceptance, another study examined the impact of organizational support, technical support, and self-efficacy on faculty perceived benefits of using an LMS [46]. A Likert-style survey was utilized to collect data on topics related to organizational support, technical support, self-efficacy for LMS usage, and faculty-perceived benefits from 379 faculty members located in four medium-sized universities in the mid-west. The quantitative results showed that LMS self-efficacy had a mean of 3.98 out of 5.0. Organizational support and technical support had a mean of 3.83 out of 5.0. Faculty perceived benefits had a mean of 3.78 out of 5.0. These results indicate that LMS support and technical support can influence the perceived benefits of faculty members. Information technology had a positive effect on faculty acceptance and use of LMS [46]. Another study showed that adequate IT support can help facilitate students' and teachers' knowledge acquisition through online tutorials and training modules in information technology. The study explained that IT support consisted of information and technological components that are connected both functionally and structurally, and it is directed to fulfill the purpose of educational processes and instructional strategies [41].

1.5 TAM constructs

The TAM [12] builds upon the Theory of Reasoned Action and the Theory of Planned Behavior [16]. The primary constructs of TAM are perceived ease of use (PEOU) (extent to which using technology is free from effort) and PU (degree to which technology enhances job performance). The TAM posits that these factors shape attitudes and behavioral intentions toward technology adoption [39]. The subsequent research expanded TAM by incorporating variables such as computer self-efficacy, facilitating conditions, and intrinsic motivation [40]. This framework has been widely used to study technology acceptance in education [20]. Several studies have utilized TAM to investigate LMS adoption in educational contexts. A study was conducted to examine the e-learning acceptance among Malaysian students. The results showed that attitude toward technology significantly influenced its adoption, especially when prior familiarity was low [25]. Another study examined Chinese teachers' perspectives on online teaching during COVID-19, emphasizing the importance of self-efficacy and pedagogical content knowledge in shaping technology acceptance [47]. These studies underscore TAM's relevance in understanding LMS adoption, revealing nuances influenced by context, user demographics, and external conditions. Along with PEOU and perceived usefulness, BI to use (degree that a person has created conscious plans to complete or not complete a certain behavior in the future), IT support, functionality and usability also influence the usage of LMS and the different technologies embedded within it.

Usability is influenced by the task which needs to be completed and the user's competence. A system is usable when it is compatible with user perception, action, and cognitive skills [19]. Functionality is something that changes depending on the functions available and the tasks that need to be completed. These two constructs are often used together to evaluate a specific piece of technology [19]. All TAM constructs are critical determinants of LMS adoption. A recent study identified usability issues such as system navigation and error prevention as barriers to LMS effectiveness [9]. Another study found that flexibility, learnability, and user satisfaction significantly influence LMS usability [37]. Perceived usability and self-efficacy are strong predictors of the BI to use technology [23]. These findings highlight the importance of addressing usability concerns to ensure successful LMS integration.

2 MATERIAL AND METHODS

2.1 Participants

A purposive sample of teachers employed by a public school district located in a suburban PK-12 school district. The district serves approximately 32,000 students and employs approximately 2,000 teachers who fill 18 elementary schools, eight middle schools, and five high schools. The average teaching experience of those surveyed is 14.7 years of experience, and the certified employee retention rate for the district is 93.13%. The average teacher daily attendance is 95.6%, which indicates a high degree of teacher dedication (NCES, 2023). A total of 348 teachers responded to the survey. The majority of respondents (97.4%) identified as non-Hispanic ($n = 339$). The remaining nine participants (2.6%) were Hispanic ($n = 9$). Table 1 shows the participants' demographic composition with 262 females (75.3%) and 84 males (24.1%). Table 2 shows the distribution of respondents.

