A Study of Factors Influencing Teachers' Usage of E-Learning for Teaching Math in the Public Secondary Schools in Makati City, Philippines

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Abstract

This thesis study examines the factors influencing teachers' use of e-learning to teach math. The study aims to identify those variables that have a significant correlation with the use of e-learning. The purpose of the study is to help improve schools' current and future implementation of e-learning by understanding and addressing the factors that have a significant correlation with the use of e-learning.

For this study, the definition of e-learning is any teaching and learning process that uses computer-network-based technologies and digital learning materials. There were three stages of investigation: the first was on the use or non-use of e-learning, the second was on the usage level of e-learning, and the third was on the impact of e-learning on students. The study on the usage level has three parts: usage frequency, usage duration, and the total usage level. The study of the impact of e-learning covers five aspects: students' attention in class, classroom participation, scores on math quizzes, overall math grades, and math scores on the standardized National Achievement Test.

The study focused on the population of math teachers in public secondary schools in Makati City, Philippines. The selected population is in a location that has the highest per capita income in the country, and where the local government allocates the highest financial resources per student to support education.

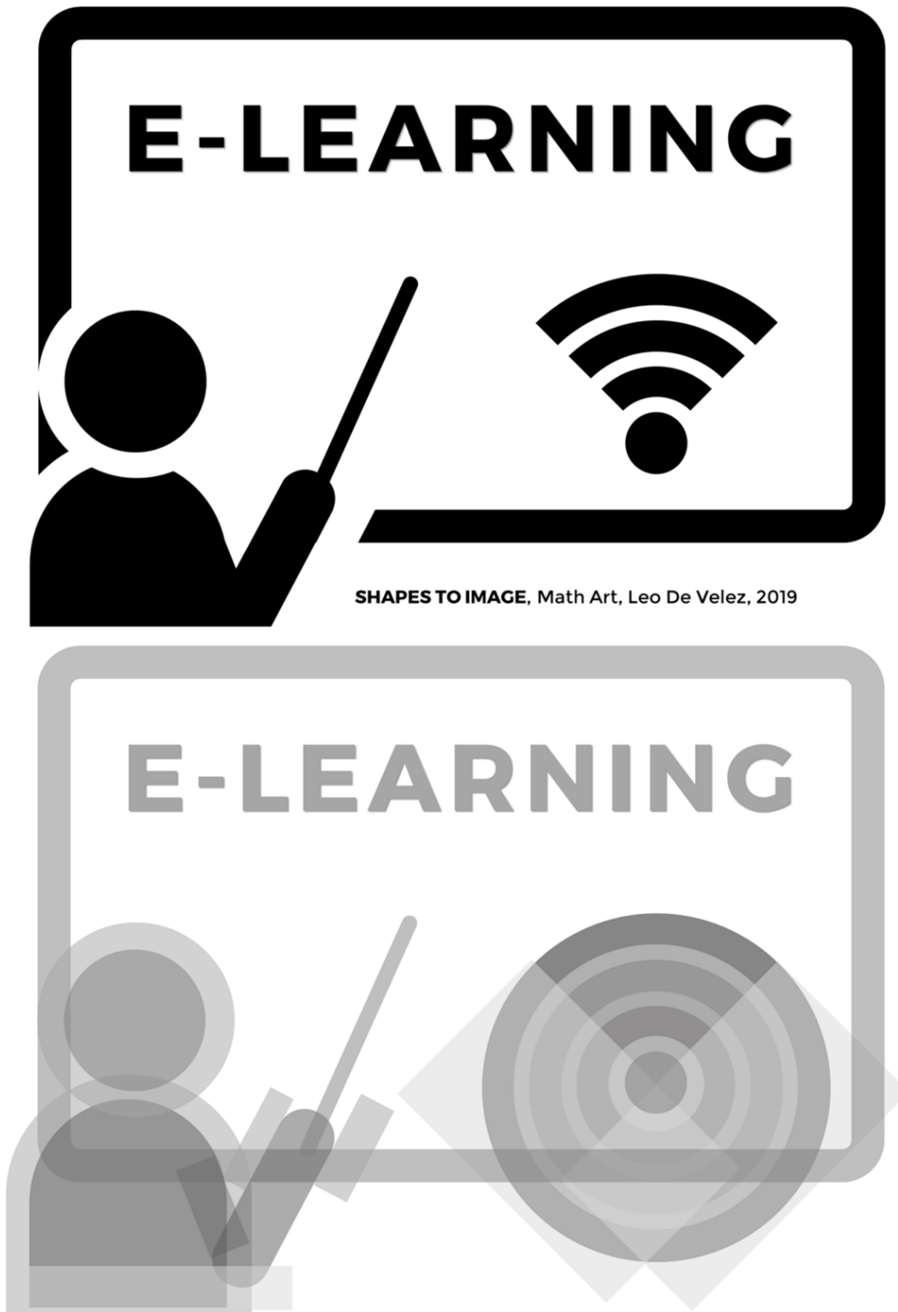
The study reviewed prior research on the factors that influence the use of e-learning and the impact of e-learning on the students. The study considered these factors, identified in prior research, in the selection of which variables to investigate.

The study investigated the correlation of selected demographic and psychographic variables that may influence the use of e-learning by the math teachers. The study assessed the correlation of selected change management components that may have affected the use of e-learning. It evaluated the impact of e-learning on students based on the assessment of the teachers who are using e-learning to teach math.

The results suggest the importance of an integrated e-learning implementation plan for successful teachers' adoption of e-learning. The results also suggest that motivating teachers to try using an e-learning system right soonest may allow them to develop the needed skills over time. The results also suggest that exposing future teachers early on to education technology will help in adopting e-learning for teaching.

Concrete plans and actions that will help more teachers adopt e-learning technology for teaching and encourage them to use it more often for a longer duration are essential and timely. The broader use of e-learning will likely generate a more positive student impact that has already been observed by the majority of the math teachers currently using e-learning.

Frontispiece



Author's Biographical Sketch

Leo De Velez graduated from Vinzons Pilot Elementary School, in Camarines Norte, Philippines, in 1977. Leo graduated from the Philippine Science High School, in Diliman, Quezon City, Philippines, in 1981. He received a Bachelor of Science degree in Mechanical Engineering, cum laude, from the University of the Philippines in 1985. In 1990, he took and topped (first place) the Philippine Mechanical Engineering Board examination. He then earned a Master's in Business Administration degree from the University of the Philippines, in 2000. He started his current graduate degree course, Master of Liberal Arts (ALM) in Extension Studies in the field of Mathematics for Teaching at the Harvard University Extension School, in 2014.

Leo worked for an oil company in the Philippines from 1986 to 2013. He held various positions, including as Vice-President for Oil Supply. His work in the company included an assignment in Singapore from 2005 to 2013. He then came back to the Philippines in 2013 and retired.

In 1990, he and his wife set up a math tutorial center. Then, in 1998, they started an online math tutorial website. Then, in 2000, together with some friends, they launched an online reviewer website for elementary students covering the core academic subjects for Grades 1 to 7. In 2014, they marketed an online reviewer for Philippine Science High School entrance examination. Moreover, in 2016, they established a corporation that provides e-learning content and technology for schools at on-grid and off-grid locations.

Dedication

To my wife Maria Elaine, my son Leonel Cray, and my daughter Lorraine Claire, who always supported, challenged, encouraged, and inspired me to continuously serve the Filipino people.

Acknowledgments

I want to thank my thesis advisor, Andrew Engelward, Ph.D., who convinced me to consider writing this thesis, and who was very supportive and encouraging in many ways throughout the process.

I like to express my love and gratitude to my daughter Lorraine Claire De Velez, who proctored me during my summer class examinations in Harvard campus, set a high-performance standard for me, and inspired me to keep on going.

I also like to express my love and gratitude to my son Leonel Cray De Velez, who set a good study habit example for me, took over some of my family and company tasks, and inspired me to keep on pushing.

Finally, I want to express my love and heartfelt gratitude to my wife, Maria Elaine Perez De Velez, who encouraged, challenged, supported, inspired, and off-loaded me with many family and company tasks for more than a year so I can allocate more time for this thesis.

This accomplishment would not have been possible without them. Thank you very much.

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Chapter I.

Introduction

The purpose of the study was to identify factors that affect the use of e-learning for teaching math. The study was limited to the population of math teachers in public secondary schools in Makati City, Philippines. It focused on how the schools and teachers introduced and used e-learning for teaching math.

In 2016, Aparicio, Bacao, and Oliveira stated that “e-learning systems are an evolving concept, rooted in the concept of Computer-Assisted Instruction” (as cited in Zinn, 2000, p. 293). Aparicio et al. (2016) showed that “e-learning unites two main areas, learning, and technology” (p. 292). According to Aparicio, et al., the current “e-learning concept, apart from technology, includes learning strategies, learning methods, and … the vast possibilities of content diffusion and connection. The concept trend no longer means simply the use of a computer as an artifact in the learning process” (p. 295).

As a definition for this study, e-learning will refer to any teaching and learning process that uses computer network-based technologies and digital learning materials.

Background

There have been some studies about the implementation of e-learning, its potential benefits, the challenges that users have faced, and its impact on student competency.

In 2006, Maggie McPherson and Miguel Baptista Nunes published their study “Organisational issues for e-learning: Critical success factors as identified by H.E.

practitioners." In that study, McPherson and Nunes stated that the “organizational CSFs for e-learning were better represented using four quadrants that resulted from the intersection of the main variables as follows:

(1) leadership, structural and cultural issues – these are inherent within HE institutions and for better or worse determine any change processes and innovation;

(2) design issues – specifically related to e-learning within institutional settings;

(3) technological issues – specific to the “e” in e-learning; and

(4) delivery issues – the implementation of e-learning” (p. 549).

In 2007, Richard Malinski published a review of a book in 2007 by editors Sharma and Mishra with the title “Cases on global e-learning practices: successes and pitfalls” in higher education. Malinski (2007) looked at the editors’ work on “23 case studies divided into three sections, i.e., completely online learning systems (10 cases), blended online learning systems (8), and resources based online learning systems (5)” (as cited in Sharma and Mishra, 2007, p. 295).

From the group composed of ten case studies, Malinski (2007) highlighted the assessment, networking, professional development, and student support as four key issues. For the next eight case studies on blended learning, he highlighted planning, student engagement, and instructor support as the issues. Then, for the last five case studies, he identified costing and planning as two additional issues (p. 296-297). The study took into consideration all of these issues in identifying potential factors that affect the use of e-learning.

In 2008, Rohleder, Bozalek, Carolissen, Leibowitz, and Swartz, in their research on the use of e-learning in two South African Universities, highlighted six factors based on students' feedback. These are: 1) technical difficulties, 2) ease of correspondence, 3) availability of information, 4) online communication, 5) access to computers, and 6) the need for face-to-face interaction (p. 101-104). The study also considered these issues in identifying the factors that affect the usage of e-learning for this study.

In 2009, Chen highlighted "seven components to evaluate how an organization can sustain e-learning, including 'Business readiness', 'Changing nature of learning and e-learning', 'Value of instruction and information', 'Role of change management', 'Reinvention of training organizations to support e-learning efforts', 'E-learning industry', and 'Personal commitment'" (as cited in Rosenberg, 2000, p. 19). According to Rosenberg (p. 6), "the results of this survey can be a catalyst for important discussions within your organization on changes that are necessary to launch and maintain successful e-learning initiative." The research done for this thesis included these high-level factors in identifying specific items that can affect the sustainable use of an e-learning system.

In December 2009, Ozkan and Koseler published their study on "Multi-dimensional students' evaluation of e-learning systems in the higher education context: An empirical investigation." In that study, they used a "conceptual model: hexagonal e-Learning assessment model (HELAM)" (p. 1287) to assess the e-learning system. As the name implies, Ozkan and Koseler (2009, p. 1289) used six general factors in their study. These were "Instructor Quality (Factor 1), information content quality (Factor 2), system quality (Factor 3), service quality (Factor 4), learner's attitude (Factor 5) and finally supportive issues (Factor 6)". Research for this thesis also considered these six factors in identifying more specific factors that can influence the usage level of the e-learning system.

In 2010, Ward, West, Peat, and Atkinson, in their study on "Making it real: Project managing strategic e-learning development processes in a large, campus-based university," identified some factors that can influence the successful implementation and use of the e-learning system in a university setting. These include

"• Selection and careful planning

• Quality control

• Reporting and other communication

• Control of timelines with flexibility

• Ongoing maintenance" (p. 35).

These factors (Dobre, 2013) may also be present in the primary education setting. The study investigated the impact of some of these on the usage level of math e-learning system.

In 2013, Iuliana Dobre published a report on "An overview of the core criteria used to develop quality management systems for e-learning in the higher education organizations." Dobre (2013, p. 335-337) identified some available related to Quality Management Systems (QMS) that may affect the use of an e-learning system. Dobre (p. 336) also identified the Malcolm Baldridge Quality Model as one of the possible options for the QMS. Also, Dobre (p. 336) identified the seven core components of the Malcolm Baldridge Quality Model that can be used to manage e-learning. These are "1. leadership, 2. strategic planning, 3. customer and market focus, 4. measurement, analysis, and knowledge management, 5. human resource focus, 6. process management, and 7. business results, individually and overall at organization's level". The study considered these components of the Malcolm Baldridge Quality Model as crucial factors that can influence the usage level of e-learning in Philippine schools.

Currently, there is insufficient information on how the different learning and teaching situations, conditions, practices, resources, management, and components of an e-learning system can contribute to its utilization level. The overall purpose of this thesis project was to generate information and use this information as the basis for recommendations that can be considered by current users in improving the utilization of their e-learning system and by the potential users in planning and implementing their e-learning projects.

Context of Problem

In 2010, the Philippine Department of Education started a nationwide computerization program that, among others, was supposed to "1. Provide computer laboratory packages to secondary schools and 2. Provide e-classroom to elementary schools" (Philippine Department of Education, 2010, p. 1). In 2016, Philippine Department of Education Secretary Briones reported in a public conference that the computerization program would continue with a target of installing more than 65,000 units in public elementary and high schools nationwide (Briones, 2016, p. 5). In a news article by Alexandria Dennise San Juan (2018), the Secretary of Department of Education Secretary, during a press conference, stated that the department would provide new computers to 22,154 schools. These new computers are significant additional resources for the implementation of e-learning.

This study aims to contribute to the general knowledge about e-learning systems in schools by providing additional data-based assessment and to use the results of this research as the basis for recommendations on how e-learning can be appropriately implemented and utilized for teaching math.

Project

According to the Philippine Department of Education website ("Historical Perspective," n.d.), there are currently 7,976 public secondary schools in the Philippines. The Department of Education organized and grouped all the schools into 221 provincial and city divisions. Based on the latest figures from the Philippine statistics office, as reported on the Philippine News Agency website (Raymundo, 2018), Makati City is the school division with the highest per capita income. Based on a 2015 Rappler report by Mendoza and Altavas, Makati City has the highest spending for Basic Education on per student basis. The spending was more than ten times that of the school division with the next highest spending per student (Mendoza, R. & Altavas, M., 2015).

The thesis selected and studied the Makati City school division. The division has the highest financial resources provided by the local government to the teachers and students in public secondary schools. The study aimed to identify the factors that are affecting the usage of e-learning by the math teachers in the public secondary schools with comparatively much higher financial support as compared to the rest of 221 school divisions in the country.

Overview of Thesis Organization

Chapter II provides details about the objective of the study on math e-learning. It discusses the identified dependent and independent variables included in the survey questionnaire used for collecting the data used in this thesis. Additionally, it gives the rationale for selecting Makati City public secondary math school teachers as the study population. It then explains the sampling methods used and describes the survey method.

Chapter III describes and explains how the survey returns were screened, organized, and analyzed. It presents the resulting data analysis in the form of graphical charts and regression summaries. It then outlines some possible interpretations of the results, along with explanations of the charts and regression results. It also discusses the potential limitations of the current study.

Chapter IV summarizes the key results and interpretations. It offers some conclusions and generalization relating to the factors that affect the use of e-learning for teaching math. Finally, it presents some recommendations on how to enhance the implementation and use of e-learning system for teaching math in schools based on the results of the survey data. It also gives suggestions on possible further studies that may help in better understanding the other issues not covered by the project.

Chapter II.

Project Description

This thesis study aims to contribute to the understanding of the use and implementation of e-learning system in schools by providing additional data-based assessment along with suggestions on how e-learning can be appropriately implemented and utilized for teaching math. Its primary focus is to identify factors that affect the use of e-learning for teaching math. The study population was limited to the math teachers in the public secondary schools in Makati City, the school division in the Philippines with the highest per capita income and financial support given to education on per student basis. The main reason for selecting the Makati City School Division for this study was to uncover the challenge in the implementation and use of e-learning in a school division that has the highest financial support and resources received. Most of the challenges in this division will most likely also be present in the rest of the schools in the country that receive less financial support and resources.

Methods

The official portal of Makati City, Philippines, listed thirteen (13) public secondary school under the Makati City Division Office of the Department of Education. The list includes three (3) public senior high schools (http://www.makati.gov.ph/portal/main/index.jsp?main=49&content=0&menu=0 Education – Public Schools tab).

The Superintendent of the School Division of Makati City approved on August 8, 2018, a request by the researcher for this thesis study to conduct surveys in all of the Makati City public secondary schools (Riddle, 2018). The survey started on August 9th and closed on September 30th, 2018. Due to time constraints, the study has no data from two schools, each of which has one math teacher. From the face-to-face meetings with the school heads and math coordinators of the thirteen schools, the tallied total of the estimated number of public secondary school math teachers per location, at the time of the visits, was 145 as shown in Table 1. Most of the school heads and math coordinators recalled the number of their math teachers from memory or from asking other teachers, not from an official list. The estimated math teacher population of 145 may be slightly different from the official count.

Table 1. Estimated Number of Math Teachers and Actual Returns Per School.

Secondary Schools	Math Teachers	Survey Forms	Actual Returns	Percent Returns
School 1	25	25	23	92%
School 2	20	20	19	95%
School 3	18	18	13	72%
School 4	17	17	12	71%
School 5	11	11	11	100%
School 6	11	11	9	82%
School 7	10	10	10	100%
School 8	9	9	8	89%
School 9	9	9	9	100%
School 10	8	8	8	100%
School 11	5	5	4	80%
School 12	1	1	0	0%

School 13	1	1	0	0%
TOTAL	145	145	126	87%

Table 1 shows the tally of the estimated number of math teachers per public secondary school in Makati City, Philippines, and the corresponding actual number of returns.

The survey form contained 42 questions with 20 primary questions applicable to both users and non-users of e-learning. Given that the main focus of this study was on e-learning usage, two dependent variables were used in the study, both measuring the usage of e-learning. The first was the use or non-use of e-learning by the math teachers. The second was the usage level of e-learning based on the frequency and duration of use of e-learning by the math teachers per week. There were also five questions on the impact of the use of e-learning by the math teachers on the students. The questions on impact included the effects on students' attention during class, their classroom participation, scores on math examinations, their overall grades, along with scores on the math portion of the National Achievement Test.

The rest of the questions were related to factors that may affect the use of e-learning for teaching math found in the prior research already referred to in this thesis. The survey questions also included typical demographic factors such as age and gender. The factors from cited researches included some change management related aspects as well. These were:

1. the school heads' overall e-learning plan;
2. the school heads promoting the use of e-learning for math class;
3. the provision of equipment and resources to the teachers such as computers, internet, e-learning system, digital materials; and

4. efforts to further enhance the existing system through feedback, audit and improvement actions.

Survey questions also contained some items related to the teaching conditions such as the number of math subject taught, class size, and the number of classes per day. The survey included questions about teaching practices such as the use of computers, projectors, and accessing the internet while teaching in the classroom. Questions also covered the use of e-learning features for teaching such as Assignments, Reading Materials, Forums, Chats, Exercises, Quizzes, and Uploaded Lectures. One of the author's colleagues, who had completed several research studies, suggested that prior experience of the teachers on the use of technology may also be a factor (C. Deocaris, Ph.D., personal conversation, July 7, 2018). Thus, the questionnaires looked at the time when the teacher first used a computer, played a computer game, and played an internet game. The questionnaire also included teachers' experience in using the computer and internet for studying when there were still students. It also asked about the teachers' experience in attending classes as a student with a teacher using a computer to teach. All of these were considered in this study to identify those that affect the usage of e-learning for math teaching.

Based on the Creative Research Systems' calculation formula, from a population of 145 math teachers, the number of survey responses required to generate statistically significant results at a 95% confidence level, with a +/- 5% confidence interval is approximately 106 (Creative Research Systems, 2016).

Survey questionnaires and consent forms were given to all the 145 public secondary math school teachers in the School Division of Makati City through their principals or coordinators. Of the 145 math teachers, 126 answered and gave back the survey questionnaire with the corresponding consent form. The 126 survey forms collected cover about 88% of the public secondary school math teachers. After rejecting those surveys that contained answers to less than 75% of the survey's primary questions (a rejection criterion determined before survey collection), the number of acceptable survey returns was 125. These returns are more than the needed sample size for a 95% confidence level with a +/- 5% confidence interval.

The ratio of e-learning users to the 125 survey returns was used to estimate the total number of e-learning users in the whole population of 145 public secondary school math teachers in Makati City. Based on the 125 survey returns, there were 81 e-learning users. Extending this to the total population of 145 teachers gave an estimate of approximately 94 public secondary school math teachers who are using e-learning to teach math in Makati City. Using the same formula to compute for the sample size at 95% confidence level and +/- 5% confidence interval for a finite population of 94 e-learning users, the required number of e-learning users, is 76. The study aimed for this sample size in grouping the independent variables in the multiple regression analysis.

The data collected from the population sample were analyzed using regression tools. Our null hypothesis was that the data on the factors or variables collected in this study were not significantly correlated. The generally accepted practice is to reject the null hypothesis that there is no significant correlation between the dependent and independent variables if the p value from the regression analysis of the variables is less than or equal to 0.05. This study uses the same rejection criteria.

There were four stages used in the data analysis. The first stage involved looking at the correlation of selected independent factors or variables to the use or non-use of e-learning by the math teachers. The second stage investigated the relationship of selected independent variables to the usage level of e-learning by the math teachers who are currently using e-learning to teach math. The population used excludes those teachers who are not using e-learning to teach math. The third stage looked at the teachers' assessment of the impact of using e-learning on the students' performance. The fourth stage looked at the challenges that prevent the teachers from using e-learning.

For the first stage, the selected independent variables were presented individually on graphical charts against the dependent variable. Logistic regression analysis was done for each independent variable together with the dichotomous dependent variable. The logistic regression test identified the variables that gave a p value of less than or equal to 0.05. There were two groups of independent variables. The first group included the variables about demographic and psychographic factors. The sample size for this group meets the 95% confidence level and the +/- 5% confidence interval. The second group includes questions on the change management aspects as seen by the teachers. These questions were more difficult to answer, and many returns had no responses to these particular questions. The sample size of this group of variables did not meet the 95% confidence level, but met a 90% confidence level with a +/- 5% confidence interval. The sample size for a 90% confidence level and +/- 5% confidence interval is approximately 95.

The selected factors from the two groups, with a significant correlation with the dependent variable, were combined for multiple logistic regression statistics. Variables were removed one at a time from the model until all the remaining variables have p values less than or equal to 0.05. The regression analysis used the RegressIt add-in for Microsoft Excel software (RegressIt, n.d.).

The analysis used the same process for the second independent variable except that there was no need for logistic regression. The second independent variable has a continuous scale of 1 to 4 so that multiple regression analysis could be employed. The population for the second phase is the number of public secondary school math teachers in Makati City and estimated at 94 teachers. Based on this, the target sample size was 76 to meet a 95% confidence level with a +/- 5% confidence interval. For a 90% confidence level and +/- 5% confidence interval, the sample size needed is 70.

The third phase presented the impact of the use of e-learning on five charts. The feedback came from the math teachers who are using e-learning to teach math.

The fourth phase presented the feedback from the teachers on why some of them are not using e-learning, the challenges that they face, and their suggestions on how to improve their e-learning.

The study presents possible interpretations of the results found in the four phases of the data analysis. It presents inferences that can be made based on possible interpretations of the results. It then provides recommendations on how to implement and use e-learning in schools. The thesis also included some discussion of the limitations of the study and suggested further research to look at the areas not covered by this project.

Chapter III.

Results and Data Analysis

There were four phases in the analysis of the survey data. The first phase focused on contributing factors to the use and non-use of the e-learning system for teaching math. The second phase evaluated the factors that may contribute to the level of usage of e-learning for teaching math. The third phase investigated the impact of the use of e-learning based on the feedback from the teachers who used e-learning to teach math. The fourth looked at the reasons and challenges that prevent the teacher from using e-learning.

Selected factors were presented as charts and analyzed using regression models. For the first phase, the use and non-use analysis required the use of a logistic regression model. This analysis made use of a Microsoft Excel add-in tool that came from the RegressIt website (RegressIt, n.d.). For the second phase, multiple regression analysis involving usage levels used the same Microsoft Excel add-in tool for consistency. For the third phase, the study presented graphically the impact of e-learning on students as observed by math teachers in their classes. It also presented multiple regression statistics of the impact variables along with other variables covered by this study. For the fourth phase, it grouped the qualitative feedback from the respondents into similar reasons and challenges and presented these in the charts.

The study discovered various models of the factors with a significant correlation with the depended variables. The study presented the models that helped form the recommendations on how to improve the implementation and use an e-learning system.

Number of E-Learning Users

The main question in the survey was “Do you use an E-Learning System to teach math?” The available answers for this question were: a) Yes, b) No, and c) I do not understand.

Based on the 125 survey returns, 81 of them are currently using e-learning to teach math. Please see Figure 1 for a breakdown of all the survey responses to this question.

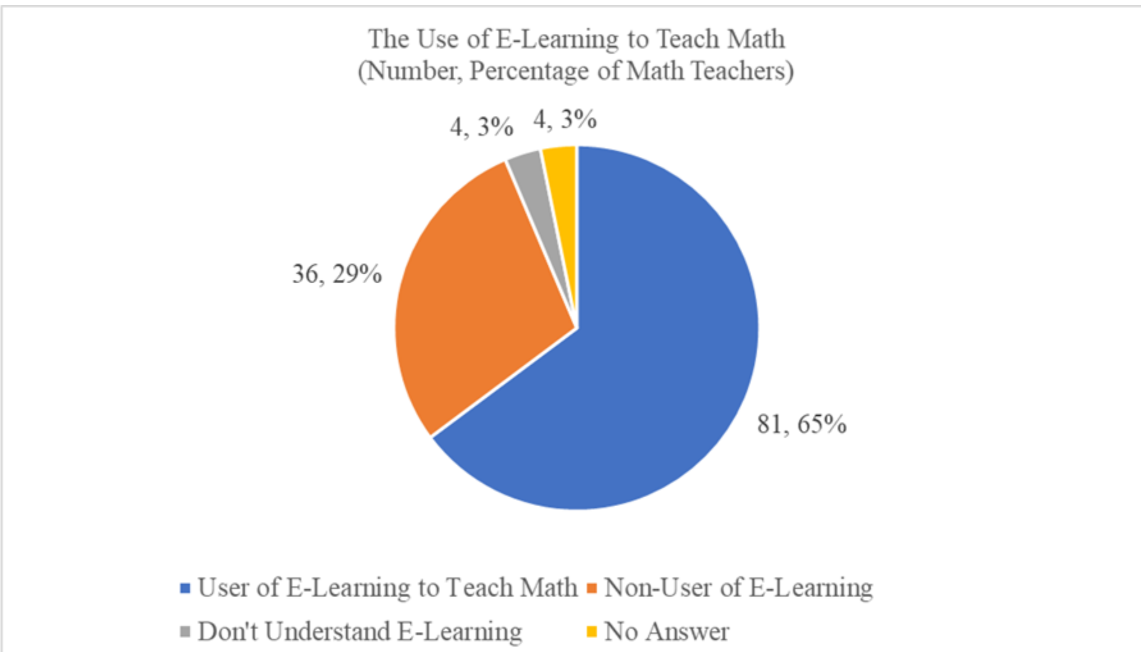

Figure 1. Survey Return on the Use of E-Learning.

Figure 1 shows the number of users and non-users of the e-learning system among the survey respondents from public secondary school math teachers in Makati City.

Using the ratio of the 81 e-learning users to the 125 survey returns, the estimated number of e-learning users among the 145 public secondary school math teachers is 94.

The sample size needed, for the 145 population of public secondary school math teachers in Makati City, at a 95% confidence level and with a +/- 5% confidence interval, is 106. For a 90% confidence level and +/- 5% confidence interval, the required sample size is 95.

The sample size needed, for the 94 estimated population of e-learning users, at 95% confidence level and +/- 5% confidence interval, is 76. For the same population and confidence interval, the sample size needed for a 90% confidence level is 70.

E-Learning Users at School Locations

The survey covered all 13 public secondary schools in Makati City. Due to resource and timing constraints, the survey study did not include survey returns from two schools that have one math teacher each.

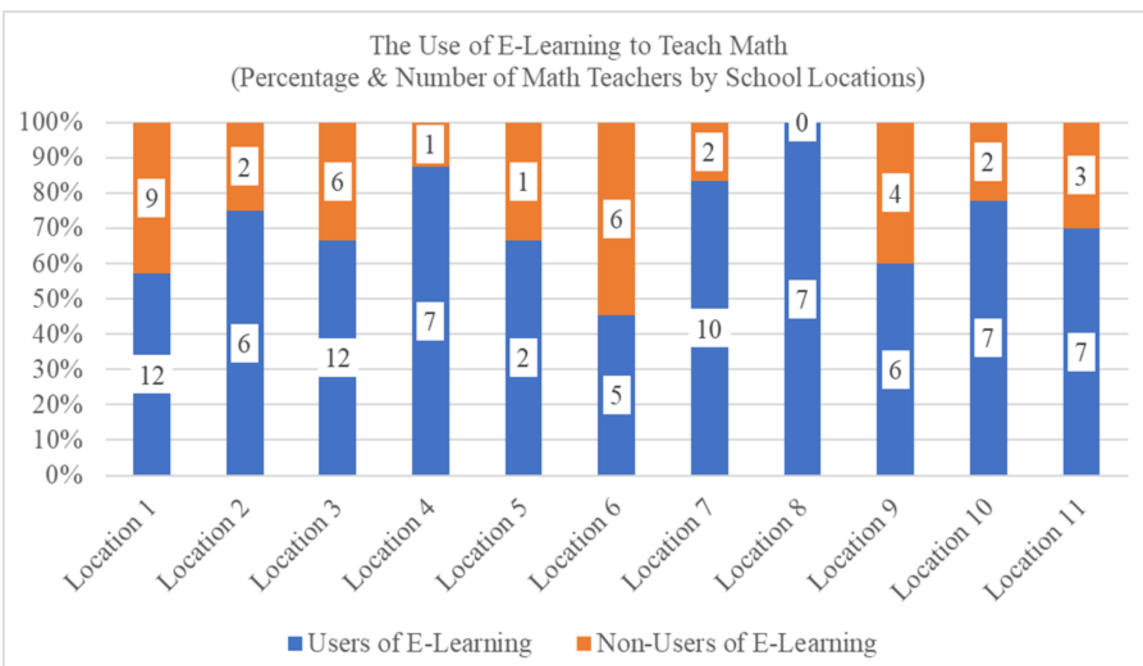

Figure 2. E-Learning Users at School Location.

Figure 2 shows the percentage and number of users and non-users of the e-learning system at each school surveyed in Makati City.

Except in one case, more than half of the teachers at each location are using e-learning. In general, this indicates that the majority of the teachers support the use of e-learning. Supporting them with the right resources can encourage more teachers to use e-learning for teaching math.

Use of E-Learning System

Many factors influence the use or non-use of e-learning for teaching math. The purpose of the analysis in this section is to assess whether there is a correlation between the use or non-use of an e-learning system to teach math and the demographic and psychographic factors. Identifying those factors with significant correlation can help in better understanding the current state of e-learning system implementation. It can also help in crafting strategies to better support users of the e-learning system for teaching math.

Use of E-Learning versus Age

Figure 3 shows the age and the use of e-learning by the survey respondents. The second column for the age bracket 25 to 30 years old has the highest percentage of e-learning users. Percentages appear to decrease with increasing age until the fifth bracket of 40 to 45 years old. In general, there is no visible correlation in the percentage of e-learning users with the age of the users.

Figure 4 shows the logistic regression statistics of the age of the teachers and the use of e-learning by the survey respondents. The p value is 0.650, and it indicates that there is no significant correlation between the two factors. The data do not support the view that the percentage of e-learning users among young teachers is higher than among the more seasoned teachers.

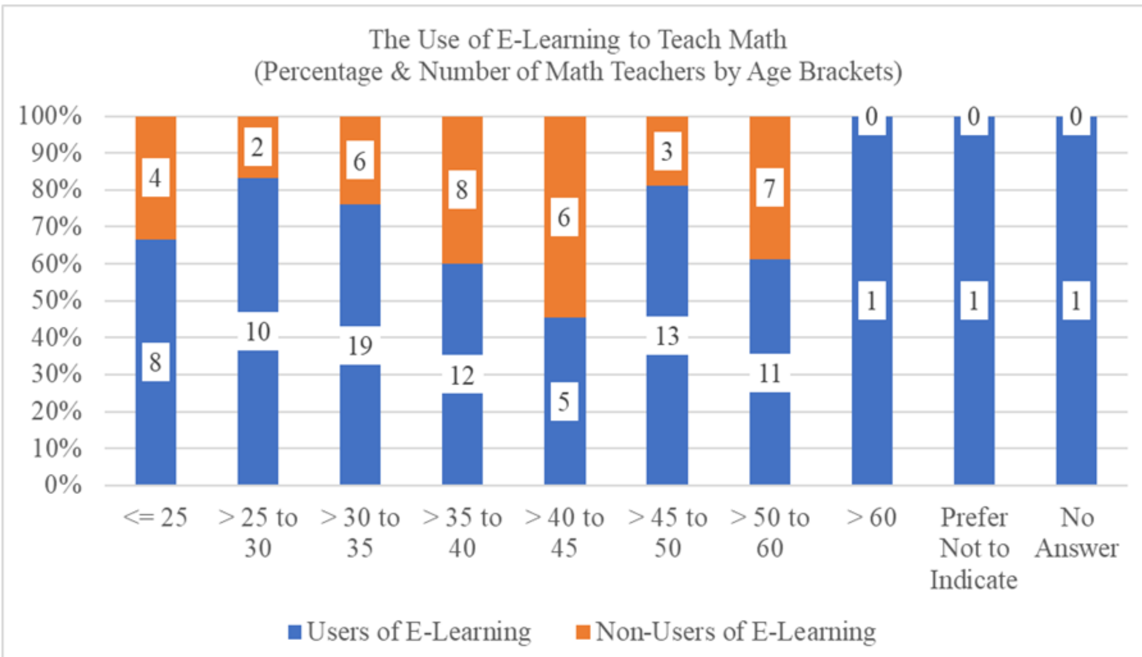

Figure 3. Age of Math Teachers

Figure 3 shows the age and the use of e-learning by the survey respondents.

Binary Dependent Variable: V000_20_Using_E_Learning_System_to_Teach_Math **0-1 value labels:** No | Yes

Logistic Regression Statistics: Use2 for V000 20 Using E Learning System to Teach Math (1 variable, n=116)

R-squared (McFadden)	Adj.R-Sqr.	RMSE	Mean	# Fitted	ROC area	Critical z	Conf. level
0.001	0.000	0.462	0.690	116	0.00	1.960	95.0%

Logistic Regression Coefficient Estimates: Use2 for V000 20 Using E Learning System to Teach Math (1 variable, n=116)

Variable	Coefficient	Std.Err.	z-statistic	P-value	Lower95%	Upper95%	VIF	Std. coeff.
Constant	0.992	0.475	2.089	0.037	0.061	1.923		
V002_1_Age_Bracket_o	-0.046	0.101	-0.454	0.650	-0.244	0.153	1.000	-0.050

Analysis of Deviance: Use2 for V000 20 Using E Learning System to Teach Math (1 variable, n=116)

Correlation Matrix of Coefficient Estimates : Use2 for V000 20 Using E Learning System to Teach Math (1 variable, n=116)

V002_1_Age_Bracket_of_Math_Teachers

Figure 4. Age Logistic Regression.

Figure 4 shows the logistic regression statistics between the age and the use of e-learning (output from the RegressIt Excel add-in tool.)

Use of E-Learning versus Gender

Figure 5 shows the gender and the use of e-learning by the survey respondents. The percentage of male teachers using e-learning is above 80% and is 20 percentage points higher than the female teachers. The big difference may indicate a potential correlation between the use of e-learning and gender.

Figure 6 shows the logistic regression statistics of the gender of the teachers and the use of e-learning by the survey respondents. The p value is 0.045, and it indicates that there is a statistically significant correlation between the two factors. The data indicate that male teachers use e-learning technology more than their female colleague for teaching math.

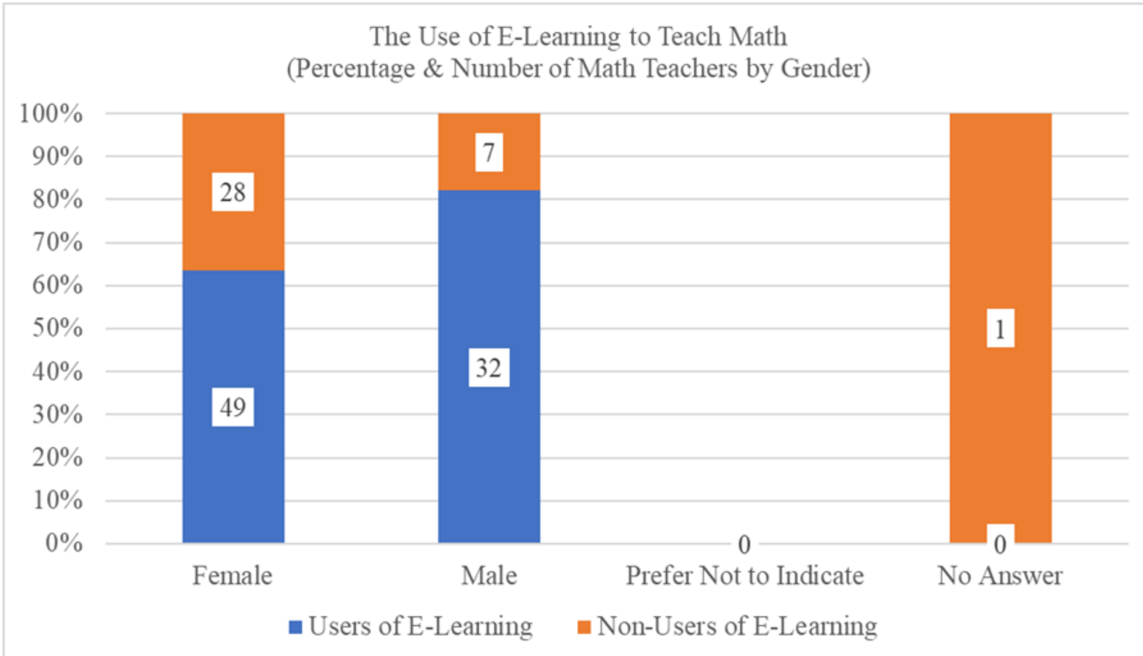

Figure 5. Gender.

Figure 5 shows the gender and the use of e-learning by the survey respondents.

Binary Dependent Variable: V000_20_Using_E_Learning_System_to_Teach_Math **0-1 value labels:** No | Yes

Logistic Regression Statistics: Use3 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=116)

R-squared (McFadden)	Adj.R-Sqr.	RMSE	Mean	# Fitted	ROC area	Critical z	Conf. level
0.031	0.003	0.451	0.698	116	0.00	1.960	95.0%

Logistic Regression Coefficient Estimates: Use3 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=116)

Variable	Coefficient	Std.Err.	z-statistic	P-value	Lower95%	Upper95%	VIF	Std. coeff.
Constant	2.480	0.867	2.859	0.004	0.780	4.180		
V003 2 Gender of Mat	-0.960	0.480	-2.001	0.045	-1.901	-0.020	1.000	-0.251

Analysis of Deviance: Use3 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=116)

Correlation Matrix of Coefficient Estimates : Use3 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=116)

V003_2_Gender_of_Math_Teachers

Figure 6. Gender Logistic Regression.

Figure 6 shows the logistic regression statistics between the usage frequency of e-learning and the gender of the e-learning users among the survey respondents. (RegressIt Excel add-in output)

Use of E-Learning versus Highest Educational Attainment

Figure 7 shows the highest educational attainment and the use of e-learning by the survey respondents. The logistic regression statistics show a p value of 0.686, and it indicates that there is no significant correlation between the two factors. It means that the teacher's highest educational attainment has no relationship with the use of e-learning.

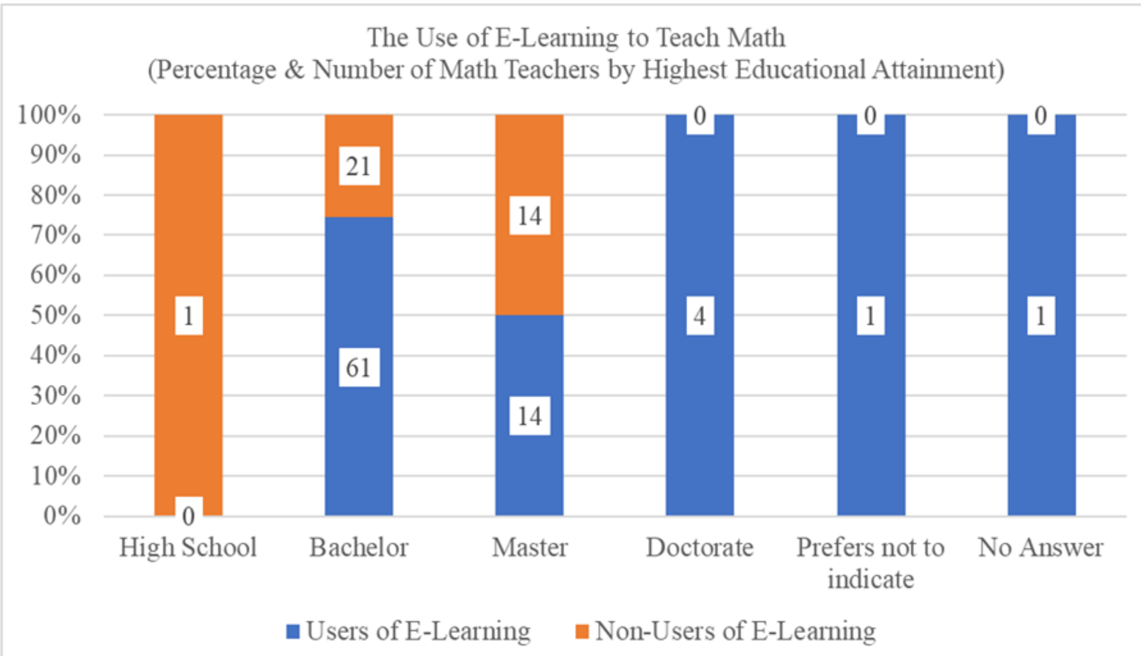

Figure 7. Highest Educational Attainment.

Figure 7 shows the highest educational attainment and the use of e-learning by the survey respondents.

Use of E-Learning versus Length of Math Teaching Experience

Figure 8 shows the length of math teaching experience and the use of e-learning by the survey respondents. There is no general trend apparent from this graph. The logistic regression analysis of the length of math teaching experience of the teachers and the use of e-learning by the survey respondents also indicated (p value of 0.618) that there is no significant correlation between the two factors. The data do not support the hypothesis that seasoned teachers prefer the traditional method of teaching over the use of technology such as e-learning.

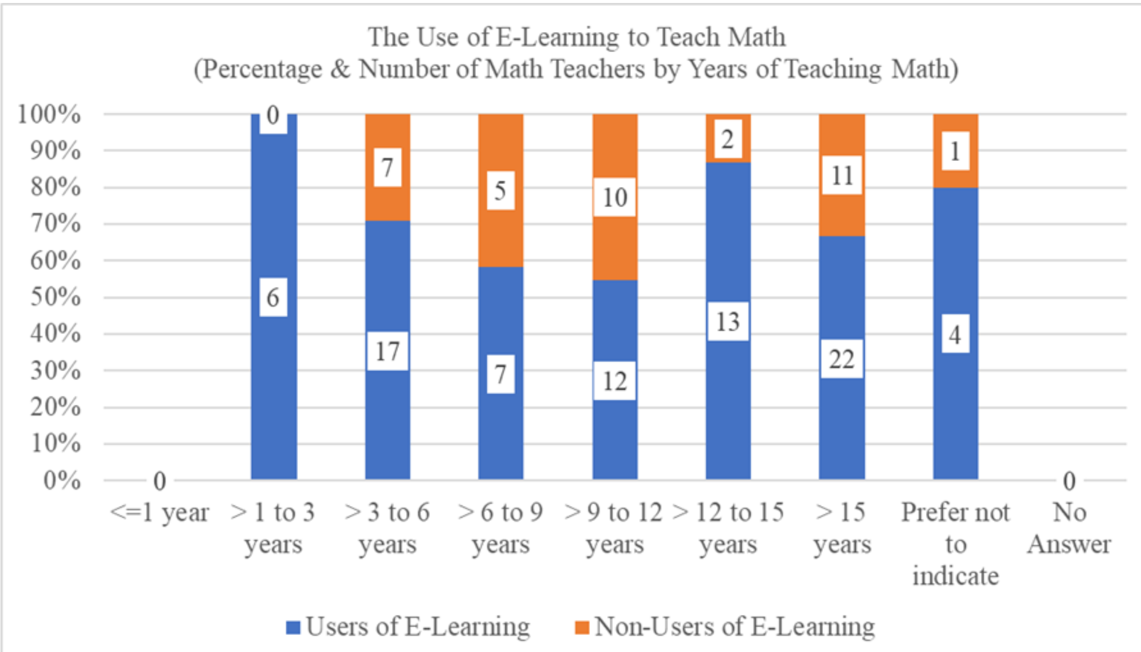

Figure 8. Length of Math Teaching Experience.