Table 1. Race of teachers' perceptions

Race	Frequency	Percent
White	309	88.8
Black or African American	26	7.5
Other	6	1.7
Asian	4	1.1
American Indian or Alaskan Native	3	0.9
Total	348	100

Table 2. School-level distribution of participants

School Level	Frequency	Percent
Elementary	82	23.6
Middle	141	40.5
High	125	35.9
Total	348	100

2.2 Data collection measures

The survey had 45 Likert items measuring the attributes of TAM, IT support, functionality, and usability constructs. The first section of the survey consisted of Likert items (1 = strongly disagree to 5 = strongly agree) that measured TAM constructs [12]—perceived usefulness, perceived ease of use, attitude towards usage, behavioral intentions to use, and actual system use. The second section of the survey consisted of Likert items adapted from the Online Service Quality Scale that were used to measure the IT support construct on a five-point Likert scale [45]. The third section of the survey consisted of Likert items adopted from individual differences and usage behavior. (Revisiting a TAM assumption survey). This instrument was used to collect data on usage frequency, usage volume, and BI to use the Google Classroom LMS on a five-point Likert scale [6, 40]. The fourth section of the survey consisted of Likert items adopted from the user experience questionnaire [27]. The items collected data on functionality and usability constructs. The fifth section of the survey was a user input section where participants could add the number of hours spent in the Google Classroom LMS. The sixth section of the survey had open-ended questions that had questions on assessment and implementation issues during the pandemic. The open-ended questions allowed teachers to provide subjective responses on the issues that they faced during the pandemic and specific types of barriers experienced when using Class Link LMS. The survey was administered online through the Qualtrics platform.

2.3 Data analysis

The descriptive statistics were computed by school level for the mean composite scores of each construct. Pearson correlation coefficients were calculated to assess the magnitude and direction of relationships between the constructs. Structural equation modeling (SEM) was used (PROC CALIS procedure in SAS) to fit the proposed model to the survey data. SEM is based on regression analysis where causal relationships can be modeled between TAM (perceived usefulness, perceived ease of use, attitude towards use, behavioral intentions to use, and actual system usage), IT support (reliability, responsiveness, competence, security, and product portfolio), functionality (novelty and stimulation), and usability (perspicuity and efficiency) constructs with actual use as the endogenous (dependent) construct (Figure 1). There were three fit indices [14, 24] that were used to assess model fit: Standardized Root Mean Square Residual (SRMR $< .08$), the Comparative Fit Index (CFI $> .95$), and Root Mean Square Error of Approximation (RMSEA $< .06$). The SRMR is sensitive to model misfit between items and factors; the CFI is sensitive to misfit in the structural parameters among factors; and the RMSEA favors model parsimony. The squared multiple correlations showed the influence of exogeneous (independent) constructs on the endogenous (dependent) constructs. SEM can be negatively impacted by missing data, outliers, nonlinearity, and nonnormality. Majority of statistics used in SEM assume normality and that violating this assumption would influence the accuracy of statistical tests [43]. The maximum likelihood (ML) estimation procedure was used, which assumes that the indicator variables follow a multivariate normal distribution and that the covariance matrix is positive definite. ML estimates are robust to violations of normality [10, 30, 42].

3 RESULTS

The Cronbach alpha reliability coefficients ranged from 0.71 to 0.98, which showed good internal consistency in the Likert survey items that measured each construct (see Table 3). Tables 4 and 5 show that high school teachers had the highest number with LMS experience ($n = 52$) by school level. Middle school teachers had the highest number with no LMS experience ($n = 91$) and no prior LMS training ($n = 96$), followed by high school teachers ($n = 92$). Approximately half of the respondent teachers had between five to seven years of LMS experience (see Table 5). The usability and functionality perceptions showed that middle school teachers found Google LMS more usable in their teaching than elementary and high school teachers (see Table 6). Overall, the average perceptions scores for IT support constructs were similar across teachers, with middle school teachers (see Table 7) having slightly higher scores on responsiveness ($M = 4.4$) and competence ($M = 4.4$). The product portfolio average scores ranged from 3.7 to 3.9, indicating that teachers were neutral when it came to the products, features, and functions available in Google Classroom. In terms of TAM constructs, the lowest average teachers' perception scores were for attitude towards use (see Table 7).

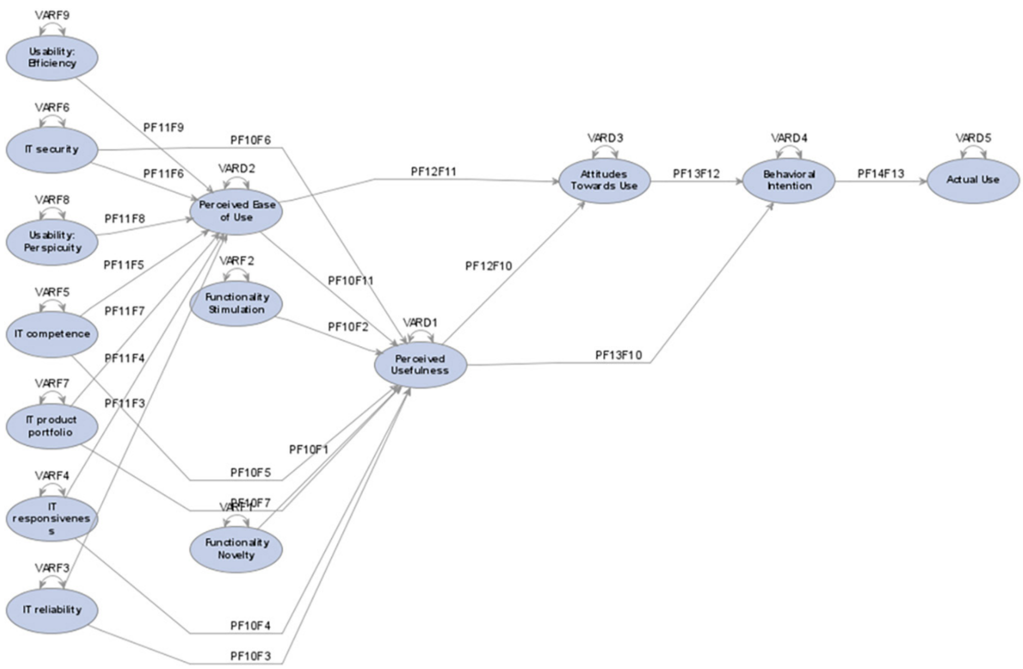

Fig. 1. Hypothesized model

Table 8 shows that PEOU had a large correlation with PU ($r = 0.60$). Functionality had positive correlations with PU ($r = 0.45$) and PEOU ($r = 0.41$). IT support had positive correlations with PU and PEOU ($r = 0.44$) and functionality ($r = 0.27$). BI to use (BI) had strong positive correlations with PU ($r = 0.66$) and PEOU ($r = 0.68$). It had a moderate positive correlation with IT support ($r = 0.48$). ATU had strong positive correlations with PU ($r = 0.72$), PEOU ($r = 0.59$), and BI ($r = 0.73$). It had a moderate positive correlation with IT support ($r = 0.46$). Actual usage (AU) had weak positive correlations with PU and ATU ($r = 0.21$) and functionality ($r = 0.22$).

Table 3. Reliability coefficients for the constructs

Construct	No. of Items	Cronbach Alpha
TAM		
Perceived Ease of Use	6	.94
Perceived Usefulness	6	.98
Attitude Towards Use	5	.89
Behavioral Intentions	3	.91
IT Support		
Reliability	3	.86
Responsiveness	3	.76
Competence	3	.83
Security	4	.83
Product of Portfolio	4	.75
Functionality		
Novelty	2	.82
Stimulation	2	.88
Usability		
Perspicuity	2	.71
Efficiency	2	.79