Figure 8 shows the length of math teaching experience and the use of e-learning by the survey respondents.

Use of E-Learning versus Grade-level-teaching-load

Figures 9 and 10 show the grade-level-teaching-load and the use of e-learning by the survey respondents. Except for one teacher with Grade 12 teaching-load, the percentages of e-learning users are highest in both charts among teachers with Grade 10 teaching-load. The high percentage may be related to an initiative by the school division of Makati City to use the e-learning system for Grade 10 in all Makati City schools (Riddle, 2017). Further study may look into the correlation of the high percentage of e-learning users with the School Division e-learning initiative for Grade 10.

Based on the data shown in Figure 10, some of the Grade 10 teachers are also teaching other grade levels. The data also show that some of the teachers handling non-Grade ten classes are also using an e-learning system.

Figure 11 shows the logistic regression statistics of the grade-level-teaching-load of the teachers and the use of e-learning by the survey respondents. The p value for Grade 10 is 0.010. The other grade levels have high p values. The p value for Grade 10 indicates that there is a significant correlation between the use of e-learning and the Grade 10 teaching-load for the teachers in Makati City. Further study is needed to determine if the high usage level of e-learning is related to the school division's initiative to provide e-learning for Grade 10 teachers.

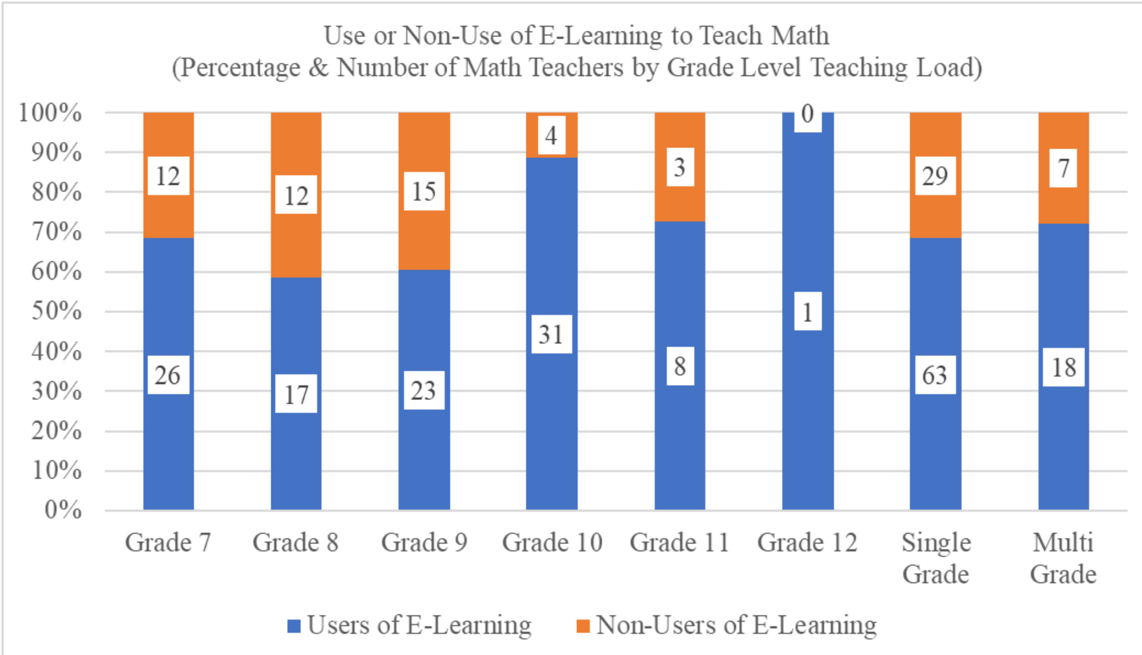

Figure 9. Grade-level-teaching-load.

Figure 9 shows the grade-level-teaching-load and the use of e-learning by the survey respondents.

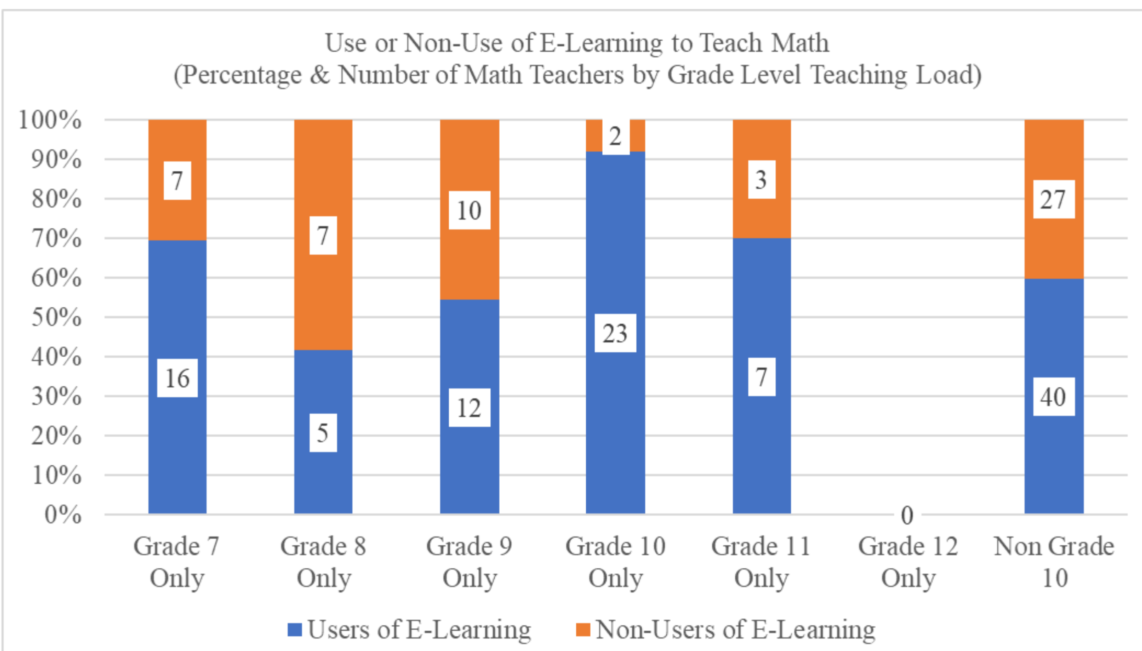

Figure 10. Single Grade-level-teaching-load.

Figure 10 shows the single grade-level-teaching-load and the use of e-learning by the survey respondents.

Binary Dependent Variable: V000_20_Using_E_Learning_System_to_Teach_Math **0-1 value labels:** No | Yes

Logistic Regression Statistics: Model 44 for V000_20_Using_E_Learning_System_to_Teach_Math (5 variables, n=117)

R-squared (McFadden)	Adj.R-Sqr.	RMSE	Mean	# Fitted	ROC area	Critical z	Conf. level
0.085	0.002	0.438	0.692	117	0.70	1.960	95.0%

Logistic Regression Coefficient Estimates: Model 44 for V000_20_Using_E_Learning_System_to_Teach_Math (5 variables, n=117)

Variable	Coefficient	Std.Err.	z-statistic	P-value	Lower95%	Upper95%	VIF	Std. coeff.
Constant	-0.741	2.444	-0.303	0.762	-5.532	4.049		
V009_8_Teaching___aG	0.164	0.513	0.319	0.750	-0.842	1.169	1.253	0.042
V010_8_Teaching___bG	-0.416	0.491	-0.847	0.397	-1.377	0.546	1.088	-0.099
V011_8_Teaching___cG	-0.368	0.509	-0.724	0.469	-1.366	0.629	1.206	-0.096
V012_8_Teaching___dG	1.582	0.615	2.572	0.010	0.377	2.788	1.282	0.401
V013_8_Teaching___eG	0.380	0.847	0.449	0.654	-1.281	2.041	1.358	0.061

Analysis of Deviance: Model 44 for V000_20_Using_E_Learning_System_to_Teach_Math (5 variables, n=117)

Correlation Matrix of Coefficient Estimates: Model 44 for V000_20_Using_E_Learning_System_to_Teach_Math (5 variables, n=117)

V009_8_Teaching___aGrade_7
V010_8_Teaching___bGrade_8
V011_8_Teaching___cGrade_9
V012_8_Teaching___dGrade_10
V013_8_Teaching___eGrade_11

Figure 11 Grade-level-teaching-load Logistic Regression.

Figure 11 shows the logistic regression statistics of the grade-level-teaching-load and the use of e-learning by the survey respondents. (RegressIt Excel add-in output)

Use of E-Learning versus Math Subject Teaching-load

Figure 12 shows the math subject teaching-load and the use of e-learning by the survey respondents. The logistic regression analysis of the number of math subjects teaching load and the use of e-learning shows a p value of 0.697, and it indicates that there is no significant correlation between the two factors. The data do not support the hypothesis that the teachers with more subjects teaching load will be encouraged to use an e-learning system to benefit from its built-in teaching materials for the different math subjects.

Figure 13 shows the logistic regression p values for Statistics and Geometry subjects at 0.038 and 0.015 respectively. These indicate that the two factors have significant correlations with the use of e-learning. The data may suggest that teachers with Statistics or Geometry math subjects teaching-load prefer to use an e-learning system to help them in illustrating visually the concepts they are teaching.

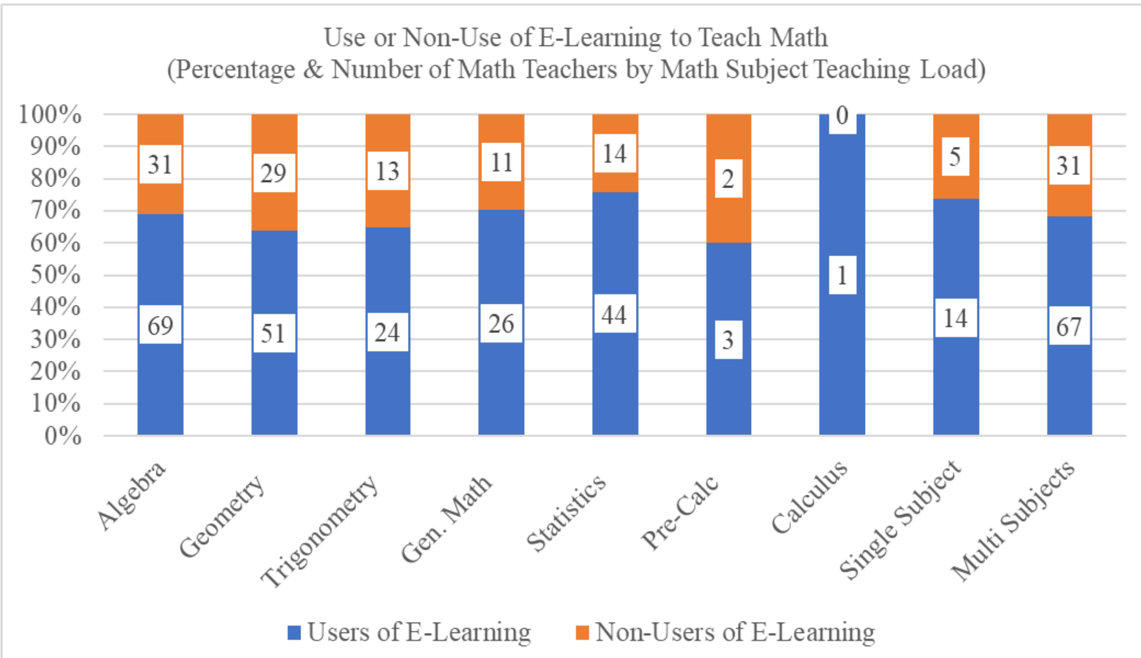

Figure 12. Math Subjects Teaching-load.

Figure 12 shows the math subjects teaching-load and the use of e-learning by the survey respondents.

Binary Dependent Variable:	V000_20_Using_E_Learning_System_to_Teach_Math	0-1 value labels:	No	Yes

Logistic Regression Statistics: Model 45 for V000_20_Using_E_Learning_System_to_Teach_Math (6 variables, n=117)

R-squared (McFadden)	Adj.R-Sqr.	RMSE	Mean	# Fitted	ROC area	Critical z	Conf. level
0.069	0.000	0.444	0.692	117	0.67	1.960	95.0%

Logistic Regression Coefficient Estimates: Model 45 for V000_20_Using_E_Learning_System_to_Teach_Math (6 variables, n=117)

Variable	Coefficient	Std.Err.	z-statistic	P-value	Lower95%	Upper95%	VIF	Std. coeff.
Constant	2.906	2.645	1.099	0.272	-2.278	8.090		
V022_10_Teaching___a	0.079	0.845	0.094	0.925	-1.577	1.735	1.803	0.015
V023_10_Teaching___b	-1.518	0.623	-2.435	0.015	-2.740	-0.296	1.445	-0.391
V024_10_Teaching___c	0.184	0.476	0.387	0.698	-0.748	1.116	1.132	0.047
V025_10_Teaching___d	-0.144	0.518	-0.278	0.781	-1.159	0.871	1.355	-0.037
V026_10_Teaching___e	0.991	0.477	2.077	0.038	0.056	1.925	1.206	0.274
V027_10_Teaching___fI	-1.082	1.212	-0.893	0.372	-3.456	1.293	1.392	-0.121

Analysis of Deviance: Model 45 for V000_20_Using_E_Learning_System_to_Teach_Math (6 variables, n=117)

Correlation Matrix of Coefficient Estimates : Model 45 for V000_20_Using_E_Learning_System_to_Teach_Math (6 variables, n=117)

V022_10_Teaching___aAlgebra

V023_10_Teaching___bGeometry

V024_10_Teaching___cTrigonometry

V025_10_Teaching___dGen._Math

V026_10_Teaching___eStatistics

V027_10_Teaching___fPre_Calc

Figure 13. Math Subjects Teaching-load Logistic Regression.

Figure 13 shows the logistic regression statistics of the math subjects teaching-load and the use of e-learning by the survey respondents. (RegressIt Excel add-in output)

Use of E-Learning versus First-Time-to-Use-Computer

Figure 14 shows the first-time-to-use-computer and the use of e-learning by the survey respondents. When logistic regression analysis was done to compare first-time-to-use-computer to the use of e-learning by the survey respondents, the resulting p value was 0.070. Given our null hypothesis rejection criteria, the p value was not low enough to reject it.

Figure 14 also shows a drop in the percentage of e-learning users for those who indicated that they first use a computer after college. Dichotomizing the first-time-to-use-computer data into on-or-before and after college shows a significant correlation. Figure 15 shows the logistic regression statistics of the dichotomized first-time-to-use-computer by the teachers and the use of e-learning by the survey respondents. It shows a p value of 0.008. It indicates that there is a significant correlation between the two variables. The correlation with the time of first use of a computer may also be related to the computer or internet era when the teachers were studying. The data may suggest that those who first used a computer after college had finished schooling before the computer or internet boom. Further study on the time-of-first-use of a computer by the teachers may show the reason behind the significant correlation found in this study.

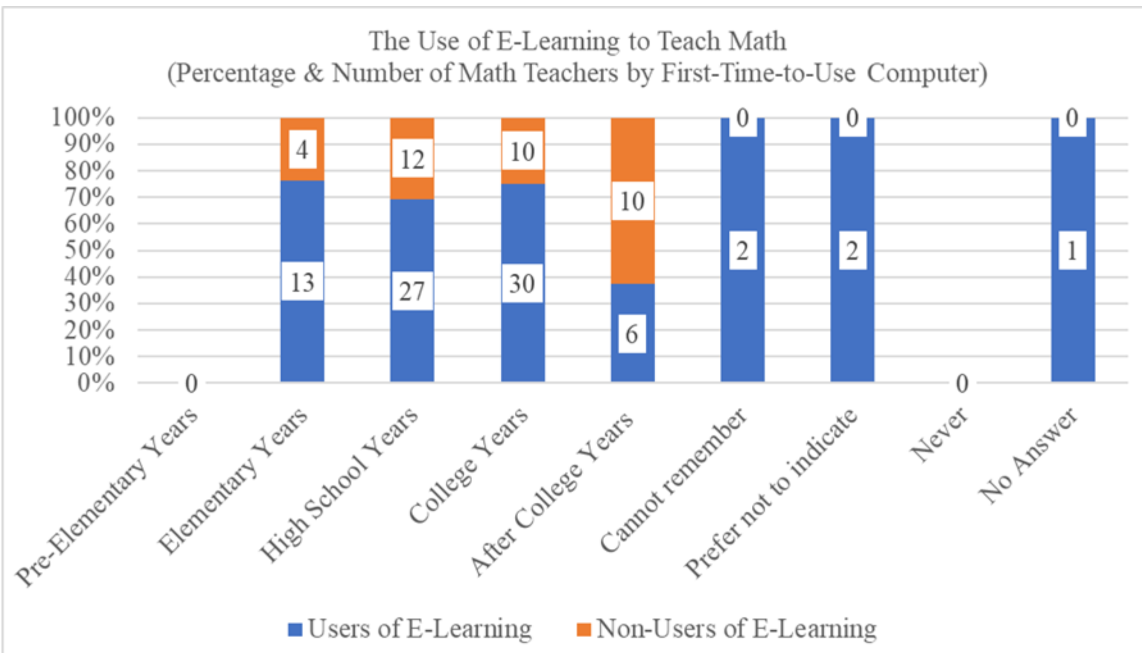

Figure 14. First-Time-to-Use-Computer.

Figure 14 shows the first-time-to-use-computer and the use of e-learning by the survey respondents.

Binary Dependent Variable:	V000_20_Using_E_Learning_System_to_Teach_Math	**0-1 value labels:**	No	Yes

Logistic Regression Statistics: Model 57 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=112)

R-squared (McFadden)	Adj.R-Sqr.	RMSE	Mean	# Fitted	ROC area	Critical z	Conf. level
0.052	0.024	0.450	0.679	112	0.00	1.960	95.0%

Logistic Regression Coefficient Estimates: Model 57 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=112)

Variable	Coefficient	Std.Err.	z-statistic	P-value	Lower95%	Upper95%	VIF	Std. coeff.
Constant	6.995	2.363	2.960	0.003	2.363	11.627		
V032_13_First_Use_of_	-1.501	0.565	-2.656	0.008	-2.609	-0.394	1.000	-0.291

Analysis of Deviance: Model 57 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=112)

Correlation Matrix of Coefficient Estimates : Model 57 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=112)

V032_13_First_Use_of_Computer___Dichotomize_OnOrBefore___After_College

Figure 15. Dichotomized First-Time-to-Use-Computer Logistic Regression.

Figure 15 shows the logistic regression statistics of the dichotomized first-time-to-use-computer feedback and the use of e-learning by the survey respondents. (RegressIt Excel add-in output)

Use of E-Learning versus First-Time-to-Play-Computer-Game

Figure 16 shows the first-time-to-play-computer-game and the use of e-learning by the survey respondents. There is no observable pattern on the percentages of e-learning users, and logistic regression analysis done for this yielded a p value of 0.077, not low enough to reject the null hypothesis in this case.

Dichotomizing the first-time-to-play-computer-game data into on-or-before and after college show no significant correlation. The logistic regression statistics of the dichotomized first-time-to-play-computer-game by the teachers and the use of e-learning yielded a p value of 0.3422, which indicates that there is no significant correlation between the two variables.

The data do not support the hypothesis that the early experience of playing computer games may encourage the use of e-learning for teaching.

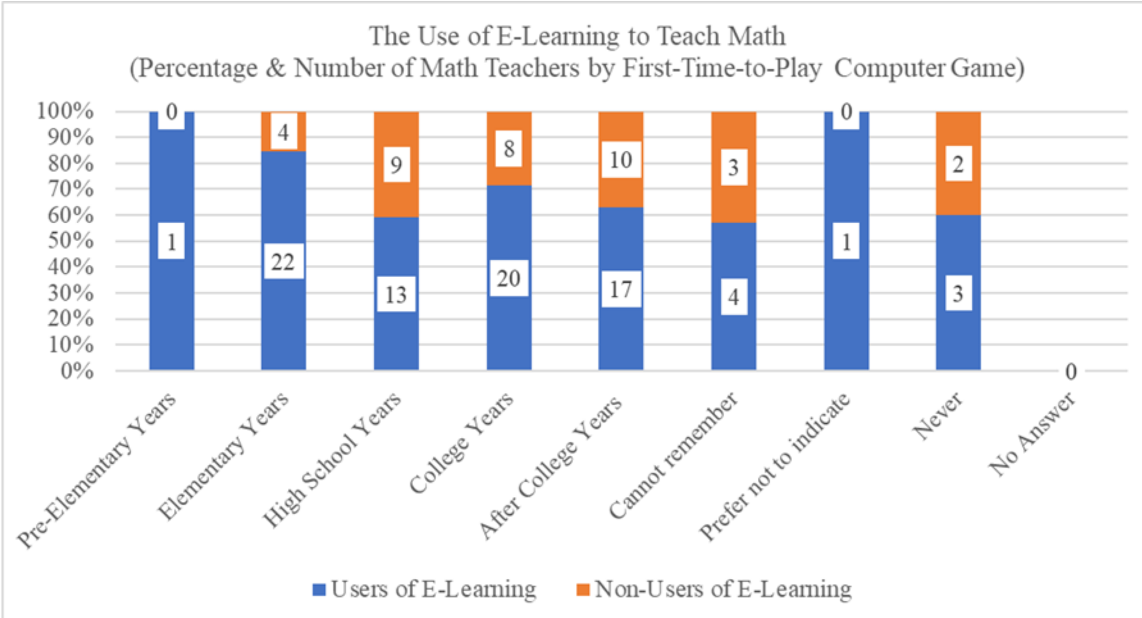

Figure 16. First-Time-to-Play-Computer-Game.

Figure 16 shows the first-time-to-play-computer-game and the use of e-learning by the survey respondents.

Use of E-Learning versus First-Time-to-Play-Internet-Game

Figure 17 shows the first-time-to-play-internet-game and the use of e-learning by the survey respondents. There is no observable pattern on the percentages of e-learning users, and logistic regression analysis done for this yielded a p value of 0.089, not low enough to reject the null hypothesis in this case. The data do not support the hypothesis that the early experience of playing internet games may encourage the use of e-learning for teaching.

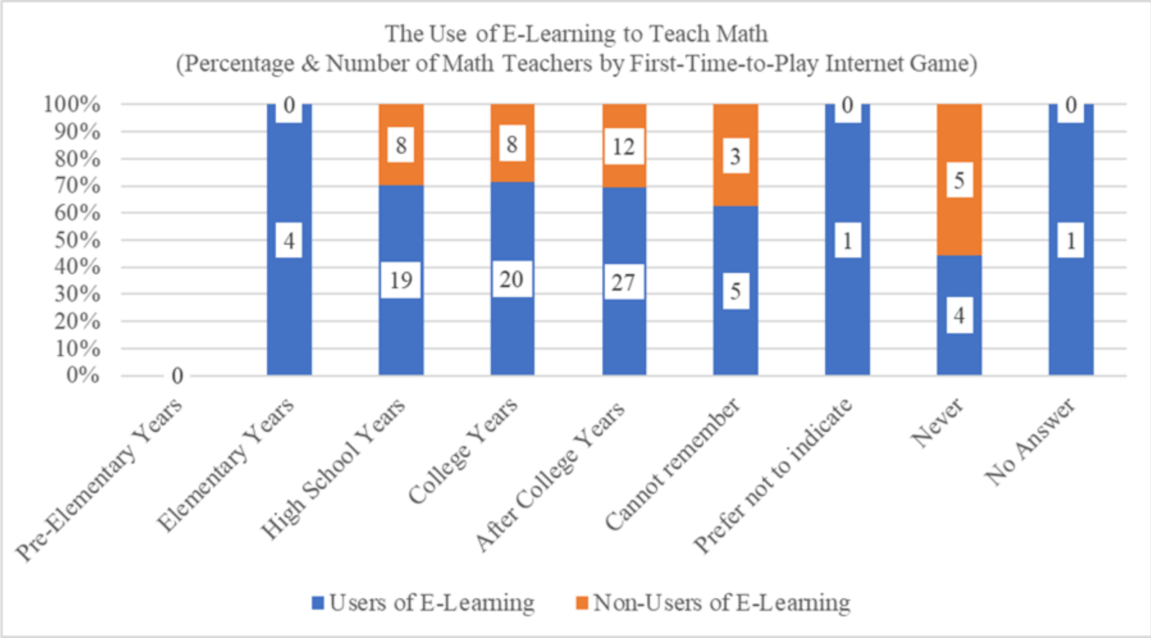

Figure 17. First-Time-to-Play-Internet-Game.

Figure 17 shows the first-time-to-play-internet-game and the use of e-learning by the survey respondents.

Use of E-Learning versus Prior Use of Computer as Student

Figure 18 shows the prior use of a computer as a student by the teachers and the use of e-learning by the survey respondents. There is no observable pattern on the percentages of e-learning users, and logistic regression analysis done for this yielded a p value of 0.666, not low enough to reject the null hypothesis in this case. The data do not support the hypothesis that prior experience on the use of a computer as a student may encourage the use of e-learning for teaching.

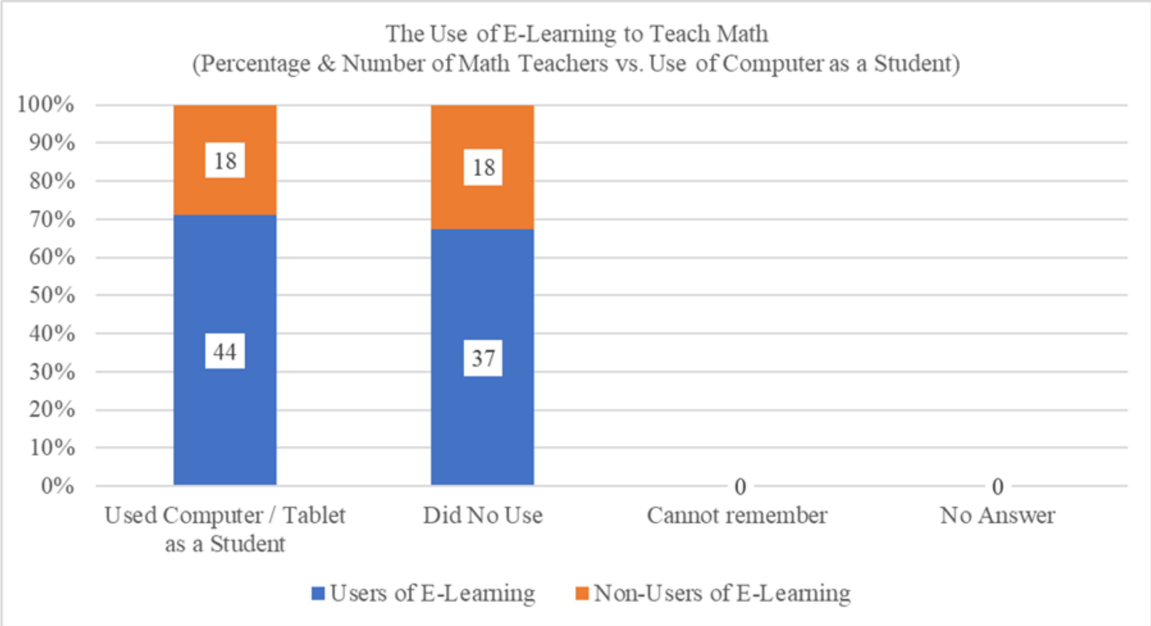

Figure 18. Prior Use of Computer as Student.

Figure 18 shows the prior use of the computer as a student and the use of e-learning by the survey respondents.

Use of E-Learning versus Prior Experience with a Teacher Using a Computer

Figure 19 shows the prior experience as a student with a teacher using a computer to teach and the use of e-learning by the survey respondents. There is no observable pattern on the percentages of e-learning users, and logistic regression analysis done for this yielded a p value of 0.168, not low enough to reject the null hypothesis in this case. The data do not support the hypothesis that prior exposure to teachers using a computer may encourage the use of e-learning for teaching.

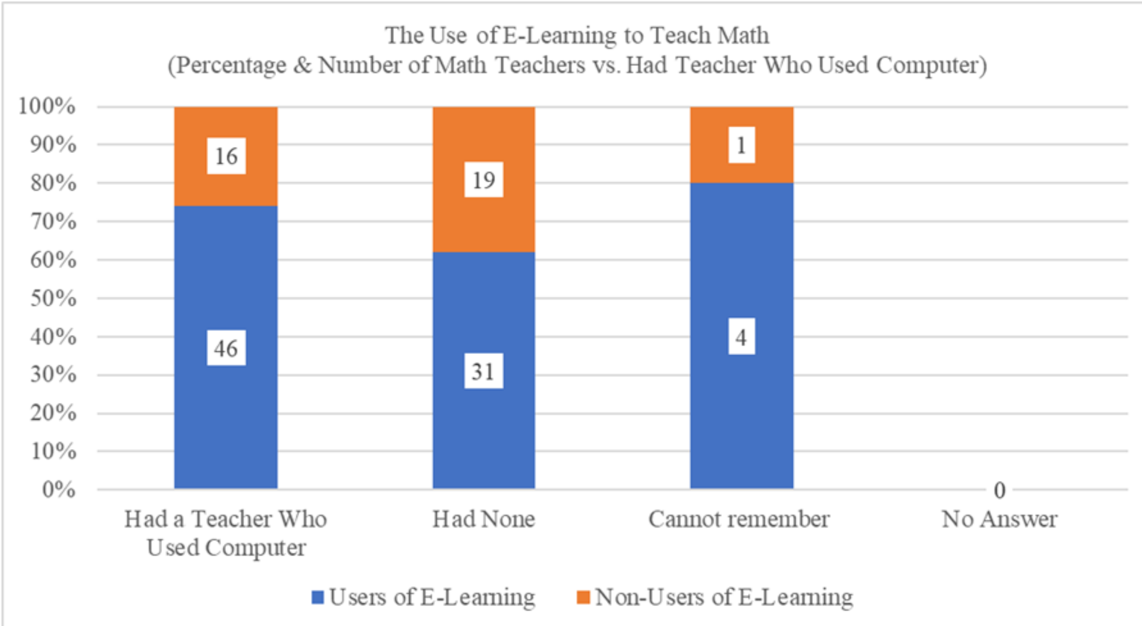

Figure 19. Prior Experience as a Student with a Teacher Using a Computer.

Figure 19 shows the prior experience as a student with the teacher using a computer and the use of e-learning by the survey respondents.

Use of E-Learning versus Use of a Computer for Teaching Math

Figure 20 shows the use of a computer to teach math and the use of e-learning by the survey respondents.

Figure 21 shows the logistic regression statistics, where the p value is 0.001, and it indicates that there is a significant correlation between the two variables. The correlation is not surprising because the use of a computer is a step towards or a prerequisite to the use of e-learning. However, the scope of the current study does not include the assessment of the causal relationship between the variables. Further study may look into the possible causal relationship of these two variables.

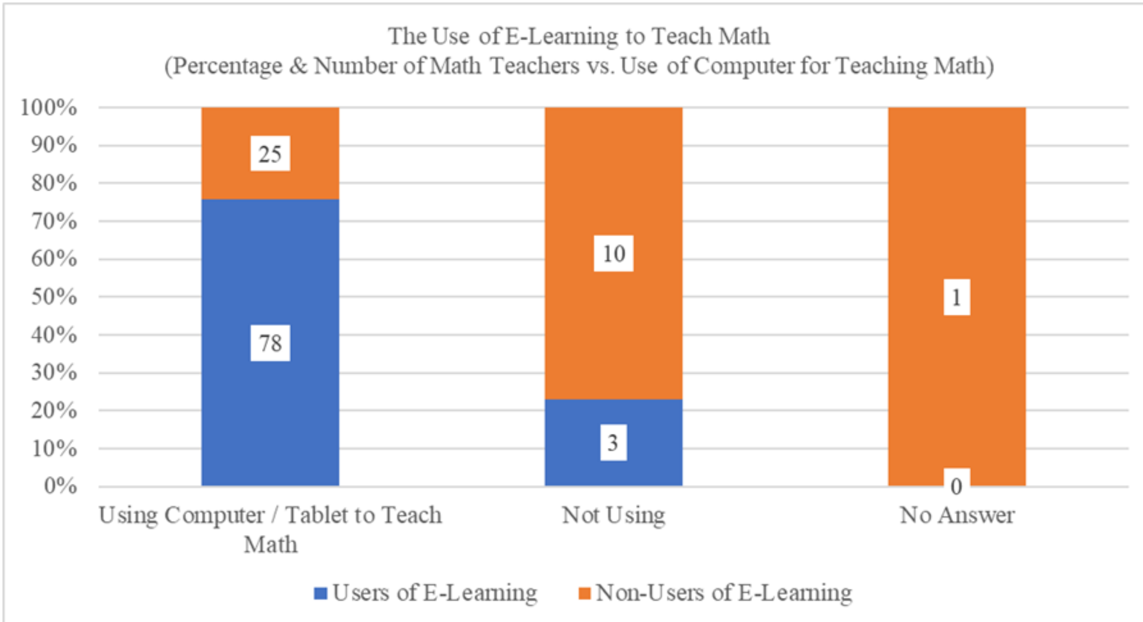

Figure 20. Use of a Computer for Teaching Math.

Figure 20 shows the use of a computer to teach math and the use of e-learning by the survey respondents.

Binary Dependent Variable: V000_20_Using_E_Learning_System_to_Teach_Math **0-1 value labels:** No | Yes

Logistic Regression Statistics: Use28 for V000 20 Using E Learning System to Teach Math (1 variable, n=116)

R-squared (McFadden)	Adj.R-Sqr.	RMSE	Mean	# Fitted	ROC area	Critical z	Conf. level
0.097	0.069	0.428	0.698	116	0.00	1.960	95.0%

Logistic Regression Coefficient Estimates: Use28 for V000 20 Using E Learning System to Teach Math (1 variable, n=116)

Variable	Coefficient	Std.Err.	z-statistic	P-value	Lower95%	Upper95%	VIF	Std. coeff.
Constant	-3.546	1.336	-2.653	0.008	-6.165	-0.926		
V040_18_Using_Compu	2.342	0.697	3.359	0.001	0.975	3.708	1.000	0.409

Analysis of Deviance: Use28 for V000 20 Using E Learning System to Teach Math (1 variable, n=116)

Correlation Matrix of Coefficient Estimates : Use28 for V000 20 Using E Learning System to Teach Math (1 variable, n=116)

V040_18_Using_Computer___Tablet_for_Teaching_Math

Figure 21. Use of Computer for Teaching Math Logistic Regression.

Figure 21 shows the logistic regression statistics of the use of a computer to teach math and the use of e-learning by the survey respondents. (RegressIt Excel add-in output)

Use of E-Learning System and Change Management Factors

The purpose of the analysis in this section is to assess the correlation between the selected change management related factors and the use or non-use of the e-learning system to teach math. Identifying those factors with significant correlation can help in better understanding the current state of e-learning system implementation. It can also help in crafting strategies to better support users of the e-learning system for teaching math.

Use of E-Learning versus Familiarity with School Head's Overall E-Learning Plan

Figure 22 shows the familiarity of the math teachers to their school head's overall e-learning plan and the use of e-learning by the survey respondents.

Figure 23 shows the logistic regression statistics of the familiar of math teachers with their school head's overall e-learning plan and the use of e-learning by the survey respondents. The p value is 0.001, and it indicates that there is a significant correlation between the two variables. The sample excludes the teachers who did not provide an answer to the question of their familiarity with the e-learning plan. The sample size is 102, and it is below the target sample size of 106 for 95% confidence level and +/-5% confidence interval. It is above the required size of 95 for a 90% confidence level at the same interval.

The data support the hypothesis that when the school heads communicate their overall plan and direction for the school e-learning, it will encourage the teachers to use it. Further study is required to establish the causal relationship between these two variables.

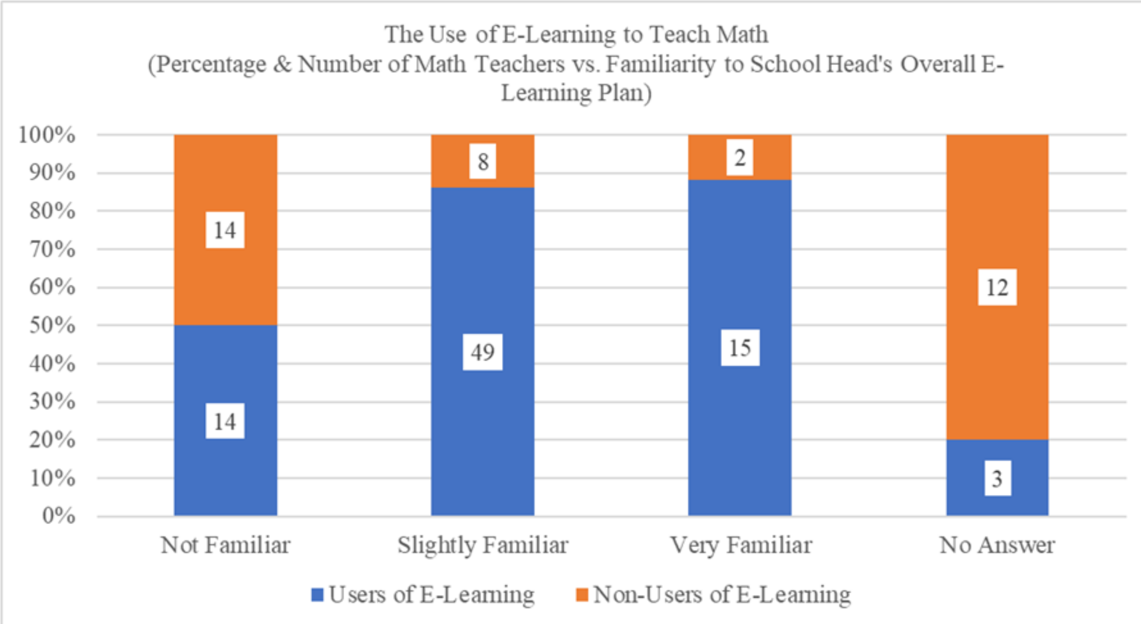

Figure 22. Familiarity with School Head’s Overall E-Learning Plan.

Figure 22 shows the familiarity with the school head’s overall e-learning plan and the use of e-learning by the survey respondents.

Binary Dependent Variable: V000_20_Using_E_Learning_System_to_Teach_Math **0-1 value labels:** No | Yes

Logistic Regression Statistics: UseMS2 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=102)

R-squared (McFadden)	Adj.R-Sqr.	RMSE	Mean	# Fitted	ROC area	Critical z	Conf. level
0.108	0.072	0.394	0.765	102	0.00	1.645	90.0%

Logistic Regression Coefficient Estimates: UseMS2 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=102)

Variable	Coefficient	Std.Err.	z-statistic	P-value	Lower90%	Upper90%	VIF	Std. coeff.
Constant	-1.207	0.735	-1.642	0.101	-2.416	0.002		
V089_27_Familiarity_to_	1.365	0.426	3.202	0.001	0.664	2.066	1.000	0.496

Analysis of Deviance: UseMS2 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=102)

Correlation Matrix of Coefficient Estimates : UseMS2 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=102)

V089_27_Familiarity_to_School_Head_s_Overall_E_Learning_Plan

Figure 23. Familiarity with School Head’s Overall E-Learning Plan Logistic Regression.

Figure 23 shows the logistic regression statistics of the familiarity with the school head’s overall e-learning plan and the use of e-learning by the survey respondents. (RegressIt Excel add-in output)

Use of E-Learning versus School Head Promoting the Use of E-Learning

Figure 24 shows the math teachers' observation of their school heads' effort to promote the use of e-learning in math class and the use of e-learning by the survey respondents.

Figure 25 shows the logistic regression statistics of the math teachers' observation on their school heads' effort to promote the use of e-learning in math class and the use of e-learning by the survey respondents. The p value is 0.013, and it indicates that there is a significant correlation between the two variables. The sample size was 103.

The data support the hypothesis that when the school heads campaign for the use of e-learning for math class, it will encourage the teachers to use it. Further study is needed to establish the causal relationship between these two variables.

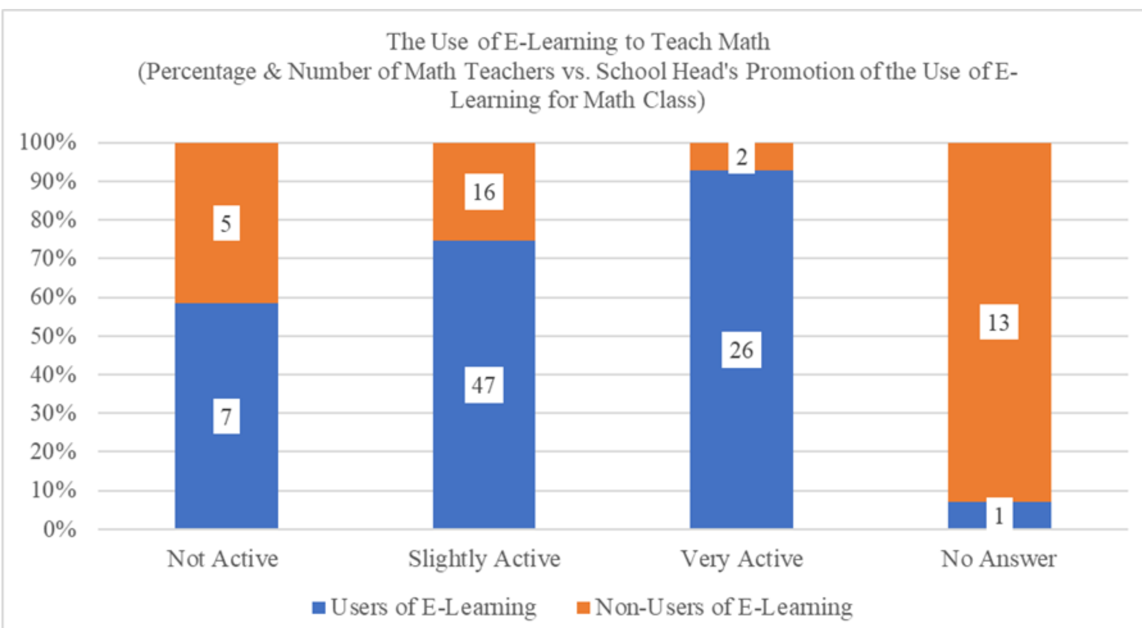

Figure 24. School Head Promoting the Use of E-Learning in Math Class.

Figure 24 shows the observation of the school heads' effort to promote the use of e-learning in a math class by the survey respondents.

Binary Dependent Variable: V000_20_Using_E_Learning_System_to_Teach_Math **0-1 value labels:** No | Yes

Logistic Regression Statistics: UseMS3 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=103)

R-squared (McFadden)	Adj.R-Sqr.	RMSE	Mean	# Fitted	ROC area	Critical z	Conf. level
0.062	0.026	0.404	0.777	103	0.00	1.645	90.0%

Logistic Regression Coefficient Estimates: UseMS3 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=103)

Variable	Coefficient	Std.Err.	z-statistic	P-value	Lower90%	Upper90%	VIF	Std. coeff.
Constant	-0.953	0.883	-1.079	0.280	-2.405	0.499		
V090_28_School_Head_	1.071	0.432	2.480	0.013	0.361	1.781	1.000	0.358

Analysis of Deviance: UseMS3 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=103)

Correlation Matrix of Coefficient Estimates : UseMS3 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=103)

V090_28_School_Head_Promoting_Use_of_E_Learning_in_Math_Class

Figure 25. School Head Promoting the Use of E-Learning Logistic Regression.

Figure 25 shows the logistic regression statistics of the observation on the school heads' effort to promote the use of e-learning in math class by the survey respondents. (RegressIt Excel add-in output)

Use of E-Learning versus School Providing TV or Projector

Figure 26 shows the school providing a TV or projector for use in math class and the use of e-learning by the survey respondents. There is no observable pattern on the percentages of e-learning users, and logistic regression analysis done for this yielded a p value of 0.665, not low enough to reject the null hypothesis in this case. The sample size was 105.

The data do not support the hypothesis that by providing teachers with digital classroom equipment such as TV screens and projectors, it will encourage them to use e-learning.