Table 4. Descriptive statistics for LMS experience and usage by school type

LMS Experience	Elementary	Middle	High	Total
Teacher LMS Experience				
Yes#	25 (7.2)	50 (14.4)	52 (14.9)	127 (36.5)
No#	57 (16.4)	91 (26.1)	73 (21.0)	221 (63.5)
Total#	82 (23.6)	141 (40.5)	125 (35.9)	348 (100.0)
Prior LMS Training				
Yes#	18 (5.2)	45 (12.9)	33 (9.5)	96 (27.6)
No#	64 (18.4)	96 (27.6)	92 (26.4)	252 (72.4)
Total#	82 (23.6)	141 (40.5)	125 (35.9)	348 (100)
LMS Usage (Years)				
GC LMS Usage*	5.6 (3.7)	5.9 (2.7)	6.1 (2.8)	5.9 (3.1)
Other LMS Usage*	6.2 (6.0)	4.4 (4.6)	4.9 (3.8)	5.2 (4.8)
Actual Usage*	4.0 (0.8)	4.2 (0.8)	4.0 (0.8)	4.1 (0.8)

Notes: #Percentage shown in parentheses; *Standard Deviation shown in parentheses; GC-Google Classroom.

Table 5. Frequency table showing respondent LMS experience in years

Number of Years	Google Classroom Use ($N = 307$)	Other LMS Use ($N = 119$)
0–1	8 (5.2)	7 (6.0)
2	8 (2.3)	26 (22.4)
3	23 (6.6)	20 (17.2)
4	34 (9.8)	13 (11.2)
5	79 (22.8)	22 (19.0)
6	67 (19.3)	5 (4.3)
7	36 (10.4)	3 (2.6)
8	4 (9.8)	4 (3.4)
9	9 (2.6)	1 (0.8)
10	28 (3.1)	7 (6.0)
> 10	11 (3.1)	11 (9.5)

Note: Percentage shown in parentheses.

Table 6. Descriptive statistics for perceptions of usability and functionality constructs

Construct	Elementary		Middle		High	
	1	2	1	2	1	2
Usability						
Efficiency: Supportive	20 (6.1)	62 (18.9)	27 (4.8)	114 (20.2)	35 (7.0)	90 (18.0)
Perspicuity: Easy	22 (6.7)	60 (18.3)	32 (5.7)	109 (19.3)	39 (7.8)	86 (17.2)
Efficiency: Efficient	26 (7.9)	56 (17.1)	32 (5.7)	109 (19.3)	33 (6.6)	92 (18.4)
Perspicuity: Clear	23 (7.0)	59 (18.0)	37 (6.6)	104 (18.4)	30 (6.0)	95 (19.0)
Total	91 (27.7)	237 (72.3)	128 (22.7)	436 (77.3)	137 (27.4)	363 (72.6)
Functionality						
Stimulation: Exciting	35 (11.1)	47 (14.9)	74 (13.5)	67 (12.2)	70 (13.7)	55 (10.8)
Stimulation: Interesting	34 (10.8)	48 (15.2)	63 (11.5)	63 (11.5)	65 (12.7)	60 (11.7)
Novelty: Inventive	35 (11.1)	35 (11.1)	71 (12.9)	71 (12.9)	62 (12.1)	62 (12.1)
Novelty: Leading Edge	34 (10.8)	48 (15.2)	68 (12.4)	73 (13.3)	73 (14.3)	64 (12.5)
Total	138 (43.7)	178 (56.3)	276 (50.2)	274 (49.8)	270 (52.8)	241 (47.2)

Notes: 1=Google LMS Not Usable/Functional; 2=Google LMS Usable/Functional, Numbers in parentheses represent percentages.