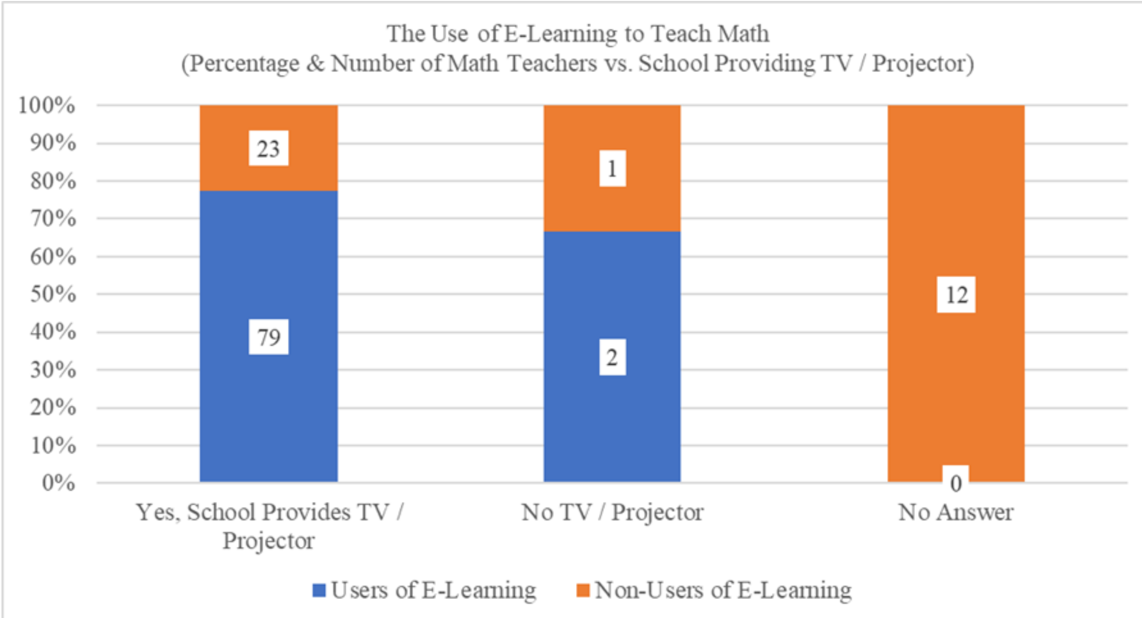

Figure 26. School Providing TV or Projector.

Figure 26 shows the availability of school TV or projector as observed by the survey respondents.

Use of E-Learning versus School Providing Computer or Tablet

Figure 27 shows the math teachers' observation on their school's provision of computer or tablet for use in math class and the use of e-learning by the survey respondents. There is no observable pattern on the percentages of e-learning users, and logistic regression analysis done for this yielded a p value of 0.226, not low enough to reject the null hypothesis in this case. The sample size was 105.

The data do not support the hypothesis that by providing teachers with computers and devices, it will encourage them to use e-learning. This lack of correlation is surprising based on the general feedback that the lack of access to computers and devices is one of the main blockers on the use of e-learning. Further study on the relationship between the availability of computers and devices for teachers and the use of e-learning may reveal the reason behind the observed lack of correlation.

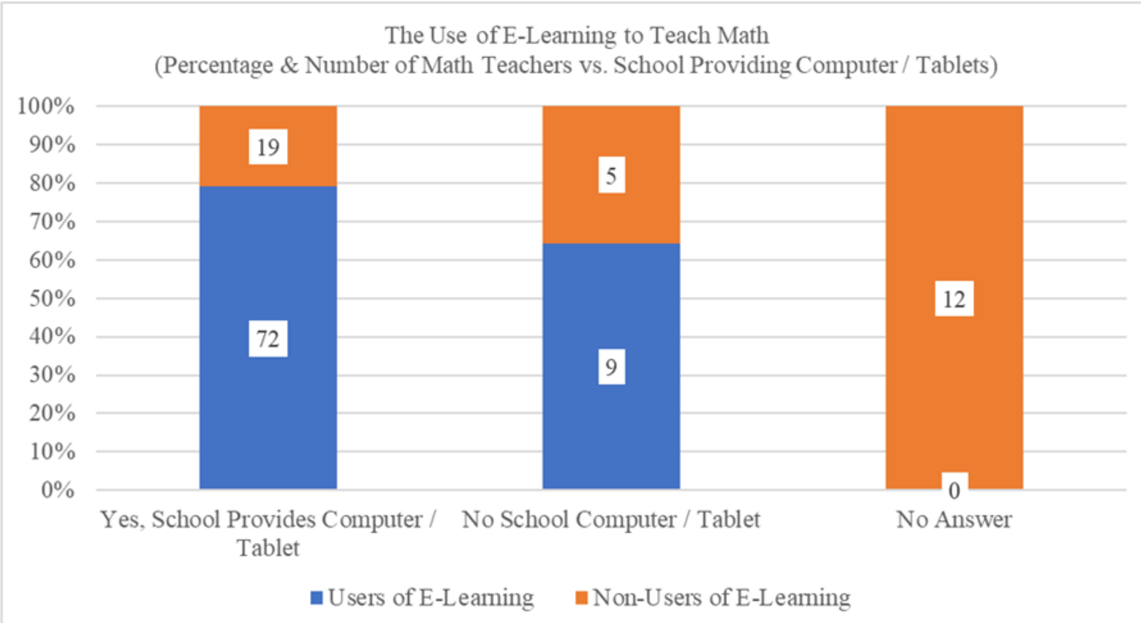

Figure 27. Availability of School Computer or Tablet.

Figure 27 shows the school computer or tablet availability as observed by the survey respondents.

Use of E-Learning versus School Providing Internet Access

Figure 28 shows the math teachers' observation on their school's provision of internet access for use in math class and the use of e-learning by the survey respondents. There is no observable pattern on the percentages of e-learning users, and logistic regression analysis done for this yielded a p value of 0.908, not low enough to reject the null hypothesis in this case. The sample size was 105.

The data do not support the hypothesis that by providing teachers with internet access, it will encourage them to use e-learning. This lack of correlation is surprising based on the general feedback that the lack of internet access is one of the main blockers on the use of e-learning. The data may also suggest that with or without internet access at school, the teachers who decided to use e-learning for teaching will find ways to do it. Further study of the relationship between the availability of internet access in school and the use of e-learning may reveal the reason behind the observed lack of correlation.

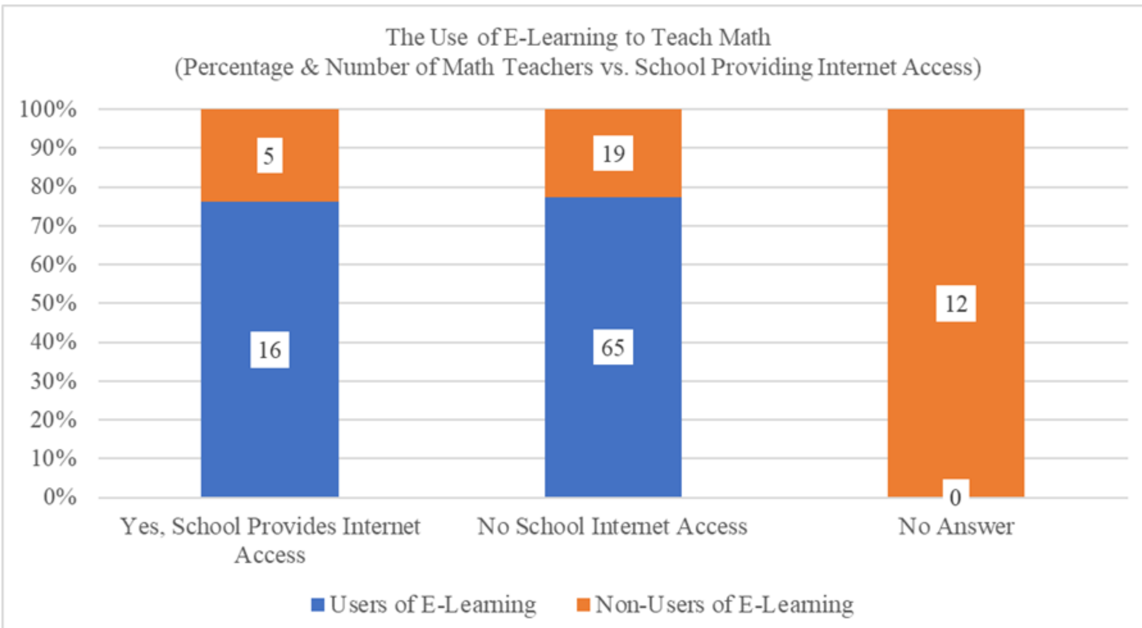

Figure 28. School Providing Internet Access.

Figure 28 shows the school internet access as observed by the survey respondents.

Use of E-Learning versus Sufficiency of Internet Speed

Figure 29 shows the math teachers' observation on their school's provision of internet access with sufficient speed for use in math class and the use of e-learning by the survey respondents. There is no observable pattern on the percentages of e-learning users, and logistic regression analysis done for this yielded a p value of 0.064, not low enough to reject the null hypothesis in this case. The sample size was 96.

The data do not support the hypothesis that by providing teachers with a fast internet connection, it will encourage them to use e-learning. This lack of correlation is surprising based on the general feedback that the slow speed of internet connection is one of the main blockers on the use of e-learning. Further study on the relationship between the speed of internet connection at school and the use of e-learning may reveal the reason behind the observed lack of significant correlation.

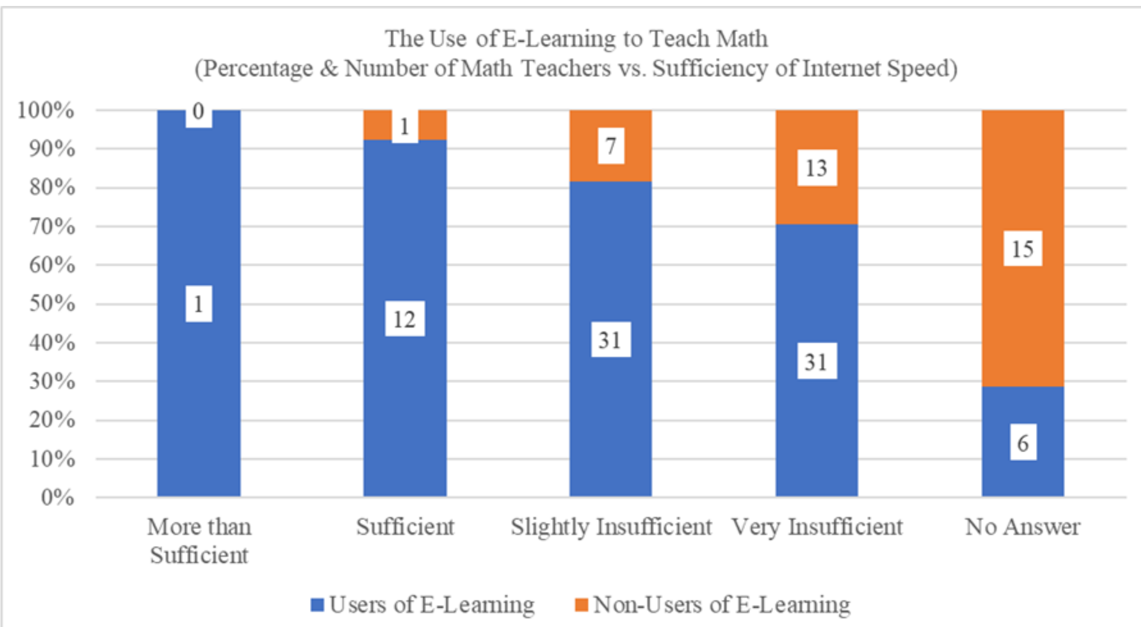

Figure 29. School Internet Access.

Figure 29 shows the school internet access as observed by the survey respondents.

Use of E-Learning versus School Providing E-Learning System

Figure 30 shows the math teachers' observation on their school's provision of an e-learning system for use in math class and the use of e-learning by the survey respondents.

Figure 31 shows the logistic regression statistics of the math teachers' observation on their school's provision of an e-learning system for use in math class and the use of e-learning by the survey respondents. The p value is 0.045, and it indicates that there is a significant correlation between the two variables. The 101 samples were above the required size of 95 for a 90% confidence level at +/-5% confidence interval.

The data support the hypothesis that the school should provide the teachers with an e-learning system to encourage its use. It may be possible that by expecting the teachers to take their initiative in sourcing and using an e-learning system may not encourage its use for teaching.

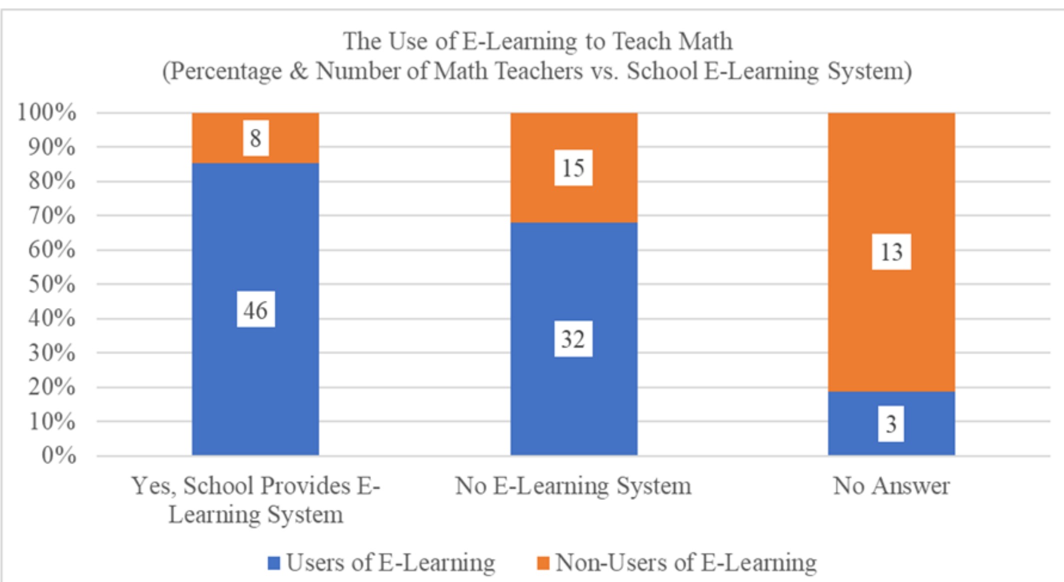

Figure 30. School Providing E-Learning System.

Figure 30 shows the school providing e-learning system as observed by the survey respondents.

Binary Dependent Variable: V000_20_Using_E_Learning_System_to_Teach_Math **0-1 value labels:** No Yes

Logistic Regression Statistics: UseMS8 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=101)

R-squared (McFadden)	Adj.R-Sqr.	RMSE	Mean	# Fitted	ROC area	Critical z	Conf. level
0.039	0.002	0.411	0.772	101	0.00	1.645	90.0%

Logistic Regression Coefficient Estimates: UseMS8 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=101)

Variable	Coefficient	Std.Err.	z-statistic	P-value	Lower90%	Upper90%	VIF	Std. coeff.
Constant	-0.234	0.734	-0.319	0.750	-1.441	0.973		
V095_33_School_Provid	0.992	0.495	2.005	0.045	0.178	1.805	1.000	0.274

Analysis of Deviance: UseMS8 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=101)

Correlation Matrix of Coefficient Estimates : UseMS8 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=101)

V095_33_School_Providing_E_Learning_System_for_Use_in_Math_Classes

Figure 31. School Providing E-Learning System Logistic Regression.

Figure 31 shows the logistic regression statistics of the school providing e-learning system as observed by the survey respondents. (RegressIt Excel add-in output)

Use of E-Learning versus School Providing Digital Learning Materials

Figure 32 shows the math teachers' observation on their school's provision of digital learning materials for use in math class and the use of e-learning by the survey respondents.

Figure 33 shows the logistic regression statistics of the math teachers' observation on their school's provision of digital learning materials for use in math class and the use of e-learning by the survey respondents. The p value is 0.008, and it indicates that there is a significant correlation between the two variables. The sample size was 101.

The data support the hypothesis that the school should provide the teachers with digital learning materials to encourage the use of e-learning for teaching. It may be possible that by expecting the teachers to make or collect their needed digital learning materials may not encourage the use of e-learning for teaching.

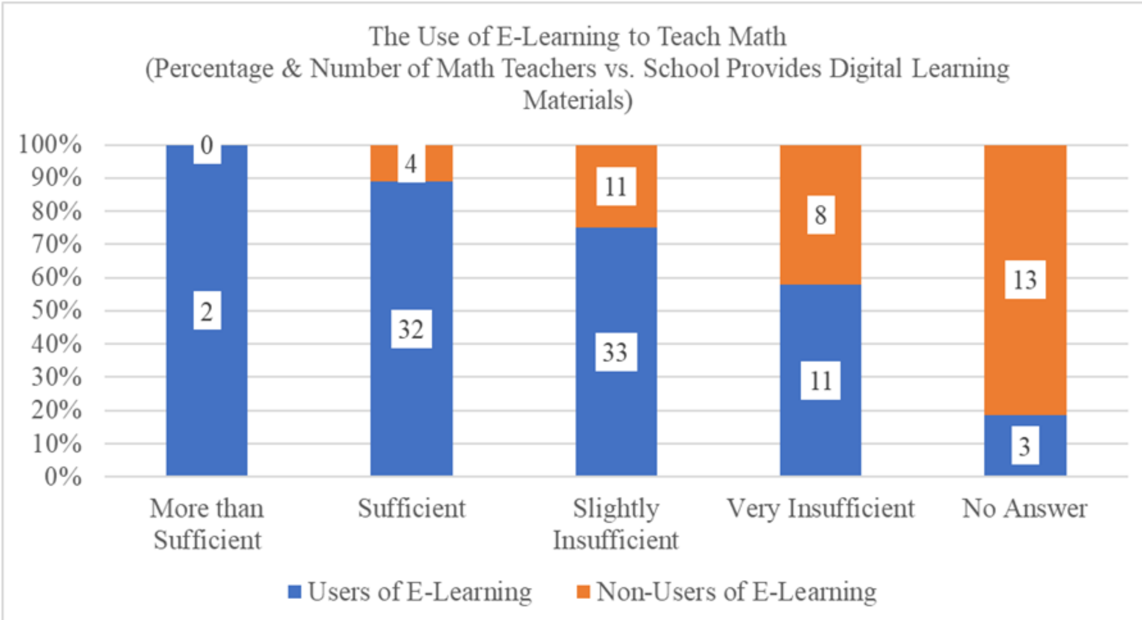

Figure 32. School Providing Digital Learning Materials.

Figure 32 shows the school providing digital learning materials as observed by the survey respondents.

Binary Dependent Variable: V000_20_Using_E_Learning_System_to_Teach_Math **0-1 value labels:** No | Yes

Logistic Regression Statistics: UseMS9 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=101)

R-squared (McFadden)	Adj.R-Sqr.	RMSE	Mean	# Fitted	ROC area	Critical z	Conf. level
0.071	0.034	0.404	0.772	101	0.00	1.645	90.0%

Logistic Regression Coefficient Estimates: UseMS9 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=101)

Variable	Coefficient	Std.Err.	z-statistic	P-value	Lower90%	Upper90%	VIF	Std. coeff.
Constant	-0.642	0.708	-0.907	0.364	-1.806	0.522		
V096_34_School_Provid	0.899	0.340	2.640	0.008	0.339	1.459	1.000	0.380

Analysis of Deviance: UseMS9 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=101)

Correlation Matrix of Coefficient Estimates : UseMS9 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=101)

V096_34_School_Providing_Digital_Learning_Materials_for_Math_Classes

Figure 33. School Providing Digital Learning Materials Logistic Regression.

Figure 33 shows the logistic regression statistics of the school providing digital learning materials as observed by the survey respondents. (RegressIt Excel add-in output)

Use of E-Learning versus School Providing Teacher Training on E-Learning

Figure 34 shows the math teachers' observation on their school's provision of teacher training on e-learning for use in math class and the use of e-learning by the survey respondents.

Figure 35 shows the logistic regression statistics of the math teachers' observation on their school's provision of teacher training on e-learning for use in math class and the use of e-learning by the survey respondents. The p value is 0.041, and it indicates that there is a significant correlation between the two variables. The sample size was 102.

The data support the hypothesis that the school should provide the teachers with proper training on the use of e-learning to encourage its use for teaching. It may be possible that by expecting the teachers to develop the skills in using e-learning without proper training quickly may not encourage its use for teaching.

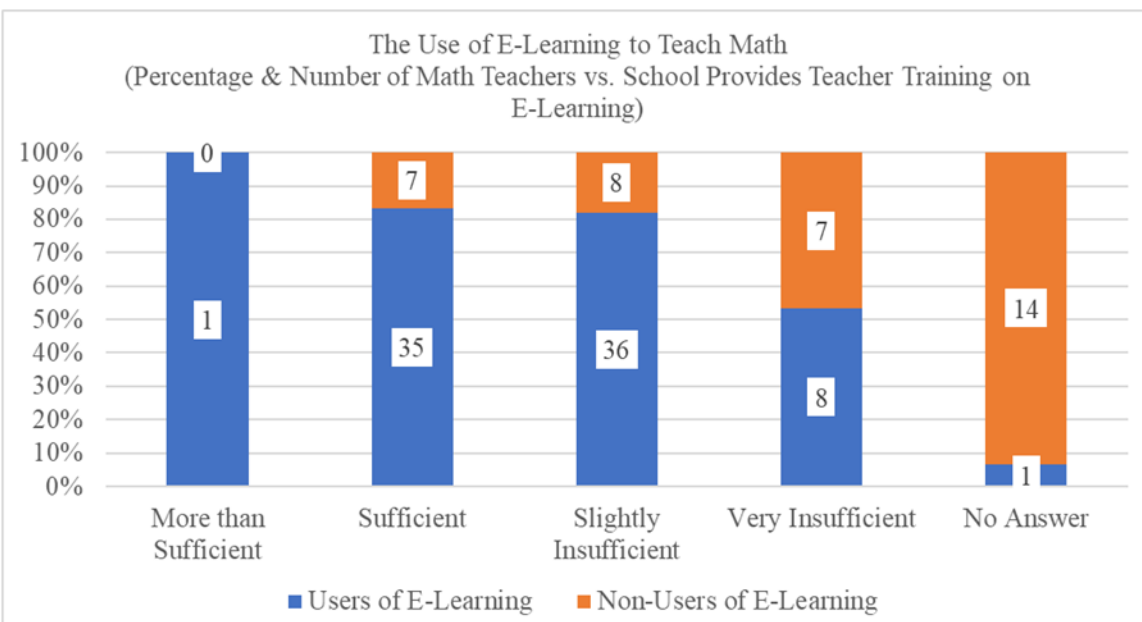

Figure 34. School Providing Teacher Training on E-Learning.

Figure 34 shows the school providing teacher training on e-learning as observed by the survey respondents.

Binary Dependent Variable:	V000_20_Using_E_Learning_System_to_Teach_Math	0-1 value labels:	No	Yes

Logistic Regression Statistics: UseMS10 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=102)

R-squared (McFadden)	Adj.R-Sqr.	RMSE	Mean	# Fitted	ROC area	Critical z	Conf. level
0.041	0.003	0.401	0.784	102	0.00	1.645	90.0%

Logistic Regression Coefficient Estimates: UseMS10 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=102)

Variable	Coefficient	Std.Err.	z-statistic	P-value	Lower90%	Upper90%	VIF	Std. coeff.
Constant	-0.236	0.754	-0.313	0.754	-1.477	1.005		
V097_35_School_Provid	0.699	0.341	2.048	0.041	0.138	1.261	1.000	0.279

Analysis of Deviance: UseMS10 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=102)

Correlation Matrix of Coefficient Estimates : UseMS10 for V000_20_Using_E_Learning_System_to_Teach_Math (1 variable, n=102)

V097_35_School_Providing_Math_Teacher_Training_on_E_Learning

Figure 35. School Providing Teacher Training on E-Learning Logistic Regression.

Figure 35 shows the logistic regression statistics of the school providing teacher training on e-learning as observed by the survey respondents. (RegressIt Excel add-in output)

Use of E-Learning versus School Providing Manuals and Technical Support

Figure 36 shows the math teachers' observation on their school's provision of e-learning manuals, and technical support for math class and the use of e-learning by the survey respondents. There is no observable pattern on the percentages of e-learning users, and logistic regression analysis done for this yielded a p value of 0.179, not low enough to reject the null hypothesis in this case. The sample size was 101.

The data do not support the hypothesis that by providing teachers with technical support and manuals, it will encourage them to use e-learning. Further study on the relationship between the two variables may reveal the reason behind the observed lack of significant correlation.

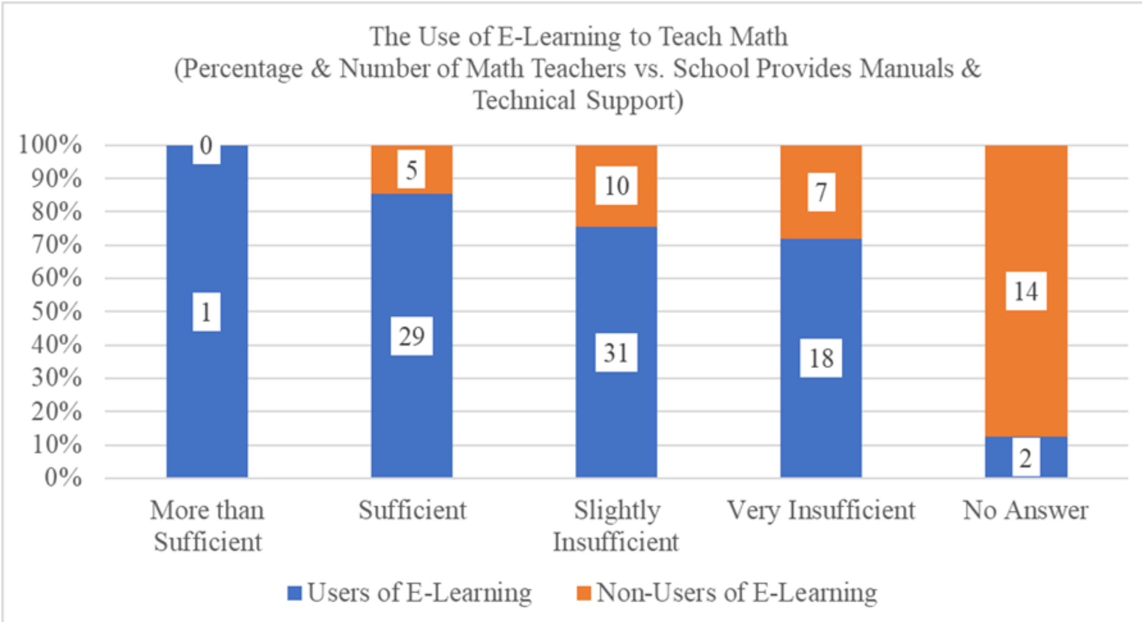

Figure 36. School Providing Manuals and Technical Support.

Figure 36 shows the school providing manuals, and technical support as observed by the survey respondents.

Use of E-Learning versus School Head Sharing Report on Usage of E-Learning

Figure 37 shows the math teachers' observation on their school head's sharing of a regular report on the usage of the e-learning system and the use of e-learning by the survey respondents. There is no observable pattern on the percentages of e-learning users, and logistic regression analysis done for this yielded a p value of 0.079, not low enough to reject the null hypothesis in this case. The sample size was 103.

The data do not support the hypothesis that by providing teachers regular report on the usage of e-learning, it will encourage its use for teaching. The assumption was that when people know that their superior is measuring and reporting their use of e-learning, it will encourage them to use it to meet the superior's expectations. It may be possible that the school heads are not yet regularly measuring and reporting the use of e-learning. Further study on the relationship between the two variables may reveal the reason behind the observed lack of significant correlation.

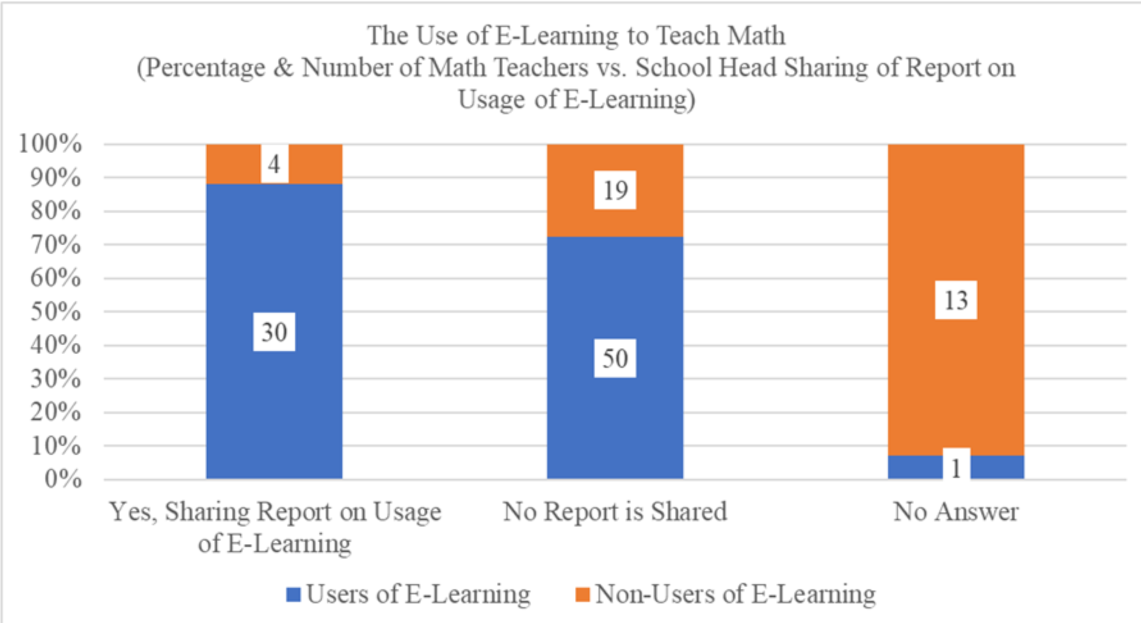

Figure 37. School Head Sharing Report on Usage of E-Learning.

Figure 37 shows the school head sharing of the report on the usage of e-learning as observed by the survey respondents.

Use of E-Learning versus Participation in Third Party Interview on E-Learning

Figure 38 shows the math teachers' participation in a third-party interview about their school's e-learning system and the use of e-learning by the survey respondents. There is no observable pattern on the percentages of e-learning users, and logistic regression analysis done for this yielded a p value of 0.200, not low enough to reject the null hypothesis in this case. The sample size was 104.

The data do not support the hypothesis that by allowing a third party to audit the school's e-learning that includes interviewing the teachers in their use of the e-learning, it will produce a list of improvement action items. The assumption was that when the audit recommendations are implemented, it will encourage the use of e-learning for teaching. It may be possible that the school was not yet subjected to third-party audit on the use of e-learning. Further study on the relationship between them may reveal the reason behind the observed lack of significant correlation.

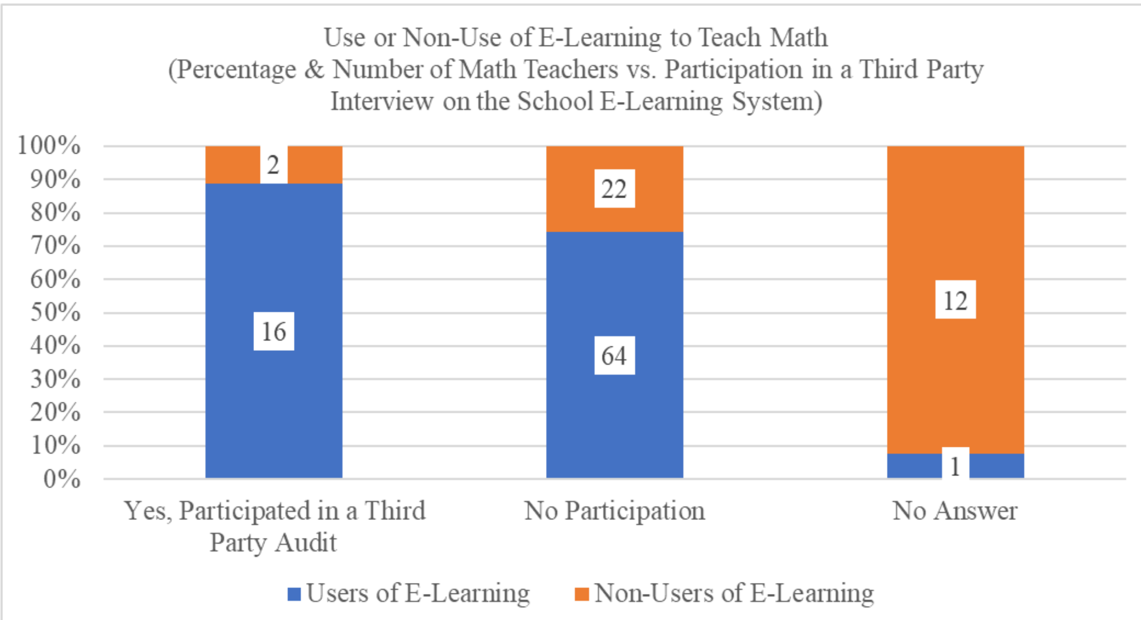

Figure 38. Participation in Third Party Interview on E-Learning.

Figure 38 shows the participation in a third party interview on e-learning by the survey respondents.

Use of E-Learning versus School Head Discussion and Agreement on Improvement Actions

Figure 39 shows the math teachers' observation on their school head's action to discuss and agree on e-learning improvement items and the use of e-learning by the survey respondents. There is no observable pattern on the percentages of e-learning users, and logistic regression analysis done for this yielded a p value of 0.053, not low enough to reject the null hypothesis in this case. The sample size was 103.

The data do not support the hypothesis that when the school head discuss and agree on action items on how to improve the use of the school e-learning, it will encourage its use for teaching. The assumption was that when people know that their superior is monitoring, discussing, and implementing improvements on school e-learning system, it will encourage its use for teaching. It may be possible that the school heads are not yet discussing the agreed improvement action items. Further study on the relationship between the two variables may reveal the reason behind the observed lack of significant correlation.

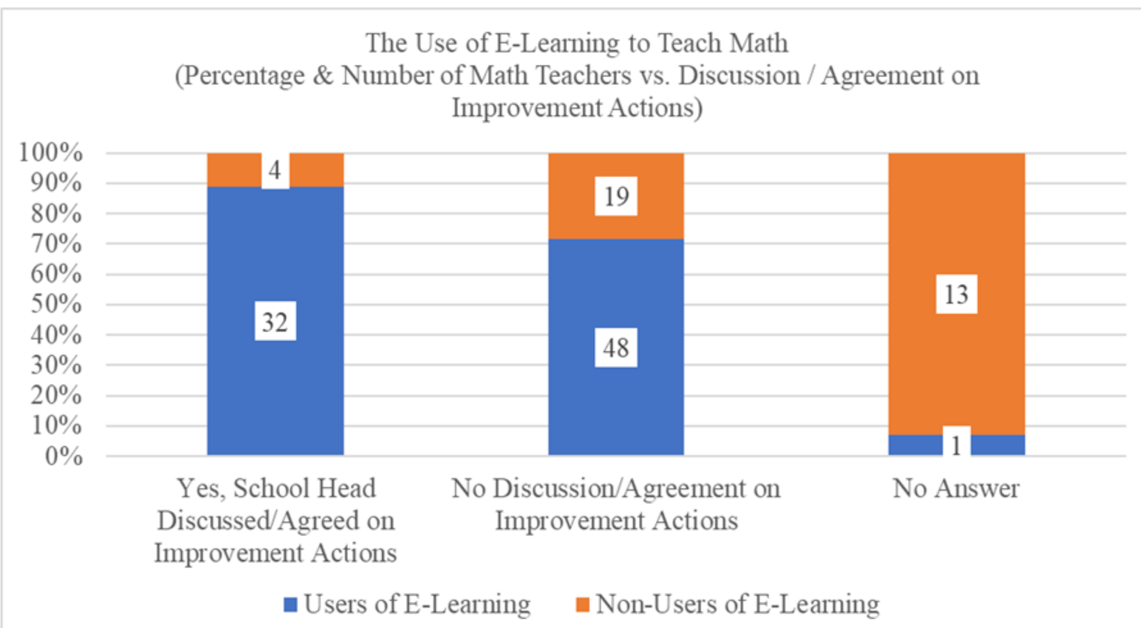

Figure 39. School Head Discussion and Agreement on Improvement Actions.

Figure 39 shows the school head discussing and agreeing on improvement actions as observed by the survey respondents.

Use of E-Learning Multiple Logistic Regression

The purpose of the analysis in this section is to identify a set of independent variables that all have a significant correlation in a group with the use of e-learning system to teach math. Identifying those factors with significant correlation can help in better understanding the current state of e-learning system implementation. It can also help in crafting strategies to better support users of the e-learning system for teaching math.

Multiple Logistic Regression of the Use of E-Learning and Selected Variables

From the separate analysis of each independent variable, there are 11 variables with significant correlations with the use of e-learning. These variables are:

1) Gender of the math teachers,
2) Grade 10 teaching-load,
3) Geometry subject teaching-load,
4) Statistics subject teaching-load,
5) First-Time-to-Use-Computer (dichotomized on or before college and after college),
6) Allowing students to use tablets in math class,
7) The familiarity of math teachers with the school head's overall e-learning plan,
8) School head's promotion of the use of e-learning in math class,
9) School's provision of a school e-learning system,
10) School's provision of digital learning materials, and
11) School's provision of teacher training on e-learning.

These 11 variables, separately, have a significant correlation with the total usage level of the e-learning system for teaching math based on the survey data.

Figure 40 shows the multiple logistic regression model of the use of e-learning dependent variable and selected independent variables that have p value less than or equal to 0.05 from the previous logistic regression statistics.

Binary Dependent Variable: V000_20_Using_E_Learning_System_to_Teach_Math **0-1 value labels:** No | Yes

Logistic Regression Statistics: Model 61 for V000_20_Using_E_Learning_System_to_Teach_Math (11 variables, n=91)

R-squared (McFadden)	Adj.R-Sqr.	RMSE	Mean	# Fitted	ROC area	Critical z	Conf. level
0.324	0.080	0.341	0.769	91	0.86	1.960	95.0%

Logistic Regression Coefficient Estimates: Model 61 for V000_20_Using_E_Learning_System_to_Teach_Math (11 variables, n=91)

Variable	Coefficient	Std.Err.	z-statistic	P-value	Lower95%	Upper95%	VIF	Std. coeff.
Constant	4.861	6.212	0.783	0.434	-7.313	17.036		
V003_2_Gender_of_Mat	-1.592	0.770	-2.068	0.039	-3.100	-0.084	1.132	-0.429
V012_8_Teaching___dG	0.013	0.816	0.016	0.987	-1.586	1.612	1.386	0.003
V023_10_Teaching___b	-1.844	0.934	-1.975	0.048	-3.674	-0.014	1.074	-0.467
V026_10_Teaching___e	0.432	0.823	0.525	0.599	-1.180	2.044	1.530	0.120
V032_13_First_Use_of_	-1.165	1.117	-1.043	0.297	-3.355	1.024	1.179	-0.202
V040_18_Using_Compu	1.812	1.103	1.643	0.100	-0.350	3.974	1.285	0.314
V089_27_Familiarity_to_	1.268	0.688	1.842	0.065	-0.081	2.617	1.583	0.452
V090_28_School_Head_	-0.082	0.697	-0.117	0.907	-1.447	1.284	1.834	-0.028
V095_33_School_Provid	0.042	0.796	0.053	0.958	-1.518	1.602	1.747	0.012
V096_34_School_Provid	0.528	0.700	0.755	0.450	-0.843	1.900	2.772	0.220
V097_35_School_Provid	-0.067	0.685	-0.097	0.922	-1.409	1.275	2.428	-0.027

Analysis of Deviance: Model 61 for V000_20_Using_E_Learning_System_to_Teach_Math (11 variables, n=91)

Correlation Matrix of Coefficient Estimates : Model 61 for V000_20_Using_E_Learning_System_to_Teach_Math (11 variables, n=91)

V003_2_Gender_of_Math_Teachers
V012_8_Teaching___dGrade_10
V023_10_Teaching___bGeometry
V026_10_Teaching___eStatistics
V032_13_First_Use_of_Computer___Dichotomize_OnOrBefore___After_College
V040_18_Using_Computer___Tablet_for_Teaching_Math
V089_27_Familiarity_to_School_Head_s_Overall_E_Learning_Plan
V090_28_School_Head_Promoting_Use_of_E_Learning_in_Math_Class
V095_33_School_Providing_E_Learning_System_for_Use_in_Math_Classes
V096_34_School_Providing_Digital_Learning_Materials_for_Math_Classes
V097_35_School_Providing_Math_Teacher_Training_on_E_Learning

Figure 40. Multiple Logistic Regression of the Use of E-Learning and Selected Variables.

Figure 40 shows the multiple logistic regression statistics between the use of e-learning and selected independent variables that have p value less than or equal to 0.05 from the previous logistic regression. (RegressIt Excel add-in output)

The variables with the highest p value above 0.05 were removed one by one until the remaining variables have p values less than or equal to 0.05.

Some of the variables, that were found to have an initial significant correlation with the dependent variable did not exhibit significant correlation in the group based on the multiple logistic regression statistics. Those variables were the following:

1) Grade 10 teaching-load,
2) Statistics subject teaching-load,
3) First-Time-to-Use-a-Computer,
4) School Head's promotion of the use of e-learning in math class,
5) School's provision of a school e-learning system,
6) School's provision of digital learning materials, and
7) School's provision of teacher training on e-learning.

Figure 41 shows the multiple logistic regression statistics of the four remaining independent variables that all have significant correlations with the use or non-use of e-learning by the public secondary school math teachers in Makati City. These are the:

1) Math teachers' gender,
2) Geometry teaching-load,
3) Use of a computer to teach math, and
4) Familiarity with school head's overall e-learning plan.

The sample size was 101 and is above the target of 95 for a 90% confidence level and +/-5% confidence interval.

Binary Dependent Variable:	V000_20_Using_E_Learning_System_to_Teach_Math	**0-1 value labels:**	No	Yes

Logistic Regression Statistics: Model 69 for V000_20_Using_E_Learning_System_to_Teach_Math (4 variables, n=101)

R-squared (McFadden)	Adj.R-Sqr.	RMSE	Mean	# Fitted	ROC area	Critical z	Conf. level
0.326	0.234	0.334	0.772	101	0.86	1.960	95.0%

Logistic Regression Coefficient Estimates: Model 69 for V000_20_Using_E_Learning_System_to_Teach_Math (4 variables, n=101)

Variable	Coefficient	Std.Err.	z-statistic	P-value	Lower95%	Upper95%	VIF	Std. coeff.
Constant	-0.165	2.417	-0.068	0.946	-4.902	4.572		
V003_2_Gender_of_Mat	-1.741	0.723	-2.409	0.016	-3.157	-0.324	1.016	-0.462
V023_10_Teaching___b	-1.609	0.801	-2.008	0.045	-3.178	-0.039	1.009	-0.415
V040_18_Using_Compu	2.404	0.944	2.547	0.011	0.554	4.253	1.093	0.415
V089_27_Familiarity_to_	1.574	0.537	2.930	0.003	0.521	2.628	1.105	0.566

Analysis of Deviance: Model 69 for V000_20_Using_E_Learning_System_to_Teach_Math (4 variables, n=101)

Correlation Matrix of Coefficient Estimates : Model 69 for V000_20_Using_E_Learning_System_to_Teach_Math (4 variables, n=101)

V003_2_Gender_of_Math_Teachers

V023_10_Teaching___bGeometry

V040_18_Using_Computer___Tablet_for_Teaching_Math

V089_27_Familiarity_to_School_Head_s_Overall_E_Learning_Plan

Figure 41. Multiple Logistic Regression of the Remaining Variables with P value Less Than or Equal to 0.05

Figure 41 shows the resulting multiple logistic regression statistics of the use of e-learning and the remaining independent variables with p value less than or equal to 0.0.5. (RegressIt Excel add-in output)

The multiple logistic regression model on the use of the e-learning system and the four remaining independent variables with significant correlation suggests some actions.

1) The significant correlation between the use of e-learning and the gender of math teachers, with a higher percentage of users among male public secondary school math teachers in Makati City, suggests the need for a focused effort to help the teachers to adopt and use the e-learning system for teaching math.
2) The significant correlation between the use of e-learning and the Geometry teaching-load of the teacher, suggests that Geometry teachers are encouraged to use e-learning for teaching the subject. The teachers may need further support from the schools to help them fully utilize the technology for teaching the Geometry subject.

3) The significant correlation between the use of e-learning and the use of a computer or tablet by the teachers to teach math is logical. The data suggest that the more teachers using a computer or tablet to teach math are also using e-learning to teach math.
4) The significant correlation between the use of e-learning system and the familiarity of the math teachers to their school heads' overall e-learning plan suggests the importance of a clear, communicated, and visible overall e-learning plan for the school.

All these four possible factors, in combination, implies the importance of an integrated e-learning implementation plan. It may include a visible overall plan, a well-defined overall objective, a clear and convincing case-for-change highlighting the need and benefits for all parties, a focused effort and support for teachers on the adoption and migration, and the provision of resources such as computers and tablets for the teachers to help them in their teaching activities.

The visible overall plan, a well defined overall objective, and a clear and convincing case for change into using an e-learning system for teaching will make the teachers more familiar with the school head's overall e-learning plan. When teachers are more familiar with the overall plan, the expectation is that more teachers will be using the e-learning system.

The focused effort and support for the teachers in the adoption process will address the needs of female teachers. With focused support for the female teachers, the objective is to help them successfully migrate to the use of e-learning for teaching.

The provision of computers and tablets for the teachers will equip them to use the computer for teaching. The expectation is that when teachers become skilled in using a computer for teaching, they will be more prepared to use an e-learning system.

The provision of digital teaching and learning resources, especially for Geometry subject, will further encourage the teachers to use the e-learning system. The objective is to reduce the teachers' time for authoring and to prepare their lectures by providing them with ready to use and curriculum aligned digital teaching resources that they can access and use through an e-learning system.

Usage Frequency of E-Learning

As mentioned in the previous section, the primary question in the survey was "Do you use an E-Learning System to teach math?" The follow-up question to this was "If YES, how often do you normally use it?" The available answers were:

a) "up to once per week for every math class section I teach,"

b) "around twice per week for every math class section I teach,"

c) "around trice per week for every math class section I teach," and

d) "around four times per week or more for every math class section I teach."