Table 7. Descriptive statistics for perceptions of IT support and TAM constructs

LMS Experience	Elementary	Middle	High
IT Support			
Reliability	4.1 (0.8)	4.2 (0.7)	3.9 (0.8)
Responsiveness	4.2 (1.0)	4.4 (0.8)	4.1 (0.9)
Competence	4.3 (0.9)	4.4 (0.7)	4.2 (0.9)
Security	4.5 (0.6)	4.3 (0.8)	4.2 (0.9)
Product of Portfolio	3.9 (0.8)	3.8 (0.8)	3.7 (0.8)

(Continued)

Table 7. Descriptive statistics for perceptions of IT support and TAM constructs *(Continued)*

LMS Experience	Elementary	Middle	High
TAM			
Usefulness	4.1 (0.8)	3.9 (0.8)	3.8 (0.9)
Ease of Use	4.2 (0.8)	4.3 (0.7)	4.1 (0.7)
Attitude Towards Use	2.7 (1.8)	2.8 (1.9)	2.8 (1.7)
Behavioral Intention	4.4 (0.9)	4.4 (0.7)	4.3 (0.8)
AU	4.0 (0.8)	4.2 (0.8)	4.0 (0.8)

Note: Standard deviation shown in parentheses.

The maximum likelihood procedure converged to a proper solution in 11 iterations when SEM was fitted to the data. A review of the fit indices (CFI, SRMR, and RMSEA) suggested the model fitted the data well, meeting Hu and Bentler's (1999) criteria for fit. The CFI was 0.95, indicating an excellent fit and suggesting that the structural (factor to factor) relationships were consistent with the data. The SRMR of 0.05 also indicated an acceptable fit, suggesting the item-factor relationships were sufficiently viable. RMSEA was 0.040, indicating that the model was sufficiently parsimonious. The 90% confidence interval for RMSEA had a lower bound of 0.035 and an upper bound of 0.043. Overall, the structural diagram shows a well-fitting model.

Table 8. Correlations between actual usage, TAM, and IT support constructs

Construct	Mean	SD	PU	PEOU	U	F	ITS	BI	ATU	AU
PU	4.01	0.82	1.00							
PEOU	4.19	0.79	**0.60**	1.00						
U	2.72	1.81	–0.05	0.03	1.00					
F	3.79	1.25	**0.45**	**0.41**	–0.01	1.00				
ITS	4.22	0.64	**0.44**	**0.44**	–0.01	**0.27**	1.00			
BI	4.05	0.84	**0.66**	**0.68**	0.06	**0.34**	**0.48**	1.00		
ATU	4.41	0.86	**0.72**	**0.59**	–0.50	**0.38**	**0.46**	**0.73**	1.00	
AU	5.97	7.05	0.21	0.12	–0.08	0.22	–0.02	0.14	0.21	1.00

Notes: Significant correlation coefficients marked in bold. PU-Perceived Usefulness; PEOU-Perceived Ease of Use; U-Usability; F-Functionality; ITS-IT Support; BI-Behavioral Intentions to Use; ATU-Attitudes Towards Use; AU-Actual Usage.

The large majority of path coefficients were statistically significant at $p < .01$ and in the hypothesized direction. Figure 2 shows the standardized solution for SEM with the relationships among different variables in the Modified TAM. The arrows pointing in a specific direction show the direct effects of one observed variable on another. For example, PU has a path estimate of 0.59 for its effect on attitudes towards use. Some variables also have indirect effects on other variables. For example, IT composite effect ATU through PU and perceived ease of use.

The squared multiple correlations are the total variance explained in each endogenous variables, by a set of exogenous variables as shown in the structural diagram (Figure 2). Table 9 shows the standardized total effect of each exogenous variable on every endogenous variable. The squared multiple correlations show that approximately 57% of variance in BI to use can be explained by ATU and perceived usefulness. Similarly, 55.8% variance in ATU can be explained by PU and perceived ease of use.