This section covers the public secondary school math teachers in Makati City who are using e-learning system to teach math. The estimated population based on the tally during the survey and the ratio of e-learning users to the number of accepted survey returns is 94 teachers. The sample size requirement for 95% confidence level and +/- 5% confidence interval is 76. The sample size requirement for a 90% confidence level and +/- 5% confidence interval is 70.

The purpose of the analysis in this section is to assess the correlation between the frequency of use of e-learning for teaching math and some selected demographic and psychographic factors. Identifying those factors with significant correlation can help in better understanding the current state of e-learning system implementation. It can also help in crafting strategies to better support users of the e-learning system for teaching math.

Usage Frequency of E-Learning System versus Age

Figure 42 shows the age and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and logistic regression analysis done for this yielded a p value of 0.847, not low enough to reject the null hypothesis in this case. The sample size was 76.

The data do not support the hypothesis that younger teachers tend to use e-learning more frequently than seasoned teachers who are also using e-learning. It may be possible that all the teachers have started using the e-learning at the same time and still have a similar level of skills for using it. The null hypothesis is congruent with an earlier finding that showed no significant correlation between the age and the use of e-learning. Further study of the teachers' e-learning practices may reveal the reason behind the observed lack of correlation.

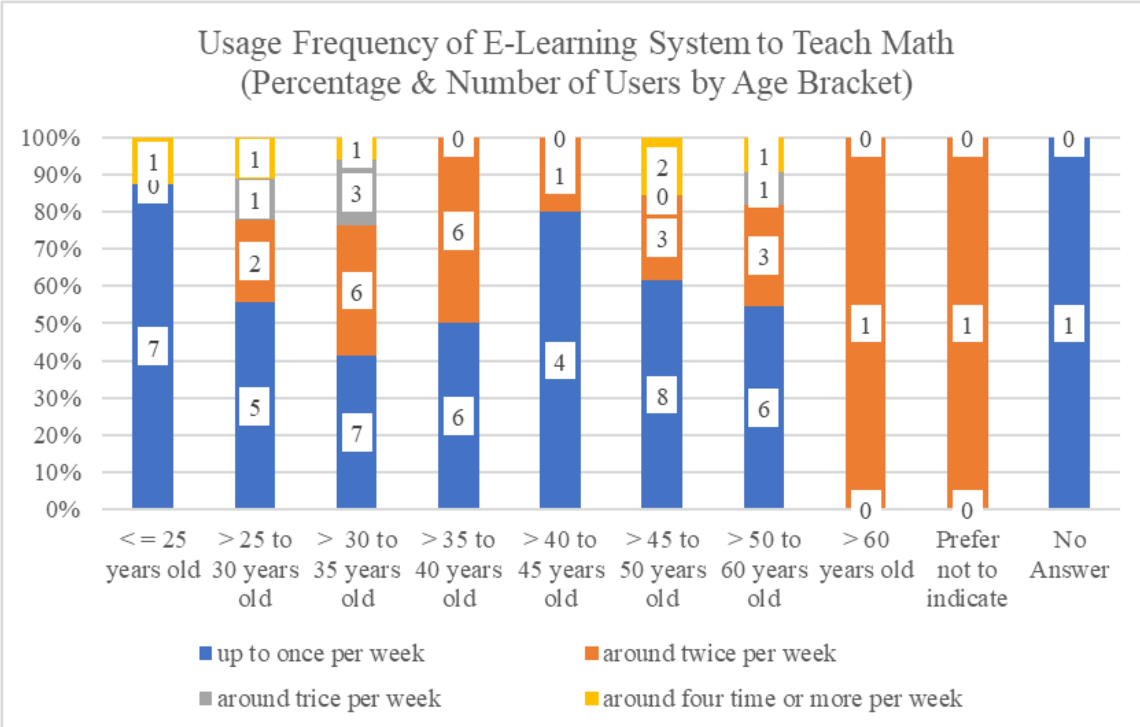

Figure 42. Usage Frequency of E-Learning versus Age.

Figure 42 shows the age and e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Gender

Figure 43 shows the gender and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.791, not low enough to reject the null hypothesis in this case. The sample size was 78.

Unlike the significant correlation between the use or non-use of e-learning and the teacher's gender, the data do not support the hypothesis that male teachers use it more frequently than their female counterpart. It may be possible that all the teachers have started using the e-learning at the same time and still have a similar level of skills for using it. The null hypothesis is not congruent with an earlier finding that showed a significant correlation between the age and the use of e-learning. Further study of the teacher's e-learning practices may reveal the reason behind the differences in the correlations.

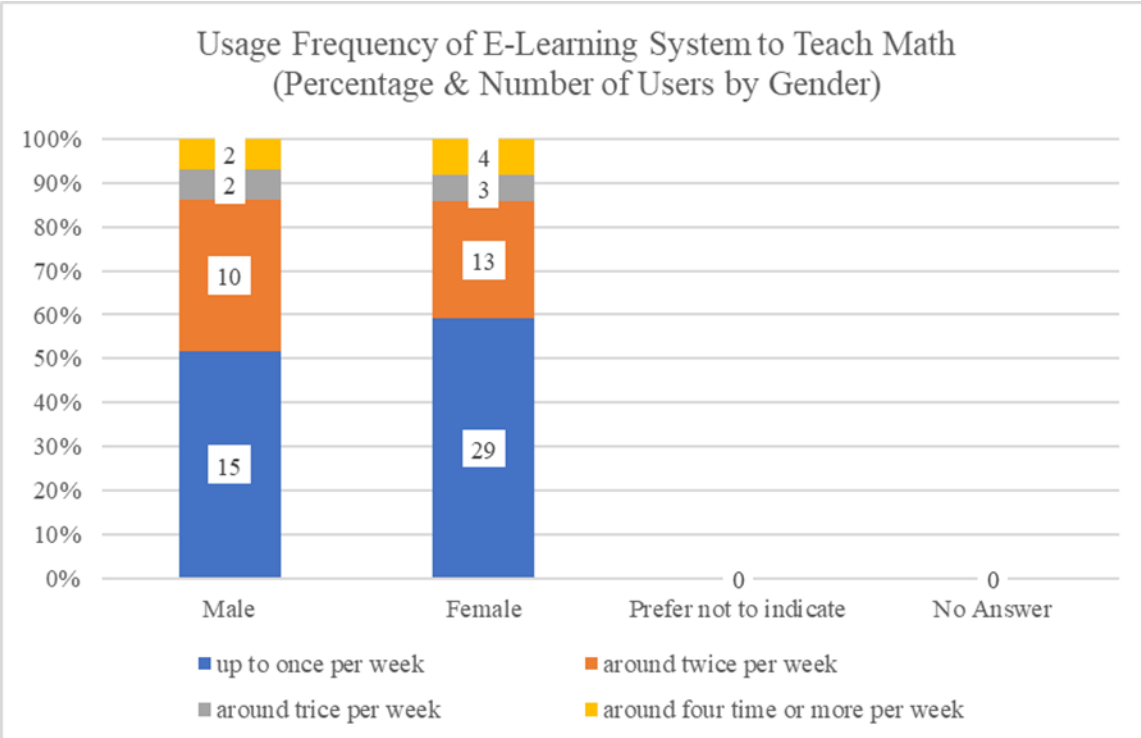

Figure 43. Usage Frequency of E-Learning versus Gender.

Figure 43 shows the gender and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Highest Educational Attainment

Figure 44 shows the highest educational attainment and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.391, not low enough to reject the null hypothesis in this case. The sample size was 76.

The data do not support the hypothesis that the teachers' educational attainment correlates with the frequency of use of e-learning. It may be possible that graduate studies do not include developing competencies in the use of e-learning for teaching. The null hypothesis is congruent with an earlier finding that showed a lack of significant correlation between the educational attainment and the use or non-use of e-learning. Further study of the teachers' e-learning practices may reveal the reason behind the observed lack of correlation.

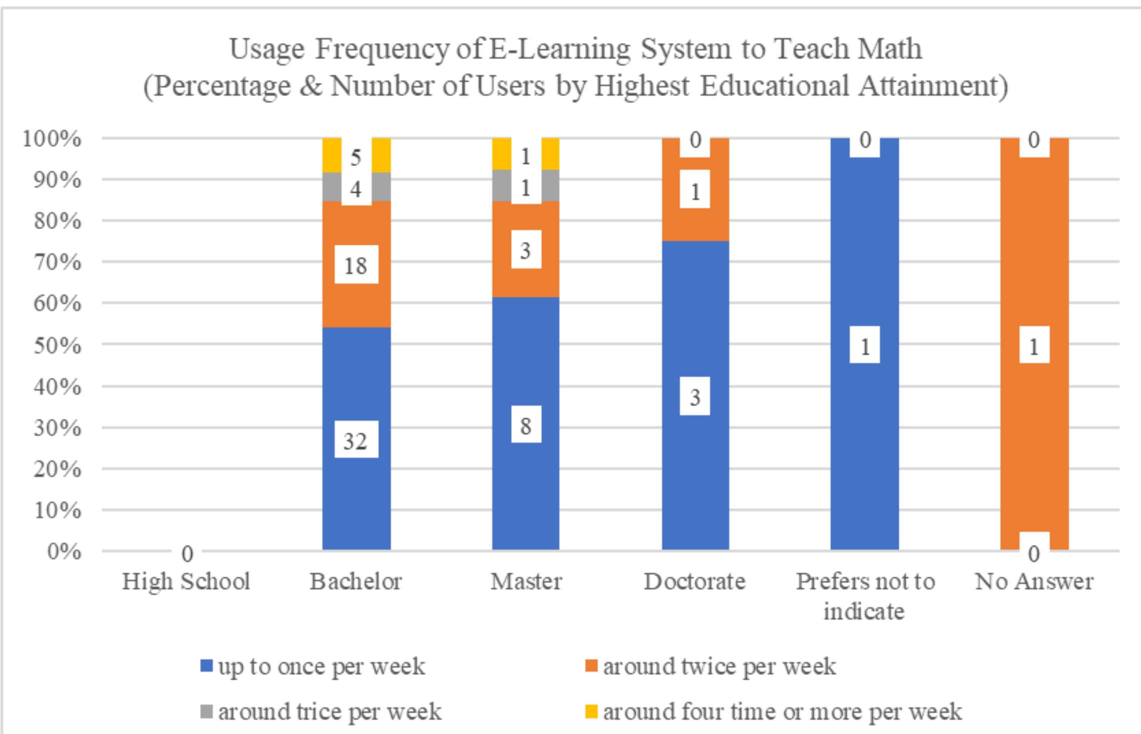

Figure 44. Usage Frequency of E-Learning versus Highest Educational Attainment.

Figure 44 shows the highest educational attainment and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Years of Teaching Math

Figure 45 shows the years of teaching math and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.723, not low enough to reject the null hypothesis in this case. The sample size was 74.

The data do not support the hypothesis that the teachers' length of service correlates with the frequency of use of e-learning. It may be possible that all the teachers have started using the e-learning at the same time and still have a similar level of skills for using it. The null hypothesis is congruent with an earlier finding that showed a lack of significant correlation between the educational attainment and the use of e-learning. Further study of the teachers' e-learning practices may reveal the reason behind the observed lack of correlation.

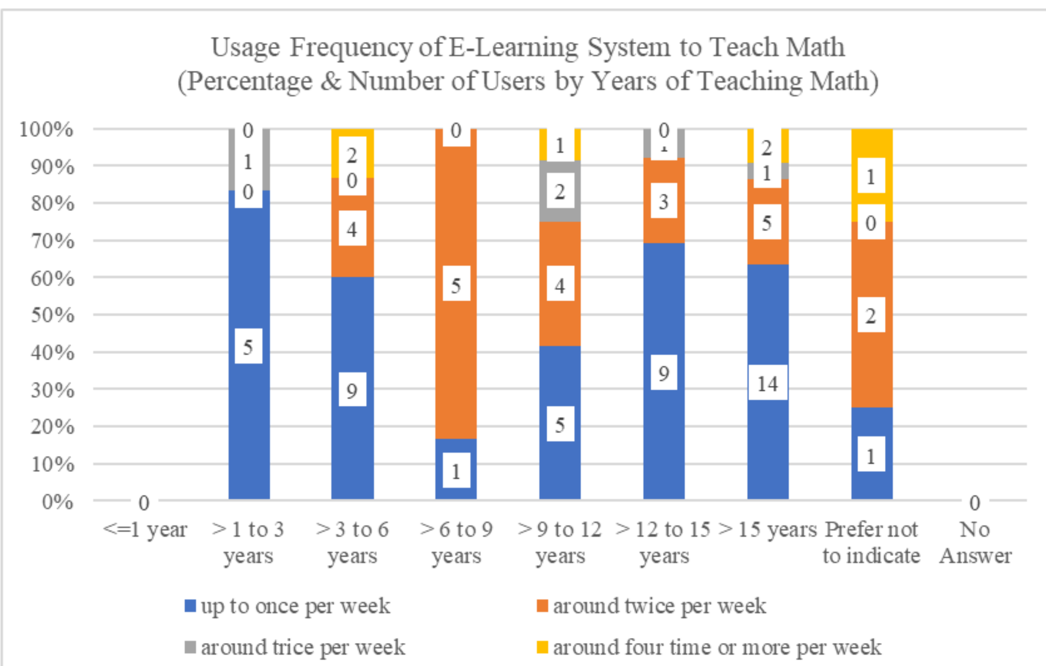

Figure 45. Usage Frequency of E-Learning versus Years of Teaching Math.

Figure 45 shows the years of teaching math and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Grade-level-teaching-load

Figure 46 shows the grade-level-teaching-load and the e-learning usage frequency by the math teachers who responded to the survey.

Figure 47 shows the regression statistics yielding a p value of 0.027 for Grade 7 teaching-load, and it indicates that there is a significant correlation with the frequency of use of e-learning. The data suggest that the profile of teachers with or without Grade 7 teaching-load is similar to the profile of the usage frequency. More data and further investigation are needed to understand the significant correlation between the two.

The data support the hypothesis that the teachers at a lower grade level may be encouraged to use e-learning more frequently to get the attention and solicit more class participation from the younger students. Further study is needed to establish the causal relationship between these two variables.

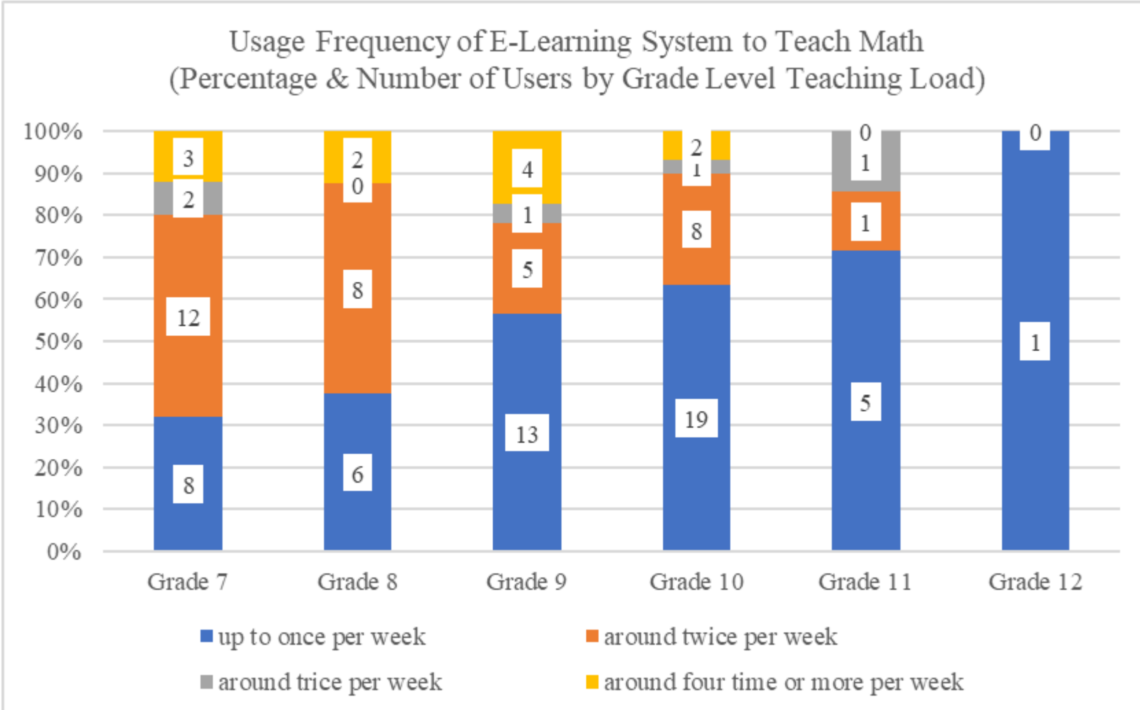

Figure 46. Usage Frequency of E-Learning versus Grade-level-teaching-load.

Figure 46 shows the grade-level-teaching-load and the e-learning usage frequency by the survey respondents.

Dependent Variable: F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math

Regression Statistics: Model 75 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (6 variables, n=78)

	R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
	0.106	0.030	0.895	0.909	78

Coefficient Estimates: Model 75 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (6 variables, n=78)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	0.474	1.387	0.342	0.734	-2.291
F08_8_Math_Grade_Level_Teaching_Load___aGrade_7	0.569	0.253	2.252	0.027	0.065
F09_8_Math_Grade_Level_Teaching_Load___bGrade_8	0.183	0.259	0.707	0.482	-0.334
F10_8_Math_Grade_Level_Teaching_Load___cGrade_9	0.334	0.241	1.390	0.169	-0.145
F11_8_Math_Grade_Level_Teaching_Load___dGrade_10	0.050	0.245	0.204	0.839	-0.439
F12_8_Math_Grade_Level_Teaching_Load___eGrade_11	0.195	0.436	0.447	0.656	-0.675
F13_8_Math_Grade_Level_Teaching_Load___fGrade_12	-0.500	0.967	-0.517	0.607	-2.428

Analysis of Variance: Model 75 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (6 variables, n=78)

Error Distribution Statistics: Model 75 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (6 variables, n=78)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=78)	0.000	0.854	0.664	-1.258	2.361

Figure 47. Usage Frequency of E-Learning versus Grade-Level-Teaching-Load

Regression.

Figure 47 shows the regression statistics between the grade-level-teaching-load and the e-learning usage frequency by the survey respondents. (RegressIt Excel add-in output)

Usage Frequency of E-Learning versus Grade Level Load Count

Figure 48 shows the grade level load count and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.061, not low enough to reject the null hypothesis in this case. The sample size was 78.

The data do not support the hypothesis that the teachers with more grade level teaching load tend to use e-learning more frequently than the teachers with less load.

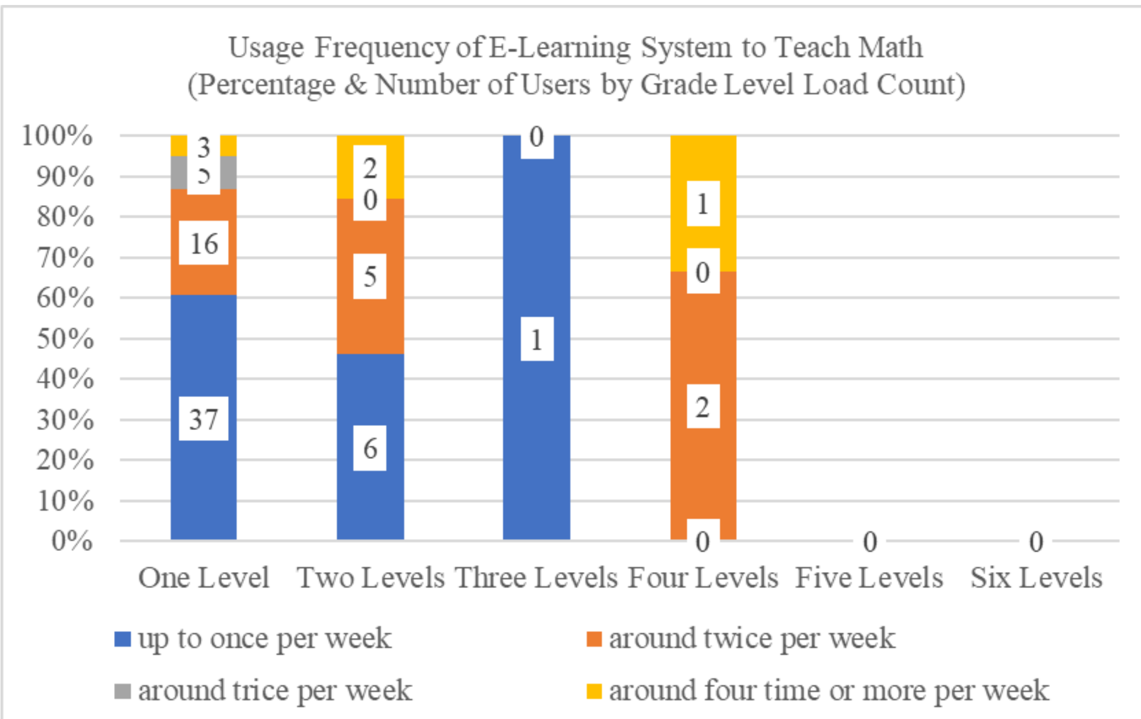

Figure 48. Usage Frequency of E-Learning versus Grade Level Load Count.

Figure 48 shows the grade level load count and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Math Subjects Teaching-load

Figure 49 shows the math subjects teaching-load and the e-learning usage frequency by the math teachers who responded to the survey.

Figure 50 shows the regression statistics between the math subjects teaching-load and the e-learning usage frequency by the math teachers who responded to the survey. The p values of all the variables are above 0.050, and these indicate that there is no significant correlation with the dependent variables.

The data do not support the hypothesis that the teachers with math subject teaching load that requires more visual illustration, such as Geometry and Statistics, tend to use e-learning more frequently than the teachers who are teaching math subjects that needs fewer visuals. The null hypothesis is not congruent with an earlier finding that showed a significant correlation between the Geometry and Statistics teaching load and the use or non-use of e-learning. Further study on the teachers' e-learning practices may reveal the reasons behind the difference in the correlations.

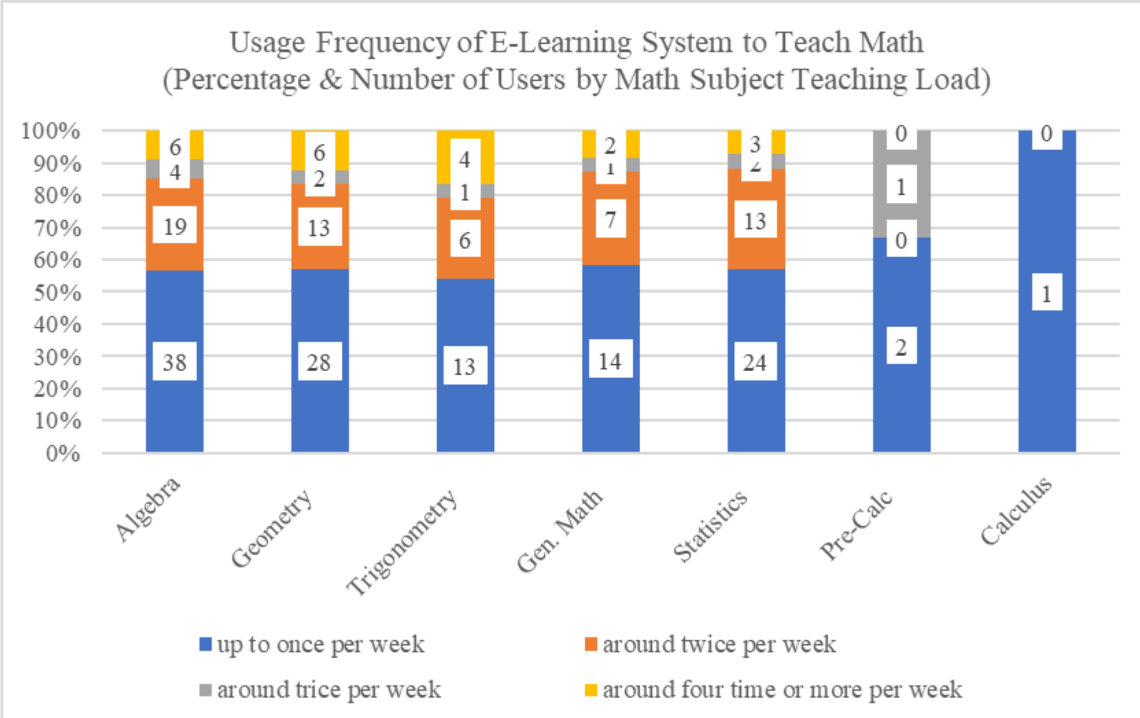

Figure 49. Usage Frequency of E-Learning versus Math Subjects Teaching-load.

Figure 49 shows the math subjects teaching-load and the e-learning usage frequency by the survey respondents.

Dependent Variable: F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math

Regression Statistics: Model 76 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (7 variables, n=78)

R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
0.034	-0.063	0.937	0.909	78

Adj. R-sqr. is negative because the standard error of the regression is greater than the standard deviation of the dependent variable.

Coefficient Estimates: Model 76 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (7 variables, n=78)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	1.463	1.478	0.990	0.325	-1.484
F15_10_Math_Subjects_Teaching_Load___aAlgebra	0.100	0.380	0.263	0.793	-0.658
F16_10_Math_Subjects_Teaching_Load___bGeometry	0.111	0.255	0.435	0.665	-0.398
F17_10_Math_Subjects_Teaching_Load___cTrigonometry	0.229	0.243	0.941	0.350	-0.256
F18_10_Math_Subjects_Teaching_Load___dGen._Math	-0.016	0.257	-0.062	0.951	-0.529
F19_10_Math_Subjects_Teaching_Load___eStatistics	-0.053	0.232	-0.227	0.821	-0.516
F20_10_Math_Subjects_Teaching_Load___fPre_Calc	0.565	0.762	0.741	0.461	-0.956
F21_10_Math_Subjects_Teaching_Load___gCalculus	-0.947	1.171	-0.809	0.421	-3.283

Analysis of Variance: Model 76 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (7 variables, n=78)

Error Distribution Statistics: Model 76 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (7 variables, n=78)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=78)	0.000	0.888	0.729	-1.000	2.390

Figure 50. Usage Frequency of E-Learning versus Math Subjects Teaching-load

Regression.

Figure 50 shows the regression statistics between the math subjects teaching-load and the e-learning usage frequency by the survey respondents. (RegressIt Excel add-in output)

Usage Frequency of E-Learning versus Math Subjects Teaching-load Count

Figure 51 shows the math subjects teaching-load count and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.536, not low enough to reject the null hypothesis in this case. The sample size was 78.

The data do not support the hypothesis that the teachers with more math subject teaching load will be encouraged to use the e-learning more frequently than those with less. The null hypothesis is congruent with the finding that showed a lack of significant correlation between the count of math-subject teaching load and the use or non-use of e-learning. Further study on the teachers' e-learning practices may reveal the reasons behind the lack of correlation.

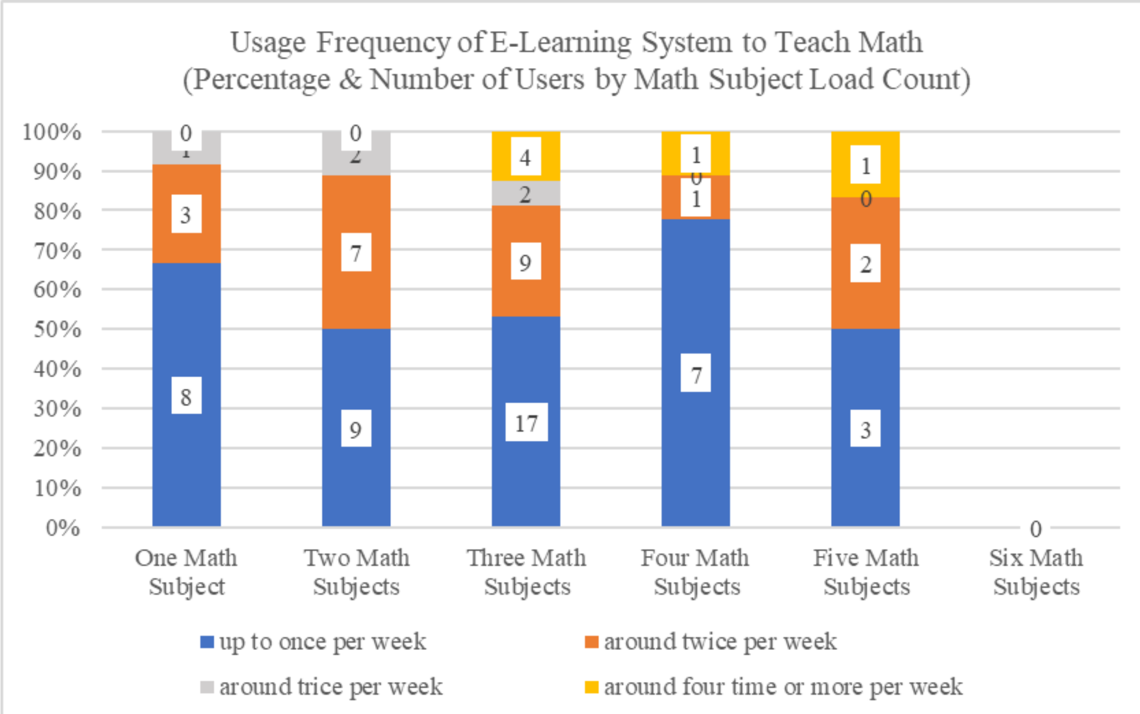

Figure 51. Usage Frequency of E-Learning versus Math Subjects Teaching-Load Count.

Figure 51 shows the math subjects teaching-load count and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Class Size

Figure 52 shows the class size and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.583, not low enough to reject the null hypothesis in this case. The sample size was 77.

The data do not support the hypothesis that the teachers who are handling a bigger class size will be encouraged to use the e-learning more frequently than those who have smaller class size.

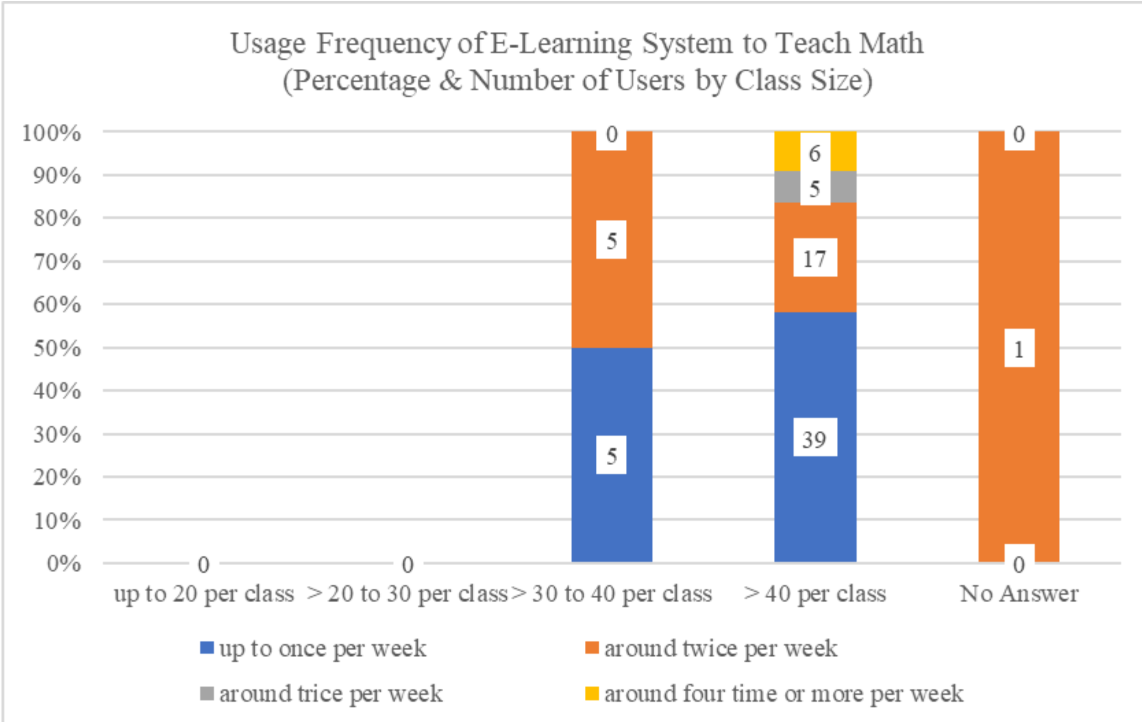

Figure 52. Usage Frequency of E-Learning versus Class Size.

Figure 52 shows the class size and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Number of Classes Teaching-load

Figure 53 shows the number of classes teaching-load and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.626, not low enough to reject the null hypothesis in this case. The sample size was 77.

The data do not support the hypothesis that the teachers who are handling more classes will be encouraged to use the e-learning more frequently than those with less.

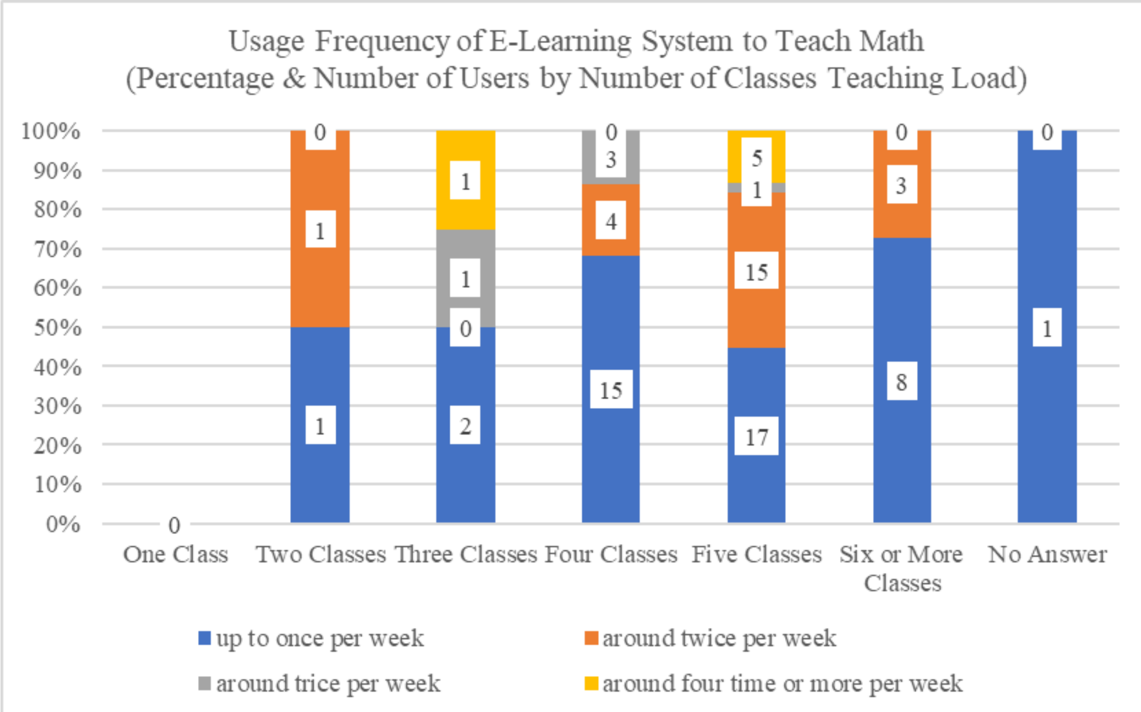

Figure 53. Usage Frequency of E-Learning versus Number of Classes Teaching-load.

Figure 53 shows the number of classes teaching-load and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus First-Time-to-Use-Computer

Figure 54 shows the first-time-to-use-computer and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.069, not low enough to reject the null hypothesis in this case. The sample size was 73.

The data do not support the hypothesis that the teachers who first used a computer at an earlier stage in their lives will be encouraged to use the e-learning more frequently than those who used it at a later stage. The null hypothesis is congruent with an earlier finding that showed a lack of significant correlation between the stage in life when they used a computer for the first time and the use or non-use of e-learning. Further study on the teachers' e-learning practices may reveal the reasons behind the lack of correlation.

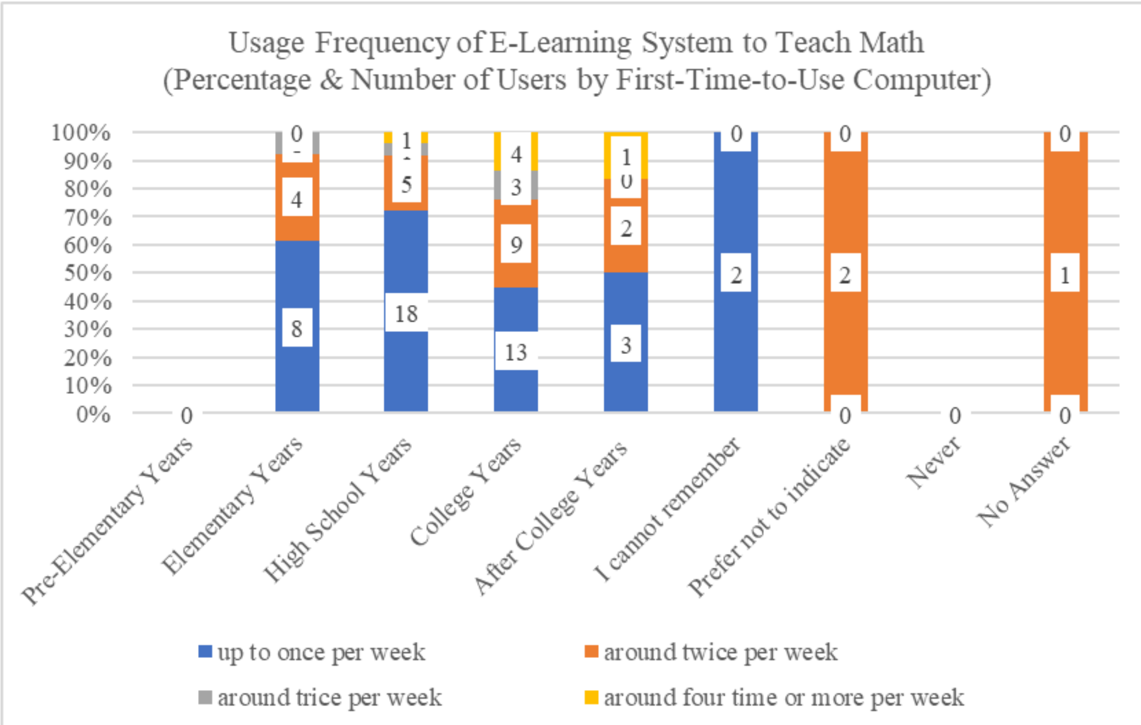

Figure 54. Usage Frequency of E-Learning versus First-Time-to-Use-Computer.

Figure 54 shows the first-time-to-use-computer and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus First-Time-to-Play-Computer-Game

Figure 55 shows the first-time-to-play-computer-game and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.632, not low enough to reject the null hypothesis in this case. The sample size was 73.

The data do not support the hypothesis that the teachers who first played a computer game at an earlier stage in their life will be encouraged to use the e-learning more frequently than those who played it at a later stage. The null hypothesis is congruent with an earlier finding that showed a lack of significant correlation between the stage in life when they played a computer game for the first time and the use or non-use of e-learning. Further study on the teachers' e-learning practices may reveal the reasons behind the lack of correlation.

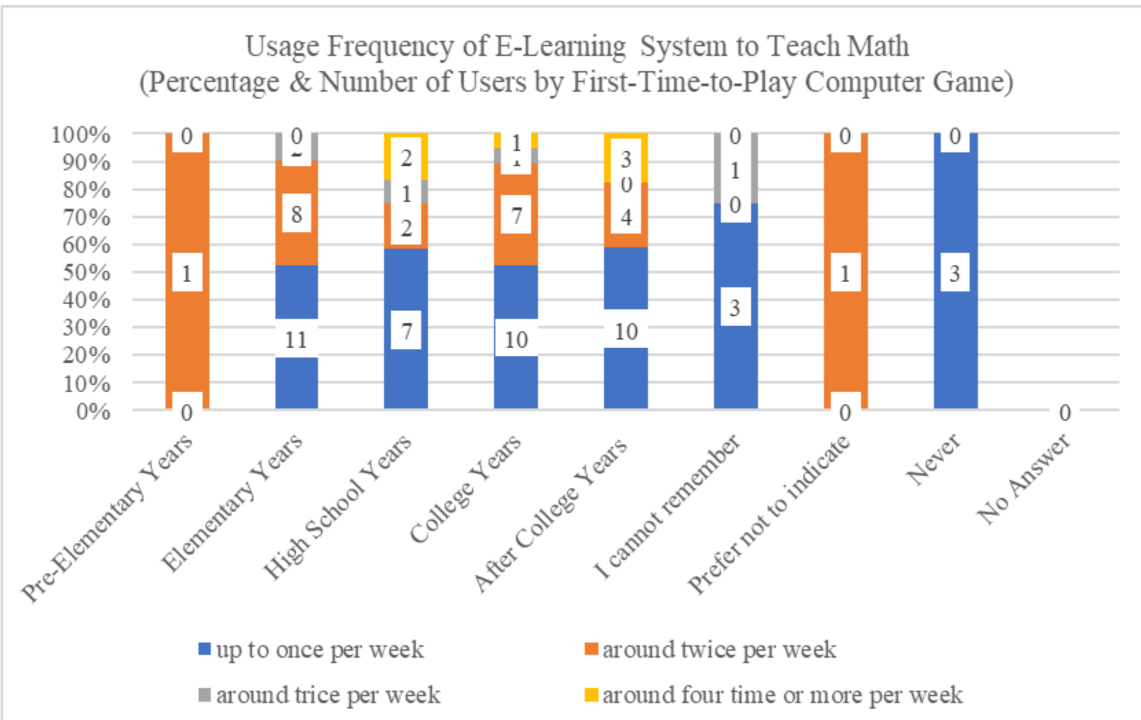

Figure 55. Usage Frequency of E-Learning versus First-Time-to-Play-Computer-Game.

Figure 55 shows the first-time-to-play-computer-game and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus First-Time-to-Play-Internet-Game

Figure 56 shows the first-time-to-play-internet-game and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.425, not low enough to reject the null hypothesis in this case. The sample size was 71.

The data do not support the hypothesis that the teachers who first played an internet game at an earlier stage in their life will be encouraged to use the e-learning more frequently than those who played it at a later stage. The null hypothesis is congruent with an earlier finding that showed a lack of significant correlation between the stage in life when they played an internet game for the first time and the use or non-use of e-learning.

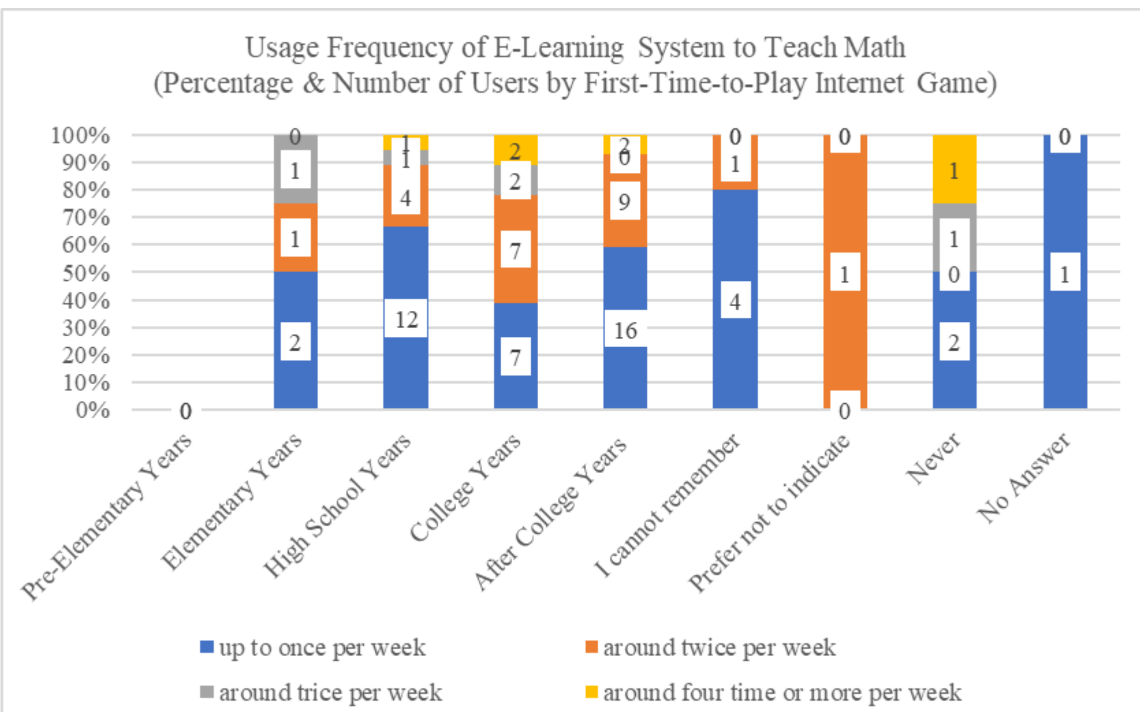

Figure 56. Usage Frequency of E-Learning versus First-Time-to-Play-Internet-Game.

Figure 56 shows the first-time-to-play-internet-game and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Prior Use of Computer as a Student

Figure 57 shows the prior use of a computer as a student and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.600, not low enough to reject the null hypothesis in this case. The sample size was 78.

The data do not support the hypothesis that the teachers who had prior experience of using a computer as a student will be encouraged to use the e-learning more frequently than those who had none. The null hypothesis is congruent with an earlier finding that showed a lack of significant correlation between the prior experience of using a computer as a student and the use or non-use of e-learning.