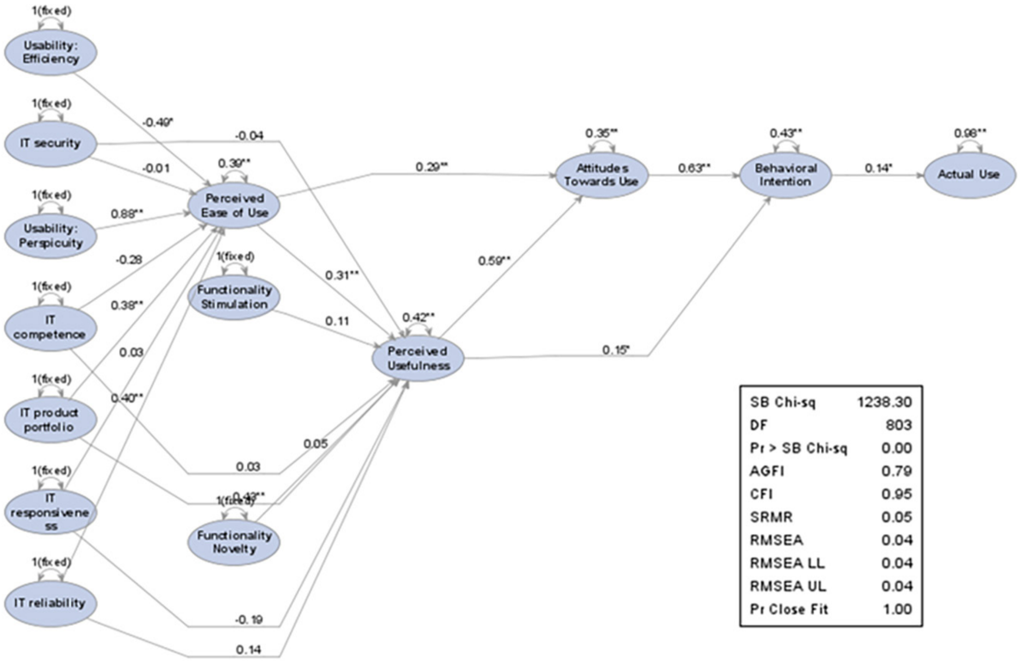

Fig. 2. Structural path model result

Approximately 46.8% of variance in PU is explained by functionality and IT support. Furthermore, 28.6% of variance in PEOU can be explained by usability (efficiency) and IT support. Attitudes towards use, BI to use, and PU all show an intermediate level of variance explained. AU and PEOU show a lower variance, indicating that they are not as well explained by their exogenous variables. The standardized effects of functionality, IT support, and PEOU are all small to medium. R-square is the total variance explained in the endogenous variable by all the exogenous variables (Figure 2). The standard effect for PEOU on PU is strong. The standard effects for PU and PEOU on attitudes toward use are strongly positive and strong.

Table 9. Squared multiple correlations

Variables	Error Variance	Total Variance	R-Square
BI to Use	0.274	0.637	0.570
Attitude Towards Use	0.029	0.662	0.558
Perceived Usefulness	1.456	0.781	0.468
Perceived Ease of Use	0.407	0.570	0.286
Actual Usage	62.266	63.547	0.020

Standard effects for ATU and PU on BI to use (BI) are strongly positive. The total effect of BI to use on AU is small and positive. Table 10 shows the significant path estimates for each endogenous variable and the exogenous variables by which they are influenced. The estimated path coefficients for this initial model significantly differed from zero. Path estimates for usability (Perspicuity) to PEU showed the highest coefficient (0.88), followed by attitude to BI (0.63). Conversely, PEU showed a small effect on PU (0.31). The negative path coefficient of –0.49 from Usability (Efficiency) to PEU shows that a one standard deviation increase in Efficiency leads to a 0.49 standard deviation decrease in PEU. A possible reason for the counterintuitive finding could be that systems optimized for efficiency are often designed for advanced functionality rather than simplicity, which could lead to a higher cognitive load in users.