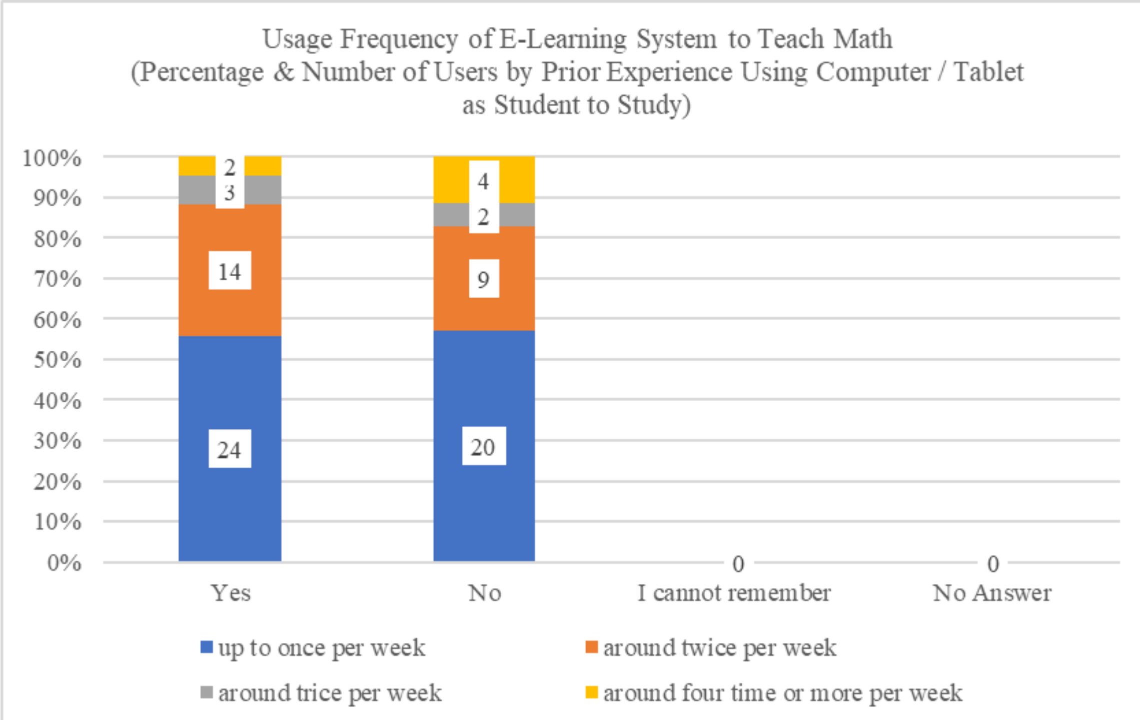

Figure 57. Usage Frequency of E-Learning versus Prior Use of Computer as a Student.

Figure 57 shows the prior use of a computer as a student and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Experience with Teacher Using A Computer

Figure 58 shows the experience with a teacher using a computer and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.747, not low enough to reject the null hypothesis in this case. The sample size was 74.

The data do not support the hypothesis that the teachers who had prior experience as a student with a teacher using a computer to teach will be encouraged to use the e-learning more frequently than those who had none. The null hypothesis is congruent with an earlier finding that showed a lack of significant correlation between the prior experience as a student with a teacher using a computer to teach and the use or non-use of e-learning.

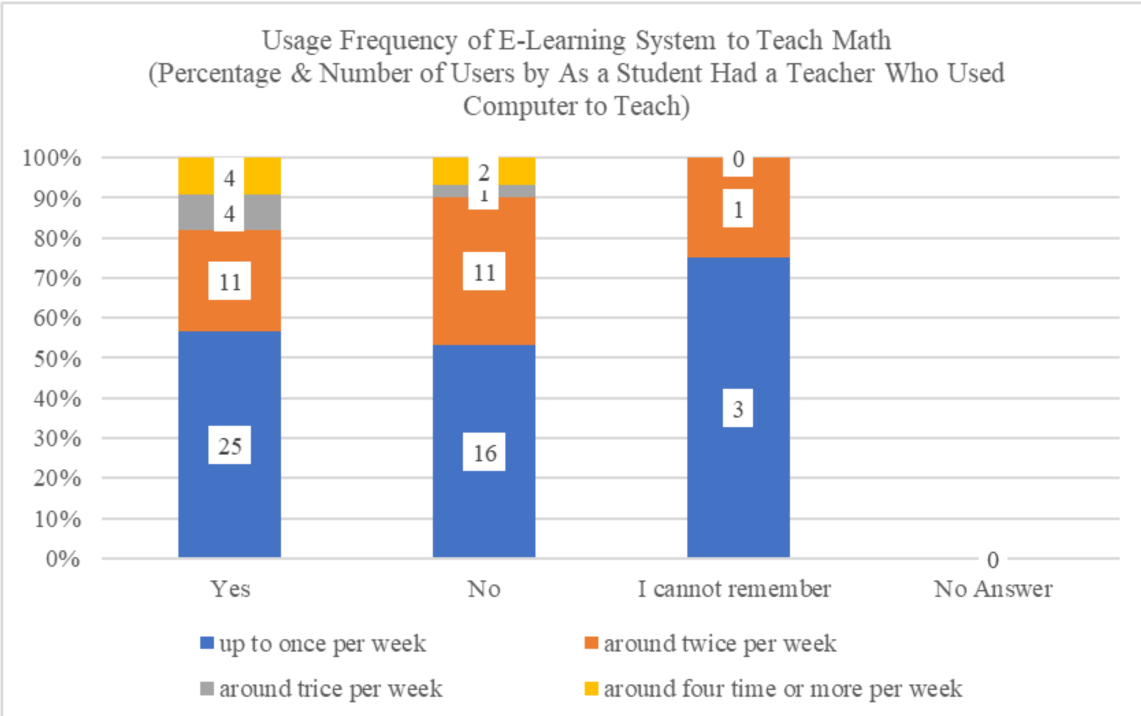

Figure 58. Usage Frequency of E-Learning versus Experience with Teacher Using a Computer.

Figure 58 shows the experience with a teacher using a computer and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Use of Computer for Teaching

Figure 59 shows the use of a computer for the teaching and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.537, not low enough to reject the null hypothesis in this case. The sample size was 78.

The data do not support the hypothesis that the teachers are using a computer to will be encouraged to use the e-learning more frequently than those who do not use a computer in class. The null hypothesis is not congruent with an earlier finding that showed a significant correlation between the use of a computer for teaching and the use or non-use of e-learning. It may be possible that access to computers help in the adoption of an e-learning system, but may not be enough to support more frequent use of the system. Further study of teachers' practices may reveal the reason behind the lack of correlation.

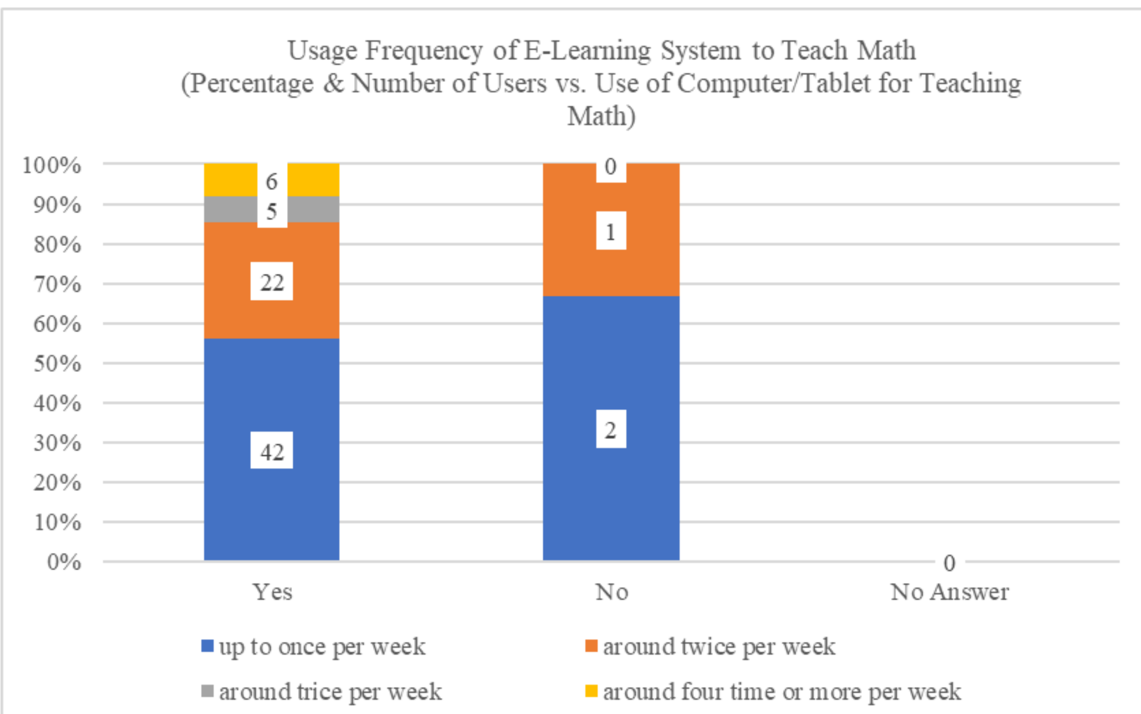

Figure 59. Usage Frequency of E-Learning versus Use of Computer for Teaching.

Figure 59 shows the use of a computer to teach and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Use of Wi-Fi, LAN, Internet for Teaching

Figure 60 shows the use of Wi-Fi, LAN, or internet for teaching and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.761, not low enough to reject the null hypothesis in this case. The sample size was 78.

The data do not support the hypothesis that the teachers who use the internet for teaching will be encouraged to use the e-learning more frequently than those who have none. It may be possible that the teachers who are not satisfied with the access speed or who are aware that their students have no access to the internet are not encouraged to use to use the e-learning system more often. Further study of teachers' practices may reveal the reason behind the lack of correlation.

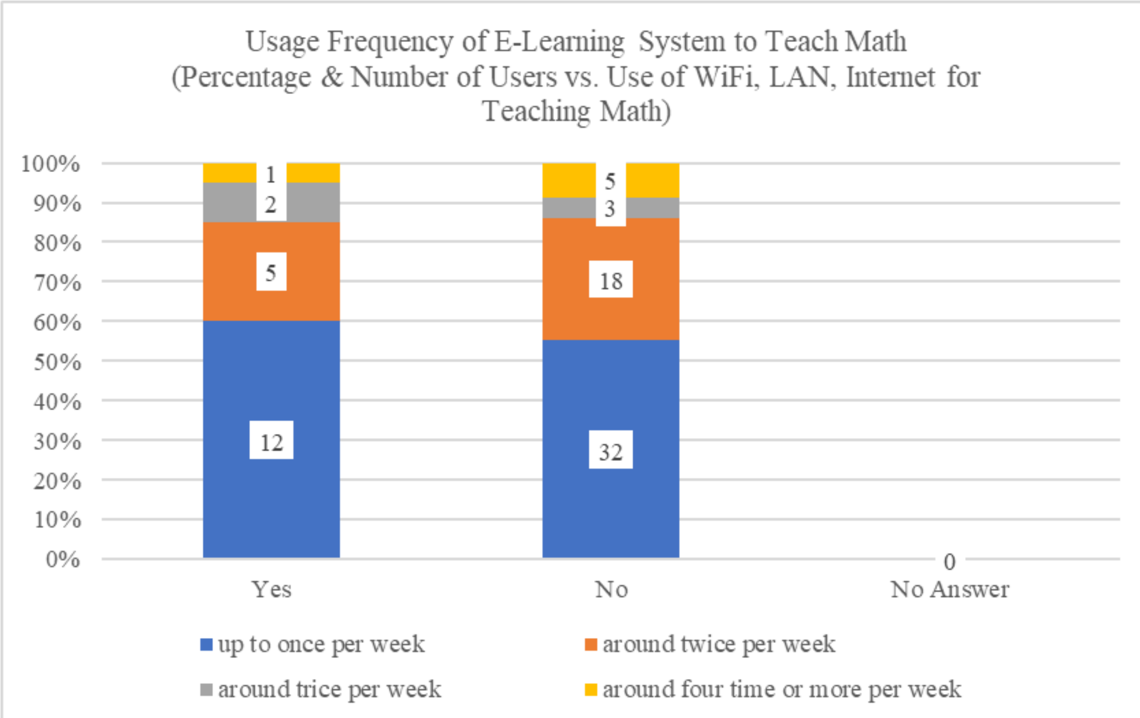

Figure 60. Usage Frequency of E-Learning versus Use of Wi-Fi, LAN, Internet for Teaching.

Figure 60 shows the use of Wi-Fi, LAN, or internet and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Years of Using E-Learning

Figure 61 shows the years of using e-learning and the e-learning usage frequency by the math teachers who responded to the survey.

Figure 62 shows the regression statistics between the years of using e-learning and the e-learning usage frequency by the math teachers who responded to the survey. The p value is 0.001, and it indicates that there is a significant correlation between the two variables.

The data support the hypothesis that the teachers who have been using the e-learning system for a longer time will be encouraged to use it more frequently than those who are just starting. It may be possible that the teachers who have been using it for some time have already developed the needed skills that encourage them to use it more frequently. Further study is required to establish the causal relationship between these two variables.

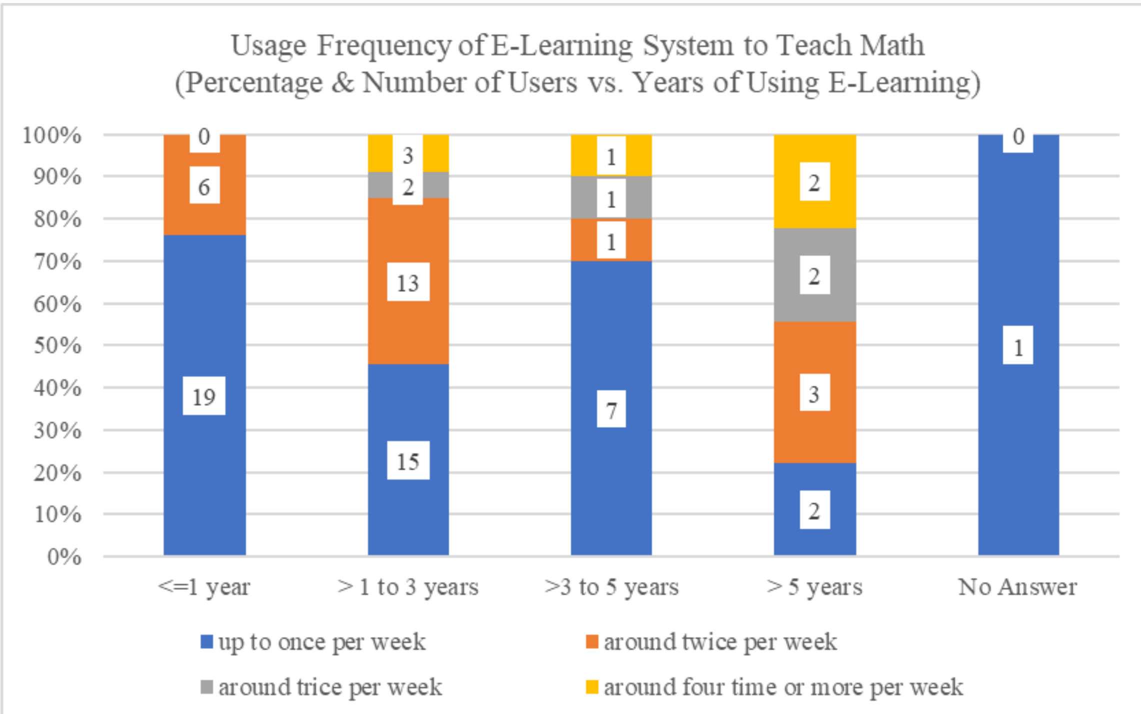

Figure 61. Usage Frequency of E-Learning versus Years of Using E-Learning.

Figure 61 shows the years of using e-learning and the e-learning usage frequency by the survey respondents.

Dependent Variable: F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math

Regression Statistics: Model 35 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (1 variable, n=77)

	R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
	0.129	0.117	0.857	0.912	77

Coefficient Estimates: Model 35 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (1 variable, n=77)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	0.972	0.229	4.236	0.000	0.515
F40_20b_Years_of_Using_E_Learning_to_Teach_Math	0.339	0.102	3.328	0.001	0.136

Analysis of Variance: Model 35 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (1 variable, n=77)

Error Distribution Statistics: Model 35 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (1 variable, n=77)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=77)	0.000	0.846	0.680	-1.327	2.351

Figure 62. Usage Frequency of E-Learning versus Years of Using E-Learning Regression.

Figure 62 shows the regression statistics between the years of using e-learning and the e-learning usage frequency by the survey respondents. (RegressIt Excel add-in output)

Usage Frequency of E-Learning versus Use of E-Learning Apps

Figure 63 shows the use of e-learning apps and the e-learning usage frequency by the math teachers who responded to the survey. The percentage of the teachers who uses e-learning up to about twice per week is highest among teachers who use the quiz application of e-learning. The percentage of frequent users of e-learning is highest among those who use e-learning for e-books.

Separate regression statistics showed p value above 0.05 except for the use of e-learning exercises application. Figure 64 shows the regression statistics between the use of e-learning exercises application and the e-learning usage frequency by the math teachers who responded to the survey. The p value is 0.031, and it indicates that there is a significant correlation between the two variables.

The data support the hypothesis that the teachers who use the exercise application of the e-learning system will be encouraged to use it more frequently than those who are not using the application. It may be possible that the teachers who are using the exercise application had to use it more often to match need to show many examples and solve many example problems. Further study is required to establish the causal relationship between these two variables.

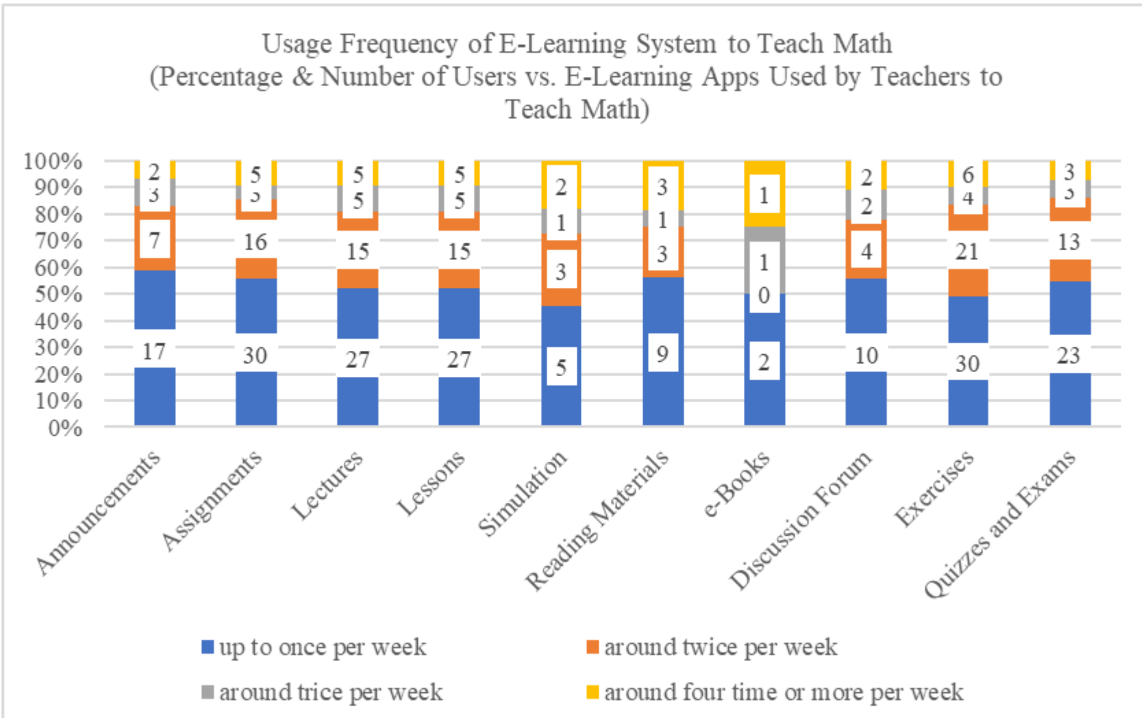

Figure 63. Usage Frequency of E-Learning versus Use of E-Learning Apps.

Figure 63 shows the use of e-learning Apps and the e-learning usage frequency by the survey respondents.

Dependent Variable:	F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math

Regression Statistics: Model 37 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (1 variable, n=78)

	R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
	0.060	0.047	0.887	0.909	78

Coefficient Estimates: Model 37 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (1 variable, n=78)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	0.700	0.445	1.573	0.120	-0.187
F49_20e_E_Learning_Apps_Used_to_Teach_Math___iExercises	0.535	0.243	2.199	0.031	0.050

Analysis of Variance: Model 37 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (1 variable, n=78)

Error Distribution Statistics: Model 37 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (1 variable, n=78)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=78)	0.000	0.876	0.677	-0.770	2.230

Figure 64. Usage Frequency of E-Learning versus Use of E-Learning Apps Regression.

Figure 64 shows the regression statistics between the use of e-learning Apps and the e-learning usage frequency by the survey respondents. (RegressIt Excel add-in output)

Usage Frequency of E-Learning versus Count of E-Learning Apps Used

Figure 65 shows the count of e-learning Apps used and the e-learning usage frequency by the math teachers who responded to the survey. The percentage of teachers who uses e-learning up to about twice per week is highest among teachers who use two e-learning applications. The percentage of frequent users of e-learning is highest among those who use six applications.

Figure 66 shows the regression statistics between the count of e-learning Apps used and the e-learning usage frequency by the math teachers who responded to the survey. The p value is 0.011, and it indicates that there is a significant correlation between the two variables.

The data support the hypothesis that the teachers who use more types of e-learning applications will be encouraged to use it more frequently than those who are using less number of applications. It may be possible that the teachers who are using more applications have already developed the needed skills that encourage them to use it more frequently. Further study is required to establish the causal relationship between these two variables.

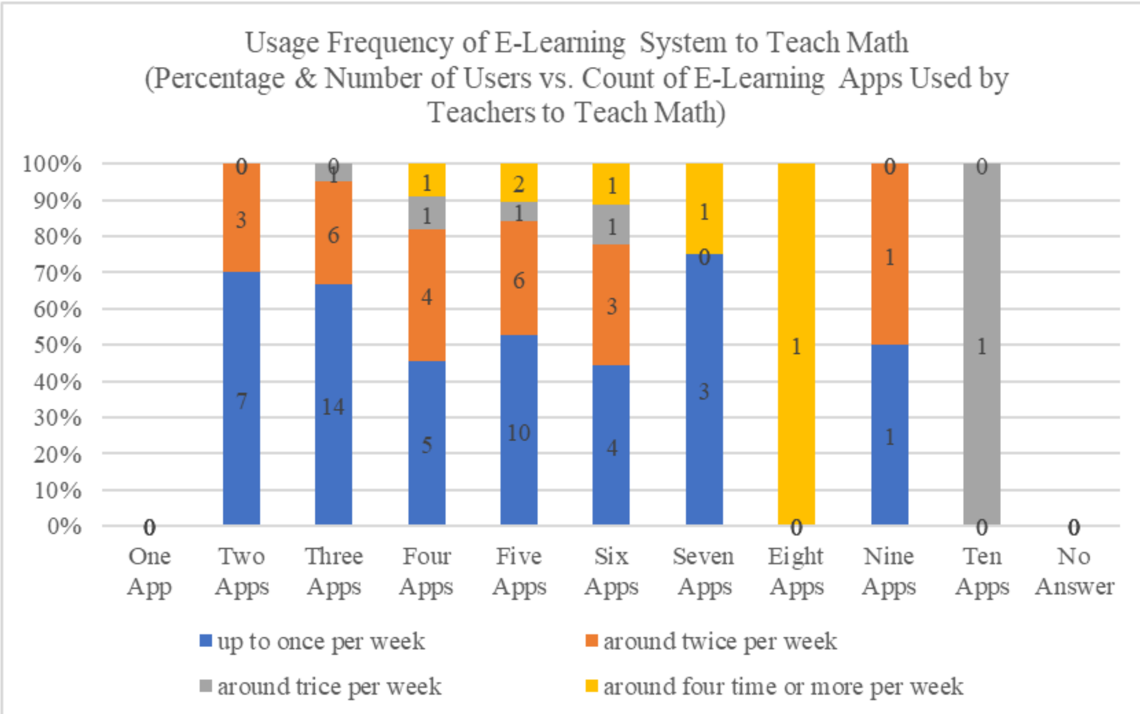

Figure 65. Usage Frequency of E-Learning versus Count of E-Learning Apps Used.

Figure 65 shows the count of e-learning Apps used and the e-learning usage frequency by the survey respondents.

Dependent Variable: F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math

Regression Statistics: Model 38 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (1 variable, n=78)

	R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
	0.082	0.070	0.877	0.909	78

Coefficient Estimates: Model 38 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (1 variable, n=78)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	1.016	0.264	3.848	0.000	0.490
F52_20e_E_Learning_Apps_Used_to_Teach_Math___Count__created	0.146	0.056	2.606	0.011	0.034

Analysis of Variance: Model 38 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (1 variable, n=78)

Error Distribution Statistics: Model 38 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (1 variable, n=78)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=78)	0.000	0.866	0.702	-1.333	2.399

Figure 66. Usage Frequency of E-Learning versus Count of E-Learning Apps Used Regression.

Figure 66 shows the regression statistics between the count of e-learning Apps used and the e-learning usage frequency by the survey respondents. (RegressIt Excel add-in output)

Usage Frequency of E-Learning versus Requiring Students to Use E-Learning

Figure 67 shows the requirement for the students to use e-learning and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.682, not low enough to reject the null hypothesis in this case. The sample size was 78.

The data do not support the hypothesis that the teachers who do require their students to use the e-learning will themselves be encouraged to use it more frequently than those who do not. It may be possible that the teachers may be requiring their students to use e-learning for after-class enrichment activities that do not require the teacher to use it themselves. Further study of teachers' practices may reveal the reason behind the lack of correlation.

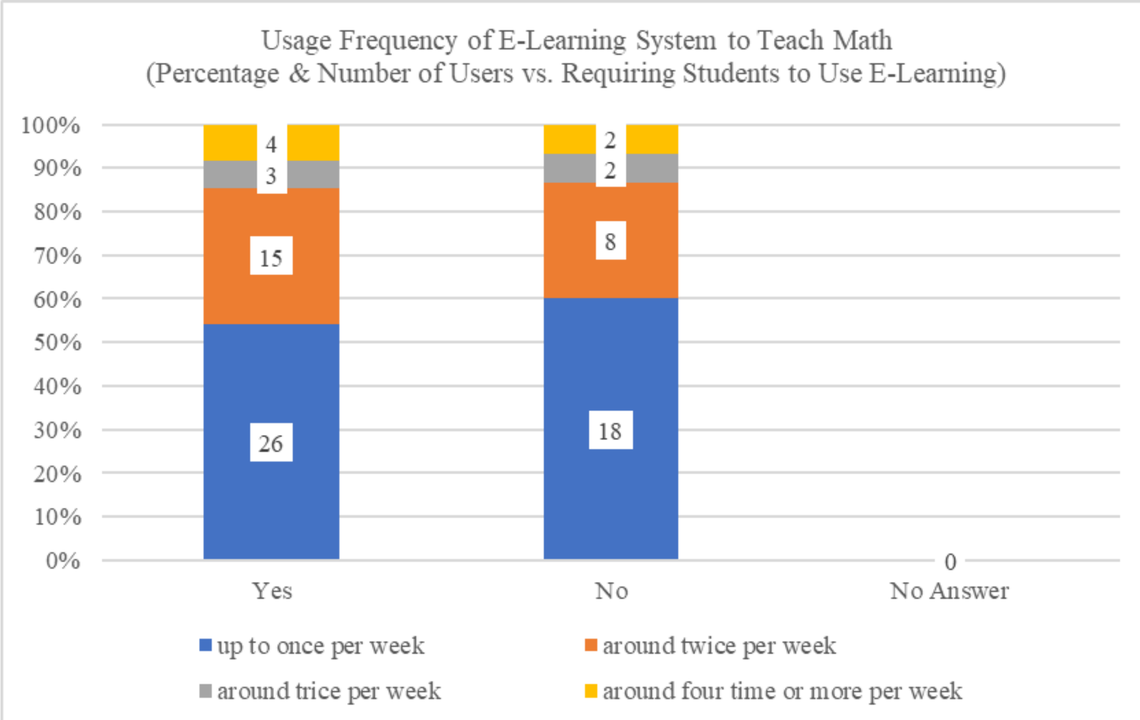

Figure 67. Usage Frequency of E-Learning versus Requiring Students to Use E-Learning.

Figure 67 shows the requirement for the students to use e-learning and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Student Devices Allowed

Figure 68 shows the student devices allowed and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded p values above 0.050, not low enough to reject the null hypothesis in this case. The sample size was 78.

The data do not support the hypothesis that the teachers who do allow their students to use devices in class will be encouraged to use the e-learning more frequently than those who do not. It may be possible that the teachers let the students use the devices for infrequent special activities. Further study of teachers' practices may reveal the reason behind the lack of correlation.

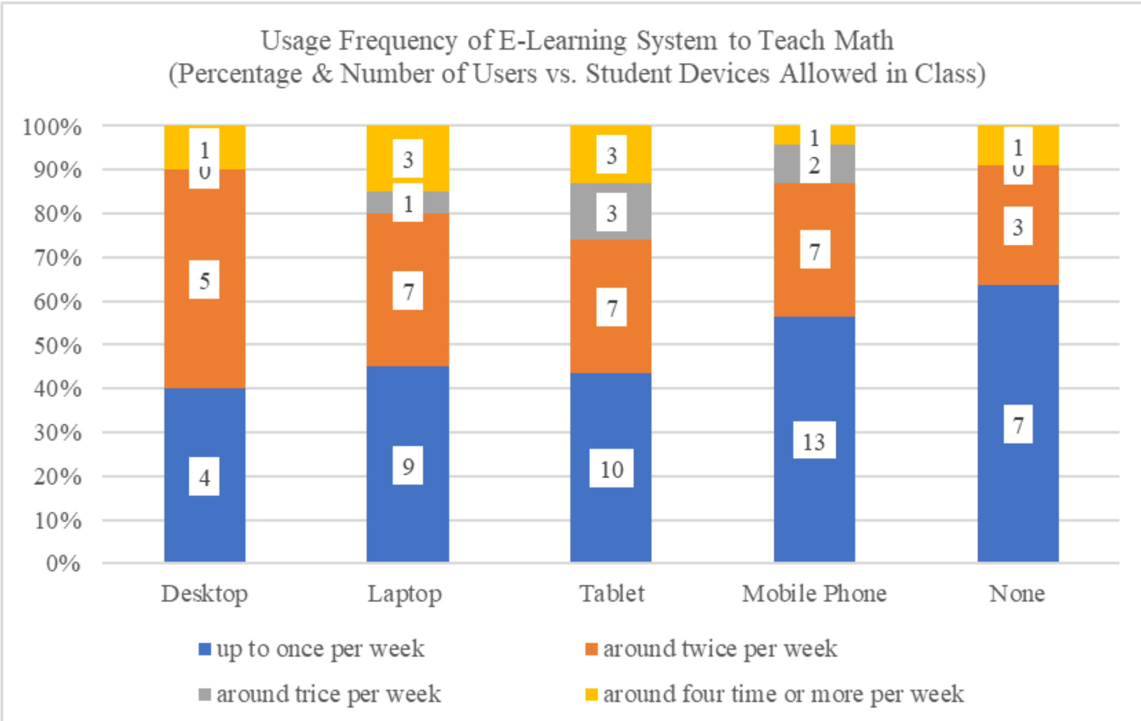

Figure 68. Usage Frequency of E-Learning versus Student Devices Allowed.

Figure 68 shows the student devices allowed and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Count of Student Devices Allowed

Figure 69 shows the count of student devices allowed and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.150, not low enough to reject the null hypothesis in this case. The sample size was 78.

The data do not support the hypothesis that allowing the students to use more types of devices in class will encourage the teachers to use the e-learning more frequently than those who allow less.

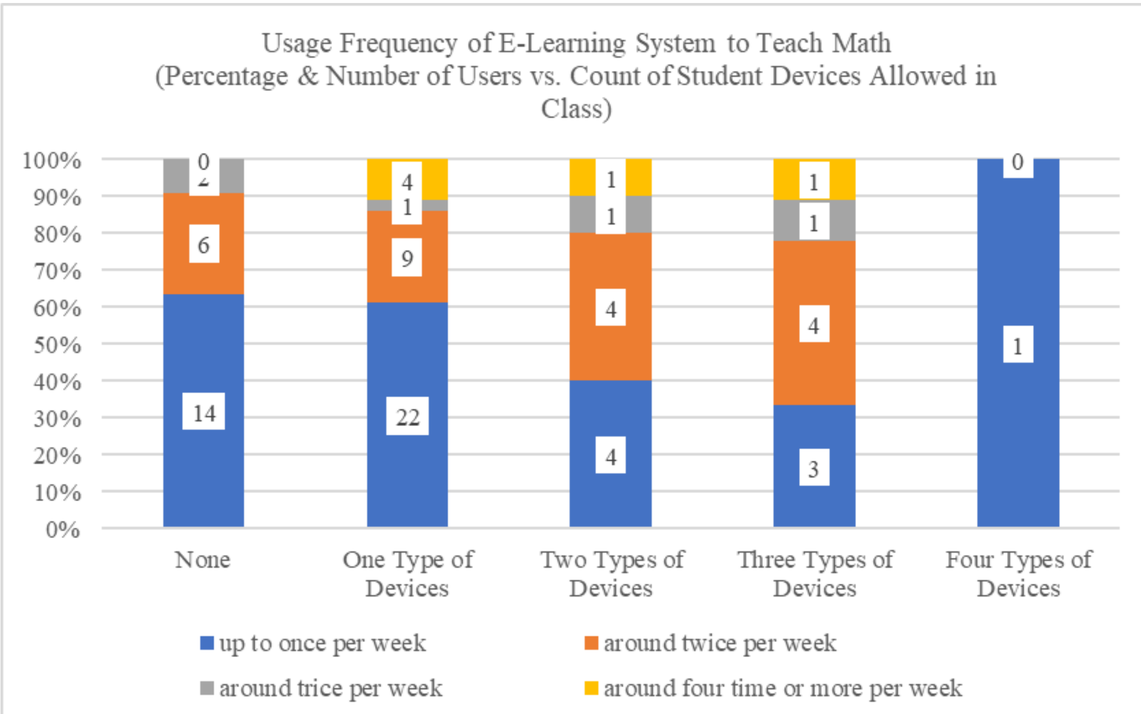

Figure 69. Usage Frequency of E-Learning versus Count of Student Devices Allowed.

Figure 69 shows the count of student devices allowed and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus E-Learning Apps Required for Student's Use

Figure 70 shows the e-learning apps required for students' use and the e-learning usage frequency by the math teachers who responded to the survey. The percentage of the teachers who uses e-learning up to about twice per week is highest among the teachers who required their students to use the assignment application of an e-learning system. The percentage of frequent users of e-learning is highest among those who require the use of the reading materials application.

Figure 71 shows the regression statistics between the e-learning application to be used by the students as required and the e-learning usage frequency by the math teachers who responded to the survey. The p values are all above 0.050, and these indicate that there is no significant correlation with the dependent variable. The sample excludes the use of the e-book application with only one data point.

The data do not support the hypothesis that requiring the students to use a particular e-learning application will encourage the teachers to use the e-learning more frequently compared to the teachers who do not require the students to use it. It may be possible that the teachers' way and the frequency of using the e-learning are different from how they expect their students to use it. Further study of student's and teachers' practices may reveal the reason behind the lack of correlation.

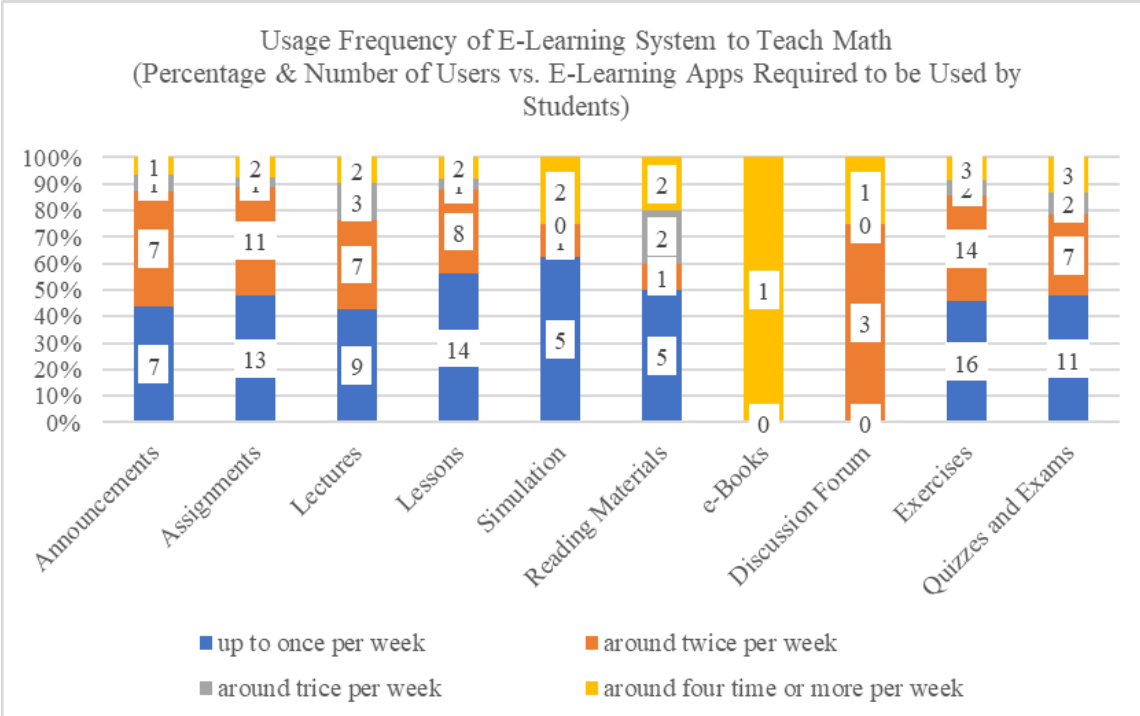

Figure 70. Usage Frequency of E-Learning versus E-Learning Apps Required for

Student's Use.

Figure 70 shows the e-learning apps required for the student and the e-learning usage frequency by the survey respondents.

Dependent Variable: F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math

Regression Statistics: Model 45 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (9 variables, n=78)

R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
0.109	-0.009	0.913	0.909	78

Adj. R-sqr. is negative because the standard error of the regression is greater than the standard deviation of the dependent variable.

Coefficient Estimates: Model 45 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (9 variables, n=78)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	0.155	0.693	0.223	0.824	-1.229
F61_21d_E_Learning_Apps_to_Use_by_Students___aAnnouncements	-0.225	0.342	-0.658	0.513	-0.907
F62_21d_E_Learning_Apps_to_Use_by_Students___bAssignments	0.100	0.322	0.312	0.756	-0.542
F63_21d_E_Learning_Apps_to_Use_by_Students___cLectures	0.298	0.319	0.933	0.354	-0.339
F64_21d_E_Learning_Apps_to_Use_by_Students___dLessons	-0.319	0.287	-1.109	0.271	-0.893
F65_21d_E_Learning_Apps_to_Use_by_Students___eSimulation	0.107	0.408	0.262	0.794	-0.706
F66_21d_E_Learning_Apps_to_Use_by_Students___fReading_Materials	0.250	0.415	0.601	0.550	-0.578
F68_21d_E_Learning_Apps_to_Use_by_Students___hDiscussion_Forum	0.940	0.504	1.866	0.066	-0.065
F69_21d_E_Learning_Apps_to_Use_by_Students___iExercises	0.092	0.267	0.345	0.731	-0.441
F70_21d_E_Learning_Apps_to_Use_by_Students___jQuizzes_and_Exams	0.122	0.279	0.436	0.664	-0.435

Analysis of Variance: Model 45 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (9 variables, n=78)

Error Distribution Statistics: Model 45 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (9 variables, n=78)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=78)	0.000	0.853	0.690	-1.067	2.601

Figure 71. Usage Frequency of E-Learning versus E-Learning Apps Required for

Student's Use Regression.

Figure 71 shows the regression statistics between the e-learning apps required for students' use and the e-learning usage frequency by the survey respondents. (RegressIt Excel add-in output)

Usage Frequency of E-Learning versus Count of E-Learning Apps Required

Figure 72 shows the e-learning apps required and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.120, not low enough to reject the null hypothesis in this case. The sample size was 78.

The data do not support the hypothesis that requiring the students to use more types of e-learning applications will encourage the teachers to use the e-learning more frequently compared to those who required less.

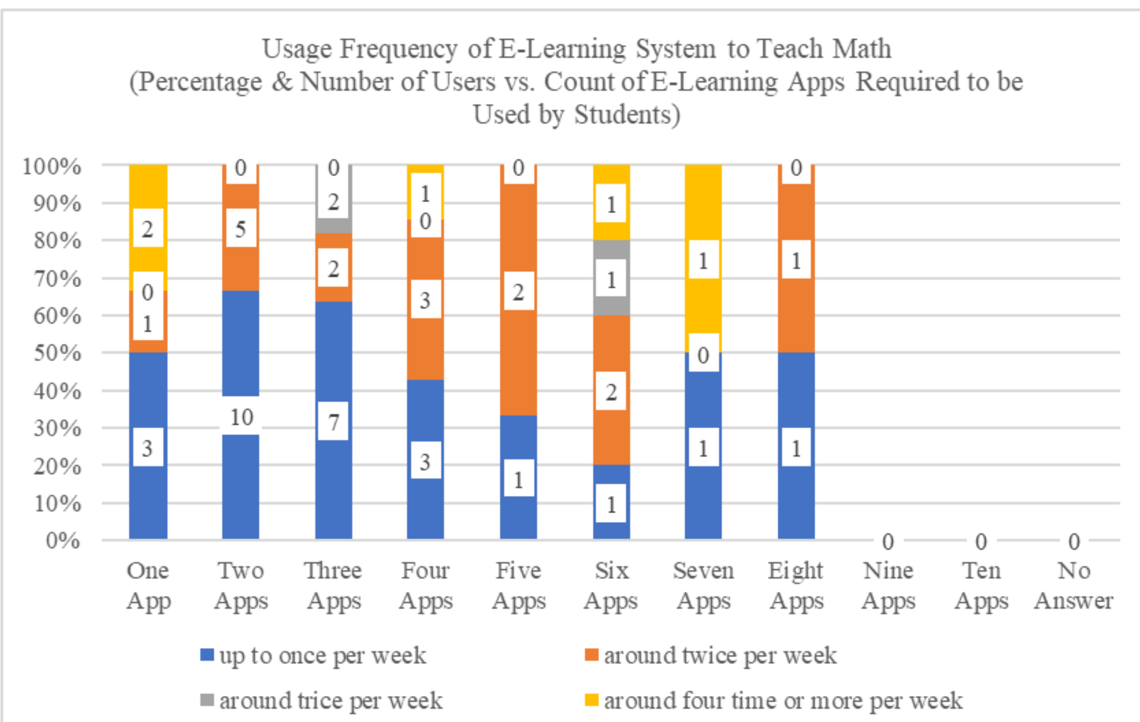

Figure 72. Usage Frequency of E-Learning versus Count of E-Learning Apps Required.

Figure 72 shows the count of e-learning apps required and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning and Change Management

The purpose of the analysis in this section is to assess the correlation between the selected change management related factors and the usage frequency of the e-learning system to teach math. Identifying those factors with significant correlation can help in better understanding the current state of e-learning system implementation. It can also help in crafting strategies to better support users of the e-learning system for teaching math.

Usage Frequency of E-Learning versus Familiarity to Overall E-Learning Plan

Figure 73 shows the familiarity with the overall e-learning plan and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.125, not low enough to reject the null hypothesis in this case. The sample size was 75.

The data do not support the hypothesis that when the school heads communicate their overall plan and direction for the school e-learning, it will encourage the teachers to use it more often. It may be possible that the teachers have other challenges that discourage the more frequent use of the e-learning. The null hypothesis is not congruent with the earlier finding that showed a significant correlation between the communicated overall plan and the teachers' use of the e-learning. Further study is required to understand the differences in the correlations.