The qualitative responses with regards to assessment problems that teachers faced during online learning were cheating and academic integrity. There were 70 respondents who mentioned the broader topic of cheating, while 41 teachers addressed test security, 11 reported the inability to monitor students during assessments, and 18 addressed various other problems related to academic integrity. Technical problems were the next common issue (limited access and accessibility issues with devices and connectivity), followed by lack of training. These technical barriers to implementation were especially difficult for teachers to work through because they often had no recourse to help students through these difficulties. Although many schools had technology and devices for check-out, there was no way to ensure that students had adequate internet connection or experience using personal laptops or MacBooks. Teachers also had challenges with student motivation and engagement in online teaching, especially with timely assignment submission and not logging in or joining class virtually, so they would miss instruction and then not complete the assessment. The teachers also noted several barriers related to students' home environment, lack of parental assistance, and quiet space for online learning. Several teachers (especially in elementary grade levels) reported issues with using the online Math tools, especially when trying to teach students how to use them in a virtual classroom.

Table 10. Significant path coefficients

Exogenous Variable	Endogenous Variable	Path Estimate
Usability (Efficiency)	PEU	–0.49
Usability (Perspicuity)	PEU	0.88
IT Product Portfolio	PEU	0.38
IT Product Portfolio	PU	0.43
IT Reliability	PEU	0.40
PEU	PU	0.31
PEU	AU	0.29
PU	AU	0.59
Attitude Towards Use	BI	0.63
BI	Actual Use	0.14

4 DISCUSSION

This study validates the TAM to demonstrate its applicability in understanding K-12 teachers' acceptance of the Google Classroom LMS. The findings confirm significant positive correlations among the TAM constructs and BI to use the system. PEOU and PU emerged as strong predictors of attitudes towards use, which in turn significantly influenced behavioral intention. These findings align with prior research [1, 39, 40], reinforcing the robustness of the TAM constructs in predicting behavioral intention. The study revealed nuanced interactions among TAM constructs. While both PEOU and PU influenced attitudes towards use, the latter exhibited a stronger impact. Similarly, ATU had a more pronounced effect on BI than perceived usefulness. However, BI usage demonstrated only a minor influence on actual system usage, suggesting that external factors, such as individual differences [6], might play a significant role in shaping AU behaviors. These results emphasize the complexity of the relationship between intention and action [38]. Turner's work, which differentiated between subjective and objective measures of actual usage, highlighted potential discrepancies in data collection methods [38]. This study's reliance on self-reported usage aligns with subjective measures, but future research should explore objective metrics, such as system logs, to yield more precise insights.

A critical finding highlights the importance of IT support in influencing perceived usefulness, perceived ease of use, and behavioral intention. Correlation analyses demonstrated significant relationships between IT support and these variables, with IT support having a strong influence on PU and perceived ease of use. Notably, the product portfolio emerged as the most significant IT support sub-construct. These results align with previous studies [32, 46], which emphasize the pivotal role of robust IT support in fostering technological acceptance among educators. However, the non-significance of certain sub-constructs, such as responsiveness and competence, underscores the need for further refinement and validation of the IT support construct. Functionality showed significant positive correlations with PU across school levels, yet SEM analysis revealed no significant effects of functionality sub-constructs on perceived usefulness. Conversely, usability demonstrated weak or nonsignificant correlations with BI and perceived usefulness, though perspicuity significantly influenced perceived ease of use, accounting for 88.0% of its variance. These inconsistencies suggest a need for reevaluation of these constructs and their measurement. The findings challenge prior research [23], which underscored the importance of usability in technology acceptance. Future studies should consider integrating perspicuity into PEOU or revising usability to better capture its impact on TAM constructs.

Discrepancies between Pearson correlations and SEM analyses in sub-constructs, such as novelty and stimulation, further highlight methodological challenges. The lack of definitions in survey instruments and potential biases introduced by the sliding scale format may have contributed to these inconsistencies. The finding that efficiency negatively influenced PEOU (–0.492) deviates from expectations, warranting further investigation into the efficiency of sub-construct's conceptualization and measurement. Previous studies [5] suggest that usability sub-constructs like efficiency, memorability, and learnability may need to be reexamined and realigned with TAM frameworks. The study also identifies barriers faced by teachers during the COVID-19 pandemic, including academic dishonesty and technology-related challenges. Academic honesty was a significant concern, with 70 respondents reporting issues such as unsecured testing environments and student misconduct. This aligns with findings from prior studies [11, 18], which document similar challenges. Technical barriers, including limited access to devices and connectivity issues, were reported by 166 respondents, emphasizing the need for equitable technology access. Prior studies [2, 7] corroborate these findings, underscoring the importance of proactive measures by educational leaders to address these barriers.

The implications of this study are profound for educational leaders. First, the lack of prior LMS training for 63.5% of teachers underscores the need for comprehensive professional development. Prior research [22, 32] highlights the critical role of training in enhancing teacher efficacy and technology acceptance. Tailored professional development initiatives focusing on grade-appropriate LMS features and integration strategies could bridge the gaps identified in this study. Second, the study reveals significant differences in LMS usage across school levels. Elementary teachers reported lower usage and perceived utility of Google Classroom, citing challenges such as digital literacy gaps and misalignment with curriculum needs. This aligns with a study conducted during the pandemic that identified similar barriers [4]. Educational leaders should consider implementing personalized learning environments that integrate LMS features with additional tools to support younger learners. Research suggests that PLEs can enhance engagement and learning outcomes when appropriately designed [3, 8]. Third, the study highlights a disconnect between teachers' behavioral intentions and actual LMS usage. This aligns with findings from prior research [36], which reported similar gaps in pedagogical practices. Factors such as teacher experience and age are shown to negatively correlate with technology acceptance and may contribute to this disconnect. The presence of dedicated support staff and ongoing training, as suggested in previous studies [13, 28], could mitigate these challenges and promote sustained LMS integration. Finally, the study's findings on diversity and equity highlight systemic disparities in technology access and support. Minority teachers consistently rated Google Classroom LMS lower in usability and PU while acknowledging its functionality. These results mirror broader socio-economic inequities documented in past research [44]. Targeted professional development and resource allocation could address these disparities, ensuring equitable access to technology and fostering inclusive educational environments.

It is important to point out that this study has one notable limitation. The research sample drawn from a large school district located in a southern state within the USA does not have the diversity other states would have in terms of participants (91.1% White). This may skew how the results apply to minority educators. Future research should prioritize refining sub-constructs of IT support, functionality, and usability to enhance the Modified TAM's explanatory power. Investigating the role of external factors in actual system usage and exploring emerging challenges, such as AI's impact on academic honesty, represent critical avenues for further study. The advent of generative AI technologies introduces new dimensions to the TAM framework, necessitating updated models that account for these innovations [21, 26]. This study contributes to the growing body of research on technology acceptance in education, offering valuable insights for policymakers and practitioners aiming to navigate the complexities of digital transformation in K-12 settings. Enhanced training through regular professional development programs focusing on LMS functionalities and online teaching strategies is essential. Improved IT infrastructure, including reliable internet access and updated hardware, is necessary to minimize technical disruptions. Holistic support systems combining organizational, technical, and peer support are vital to address the diverse challenges faced by educators.

5 CONCLUSION

This study examined K-12 teacher technology acceptance through their perceptions of a learning management system (Google Classroom) in the aftermath of the COVID-19 pandemic. The results are intended to inform educational leaders about teacher perceptions of technology acceptance in conjunction with IT support and the problems faced by them to better support K-12 schools in the event of another emergency and for the betterment of online learning as a whole.

5.1 Declaration of interest

The author declares no competing financial or non-financial interests related to this study.

5.2 Funding

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