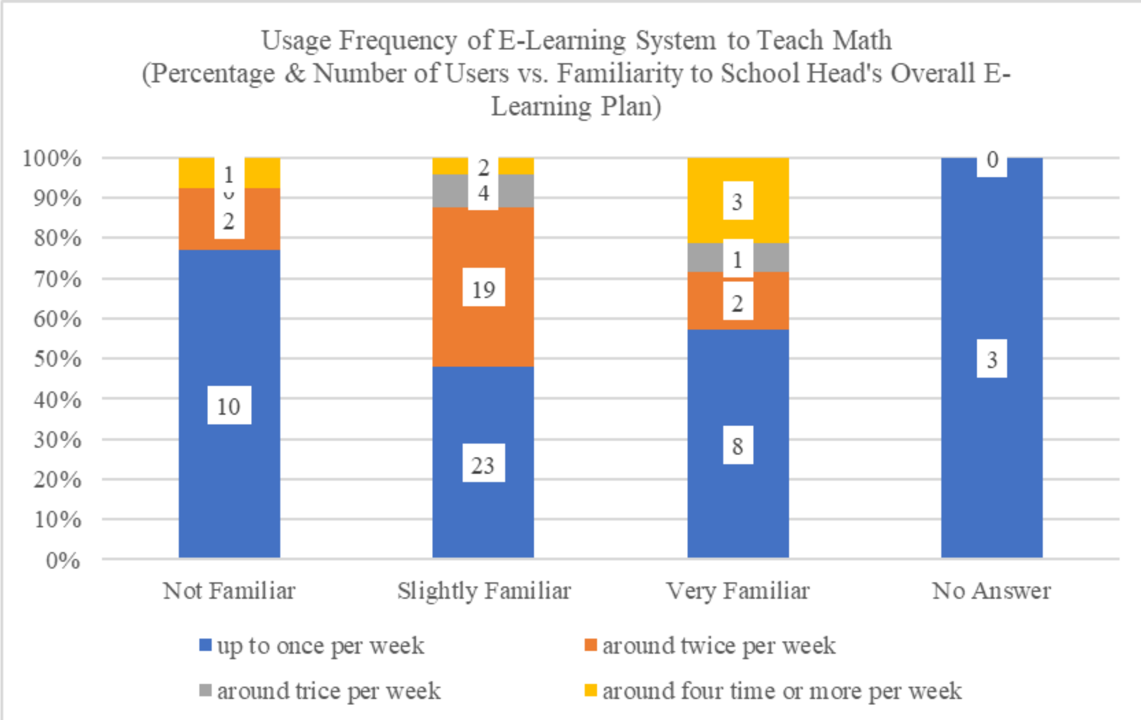

Figure 73. Usage Frequency of E-Learning versus Familiarity to Overall E-Learning Plan.

Figure 73 shows the familiarity with the overall e-learning plan and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Promoting the Use of E-Learning in Math Class

Figure 74 shows the school head's promotion of the use of e-learning in math class and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.114, not low enough to reject the null hypothesis in this case. The sample size was 77.

The data do not support the hypothesis that when the school heads promote and campaign for the use of e-learning in math class, it will encourage the teachers to use it more often. It may be possible that the teachers have other challenges that discourage the more frequent use of the e-learning. The null hypothesis is not congruent with the earlier finding that showed a significant correlation between the school heads promotion and campaign efforts and the teachers' use of the e-learning. Further study is required to understand the differences in the correlations.

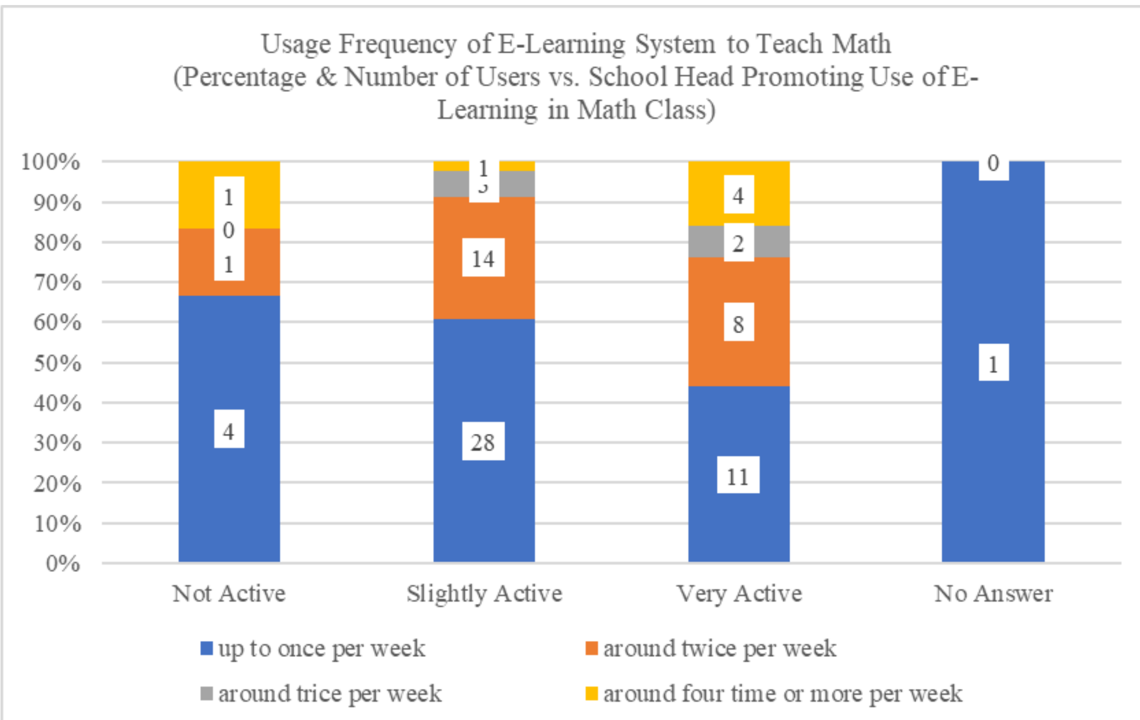

Figure 74. Usage Frequency of E-Learning versus Promoting the Use of E-Learning in Math Class.

Figure 74 shows the school head's promotion of the use of e-learning in math class and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus School Providing Projector or TV Screen

Figure 75 shows the school providing projector or TV screen and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.306, not low enough to reject the null hypothesis in this case. The sample size was 78.

The data do not support the hypothesis that when the schools provide the teachers with classroom TV or projector, it will encourage the teachers to use the e-learning more often. It may be possible that the teachers have other challenges, such as the lack of confidence and skills in using digital classroom equipment, that discourage the more frequent use of the e-learning. The null hypothesis is congruent with the earlier finding that showed no significant correlation between the provision of TV or projector and the teachers' use of the e-learning. Further study is needed to understand the lack of correlation between the variables.

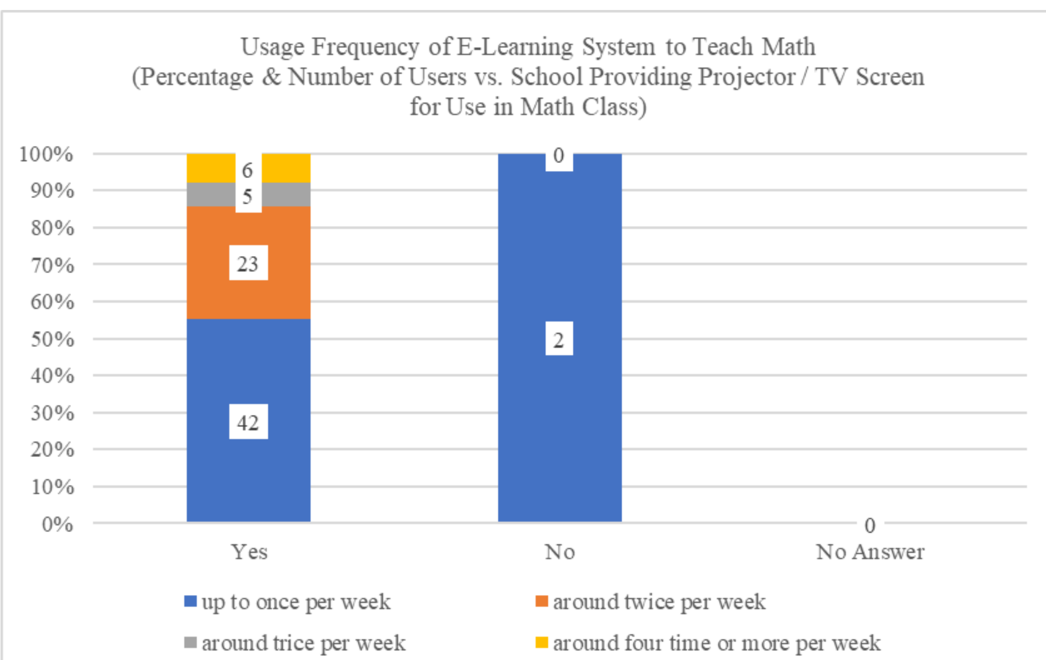

Figure 75. Usage Frequency of E-Learning versus School Providing Projector or TV Screen.

Figure 75 shows the school providing a projector or TV screen and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus School Providing Computers or Tablets

Figure 76 shows the school providing computers or tablets and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.733, not low enough to reject the null hypothesis in this case. The sample size was 78.

The data do not support the hypothesis that when the schools provide the teachers with computers and devices, it will encourage the teachers to use the e-learning more often. It may be possible that the teachers have other challenges, such as the lack of computers or devices for students' use, that discourage the more frequent use of the e-learning. The null hypothesis is congruent with the earlier finding that showed no significant correlation between the provision of computers and devices and the teachers' use of the e-learning. Further study is needed to understand the lack of correlation between the variables.

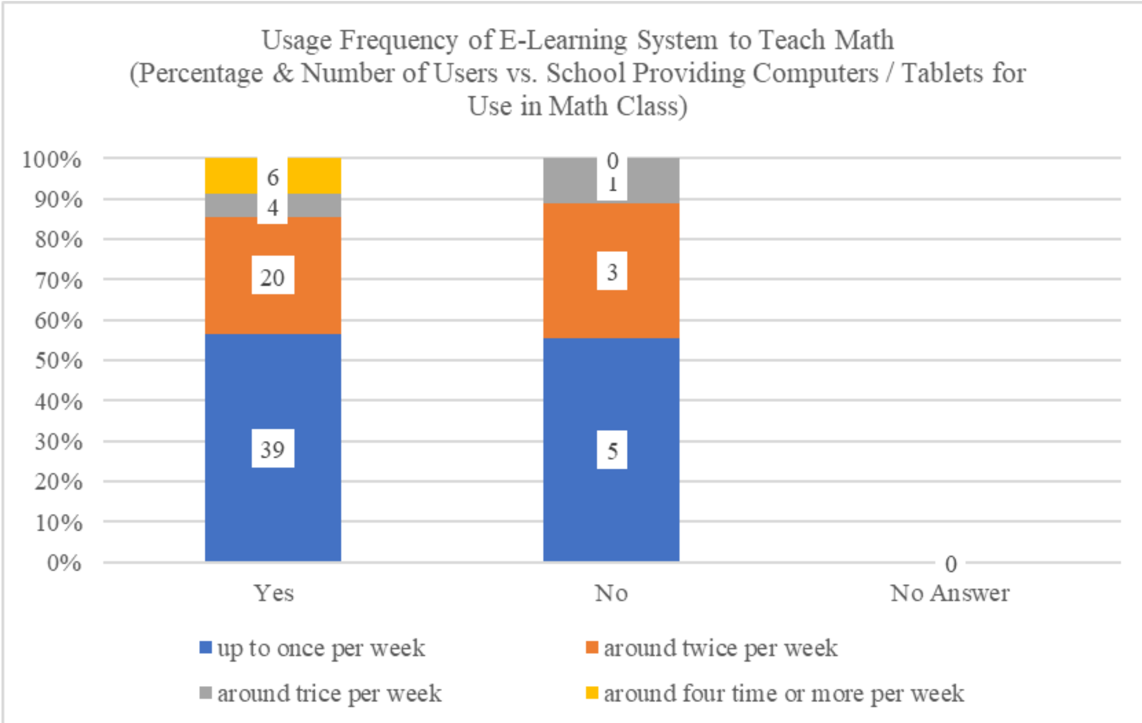

Figure 76. Usage Frequency of E-Learning versus School Providing Computers or Tablets.

Figure 76 shows the school providing computers or tablets and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus School Providing Wi-Fi, LAN, Internet

Figure 77 shows the school providing Wi-Fi, LAN, or internet and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.952, not low enough to reject the null hypothesis in this case. The sample size was 78.

The data do not support the hypothesis that when the schools provide the teachers with internet or network access, it will encourage the teachers to use the e-learning more often. It may be possible that the teachers have other challenges, such as the lack of curriculum-aligned digital learning materials, that discourage the more frequent use of the e-learning. The null hypothesis is congruent with the earlier finding that showed no significant correlation between the provision of an internet or network access and the teachers' use of the e-learning. Further study is needed to understand the lack of correlation between the variables.

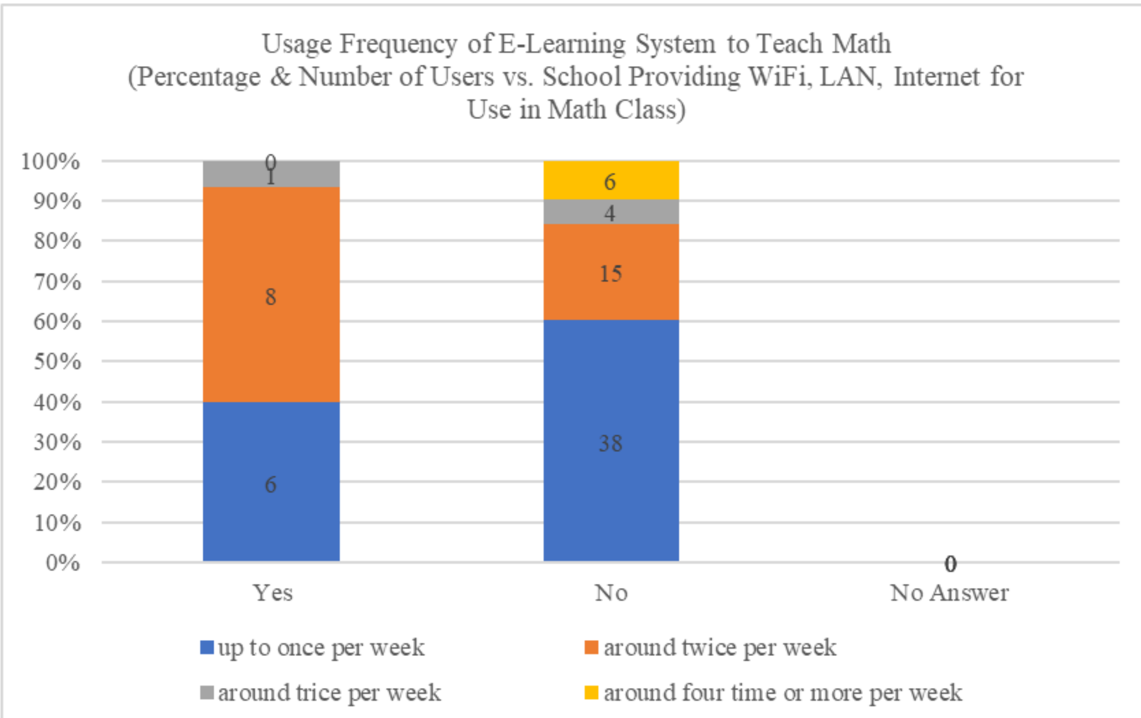

Figure 77. Usage Frequency of E-Learning versus School Providing Wi-Fi, LAN, Internet.

Figure 77 shows the school providing Wi-Fi, LAN, or internet and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Speed of Internet

Figure 78 shows the speed of the internet and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.572, not low enough to reject the null hypothesis in this case. The sample size was 73.

The data do not support the hypothesis that when the schools provide the teachers with sufficient internet connection speed, it will encourage the teachers to use the e-learning more often. It may be possible that the teachers have other challenges, such as the student's lack of access to the internet at home, that discourage the more frequent use of the e-learning. The null hypothesis is congruent with the earlier finding that showed no significant correlation between the provision of sufficient internet connection speed and the teachers' use of the e-learning. Further study is needed to understand the lack of correlation between the variables.

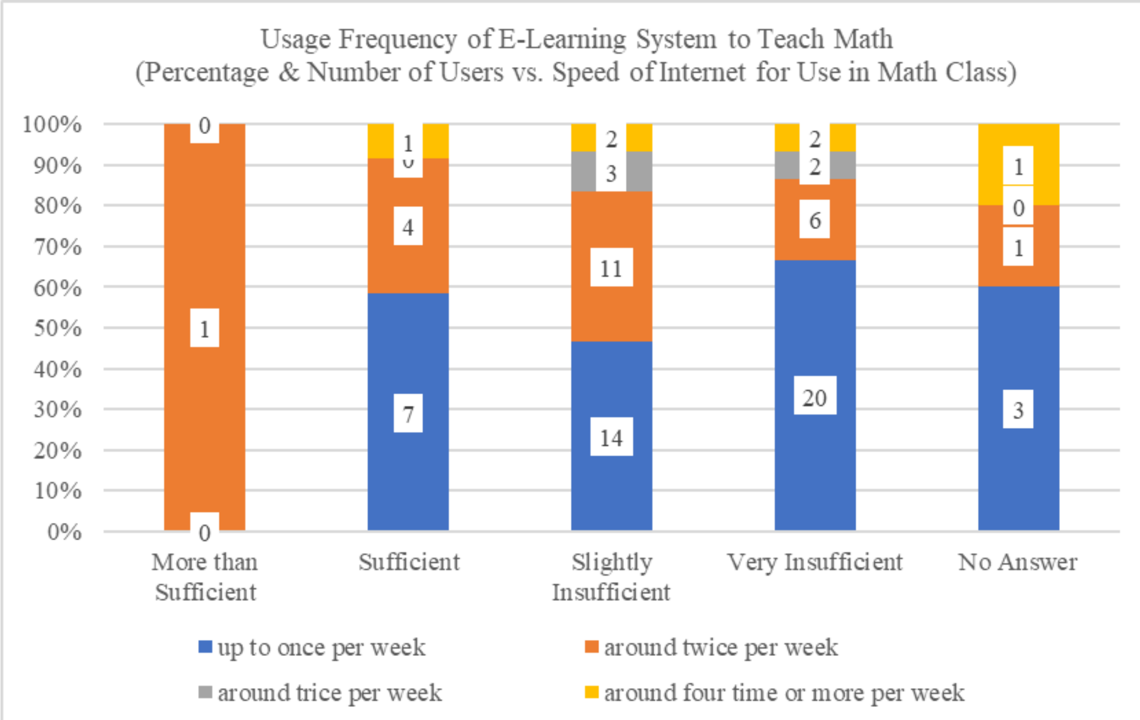

Figure 78. Usage Frequency of E-Learning versus Speed of Internet.

Figure 78 shows the speed of the internet and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus School Providing E-Learning System

Figure 79 shows the school providing e-learning system and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.559, not low enough to reject the null hypothesis in this case. The sample size was 75.

The data do not support the hypothesis that when the schools provide the teachers with an e-learning system, it will encourage the teachers to use the e-learning more often. It may be possible that the teachers need more time to develop the skills needed to utilize the e-learning system properly. The null hypothesis is not congruent with the earlier finding that showed a significant correlation between the provision of a school e-learning system and the teachers' use of the e-learning. Further study is needed to understand the differences in the correlations.

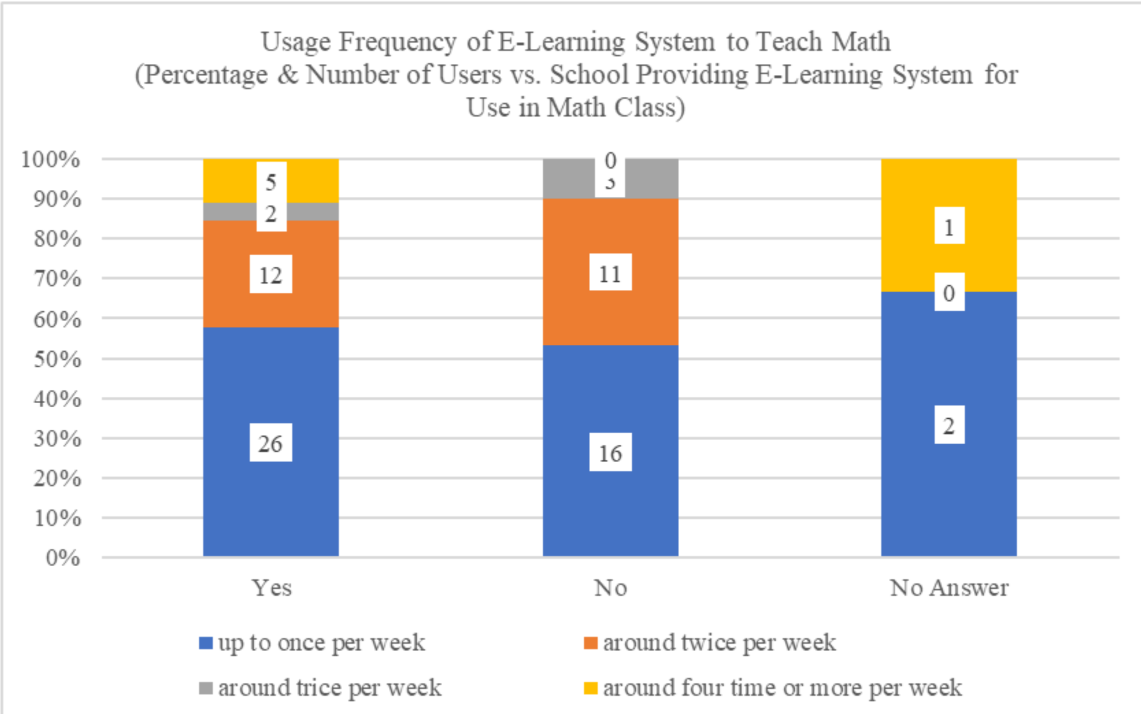

Figure 79. Usage Frequency of E-Learning versus School Providing E-Learning System.

Figure 79 shows the school providing e-learning system and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus School Providing Digital Learning Materials

Figure 80 shows the school providing digital learning materials and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.362, not low enough to reject the null hypothesis in this case. The sample size was 75.

The data do not support the hypothesis that when the schools provide the teachers with sufficient digital learning materials, it will encourage the teachers to use the e-learning more often. It may be possible that the teachers still need time to develop the skills in using digital learning materials for teaching. The null hypothesis is not congruent with the earlier finding that showed a significant correlation between the provision of digital learning materials and the teachers' use of the e-learning. Further study is needed to understand the differences in the correlations.

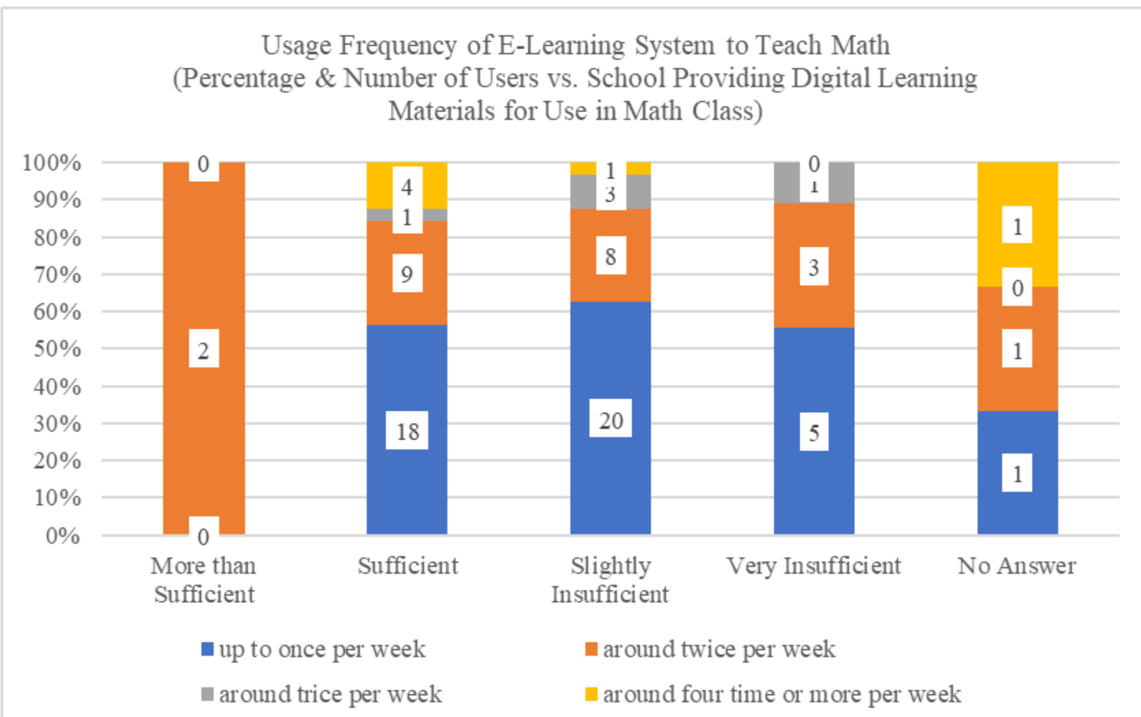

Figure 80. Usage Frequency of E-Learning versus School Providing Digital Learning Materials.

Figure 80 shows the school providing digital learning materials and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus School Providing Teacher Training on E-Learning

Figure 81 shows the school providing teacher training on e-learning and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.872, not low enough to reject the null hypothesis in this case. The sample size was 77.

The data do not support the hypothesis that when the schools provide the teachers with enough training on how to use an e-learning system, it will encourage the teachers to use the e-learning more often. It may be possible that the teachers need more time to develop the skills in using the e-learning system. The null hypothesis is not congruent with the earlier finding that showed a significant correlation between the provision of sufficient teacher training and the teachers' use of the e-learning. Further study is needed to understand the differences in the correlations.

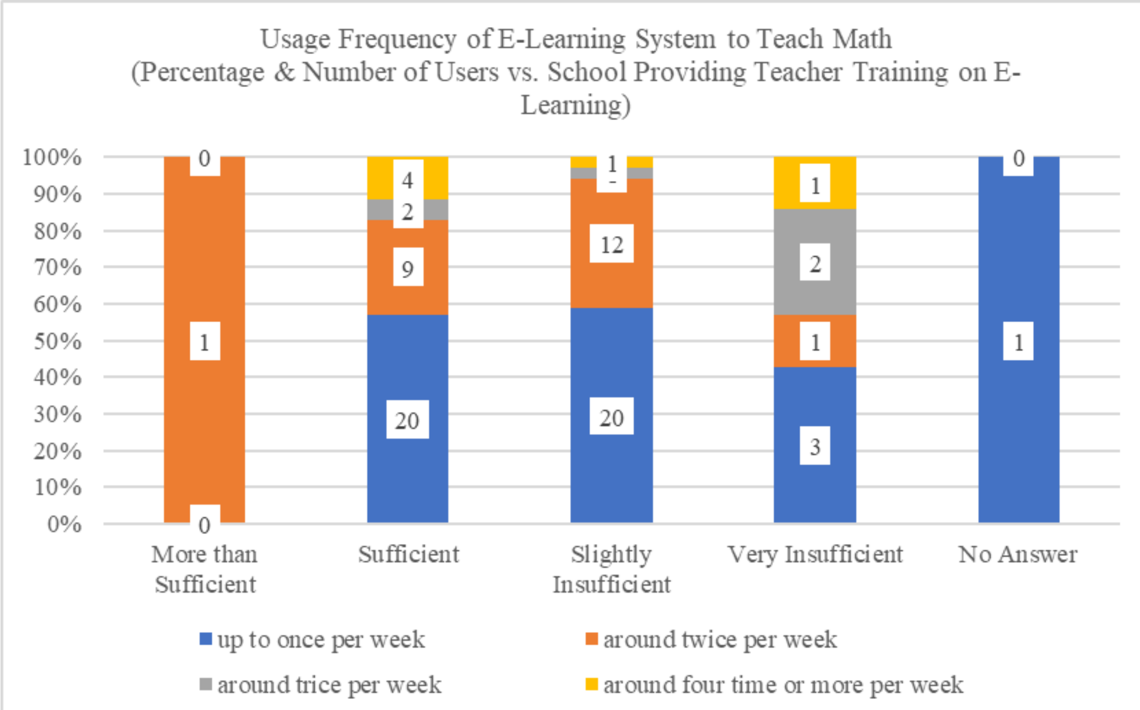

Figure 81. Usage Frequency of E-Learning versus School Providing Teacher Training on E-Learning.

Figure 81 shows the school providing teacher training on e-learning and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus School Providing Manuals and Technical Support

Figure 82 shows the school providing manuals with technical support and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.342, not low enough to reject the null hypothesis in this case. The sample size was 76.

The data do not support the hypothesis that when the schools provide the teachers with technical support and manuals, it will encourage the teachers to use the e-learning more often. It may be possible that the teachers have other challenges that discourage the more frequent use of the e-learning. The null hypothesis is congruent with the earlier finding that showed no significant correlation between the provision of technical support and manuals, and the teachers' use of the e-learning. Further study is needed to understand the lack of correlation between the variables.

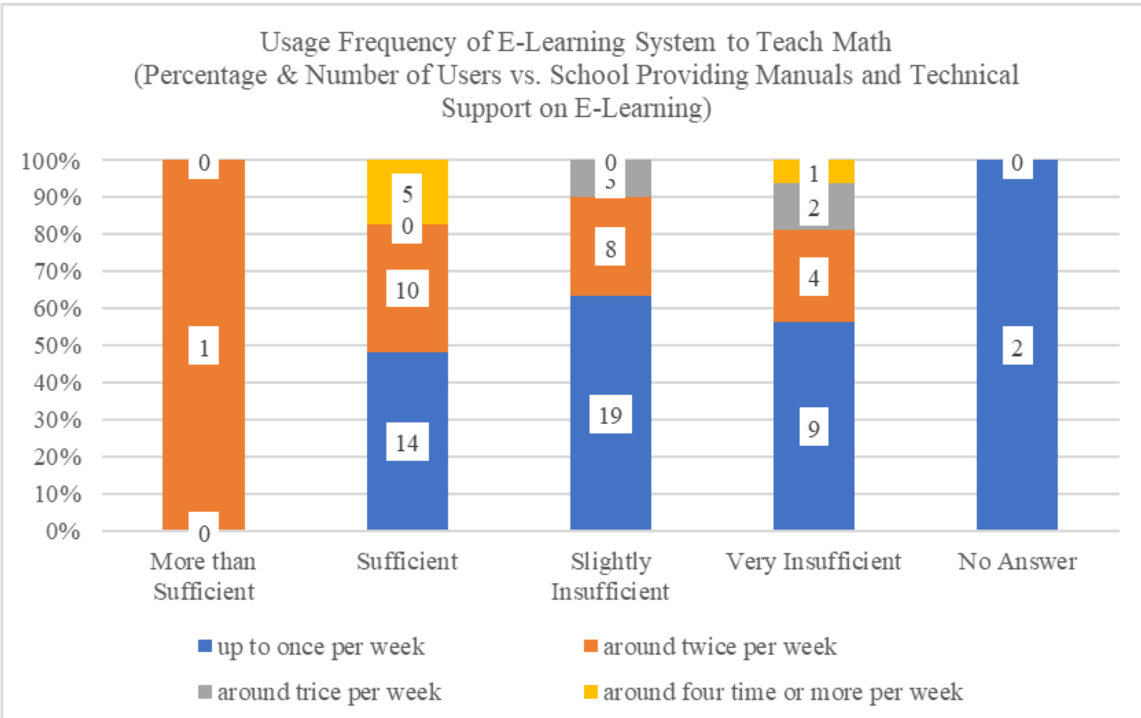

Figure 82. Usage Frequency of E-Learning versus School Providing Manuals and Technical Support.

Figure 82 shows the school providing manuals with technical support and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus School Head Sharing Report on Usage of E-Learning

Figure 83 shows the school head sharing the e-learning usage report and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.958, not low enough to reject the null hypothesis in this case. The sample size was 77.

The data do not support the hypothesis that when the school heads share the e-learning usage report to teachers, it will encourage the teachers to use the e-learning more often. It may be possible that the school heads are not yet measuring the reporting the usage level of their e-learning system. The null hypothesis is congruent with the earlier finding that showed no significant correlation between the school heads' sharing of the e-learning usage report, and the teachers' use of the e-learning. Further study is needed to understand the lack of correlation between the variables.

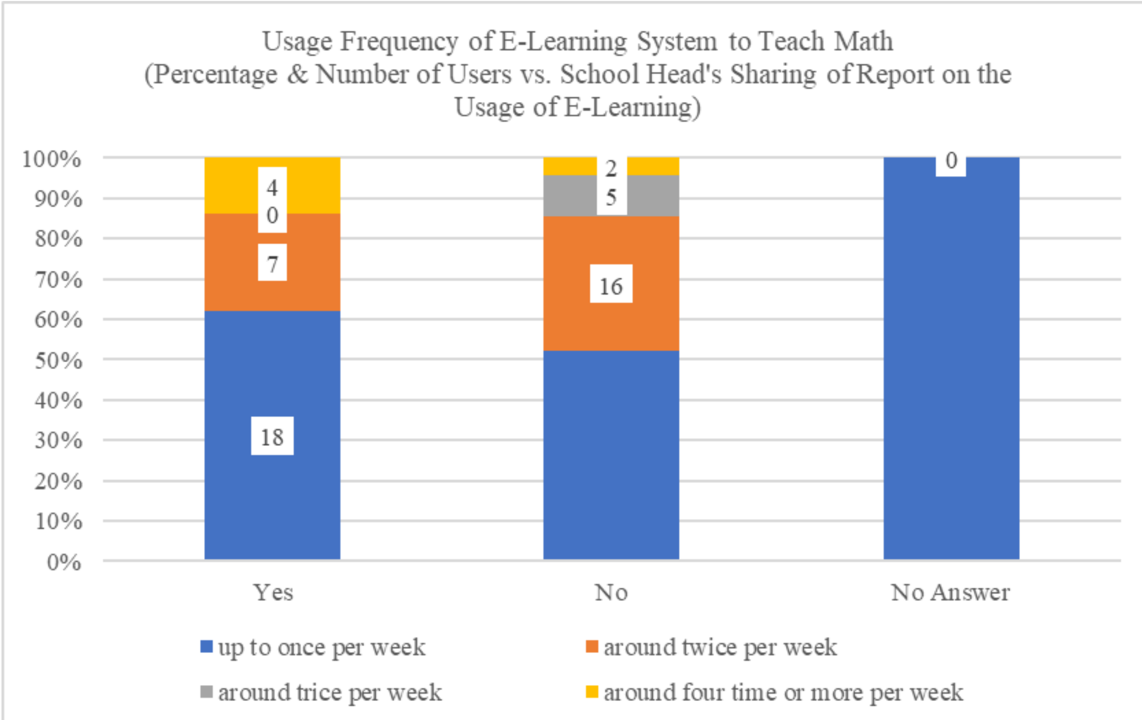

Figure 83. Usage Frequency of E-Learning versus School Head Sharing Usage Report.

Figure 83 shows the school head sharing the e-learning usage report and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus Participation in Third Party Interview on E-Learning

Figure 84 shows the participation in a third-party interview on e-learning and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.545, not low enough to reject the null hypothesis in this case. The sample size was 77.

The data do not support the hypothesis that when the teachers participate in a third-party interview on e-learning, it will encourage the teachers to use the e-learning more often. It may be possible that the schools are not yet implementing a third-party audit of their e-learning system. The null hypothesis is congruent with the earlier finding that showed no significant correlation between the teachers' participation in a third-party interview on e-learning, and the teachers' use of the e-learning. Further study is needed to understand the lack of correlation between the variables.

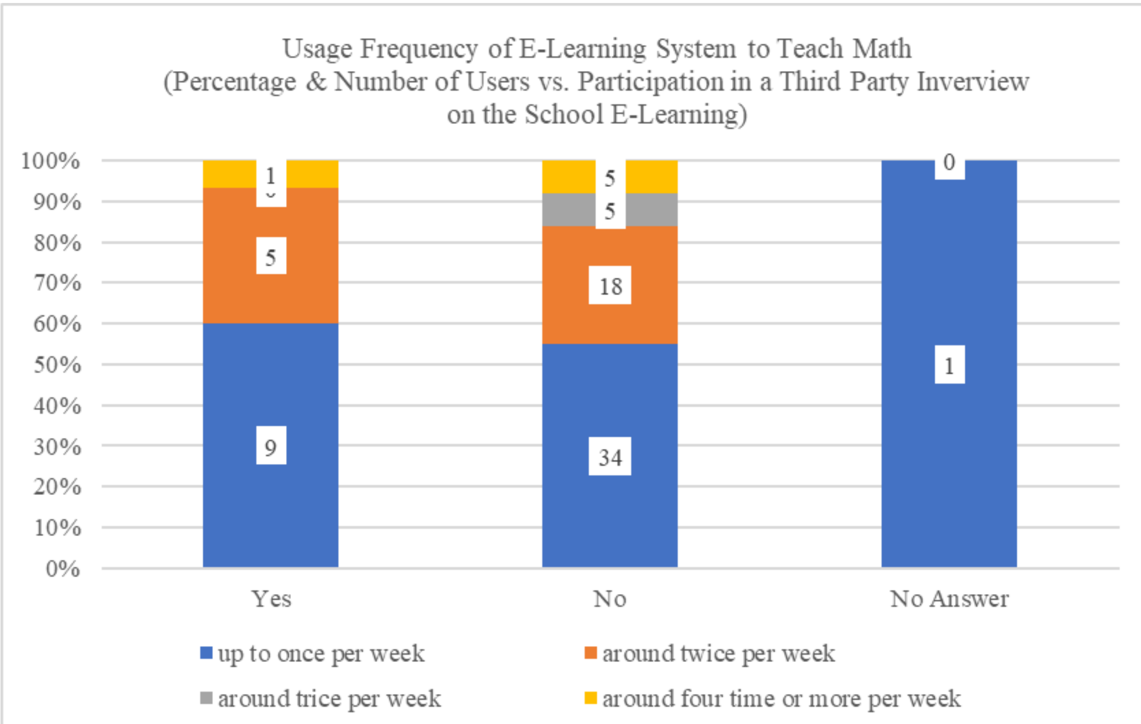

Figure 84. Usage Frequency of E-Learning versus Participation in Third Party Interview on E-Learning.

Figure 84 shows the participation in a third-party interview about the school e-learning and the e-learning usage frequency by the survey respondents.

Usage Frequency of E-Learning versus School Head Discussing / Agreeing on Improvement Actions

Figure 85 shows the school head discussing/agreeing on improvement actions and the e-learning usage frequency by the math teachers who responded to the survey. There is no observable pattern on the percentages of e-learning users, and regression analysis done for this yielded a p value of 0.699, not low enough to reject the null hypothesis in this case. The sample size was 77.

The data do not support the hypothesis that when the school heads discuss and agree on improvement action items, it will encourage the teachers to use the e-learning more often. It may be possible that the school heads are not yet consistently discussing and implementing the needed improvement action items. The null hypothesis is congruent with the earlier finding that showed no significant correlation between the school heads’ discussion and agreement on improvement action items, and the teachers’ use of the e-learning. Further study is needed to understand the lack of correlation between the variables.

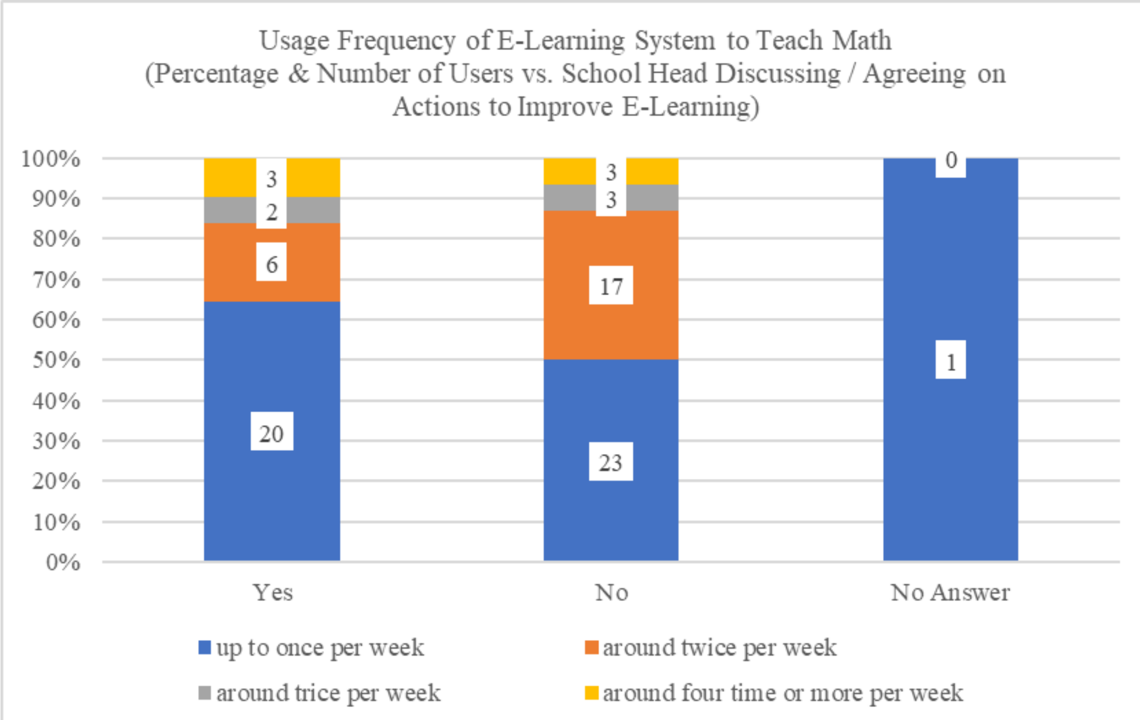

Figure 85. Usage Frequency of E-Learning versus School Head's Discussion and Agreement on Improvement Actions.

Figure 85 shows the school head discussing and agreeing on improvement actions and the e-learning usage frequency by the survey respondents.

E-Learning Usage Frequency Multiple Regression

The purpose of the analysis in this section is to identify a set of independent variables that all have a significant correlation with the usage frequency of the e-learning system for teaching math. Identifying those factors with significant correlation can help in better understanding the current state of e-learning system implementation. It can also help in crafting strategies to better support users of the e-learning system for teaching math.

From the separate assessment of each independent variable, there are four that have p value less than 0.05 based on from the separate linear regression with the usage frequency of the e-learning system for teaching math. These are the:

1) Grade 7 teaching-load,

2) Years of using an e-learning system,

3) Teachers' use of e-learning exercises application, and

4) The count of e-learning applications used by the teachers to teach.

These variables, separately, have a significant correlation with the total usage level of the e-learning system for teaching math based on the survey data.

Usage Frequency Multiple Regression of Selected Variables

Figure 86 shows the regression statistics between the four variables with significant correlation when assessing separately. The sample was 75 and above the required size of 76 for a 95% confidence level at +/-5% confidence interval.

The variable with the highest p value greater than 0.05 was removed, one by one, until all the remaining variables in the multiple regression have p values less than or equal to 0.05.

Dependent Variable:	F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math

Regression Statistics: Model 87 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (4 variables, n=77)

	R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
	0.226	0.183	0.824	0.912	77

Coefficient Estimates: Model 87 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (4 variables, n=77)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	-0.108	0.487	-0.222	0.825	-1.079
F08_8_Math_Grade_Level_Teaching_Load___aGrade_7	0.463	0.204	2.266	0.026	0.056
F40_20b_Years_of_Using_E_Learning_to_Teach_Math	0.293	0.104	2.817	0.006	0.086
F49_20e_E_Learning_Apps_Used_to_Teach_Math___iExercises	0.145	0.257	0.565	0.574	-0.368
F52_20e_E_Learning_Apps_Used_to_Teach_Math___Count__created	0.068	0.059	1.149	0.255	-0.050

Analysis of Variance: Model 87 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (4 variables, n=77)

Error Distribution Statistics: Model 87 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (4 variables, n=77)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=77)	0.000	0.797	0.587	-1.330	2.495

Figure 86. Usage Frequency of E-Learning versus Four Selected Variables Regression.

Figure 86 shows the regression statistics between the four selected variables and the e-learning usage frequency by the survey respondents. (RegressIt Excel add-in output)

Two of the variables, that have significant correlation individually with the usage frequency of e-learning by the math teachers, have p values above 0.05 from the multiple regression statistics with the selected group of variables. These are the:

1) Use of Exercises Application of E-Learning by the Teacher and

2) Count of E-Learning Applications used by the Teachers.

Figure 136 shows the regression statistics between the remaining two variables that have a significant correlation. The sample was 77 and above the required size of 76 for a 95% confidence level at +/-5% confidence interval.

The two variables that remained to have a significant correlation with the usage frequency of e-learning, based on the multiple regression statistics, are:

1) Grade 7 teaching-load, and

2) Years of using e-learning by the teacher.

Dependent Variable: F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math

Regression Statistics: Model 89 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (2 variables, n=77)

	R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
	0.201	0.179	0.826	0.912	77

Coefficient Estimates: Model 89 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (2 variables, n=77)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	0.268	0.351	0.765	0.447	-0.430
F08_8_Math_Grade_Level_Teaching_Load___aGrade_7	0.520	0.201	2.585	0.012	0.119
F40_20b_Years_of_Using_E_Learning_to_Teach_Math	0.346	0.098	3.523	0.001	0.150

Analysis of Variance: Model 89 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (2 variables, n=77)

Error Distribution Statistics: Model 89 for F00_20c_Frequency_of_Using_E_Learning_to_Teach_Math (2 variables, n=77)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=77)	0.000	0.810	0.586	-1.346	2.520

Figure 87. Usage Frequency of E-Learning versus Remaining Variables Regression.

Figure 87 shows the regression statistics between the remaining variables and the e-learning usage frequency by the survey respondents. (RegressIt Excel add-in output)

The regression data for the Grade 7 teaching-load suggests that the respondents who are teaching Grade 7 have indicated more frequent use of e-learning for teaching than those who do not teach Grade 7 students. The correlation may imply that the teachers adapt to the learning need of younger students by using e-learning technology.

The regression data for the years of use of e-learning suggests that the teachers who have been using e-learning longer also indicated a longer duration of using e-learning for teaching. The data imply that the teachers, who have been using e-learning longer, are more adept at using it for teaching math. The data suggest that motivating teachers to try using an e-learning system now may be beneficial later.

E-Learning Usage Duration Multiple Regression

The purpose of the analysis in this section is to identify a set of independent variables that all have a significant correlation with the usage duration of the e-learning system for teaching math. Identifying those factors with significant correlation can help in better understanding the current state of e-learning system implementation. It can also help in crafting strategies to better support users of the e-learning system for teaching math.

The survey question for this section was a follow-up question on the use of e-learning for teaching math. The question was “If YES, how long do you normally use it?” The four possible answers were:

a) up to 25% of the class duration for every math class section I teach,
b) more than 25% up to 50% of the class duration for every math class section I teach,
c) more than 50% up to 75% of the class duration for every math class section I teach, and
d) more than 75% up to 100% of the class duration for every math class section I teach.

This section applied the same method used for the Usage Frequency data analysis. There are six independent variables with p value of less than 0.05 from the separate linear regression with the usage duration of the e-learning system for teaching math. These are the:

1) First-time-to-use-computer,
2) Years of using an e-learning system,
3) Teacher’s use of e-learning lecture application,
4) Teacher’s use of e-learning e-book application,
5) Allowing tablets for the use of students in the class, and
6) Students required to use the reading materials application.

These variables, separately, have a significant correlation with the total usage level of the e-learning system for teaching math based on the survey data.

Usage Duration Multiple Regression of Selected Variables

Figure 88 shows the regression statistics between the usage duration of e-learning and six variables with significant correlation when assessed separately. The sample was 74 and above the required size of 70 for a 90% confidence level at +/-5% confidence interval, but below the required size of 76 for a 95% confidence level at the same confidence interval.

The variable with the highest p value greater than 0.05 was removed, one by one, until all the remaining variables in the multiple regression have p values less than or equal to 0.05.

Dependent Variable: V0_20d_Duration_of_Using_E_Learning_to_Teach_Math

Regression Statistics: Model 102 for V0_20d_Duration_of_Using_E_Learning_to_Teach_Math (6 variables, n=74)

	R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
	0.253	0.186	0.938	1.040	74

Coefficient Estimates: Model 102 for V0_20d_Duration_of_Using_E_Learning_to_Teach_Math (6 variables, n=74)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	-1.281	0.755	-1.697	0.094	-2.787
V032_13_First_Use_of_Computer	0.190	0.102	1.864	0.067	-0.014
V050_20b_Years_of_Using_E_Learning_to_Teach_Math	0.185	0.121	1.523	0.132	-0.057
V053_20e_E_Learning_Used_by_Teacher__cLectures	0.399	0.250	1.592	0.116	-0.101
V057_20e_E_Learning_Used_by_Teacher__ge_Books	0.319	0.539	0.591	0.556	-0.757
V066_21b_Devices_Allowed_in_Class___cTablet	0.226	0.256	0.883	0.380	-0.285
V076_21d_E_Learning_Used_by_Students___fReading_Materials	0.818	0.361	2.265	0.027	0.097

Analysis of Variance: Model 102 for V0_20d_Duration_of_Using_E_Learning_to_Teach_Math (6 variables, n=74)

Error Distribution Statistics: Model 102 for V0_20d_Duration_of_Using_E_Learning_to_Teach_Math (6 variables, n=74)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=74)	0.000	0.893	0.755	-1.423	1.991

Figure 88. Usage Duration of E-Learning versus Selected Variables Regression.

Figure 88 shows the regression statistics between the selected variables and the e-learning usage duration by the survey respondents. (RegressIt Excel add-in output)

Figure 89 shows the regression statistics between the usage duration of e-learning and the remaining three variables that have a significant correlation. The sample was 74 and above the required size of 70 for a 90% confidence level at +/-5% confidence interval, but below the required size of 76 for a 95% confidence level at the same confidence interval.

The three variables that have a significant correlation with the usage duration of e-learning, based on the multiple regression statistics, are:

1) First-time-to-use-computer,
2) Years of using e-learning by the teacher, and
3) Students required to use the reading materials application.

Dependent Variable: V0_20d_Duration_of_Using_E_Learning_to_Teach_Math

Regression Statistics: Model 105 for V0_20d_Duration_of_Using_E_Learning_to_Teach_Math (3 variables, n=74)

	R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
	0.210	0.177	0.944	1.040	74

Coefficient Estimates: Model 105 for V0_20d_Duration_of_Using_E_Learning_to_Teach_Math (3 variables, n=74)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	-0.433	0.581	-0.745	0.459	-1.592
V032_13_First_Use_of_Computer	0.243	0.099	2.470	0.016	0.047
V050_20b_Years_of_Using_E_Learning_to_Teach_Math	0.263	0.114	2.300	0.024	0.035
V076_21d_E_Learning_Used_by_Students___fReading_Materials	0.915	0.321	2.849	0.006	0.274

Analysis of Variance: Model 105 for V0_20d_Duration_of_Using_E_Learning_to_Teach_Math (3 variables, n=74)

Error Distribution Statistics: Model 105 for V0_20d_Duration_of_Using_E_Learning_to_Teach_Math (3 variables, n=74)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=74)	0.000	0.918	0.773	-1.421	2.263

Figure 89. Usage Duration of E-Learning versus Remaining Variables Regression.

Figure 89 shows the regression statistics between the remaining variables and the e-learning usage duration by the survey respondents. (RegressIt Excel add-in output)

The regression data for the first-time-to-use-computer suggests that the teachers who first use a computer at an earlier stage in life have indicated a longer duration of use of e-learning for teaching math. The correlation may be related to the teachers' developed skills of using technology early in life.

The regression data for the years of use of the e-learning system suggests that the teachers who have been using e-learning longer indicated the longer duration of using it for teaching. The data imply that the teachers, who have been using e-learning longer, are more adept at using it for teaching math.

The regression data for the use of e-learning application for reading materials suggests that the teachers who required their students to use the e-learning for reading materials have indicated a longer duration of using e-learning for teaching. The duration may be related to the time needed for reading the materials.

The data suggest the following:

1) motivating teachers to try using an e-learning system now will be beneficial later,
2) requiring students to use e-learning for reading course materials will encourage teachers to use the e-learning system longer, and

The data suggest that early expose of future teachers to education technology may make them more adept in using e-learning compared to those who had it later. Schools who are offering education courses should consider incorporating hands-on use of different education technologies in the course curriculum.

Total Usage Level of E-Learning

This section of the data analysis covers the correlation of different variables with the total usage level of e-learning by the math teachers. The total usage level of e-learning is the product of the usage frequency and duration. The e-learning usage frequency is the number of uses per week. The e-learning usage duration is the fractions of the class session with e-learning. The total usage level of e-learning is the number of equivalent full class sessions of using the e-learning system per week.

The purpose of the analysis in this section is to identify a set of independent variables that all have a significant correlation with the total usage level of the e-learning system for teaching math. Identifying those factors with significant correlation can help in better understanding the current state of e-learning system implementation. It can also help in crafting strategies to better support users of the e-learning system for teaching math.

This section applied the same method used for the Usage Frequency and the Usage Duration data analysis. There are four independent variables with p value of less than 0.05 from the separate linear regression with the total usage level of the e-learning system for teaching math. These are the:

1) Years of using an e-learning system,
2) Count of E-Learning Applications Used by the Teacher,
3) Allowing Tablets for Use in Math Class, and
4) Requiring Students to Use the Reading Materials Application of E-Learning.

These variables, separately, have a significant correlation with the total usage level of the e-learning system for teaching math based on the survey data.

Total Usage Level Multiple Regression of Selected Variables

Figure 90 shows the regression statistics between the total usage level of e-learning and four selected variables with significant correlation when assessed separately. The sample was 75 and above the required size of 70 for a 90% confidence level at +/-5%

confidence interval, but below the required size of 76 for a 95% confidence level at the same confidence interval.

The variable with the highest p value greater than 0.05 was removed, one by one, until all the remaining variables in the multiple regression have p values less than or equal to 0.05.

Dependent Variable: V0___Duration_x_Frequency_of_Using_E_Learning_to_Teach_Ma

Regression Statistics: Model 86 for V0___Duration_x_Frequency_of_Using_E_Learning_to_Teach_Math (4 variables, n=75)

	R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
	0.189	0.142	3.664	3.956	75

Coefficient Estimates: Model 86 for V0___Duration_x_Frequency_of_Using_E_Learning_to_Teach_Math (4 variables, n=75)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	-3.206	1.882	-1.703	0.093	-6.960
V050_20b_Years_of_Using_E_Learning_to_Teach_Math	1.089	0.474	2.297	0.025	0.143
V062_20e_E_Learning_Used_by_Teacher__Apps_Count	0.060	0.289	0.207	0.836	-0.516
V066_21b_Devices_Allowed_in_Class___cTablet	1.009	0.994	1.014	0.314	-0.974
V076_21d_E_Learning_Used_by_Students___fReading_Materials	2.905	1.438	2.021	0.047	0.037

Analysis of Variance: Model 86 for V0___Duration_x_Frequency_of_Using_E_Learning_to_Teach_Math (4 variables, n=75)

Error Distribution Statistics: Model 86 for V0___Duration_x_Frequency_of_Using_E_Learning_to_Teach_Math (4 variables, n=75)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=75)	0.000	3.540	2.557	-5.518	11.746

Figure 90. Total Usage of E-Learning versus Selected Variables Regression.

Figure 90 shows the regression statistics between the selected variables and the total usage level of e-learning by the survey respondents. (RegressIt Excel add-in output)

Figure 91 shows the regression statistics between the total usage level of e-learning and the remaining two variables that have a significant correlation. The sample was 75 and above the required size of 70 for a 90% confidence level at +/-5% confidence interval, but below the required size of 76 for a 95% confidence level at the same confidence interval.

The two variables that have a significant correlation with the usage duration of e-learning, based on the multiple regression statistics, are:

1) Years of using e-learning by the teacher and

2) Requiring students to use the reading materials application of e-learning.

Dependent Variable: V0___Duration_x_Frequency_of_Using_E_Learning_to_Teach_Ma

Regression Statistics: Model 88 for V0___Duration_x_Frequency_of_Using_E_Learning_to_Teach_Math (2 variables, n=75)

	R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
	0.175	0.152	3.643	3.956	75

Coefficient Estimates: Model 88 for V0___Duration_x_Frequency_of_Using_E_Learning_to_Teach_Math (2 variables, n=75)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	-2.392	1.713	-1.396	0.167	-5.807
V050_20b_Years_of_Using_E_Learning_to_Teach_Math	1.243	0.440	2.828	0.006	0.367
V076_21d_E_Learning_Used_by_Students___fReading_Materials	3.291	1.238	2.659	0.010	0.823

Analysis of Variance: Model 88 for V0___Duration_x_Frequency_of_Using_E_Learning_to_Teach_Math (2 variables, n=75)

Error Distribution Statistics: Model 88 for V0___Duration_x_Frequency_of_Using_E_Learning_to_Teach_Math (2 variables, n=75)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=75)	0.000	3.570	2.582	-5.162	12.615

Figure 91. Total Usage of E-Learning versus Remaining Variables Regression.

Figure 91 shows the regression statistics between the remaining variables and the e-learning usage duration by the survey respondents. (RegressIt Excel add-in output)

The regression data for the years of use of e-learning system suggests that the teachers, who have been using e-learning longer, have a higher total usage level of e-learning for teaching their math classes than those with shorter years of experience in using it. The data imply that the teachers, who have been using e-learning longer, are more adept at using it for teaching math.

The regression data on requiring the use of e-learning application for reading materials suggests that the teachers, who required their students to use the e-learning for reading materials, have a higher total usage duration of the e-learning for teaching math. The duration may be related to the time needed for reading the materials. The data suggest that 1) by motivating teachers to try using an e-learning system now will be beneficial later, and 2) by requiring students to use e-learning for reading course materials will encourage teachers to use the e-learning system longer.

Impact of E-Learning

This section covers the impact assessment of the use of e-learning on the students. The survey respondents, who are using e-learning to teach math, were asked five questions about the impact of the use of e-learning on their students.

The first question on the impact was, "What was the general change that you observed on the attention of your math students when you were using versus when you were not using e-learning tools and materials in the same class?" The available answers for this question were: a) Significant Increase, b) Slight Increase, c) No Change, d) Slight Decrease, and e) Significant Decrease

The second question was "What was the general change that you observed on the participation of your math students when you were using versus when you were not using e-learning tools and materials in the same class?" The available answers for this question were: a) Significant Increase, b) Slight Increase, c) No Change, d) Slight Decrease, and e) Significant Decrease

The third question was "What was the general trend of the scores in quizzes and exams of your math students during the school year that you observed after using e-learning in the same class?" The available answers for this question were: a) Significantly Increasing, b) Slightly Increasing, c) No Trend, d) Slightly Decreasing, and e) Significantly Decreasing

The fourth question was "What was the general trend of the overall grades of your math students during the school year that you observed after using e-learning in the same class?" The available answers for this question were: a) Significantly Increasing, b) Slightly Increasing, c) No Trend, d) Slightly Decreasing, and e) Significantly Decreasing

The fifth question was “What was the general trend of the overall math scores of your math classes in the National Achievement Test that you observed after using e-learning in the same class?” The available answers for this question were: a) Significantly Increasing, b) Slightly Increasing, c) No Trend, d) Slightly Decreasing, e) Significantly Decreasing, and f) Not Applicable or No Data

Observed Impact of E-Learning on Students’ Attention

Figure 92 shows the general change that was observed on the attention of the math students when the teacher was using versus when the teacher was not using e-learning tools and materials in the same class. About 85% of the teachers observed an increase in the attention of their students. The sample size was 81, and it was above the required size of 76 for a 95% confidence level at +/-5% confidence interval.

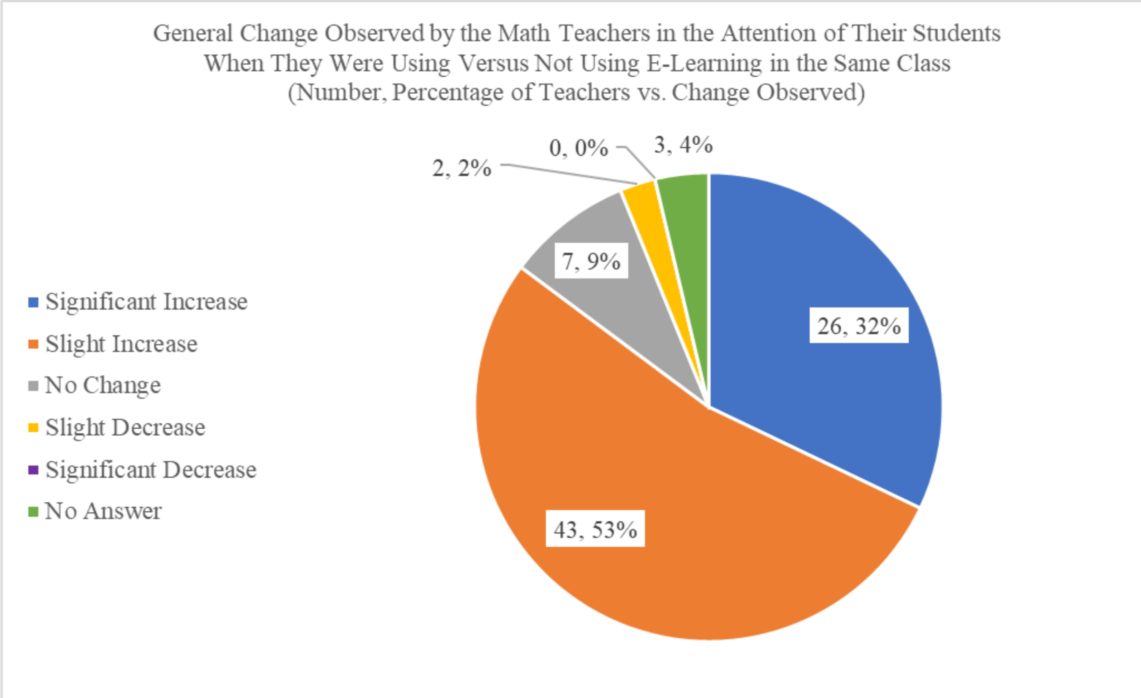

Figure 92. Observed Impact of E-Learning on Students' Attention.

Figure 92 shows the general change that was observed on the attention of the math students when the teacher was using versus when the teacher was not using e-learning tools and materials in the same class according to the e-learning users among the survey respondents.

Observed Impact of E-Learning on Students' Participation

Figure 93 shows the general change that was observed on the attention of the math students when the teacher was using versus when the teacher was not using e-learning tools and materials in the same class. About 85% of the teachers observed an increase in the attention of their students. The sample size was 81.

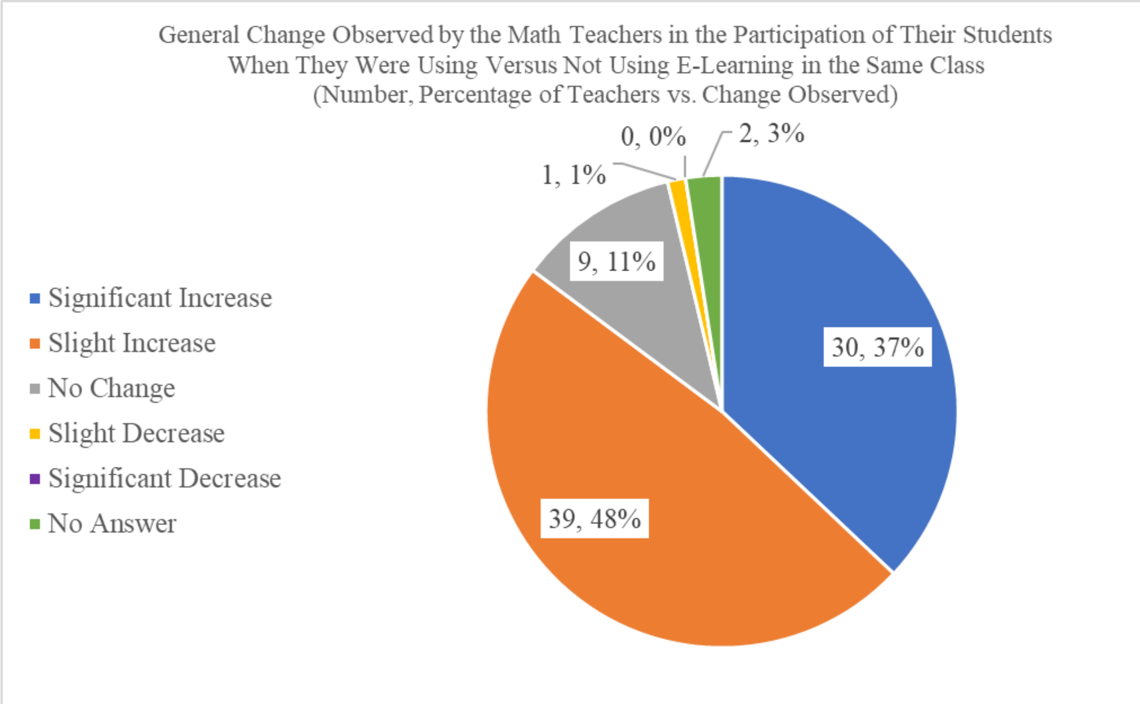

Figure 93. Observed Impact of E-Learning on Students' Participation.

Figure 93 shows the general change that was observed on the participation of the math students when the teacher was using versus when the teacher was not using e-learning tools and materials in the same class according to the e-learning users among the survey respondents.

Observed Impact of E-Learning on the Trend of Students' Scores in Math Quizzes and Exams

Figure 94 shows the general trend of the scores in quizzes and exams of the math students during the school year that the teachers observed after using e-learning in the same class. About 77% of the teachers observed an increasing trend of the scores in the quizzes and exam of their students. The sample size was 81.

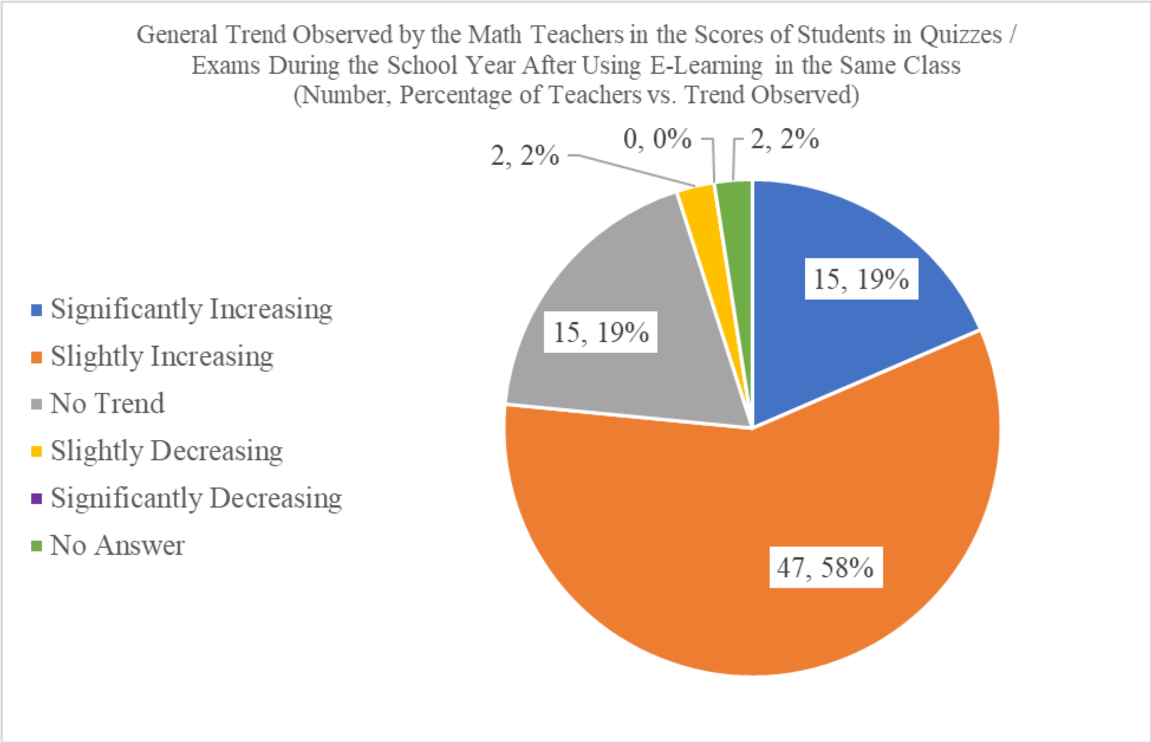

Figure 94. Observed Impact of E-Learning on the Trend of Students' Scores in Math Quizzes and Exams.

Figure 94 shows the general trend of the scores in quizzes and exams of the math students during the school year that the teachers observed after using e-learning in the same class according to the e-learning users among the survey respondents.

Observed Impact of E-Learning on the Trend of Students' Overall Math Grade

Figure 95 shows the general trend of the overall grades of the math students during the school year that the teachers observed after using e-learning in the same class. About 78% of the teachers observed an increasing trend of the overall grades of their students. The sample size was 81.

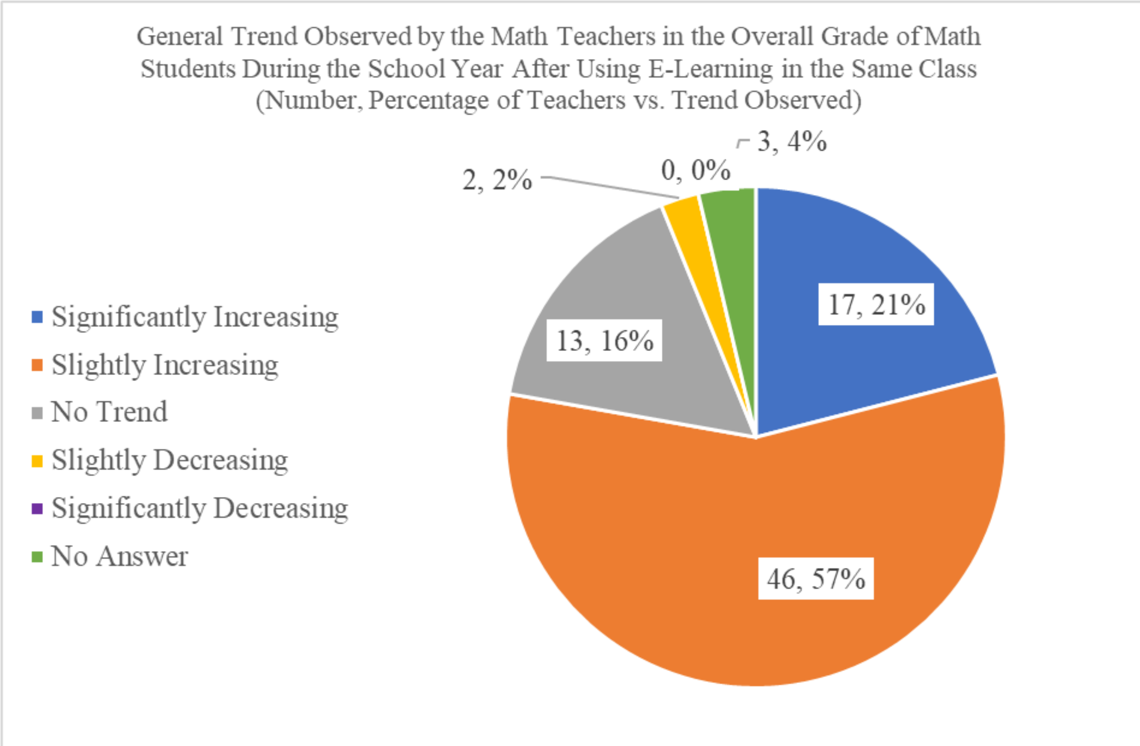

Figure 95. Observed Impact of E-Learning on the Trend of Students' Overall Math Grade.

Figure 95 shows the general trend of the overall grades of the math students during the school year that the teachers observed after using e-learning in the same class according to the e-learning users among the survey respondents.

Observed Impact of E-Learning on the Trend of Students' N.A.T. Math Score

Figure 96 shows the general trend of the overall math scores of math classes in the National Achievement Test (NAT) that the teachers observed after using e-learning in the same class. About 55% of the teachers observed an increasing trend of the overall math scores in the NAT of their math classes. The sample size was 81.

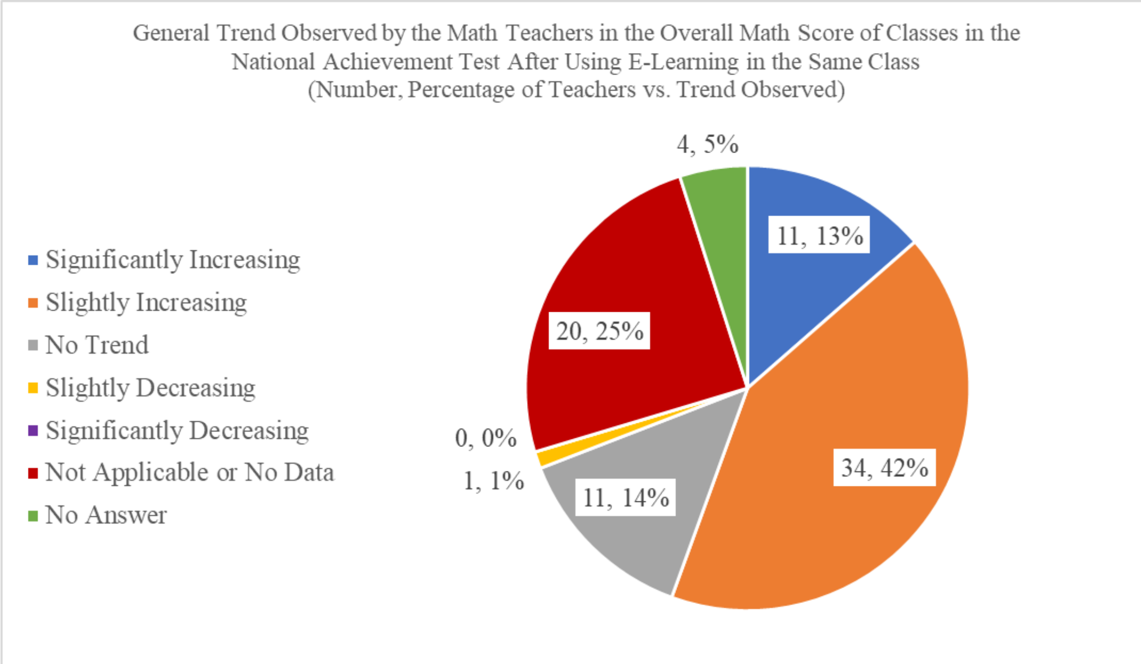

Figure 96. Observed Impact of E-Learning on the Trend of Students' N.A.T. Math Score.

Figure 96 shows the general trend of the overall scores in math in the National Achievement Test (NAT) that the teachers observed after using e-learning in the same class according to the e-learning users among the survey respondents.

Correlation Among the Types of Impact of E-Learning on the Students

Figure 97 to Figure 99 show the regression statistics among the five types of impact of e-learning on the students. The figures show a significant correlation between the students' attention and their score in math quizzes and exam. However, there is no significant correlation between the student' participation and their score in math quizzes and exams. The figures also show that there is a significant correlation between the students' overall math grade and the students' attention, participation, and scores in math quizzes and exam. However, there is no correlation between the students' National Achievement Test math score and their attention, participation, scores in math quizzes and exam, and their overall math grade. The sample sizes were 78, 77, and 75 respectively. Further studies are needed to understand the causal relationship between the usage of e-learning and the impact on the students' behaviors and performances.

Dependent Variable: M03_Trend_in_Students__Scores_in_Math_Quizzes___Exams

Regression Statistics: Model 27 for M03_Trend_in_Students__Scores_in_Math_Quizzes___Exams (2 variables, n=78)

	R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
	0.377	0.361	0.552	0.690	78

Coefficient Estimates: Model 27 for M03_Trend_in_Students__Scores_in_Math_Quizzes___Exams (2 variables, n=78)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	1.401	0.408	3.432	0.001	0.588
M01_Change_in_Students__Attention_in_Math_Class	0.596	0.133	4.478	0.000	0.331
M02_Change_in_Students__Participation_in_Math_Class	0.008190	0.133	0.062	0.951	-0.256

Analysis of Variance: Model 27 for M03_Trend_in_Students__Scores_in_Math_Quizzes___Exams (2 variables, n=78)

Error Distribution Statistics: Model 27 for M03_Trend_in_Students__Scores_in_Math_Quizzes___Exams (2 variables, n=78)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=78)	0.000	0.541	0.436	-1.827	1.390

Figure 97. Impact on the Scores in Math Quizzes and Exams versus the Impact on Attention and Participation

Figure 97 shows the regression statistics between the impact of e-learning on the scores in math quizzes and exams and the impact on students' attention and participation. (RegressIt Excel add-in output)

Dependent Variable: M04_Trend_in_Students__Overall_Grade_in_Math

Regression Statistics: Model 28 for M04_Trend_in_Students__Overall_Grade_in_Math (3 variables, n=77)

	R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
	0.720	0.708	0.382	0.707	77

Coefficient Estimates: Model 28 for M04_Trend_in_Students__Overall_Grade_in_Math (3 variables, n=77)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	0.621	0.304	2.039	0.045	0.014
M01_Change_in_Students__Attention_in_Math_Class	0.289	0.104	2.780	0.007	0.082
M02_Change_in_Students__Participation_in_Math_Class	-0.186	0.092	-2.023	0.047	-0.369
M03_Trend_in_Students__Scores_in_Math_Quizzes___Exams	0.752	0.080	9.398	0.000	0.592

Analysis of Variance: Model 28 for M04_Trend_in_Students__Overall_Grade_in_Math (3 variables, n=77)

Error Distribution Statistics: Model 28 for M04_Trend_in_Students__Overall_Grade_in_Math (3 variables, n=77)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=77)	0.000	0.372	0.222	-1.893	1.147

Figure 98. Impact on the Overall Math Grade versus Impact on Attention, Participation, and Scores in Math Quizzes and Exams

Figure 98 shows the regression statistics between the impact of e-learning on the Overall Math Grade and the impact on Attention, Participation, and Scores in Math Quizzes and Exam. (RegressIt Excel add-in output)

Dependent Variable:	M05_Trend_in_Students__Score_in_Math_Subject_of_NAT

Regression Statistics: Model 29 for M05_Trend_in_Students__Score_in_Math_Subject_of_NAT (4 variables, n=75)

	R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
	0.079	0.026	1.810	1.834	75

Coefficient Estimates: Model 29 for M05_Trend_in_Students__Score_in_Math_Subject_of_NAT (4 variables, n=75)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	1.281	1.484	0.863	0.391	-1.678
M01_Change_in_Students__Attention_in_Math_Class	-0.714	0.517	-1.380	0.172	-1.745
M02_Change_in_Students__Participation_in_Math_Class	0.189	0.448	0.423	0.673	-0.703
M03_Trend_in_Students__Scores_in_Math_Quizzes___Exams	0.315	0.564	0.559	0.578	-0.810
M04_Trend_in_Students__Overall_Grade_in_Math	0.658	0.554	1.186	0.239	-0.448

Analysis of Variance: Model 29 for M05_Trend_in_Students__Score_in_Math_Subject_of_NAT (4 variables, n=75)

Error Distribution Statistics: Model 29 for M05_Trend_in_Students__Score_in_Math_Subject_of_NAT (4 variables, n=75)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=75)	0.000	1.748	1.469	-3.733	2.448

Figure 99. Impact on National Achievement Test Math Score versus Other Impact Variables

Figure 99 shows the regression statistics between the impact of e-learning on the National Achievement Test Math Score and the other impact variables. (RegressIt Excel add-in output)

Correlation of Usage Level of E-Learning and Students' Attention and Participation

Figure 100 and Figure 101 show the regression statistics between the total teachers' usage level of e-learning and the students' attention and participation. The figures show a significant correlation between the total usage level of e-learning and the students' participation. However, there is no significant correlation between the total usage level of e-learning and the students' attention. The sample sizes were 74 and 75 respectively.

It may be possible that the current novelty of an e-learning system and the digital learning materials are influencing the changes in the students' behaviors and performances. Further studies are needed to understand the causal relationship between the usage of e-learning and the impact on the students' behaviors and performances.

Further study may be needed to measure and predict the magnitude and sustainability of these effects.

Dependent Variable: M01_Change_in_Students__Attention_in_Math_Class

Regression Statistics: Model 6 for M01_Change_in_Students__Attention_in_Math_Class (1 variable, n=74)

R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
0.012	-0.002	0.708	0.707	74

Adj. R-sqr. is negative because the standard error of the regression is greater than the standard deviation of the dependent variable.

Coefficient Estimates: Model 6 for M01_Change_in_Students__Attention_in_Math_Class (1 variable, n=74)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	4.140	0.115	35.895	0.000	3.910
M06_20e_Total_Usage_Level_of_E_Learning_to_Teach_Math	0.020	0.021	0.941	0.350	-0.022

Analysis of Variance: Model 6 for M01_Change_in_Students__Attention_in_Math_Class (1 variable, n=74)

Error Distribution Statistics: Model 6 for M01_Change_in_Students__Attention_in_Math_Class (1 variable, n=74)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=74)	0.000	0.698	0.530	-2.453	0.840

Figure 100. The impact of the use of E-Learning on Students' Attention versus the Total Usage Level of E-Learning

Figure 100 shows the regression statistics between the impact of e-learning on the students' attention and the total usage level of e-learning. (RegressIt Excel add-in output)

Dependent Variable: M02_Change_in_Students__Participation_in_Math_Class

Regression Statistics: Model 7 for M02_Change_in_Students__Participation_in_Math_Class (1 variable, n=75)

R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Fitted
0.083	0.070	0.655	0.680	75

Coefficient Estimates: Model 7 for M02_Change_in_Students__Participation_in_Math_Class (1 variable, n=75)

Variable	Coefficient	Std.Err.	t-statistic	P-value	Lower95%
Constant	4.063	0.106	38.338	0.000	3.851
M06_20e_Total_Usage_Level_of_E_Learning_to_Teach_Math	0.049	0.019	2.570	0.012	0.011

Analysis of Variance: Model 7 for M02_Change_in_Students__Participation_in_Math_Class (1 variable, n=75)

Error Distribution Statistics: Model 7 for M02_Change_in_Students__Participation_in_Math_Class (1 variable, n=75)

	Mean Error	RMSE	MAE	Minimum	Maximum
Fitted (n=75)	0.000	0.647	0.493	-2.112	0.888

Figure 101. The impact of the use of E-Learning on Students' Participation versus the Total Usage Level of E-Learning

Figure 101 shows the regression statistics between the impact of e-learning on the students' participation and the total usage level of e-learning. (RegressIt Excel add-in output)

Teachers' Comments

Some of the survey questions asked for the respondent's additional comments and feedback. These include the following:

1) Do you use an E-Learning System to teach math? If NO, please share the reasons why.
2) Do you have any suggestions on how to increase the usage or improve your e-learning system?
3) Is there anything else that you can share about the impact of e-learning on your math students?
4) Is there anything else that you can share about the impact of e-learning on you as a math teacher?

The answers to each of these questions are listed in Appendix 1 to 4 respectively.

Teachers' Reasons for Not Using E-Learning to Teach Math

Twenty-seven teachers among the 36 non-users shared their reasons for not using e-learning for teaching math. The reasons were grouped into a) Internet Access, b) E-Learning System and Tools, c) Devices, Computers, Equipment, and d) Learning Materials and resources. Figure 102 shows the number of teachers who gave the same reason for each group. The major issue is still the lack of internet access. The complete list of answers is in Appendix 1.

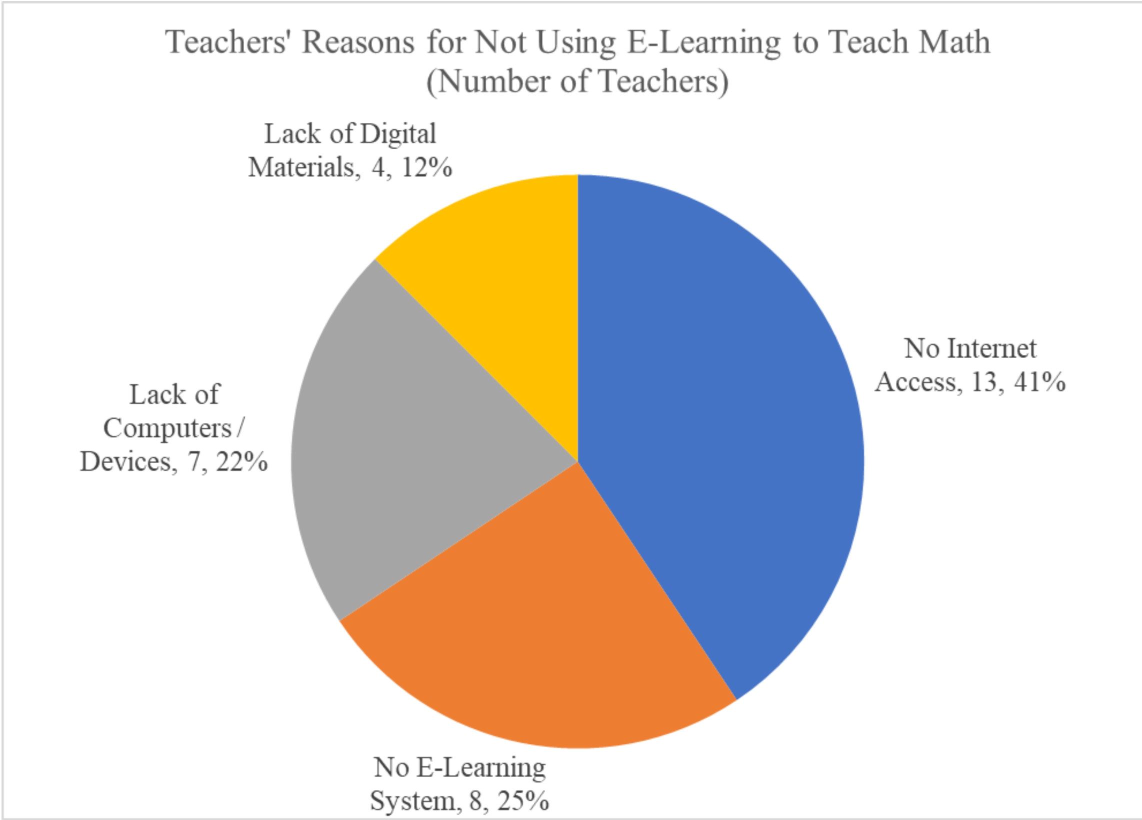

Figure 102. Teachers' Reasons for Not Using E-Learning to Teach Math

Figure 102 shows the number of teachers with the same reason for not using e-learning to teach math according to the survey respondents.

Teachers' Suggestions on How to Improve the School E-Learning

Fifty-two teachers shared their comments on the opportunity areas for improving their current e-learning. The improvement suggestion groupings were a) Internet Access, b) E-Learning System and Tools, c) Devices, Computers, Equipment, d) Learning Materials and resources, e) Training, f) Support and g) Leadership. Figure 103 shows the number of teachers who gave improvement suggestions in the same opportunity area. The top three opportunity areas for improvement of the current e-learning are internet access, teacher training, and computer availability. The complete list of answers is in Appendix 2.

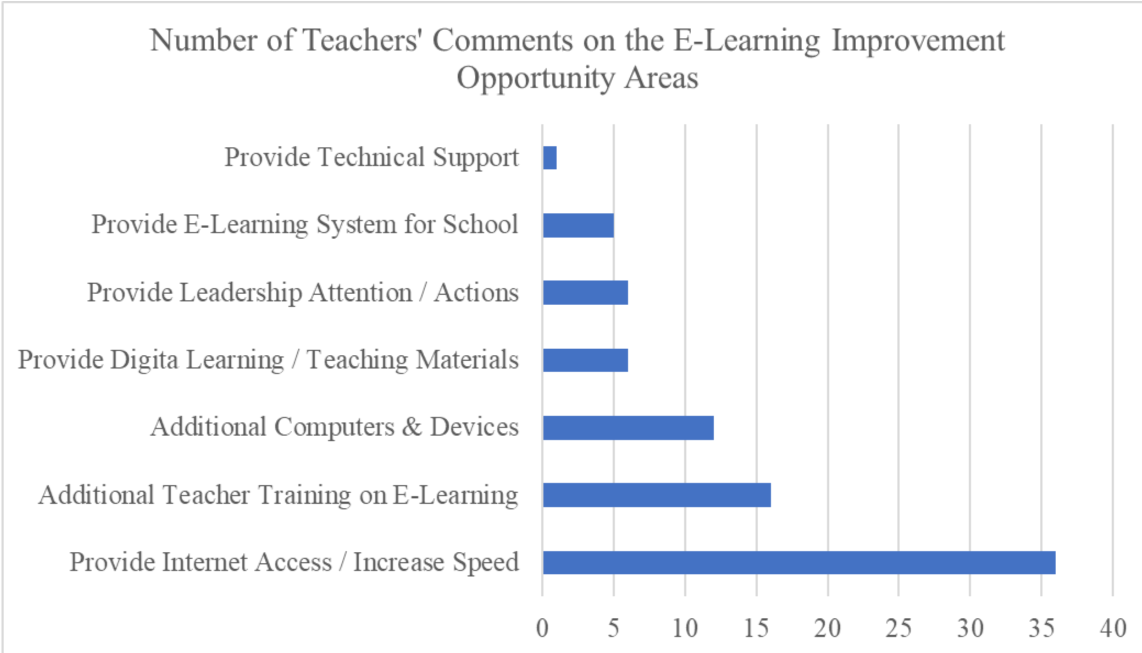

Figure 103. Suggestions Count on How to Increase Usage and Improve the E-Learning.

Figure 103 shows the count of suggestions on the different improvement opportunity areas on how to increase usage and improve the e-learning according to the survey respondents.

Teachers' Comments on the Impact of the use of E-Learning on Their Students

Thirty teachers shared their comments on the impact of the use of e-learning on their students. Twenty-two teachers gave a positive comment on the impact of e-learning on their students. The complete list of answers is in Appendix 3.

Teachers' Comments on the Impact of the use of E-Learning on them as Teacher

Twenty-eight teachers shared their comments on the impact of the use of e-learning on them as a teacher. Eighteen teachers shared the positive impact of e-learning on them as a teacher. The complete list of answers is in Appendix 4.

Probing the Internet Access Issue

The lack of internet access and the slow connection speed are challenges that were highlighted by the respondents of the survey. However, the regression statistics do not show a significant correlation of these variables with the use of e-learning.

Figures 104 and 105 show how the users and non-users of e-learning use internet in the classroom. Figures 106 to 109 show the users and non-users of e-learning and their views regarding the schools' provision of internet access and the speed of the internet connection.

Only one-fourth of the e-learning users access the internet in the classroom for using e-learning to teach. One-fifth of these teachers indicated that the school provides internet access and about one-sixth indicated that the internet speed provided by the school is sufficient. Three-fourths of the users of e-learning use it even if there is no internet access in their classroom. For these teachers, the lack of internet access in the classroom is not a blocker.

Among the non-users of e-learning, only about one-tenth use the internet in the classroom. Eighty-eight percent of them indicated that their schools do not provide access to the internet and ninety-seven percent of them indicated that the speed of internet access available in the school is not sufficient.

The non-users of e-learning highlighted the lack of internet and the slow speed of connection as a significant challenge that they face. On the other hand, three fourths or more of the e-learning users continue to use the e-learning even if there is no internet access in the classroom or the speed of connection provided by the school is insufficient.

These observations may be the reasons behind the lack of correlation of the internet access variables and the use of e-learning.

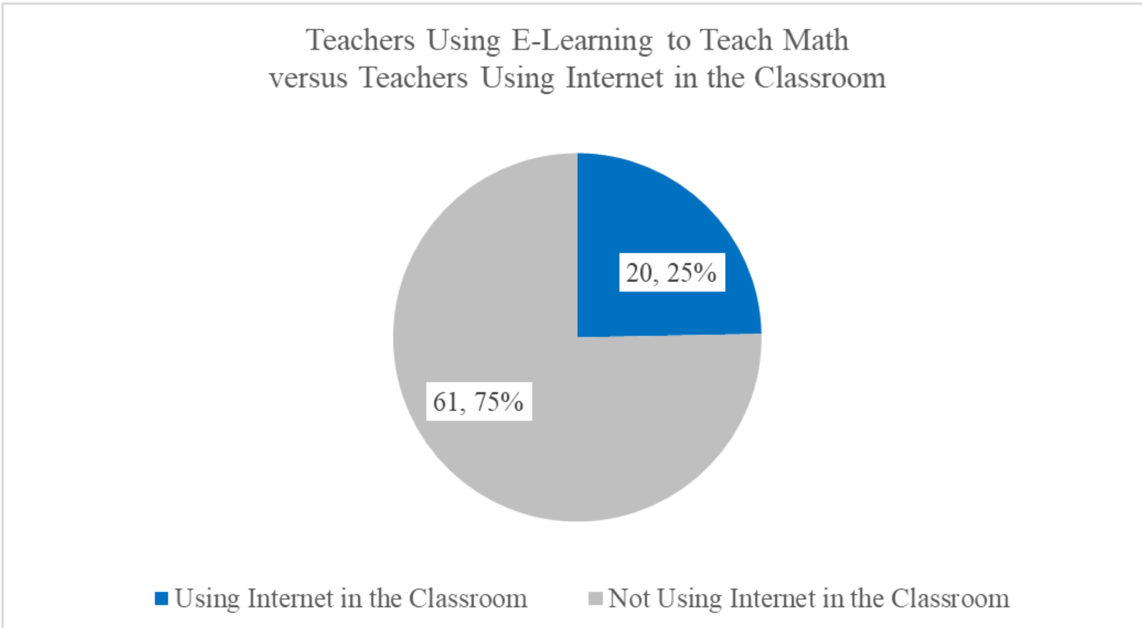

Figure 104. E-Learning Users vs. Use of Internet in the Classroom.

Figure 104 shows the users of e-learning who are using and not-using the internet in the classrooms.

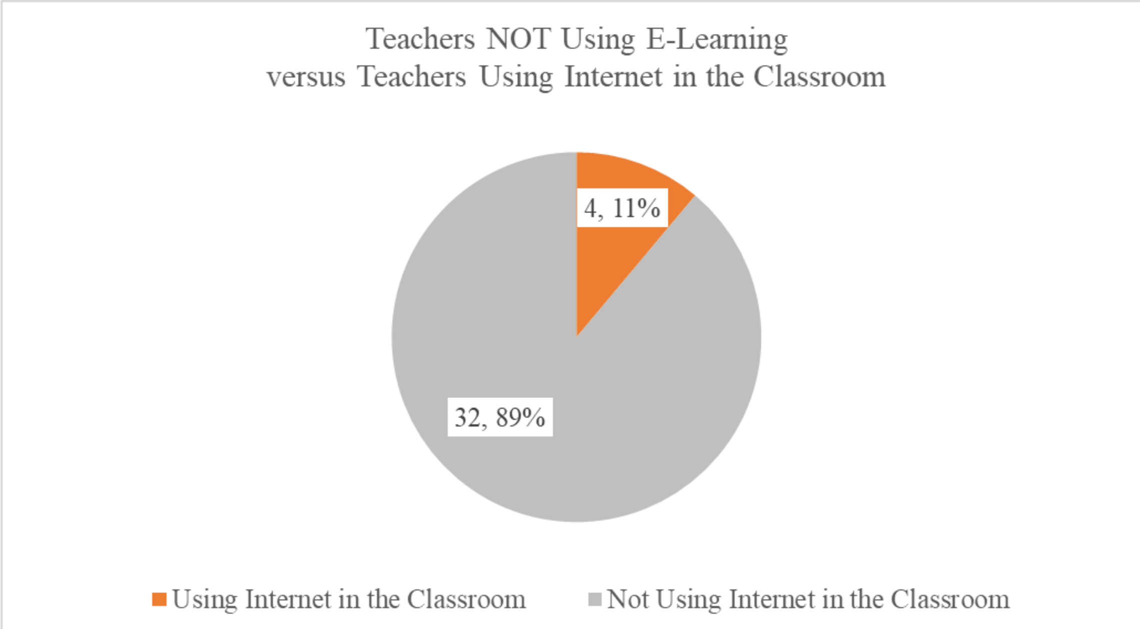

Figure 105. Non-Users of E-Learning vs. Use of Intent in the Classroom.

Figure 105 shows the non-users of e-learning who are using and not-using the internet in the classrooms.

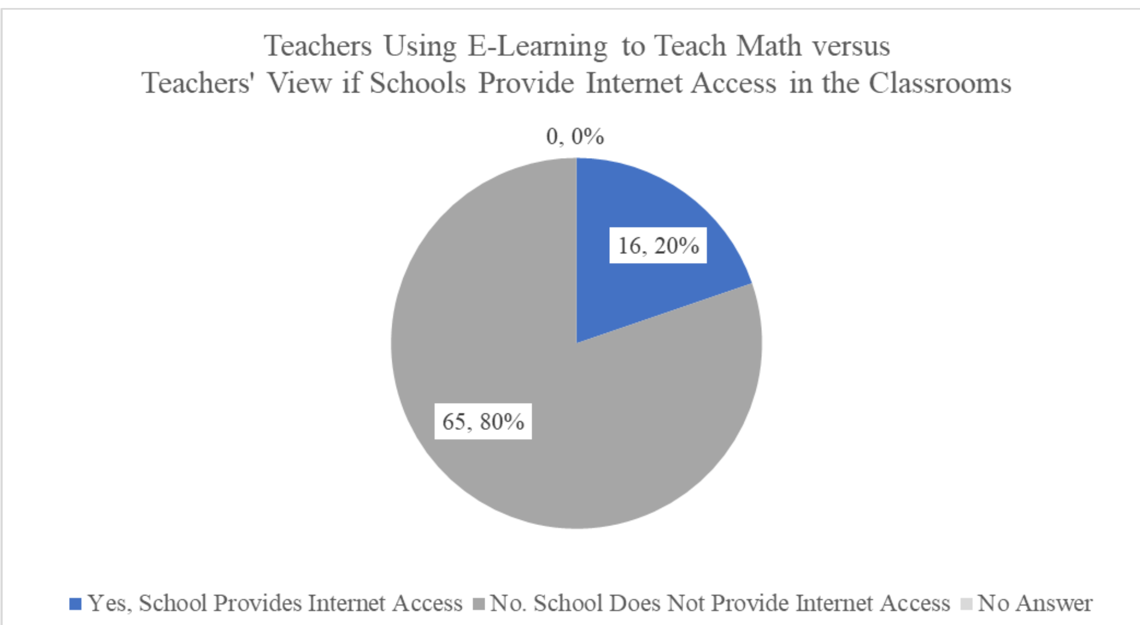

Figure 106. E-Learning Users vs. Provision of Internet Access in the Classrooms

Figure 106 shows the users of e-learning and their views about the school's provision of internet access in the classroom.

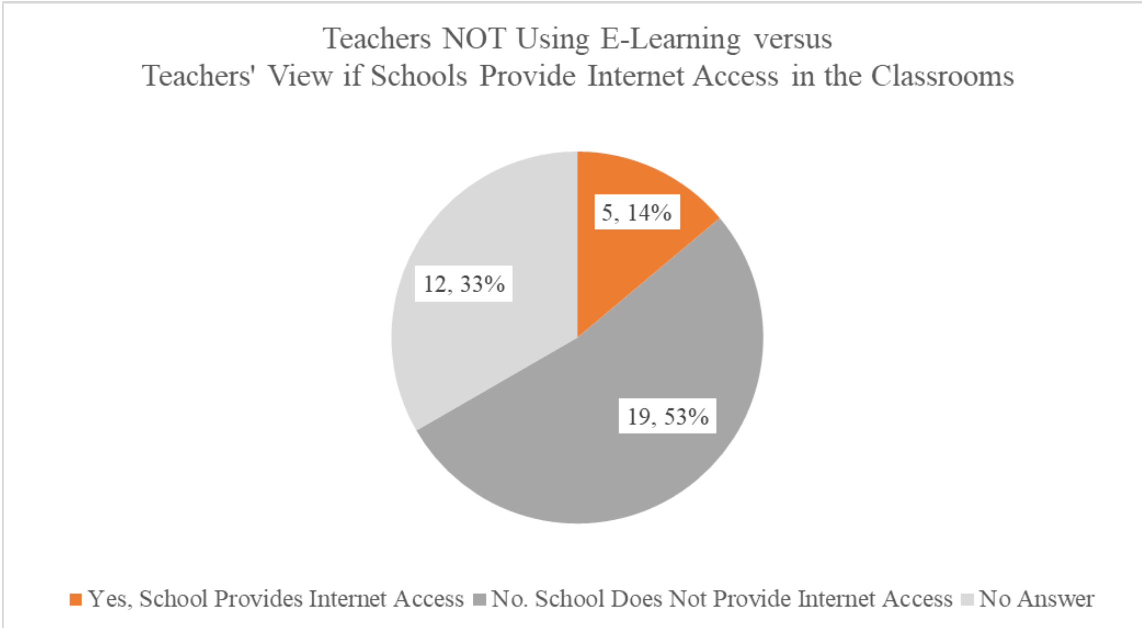

Figure 107. Non-Users of E-Learning vs. Provision of Internet Access in the Classrooms.

Figure 107 shows the non-users of e-learning and their views about the school's provision of internet access in the classroom.

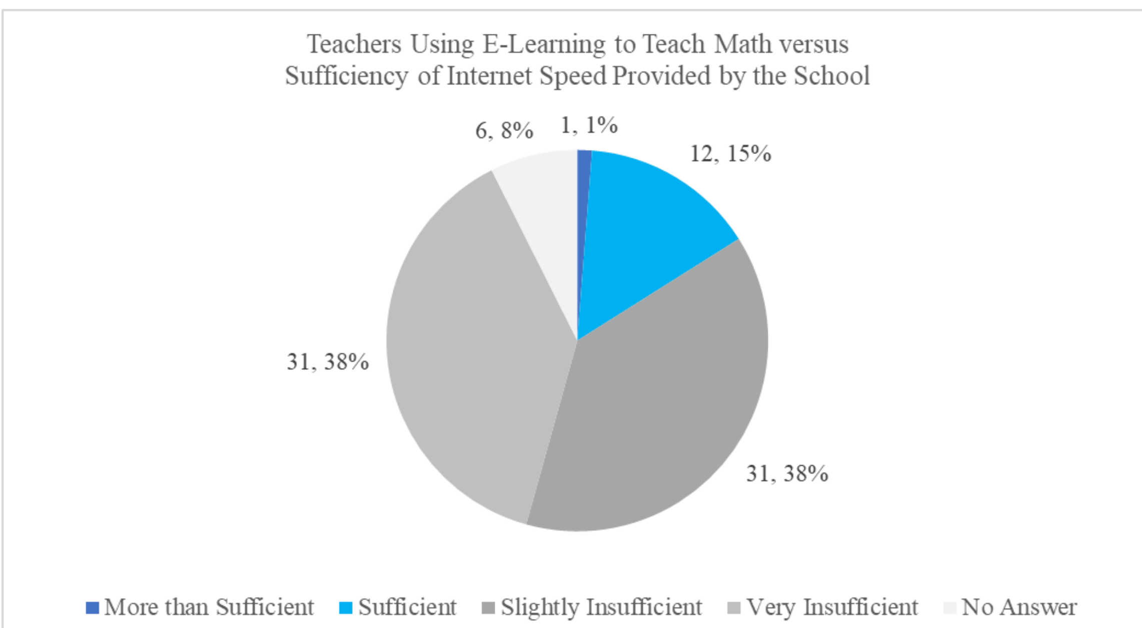

Figure 108. E-Learning Users vs. Speed of Internet Provided by the School.

Figure 108 shows the users of e-learning and their views about the speed of the internet provided by the school.

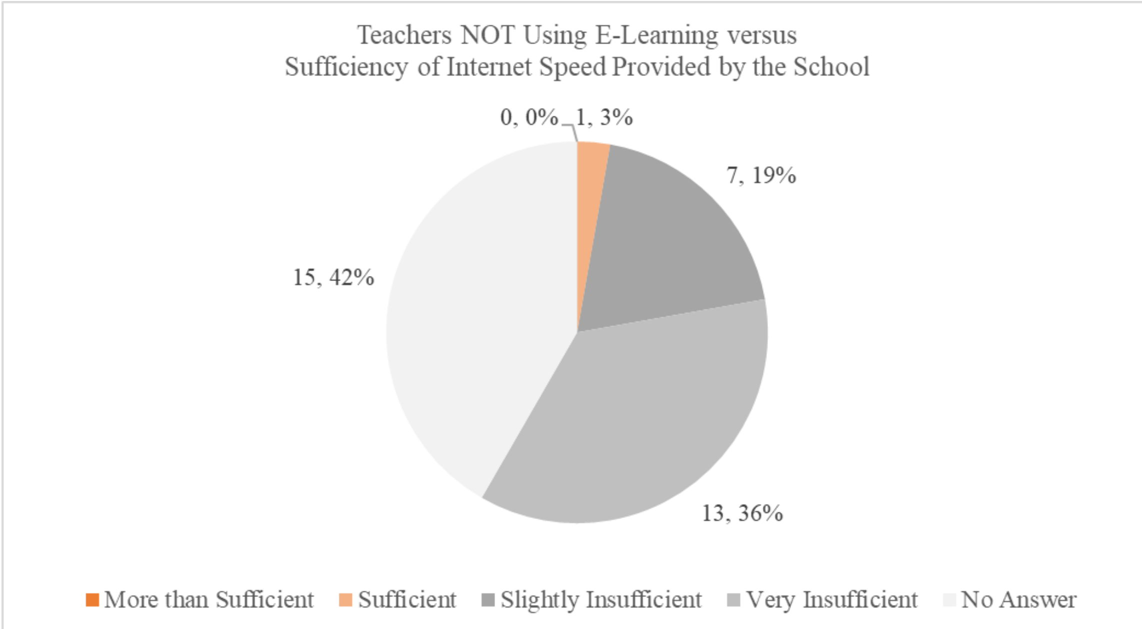

Figure 109. Non-Users of E-Learning vs. Speed of Internet Provided by the School.

Figure 109 shows the non-users of e-learning and their views about the speed of the internet provided by the school.

Chapter IV.

Summary

The thesis study focused on factors influencing the teachers' use of e-learning to teach math. One of the principal objectives of the study was to identify those variables that have a significant correlation with the use of e-learning. Results from this study can be the basis for recommendations that can help the schools in implementing and using e-learning. For this study, the definition of e-learning is the uses of computer-network-based technologies and digital learning materials for teaching and learning.

The study reviewed prior research on the factors that influence the use of e-learning and the impact of e-learning on the students. It considered the factors identified in the prior research in selecting the variables to investigate.

The study was limited to the population of math teachers in public secondary schools in Makati City, Philippines. The selected population is in a location that has the highest per capita income in the country and where the local government allocates the highest financial resources per student to support education. The study received 126 survey returns, from a population of 145 teachers.

The study has four stages; the first was on the use or non-use of e-learning, the second was on the level of usage of e-learning, the third was on the impact of e-learning, and the fourth was on the challenges the prevents the use of e-learning. The study on the usage level has three parts: 1) usage frequency, 2) usage duration, and 3) the total usage level. The study of the impact of e-learning covers five aspects: 1) the students' attention, 2) participation, 3) scores in math quizzes, 4) overall math grades, and 5) math scores on the standardized National Achievement Test.

The study investigated the correlation of selected demographic and psychographic variables that may influence the use of e-learning by the math teachers. The study also assessed the correlation of selected change management components that may have affected the use of e-learning. It also evaluated the impact of e-learning on the students based on the assessment of the teachers using e-learning to teach math.

Factors with no Significant Correlation

The study found a total of nineteen variables that have no significant correlation with the use of e-learning.

The demographic and psychographic variables are: 1) age, 2) educational attainment, 3) years of teaching math, 4) time of first use of computer game, 5) time of first use of internet game, 6) use of a computer as a student, 7) prior exposure as a student to a teacher using a computer to teach, 8) class size teaching load, 9) number of classes teaching load, 10) the connecting to the internet during classes, and 11) requiring students to use e-learning.

The variables related to change management are:1) providing TV or projector in the classrooms, 2) providing computers and tablets in the classrooms, 3) providing internet access in the classrooms, 4) providing sufficient internet speed, 5) providing technical support and manuals, 6) monitoring and reporting of e-learning usage, 7) third-party review of e-learning system, and 8) discussion and agreement on improvement action items.

It is surprising that some of the variables have no significant correlation with the use of e-learning. These include the a) teacher’s use of internet in the classroom, or b) providing computers and tables for use in the classroom or c) providing sufficient internet access in the classroom. It might be possible that there are other factors the discourage the use of e-learning. Further studies are needed to understand the reasons behind the lack of correlation of these variables with the use of e-learning.

Factors with Significant Correlation when Assessed Individually

The study also found nineteen variables that have a significant correlation with the use of e-learning when assessed individually.

The demographic and psychographic variables are: 1) gender, 2) Grade 7 teaching load, 3) Grade 10 teaching load, 4) Statistics subject teaching load, 5) Geometry subject teaching load, educational attainment, 6) time of first use of computer, 7) use of computer for teaching, 8) years of using e-learning, 9) teacher's use of exercises application, 10) teacher's use of lecture application, 11) teacher's use of e-books application, 12) allowing the students to use tablets in the classroom, 13) the count of e-learning applications used by the teachers, and 14) requiring the students to use the reading materials application of e-learning.

The variables related to change management are: 1) the familiarity of teachers with the school head's overall e-learning plan, 2) the school head's promotion of the use of e-learning, 3) providing an e-learning system to use in school, 4) providing digital teaching materials to use, and 5) providing sufficient e-learning training for teachers.

Some of these variables have a significant correlation with the use or non-use of e-learning (the adoption stage) while others have a significant correlation with the usage level (frequency and duration).

Factors with Significant Correlation when Assessed in a Group

The study found eight variables that have a significant correlation with the use of e-learning when assessed in a group. Four variables have a significant correlation as a group with the use or non-use of e-learning. These are 1) the gender of the teacher, 2) Geometry subject teaching load, 3) the teacher's use of the computer when teaching, and 4) familiarity of the teacher to the school head's overall e-learning plan. Four other variables have a significant correlation as a group with the e-learning usage level. These are 1) Grade 7 teaching load, 2) time of first use of a computer, 3) years of using e-learning, and 4) requiring students to use the reading materials e-learning application.

Focusing on these eight variables and understanding how these relate to the use of e-learning will help to implement and effectively use the e-learning system efficiently.

Impact of E-Learning

Based on the assessments of e-learning users among the math teacher surveyed, the use of e-learning has an observable positive impact on their math students. A total of 85% of the teachers observed an increase in the attention of their math students. The same percentage of teachers observed an increase in participation. A total of 77% of the teachers observed an increasing trend of the students' scores in quizzes and exams. A total of 78% of the teachers observed an increasing trend of the students' overall grades. Finally, a total of 55% of the teachers also observed an increasing trend of the overall students' scores on the math subject in the standardized National Achievement Test.

Thirty teachers shared some comments on the impact of e-learning on students. Twenty-two of them, or more than two-thirds, shared positive impact on students.

Similarly, twenty-eight teachers shared some comments on the impact of the use of e-learning on them as teachers. Eighteen of them, or almost two-thirds, also shared positive impact.

Blockers and Opportunity Areas for Improvement

Twenty-seven teachers shared their reasons for not using e-learning for teaching math. The identified four blockers are 1) the lack of internet access or slow internet connection, 2) the lack of an e-learning system, 3) the lack of computers or devices to use, and 4) the lack of digital teaching materials to use.

Fifty-two teachers shared their suggestions on how to improve their current e-learning. The top three opportunity areas for improvements are the 1) internet access, 2) e-learning training for teachers, and 3) availability of computers and devices.

Even though the teachers highlighted internet access as the primary challenge on the use of e-learning, the regression statistics data do not support this hypothesis. Further analysis of the available data from the survey revealed some additional insights. For the non-users of e-learning, more than 85% indicated that the schools do not provide internet access or the speed of connection provided is insufficient. This lack of internet access or the insufficiency of connection speed seems to discourage the majority of them from using e-learning. On the other hand, for more than three-fourths of e-learning users, the lack of internet access in the classrooms or the insufficient speed of connection does not prevent them from using e-learning to teach math.

Conclusions

Four factors have a significant correlation with the use or non-use of e-learning for teaching math among the math teachers in the public secondary school in Makati City. These are the gender of the teachers, the geometry subject teaching load, the use of a computer for teaching math, and the familiarity of the teacher to the school head's overall e-learning plan. Another four factors have a significant correlation with the usage level of e-learning. These are the years of using e-learning, the teacher's requirement for the student to use the reading materials application of e-learning, the time when the teacher first use a computer and the Grade 7 teaching load.

The use of e-learning has a significant impact on four areas. These are the impact on the students' attention, participation, scores on math quizzes, and the overall math grades. It also has a positive impact on the teachers themselves.

The implementation of e-learning currently has four primary blockers. These are the lack of internet access or low speed of connection, the lack of e-learning system to use, the lack of computers and devices to use, and the lack of digital teaching and learning materials. After the start of using e-learning, many challenges persisted that hindered its effective use. These include the challenges related to the eight factors that influence the teacher's use of e-learning. The persistent challenges also include the top three opportunity areas for improvement. These are the internet access and speed, the e-learning training for the teachers, and the provision of computers and devices to use. The schools' overall e-learning implementation plan should include strategies to address the blockers and persistent challenges. Addressing all these will better support the users of e-learning for teaching math.

Factors Influencing the Teachers' Use of E-Learning to Teach Math

Eight factors are related to the use and usage level of e-learning. The first four in the group are related to the use or non-use of e-learning. It includes the gender, subject teaching load, use of a computer, and the overall e-learning plan.

The significant correlation of the gender with the use of e-learning suggests that the gender of the teachers has some influence on the adoption of e-learning for teaching. The migration strategy may have to address the gender gap. The migration efforts may have to focus on helping the teachers adopt the e-learning equally. The migration plan may have to include tutoring and mentoring arrangements to ensure that the teachers who are lagging can catch up immediately.

The significant correlation of the Geometry subject teaching load with the use of e-learning suggests that the Geometry teaching load has some influence on the teacher's use of e-learning. The Geometry teachers may have benefited from it that encouraged the majority of them to use it for teaching. To sustain its use, the teachers may need additional support to utilize all the relevant features of e-learning for the benefit of their students. The support may have to include additional e-learning training for the teachers and the provision of additional e-learning materials to use. The additional support may help develop e-learning champions in each school that can support the school heads in improving and sustaining the use of e-learning for teaching.

The significant correlation of the teacher's use of a computer for teaching with the use of e-learning suggests that the use of the computer in the classroom for teaching has some influence on the use of e-learning. The link between the two variables seems obvious, and the research data support it. Providing teachers with computers to use for teaching is a step toward the use of e-learning. The challenges ahead may be related to the cost and the speed of providing all the teachers with computers. The implementation strategy may have to address these challenges as well as the choice between providing all the teachers first or providing selected teachers and students at the same time. Providing both teachers and students may require substantial financial resources. Developing an effective strategy may require further studies to quantify the impact of different options on the competency of the students.

The significant correlation of the teachers' familiarity with the school head's overall e-learning plan with the use of e-learning suggests that the well-communicated school head overall plan has some influence on the teacher's use of e-learning. The school heads may have to develop an overall e-learning plan and to communicate the plan to the teachers. The well-communicated overall e-learning plan may provide the teachers with some targets and directions to fulfill and follow. Developing and executing an effective overall implementation and communication plans may require the school heads to look at and learn from the experience of others who have implemented an e-learning system ahead of them. For efficiency, the department of education may consider developing an e-learning implementation plan for the school with several variations to suit the different needs and available resources at each location.

Combining all the four preceding factors may produce a strong influence on the migration, adoption, and use of e-learning for teaching. These are the:

1) a well-communicated overall plan with clear targets and directions to meet and follow;

2) a focused support efforts to ensure equal and uniform adoption by all teachers;

3) the provision of additional training and materials for those who are leading the way and can serve as models for others; and

4) a resource plan to provide teachers with computers to use for teaching as a step towards the use of e-learning.

The second group of factors is related to the usage level of e-learning for teaching math. It includes the teacher's years of experience in using e-learning, the time when the teacher first used a computer, the requirement for the students to use e-learning application and the grade level teaching load.

The significant correlation of the years of using e-learning with the usage level of e-learning suggests that the length of experience in using e-learning has some influence on the teachers' usage level of e-learning. The teachers who have long experience in using e-learning may have developed more skills to use it more often and for a longer duration. Early start of the implementation and use of e-learning may help in building the teachers' e-learning skills and competencies that require time to acquire and develop fully. The school heads may have to develop strategies and plan to implement e-learning in their school as soon as practicable. The early implementation plan may give the school more time for building skills that usually come with the length of experience.

The significant correlation of the time of teacher's first use of a computer with the use of e-learning suggests that it has some influence on the usage level of e-learning. Similar to the length of experience in using e-learning, the length of experience in using a computer may have helped in building the teachers' skills. The teachers who used a computer early in life may have developed sufficient skills and confidence in using technology that helped in their use of e-learning for teaching. The benefit of early use of a computer may require the schools, including the colleges and universities, to let their students, who are considering to pursue a teaching career, to use computers in school. This strategy may benefit students who do not have access to a computer at home. As more students, with early experience with the use of a computer, pursue teaching careers, the usage level of e-learning for teaching may significantly increase sooner than later.

The significant correlation of requiring students to use the reading materials application with the usage level of e-learning suggests that it has some influence on the teachers' usage level of e-learning. If teachers require students to use the reading materials feature of e-learning, then the teachers need to search, review, select, and upload reading materials. The process is simple yet will need time for reading, thus, increase the time spent on e-learning. The school heads may have to focus on this simple application at the early stage of e-learning implementation. The reading materials application is also similar to the traditional way of giving out printed reading materials or sending electronic copies of the materials through email. The application may encourage the teachers and the students to use e-learning more without substantially deviating from their traditional way of teaching and learning. The use of the reading materials application requires both the teachers and the students to equally participate in the process, thus, creating a mutual dependency that may make it sustainable.

The significant correlation of the Grade 7 teaching load and the usage level of e-learning suggests that it has some influence on the teachers' usage level of e-learning. Grade 7 students may have learning processes and study habits that are different from the traditional way of learning in the classroom. The change in learning needs may have some influence on the Grade 7 teachers. They may be adjusting to the interests and learning habits of the younger students, and they use e-learning as one of the tools to help them adapt. The experience of the Grade 7 teachers this year will be experienced by the Grade 8 teachers next year as the students move up the ladder. The schools may have to revisit their overall e-learning plan to cope with the students' progression. The revision may require additional focused support for the teachers with higher grade level teaching loads to prepare them for the impending change.

The preceding four factors that may influence the teacher's usage level of e-learning highlighted the need for the schools and the teachers to adopt and adapt to e-learning as soon as practicable. The teachers can start with the simple applications of e-learning, such as the reading materials. Motivating the teachers to keep on using e-learning will enable them to develop the needed skills with time. In order to prepare future teachers, schools, colleges and universities may have to incorporate in their curriculum some topics and competency targets on the use of computers and e-learning.

Blockers and Challenges to E-Learning

Knowing, understanding, and addressing the reasons why some teachers are not using e-learning may help in enhancing the program to help more teachers adopt e-learning for teaching. The current four blockers or demotivators are the lack of network or internet access, lack of access to an e-learning system, unavailability of computers and devices, and the lack of digital teaching materials. Similarly, knowing, understanding, and addressing the areas for improvement may accelerate the migration process. The top three opportunity areas for improvement are internet access, the need for more teacher training, and the need for computers and devices to use.

The Philippine government is already addressing the unavailability of computers and devices to use in schools. The government had and continuously allocates significant financial resources to address this challenge. The government is also addressing the lack of internet access and slow connection speed. However, it may remain the biggest challenge in implementing e-learning even in Makati City, which is a school division with the highest financial resources allocated to support education. It may be an uphill battle to provide internet access with sufficient speed. As internet access becomes available and the overall speed goes up, the usage will increase and will load up the system again. One of the options to consider, which is currently being used successfully in some big schools, is the intranet version of e-learning.

The Philippine government is also addressing the need for digital teaching and learning materials by creating a government portal where teachers can access these online. However, the lack of an e - learning system that can be used in schools and classrooms still have to be addressed. The government may have to tap the private sector to provide these needs.

The government may also have to adjust its organization to include assessment, approval and control of digital teaching and learning tools, systems, and materials. The change may include the setting up of standards both for the content and the e-learning system that the schools have to use and the private providers have to comply with. With an e-learning system standard to follow, proper teacher training can be done on a wider scale. With a digital teaching and learning content standard to follow, many compliant digital materials can be produced. These standard training and compliant digital materials may help the teacher effectively use the e-learning system and the digital materials for teaching.

The Need for an E-Learning

The positive impact of e-learning on the students were observed by a large majority, above 75%, of math teachers who are using e-learning in the public secondary schools in Makati City. It includes the impact on the students' attention, participation, scores on the math tests, and the overall math grades. Only a slight majority, about 55%, observed a positive impact on the students' score on the math subject in the standardized National Achievement Test. Implementing e-learning across all schools in the Philippines may bring an immediate and significant increase in the performance of the students in schools. The observed significant improvements in the performance of students, as observed by their math teachers who are using e-learning, may require a concerted effort and attention from the government to implement e-learning in schools as soon as practicable. The research data suggest that starting soonest may gain some time advantage for building the teachers' skills and confidence that are related to the length of experience of using e-learning.

Recommended Alternative E-Learning Solution

The four primary challenges in implementing and using e-learning in the classrooms are the lack of internet connection or the low speed of connection, the lack of available e-learning system and the skills in using it, the lack of computers and devices to use, and the lack of curriculum-aligned digital teaching and learning materials.

The current challenge on the lack of internet access and the related challenge on the speed of internet connection, even for a school division with the highest financial support, will remain in the foreseeable future for most of the public schools in the Philippines. A different mindset and alternative solutions may be needed to address the internet access and speed of connection issues. Instead of enlarging the pipeline connection and increasing the flow rate to the internet backbone, it may be worthwhile to look at an alternative approach of bringing the internet backbone inside the school and the classroom. One of the alternate solutions is to use an intranet or local area network (LAN). An intranet or LAN solution for high-speed network speed requirement is not new and have been in use by many business offices for decades. The technology needed for an intranet solution is not significantly different from the traditional internet approach. The only difference is the physical location of the storage device for digital teaching and learning materials. Instead of using the storage device located somewhere in the world wide web, an intranet setup has the storage device physically installed in the school or the classroom.

The current challenge on the lack of an e-learning system is related to the previous problem on the lack of internet connection. Currently, there are many e-learning systems, both open-source and proprietary. A quick search of the internet will reveal the different e-learning systems available for the schools. For a long-term sustainability solution, an open-source e-learning system is a robust alternative for schools. The schools will be able to continuously use their e-learning system even if they decide in the future to change their e-learning service and content providers for whatever reason.

The government can address the current challenge on the lack of computers and devices for teachers and students through the continuous acquisition of computers and devices for public schools. The challenge is to find a suitable low-cost solution so that more teachers and students will be able to receive these computers and devices. One of the quality and low-cost alternatives is to use an open-source operating system for computers and devices that are primarily used for accessing the e-learning system using web browser software. Another quality and the low-cost alternative is to use microcomputers in the classrooms where the only purpose is to access the e-learning system using a web browser.

The government can address the current challenge on the lack of curriculum-aligned digital teaching and learning materials through the continuous acquisition of these materials both from the open and commercial sources. The government can tap many capable private organizations and businesses to provide the needed digital teaching and learning materials aligned with the Philippines' basic education curriculum. The subsequent challenge is in the distribution and the updating of these materials in all the public schools and classrooms all over the Philippines. One of the possible solutions is to use a unified open-source e-learning system for all schools and classrooms that can all be interconnected. The interconnections will require access to the internet but will be only on-demand during the update process. The interconnection will not require a high-speed connection because only the school server will be required to connect to the central country server during the updates.

The alternate solutions discussed above, if appropriately implemented all over the Philippines, can potentially speed up the adoption and use of the e-learning system in all public schools. The solutions can enable public school classrooms to meet the teaching and learning needs of the 21st-century teachers and students. These can potentially allow all the teachers and students to access the same leading practices in teaching and the latest factual knowledge that is usually only available to the teachers and students in the urban centers. These can transform the way the teachers teach and the way the students learn.

The successful adoption and use of the e-learning system in the Philippine public schools can improve the overall competency of tens of millions of students similar to the observed improvements in the students' math performance in the Makati City public secondary schools. The system can allow the students to develop new skills on the use of technology, allow them to access a wider world of knowledge and allow them to be abreast with the current developments way beyond their physical locations to prepare them in their future studies and careers.

Appendix 1.

List of all the reasons given for not using the e-learning system to teach math

The survey respondents were asked with the question "Do you use an E-Learning System to teach math? If NO, please share the reasons why." The answers given are listed below with reason classification indicators. The classification indicators are: a) I for Internet Access, b) E for e-learning system and tools, c) D for devices, computers, and equipment, d) M for learning materials and resources, and e) O for others.

1) "There is no provision for our grade level. Also, we do not have enough available units of the computer to use. There is no internet connection as well for classroom use." – I, E, D
2) "There is not enough resources or tools." – E, M
3) "There is not enough resources or tools that we can use to facilitate e-learning." – I, M
4) "No internet connection." - I
5) "No available e-learning system." - E
6) "Preparation of e-learning materials took time, and there is no internet connection in the school plus not every student have access to the internet." – I, M
7) "No materials." - M
8) "We do not have any." - E
9) "No internet connection." - I
10) "No internet connection." - I
11) "Access problem" - I

12) “No internet connection” - I

13) “Our computer lab is not functioning, the students have no access to a computer at school, and the majority have no access to a computer at home.” – D

14) “We do not have wifi in the classroom.” - I

15) “No internet connection / no available room.” – I, D

16) “Our computer lab is not functioning, and our students have no access to the computer. Not all students have access to a computer at home.” - D

17) “Internet is not reliable, but my teaching resources is the internet.” – I, M

18) “No specific idea what e-learning is.” - E

19) “As far as I know, e-learning applies only to OHSP classes.” - E

20) “Availability of the e-learning system” - E

21) “No connection.” - I

22) “There is no sufficient Wi-Fi connection.” - I

23) “Same reason as in the previous page. (I do not use the computer in the classroom.)” - D

24) “No internet access in school” - I

25) “Yes, in my previous school. – Not applicable

26) “Availability of e-learning devices among students” - D

27) “Lack of time to set-up the computer” - D

Appendix 2.

List of all the Teachers' Comments on How to Increase Usage or Improve the School E-Learning

The survey respondents were asked with the question "Do you have any suggestions on how to increase the usage or improve your e-learning system?" The answers given are listed below with improvement area indicators. The improvement area indicators are: a) I for Internet Access, b) E for e-learning system and tools, c) D for devices, computers, and equipment, d) M for learning materials and resources, e) T for e-learning training for teachers, f) S for technical support, and g) L for leadership attention and action.

1) "Install high-speed WiFi in our school and give sufficient training to us teachers." – I, T
2) "I suggest before they implement e-learning system first, they should provide the latest tablet with the latest operating system. And they should provide a very high-speed internet connection." – I, E, D, L
3) "Provide training for e-learning system for teachers and computer or laptop for the students and access on the internet." – I, D, T
4) "School head should be actively involved in the implementation & usage of an e-learning system. WiFi or LAN connection should be installed to school with e-learning system as much as possible a fiberoptic one in order to have fast connectivity." – I, L
5) "There should be a sufficient internet connection in the school." - I

6) “The school must provide an excellent source of internet so that we can apply or maximize e-learning in our classroom.” – I
7) “Internet connection should be sufficient to all math classes. Training applicable to all math teachers related to e-learning system.” – I, T
8) “Conduct seminar and the school must provide a strong internet connection.” – I, T
9) “Be given seminars on the use of an e-learning system. Make the WiFi connection accessible to teachers.” – I, T
10) “Provide high-speed internet per class with a modern tablet, built-in projector / smart TV in all classrooms.” – I, D
11) “Provide rigid training to teachers in the use of e-learning system.” - T
12) “Make all e-learning resources available to students/teachers.” – E, M, L
13) “Lessen/decongest the curriculum content to be able to have enough time for teachers to use e-learning in /out of the class.” – M, L
14) “An internet connection should be given attention /address by the school head so that we can maximize the e-learning application through internet.” – I, L
15) “Provide first the tools & internet connection.” – I, E, D
16) “Conduct seminar and conferences” - T
17) “Please provide an internet connection in our faculty room and our classroom.” - I
18) “Give internet connection in every classroom.” - I
19) “Seminar on how to use e-learning system.” - T
20) “Internet connection / WiFi inside the classroom.” - I

21) “There should be a WiFi connection inside the classrooms.” - I

22) “I need to study more on e-learning system.” - T

23) “I wish all teachers have access to e-learning system not only a few.” - E

24) “The school must provide WiFi or internet connection that can be accessed in the classrooms.” - I

25) “I want more training using PowerPoint.” – T, M

26) “The school must provide a strong WiFi signal which can accommodate the more than 50 students who will use it. The school must provide sufficient digital learning materials in Math for each grade level. The school must provide sufficient training for the teachers on the use of e-learning system.” – I, M, T

27) “The school should provide better access to the internet so that the use of computers and tablets will be maximized.” – I, D

28) “The school should provide a strong signal of Wi-Fi so that we can use ICT in the classroom and can help students and teachers in their class.” – I, D

29) “More internet connections - accessible in the classroom.” - I

30) “Internet access and devices” – I, D

31) “Internet connection in every classroom should be given priority so that online learning can be utilized.” - I

32) “I would suggest having a strong internet connection that can be used during class.” - I

33) “Better to have a fast internet connection in every room.” - I

34) “I only use an e-learning system for assessment.” – M

35) “Provide strong Wi-Fi connection & applications (program) that will enhance student's abilities & capabilities in math.” – I, E

36) “To increase the usage or improve e-learning system the wi-fi should be accessible all the times and free for all.” - I

37) “If possible, it is a big help for students if internet connection is free even once in two weeks, so that they can access e-learning for free since some students cannot afford to rent on computer shops.” – I, D

38) “Not all of our students can afford to have a mobile data. I suggest that the admin should provide a free internet connection.” - I

39) “Proper training.”- T

40) “Train teachers in using it.” - T

41) “A wifi connection in the classroom.” - I

42) “Wi-fi connection should be available in every classroom.” - I

43) “A strong internet connection.” - I

44) “The school must have a sufficient internet connection not only in the ICT Lab, but to all classrooms. SDO Makati must conduct seminar/workshop on e-learning system; the fact that we have all the digital tools and gadgets provided by the city Gov't.” – I, D, T

45) “Involve teachers in training about different e-learning system.” - T

46) “Teachers should be more equipped in terms of training and seminars regarding the e-learning system so that we will be knowledgeable enough to use it.” - T

47) “First & foremost, there should be wi-fi available in the school to be used by the teachers & students.” - I

48) “There must be an IT support team to fix the problem encountered by the teachers in using technology in the classroom.” - S

49) “The internet connection should be provided so that e-learning system become possible to use.” - I

50) “Availability of computers for teachers in teaching for every room would help to see as not all teachers could afford to have their laptops.” - D

51) “Availability of resources” – M, D

52) “Perhaps the Government should help the teachers & the students get easy access to Educational Technology. In my case, even if I have the technology needed for e-learning, but the students do not have it available, we still cannot increase the use of the e-learning system. Internet, computers, and so forth, should be prioritized in schools so we can easily improve the use of e-learning.” – I, D, L

Appendix 3.

List of all the Teachers' Comments on the Impact of Using E-Learning on their Students

The survey respondents were asked with the question "Is there anything else that you can share about the impact of e-learning on your math students?" The answers given are the following:

1) "Students became attentive and interested."
2) "Currently, I am using… a learning management system that helped students enhance their mathematics skills using internet connection. Lessons aligned with the G10 math curriculum where given and students can actively browse and answer written questions to determine whether students understand the lessons presented."
3) "There is a slight impact on our math students because we cannot maximize it due to lack of internet source and not all students have an access to the internet."
4) "It helps students visualize the concepts in math."
5) "The internet connection in the school must be available to all so that everyone can benefit from it."
6) "E-learning motivates students appreciate the subject better."
7) "Since we started e-learning through gadgets (e-learning materials) given by the local government, it should be accompanied by internet connection in the classroom so we can maximize the usage of all applications especially in the… assign, quizzes, and so forth. It can make a difference on the part of the student."

8) “Students might be motivated by using the technology.”

9) “Using GeoGebra apps.”

10) “A little change occurs in my class because I know that we need many materials to be ready for e-learning.”

11) “Some students of mine became livelier when we are discussing a lesson with some visual effects in class. They are attracted to colors, 3D visuals, songs and audio effects.”

12) “Nothing much because they were not able to maximize the use of e-learning because of limited resources.”

13) “With the use of e-learning, students were able to participate actively in the class discussions.”

14) “Nothing to say.”

15) “Using a laptop and tv with marker and show-me-board is very useful to attract the attention of the students to learn. With these, I can identify who are studying and who are not.”

16) “Not applicable.”

17) “E-Learning encourages students to learn independently.”

18) “It is effective, but is not accessible to students.”

19) “E-learning is a great tool to improve the performance of the students provided that the user of e-learning is well-trained and knows how to use it.”

20) “The students (my students) love it when they have unlimited attempts in their homework.”

21) “None so far because we have just started.”

22) “Some students are more interested studying online than reading books.”

23) “Using e-learning is essential because it catches the attention of the students.”

24) “It will increase motivation towards good academic performance.”

25) “Students are more interested in our lessons.”

26) “It has a huge impact on students knowing that they are into technology.”

27) “If ever e-learning will be implemented in our school, I hope that it will greatly help our students to aid them in understanding mathematics more easily & realistically.”

28) “From my experience in my previous school… using technology in teaching mathematics is not that effective.”

29) “Students nowadays much engage with gadgets/technology, so the use of e-learning may become a big help.”

30) “I often give video lectures w/c I think greatly helps to achieve learning of some subjects, but I am just at the beginning of adding more videos.”

Appendix 4.

List of all the Teachers' Comments on the Impact of Using E-Learning on the Teachers

The survey respondents were asked with the question "Is there anything else that you can share about the impact of e-learning on you as a math teacher?" The answers given are the following:

1) "Very helpful for the health of teachers (avoid asthma). Time-consuming to set up the computer, projector, but lessen the movement of teachers. Helpful to improve learners' performance."
2) "The impact of e-learning on my part was positive because it helps me lessen the delivery & introduction of the lesson since topic/lessons had been presented in the e-learning already. Feedback or result can be easily downloaded and monitored."
3) "If only our school has good access to the internet, we can maximize the use of e-learning in Math. For sure, teachers can minimize the use of chalk-talk."
4) "Math applications must be used by students for their learning."
5) "It can make a difference towards our students if given a chance and more training involving the different applications on e-learning. Moreover, internet connection in the classroom is a must for us to use the e-learning application."
6) "Serve as a substitute to chalk and blackboard."
7) "Using GeoGebra apps."
8) "Nothing much because we were not able to make use of an online educational application that might be helpful for our discussion more lively."

9) “With the use of e-learning, I was able to explore more activities are examples of exercises regarding the topics that I will discuss for that day.”
10) “Nothing as of the moment. I have classes to attend to.”
11) “We can get the attention of our students easily. They listen and learn. The use of show-me-board can easily identify who get a right and wrong answer.”
12) “Not applicable.”
13) “It lessens the work of a teacher.”
14) “None”
15) “E-Learning is very timely. Effective and efficient. They are not just available and affordable on a regular basis.”
16) “E-learning would have a huge impact to students since we are now in the digital age. The enthusiasm of the students towards learning could arise due to the increasing students' interest in technologies applied in education.”
17) “The e-learning will improve the teaching skills of the math teachers in terms of technology.”
18) “Makes my job a lot easier.”
19) “With the use of e-learning, the students now have a deeper understanding of the topic.”
20) “As a teacher, it will lessen the burden. Using e-learning as a medium of instructions contribute a great impact to the learner because they easily learn most of the lessons.”
21) “There should be a stable internet connection.”

22) "I grow professionally! I am exposed to the superhighway digitally and coping for generation Z!"

23) "E-learning system is a good instructional material for the students because they can have a depth understanding of what they are about to learn. It also helps to practice their critical learning skills."

24) "I was able to share the lessons more particularly the lecture via e-learning more easily. I could also easily reach out to my students for announcements. I could give them work or activities whenever there is a suspension of classes due to bad weather so that there will be no wasted time. (Experience from another school.)"

25) "Using e-learning in the classroom will help the students to become motivated in learning mathematics. However, the teachers must learn to evaluate the content of e-learning if it is beneficial for the students in learning mathematics. Because of my experience in using e-learning, the students cannot understand the content of the learning materials. As a result, it takes more time to re-discuss the topic to the students, and some of the students have no access to technology."

26) "It helps me to manipulate my lessons & activities."

27) "Availability of devices would greatly help in the promotion of e-learning."

28) "The use of technology in math class is beneficial and relief for Math teachers. Math is somehow abstract that seems hard to understand if just taught by lecture alone. We can integrate technology to it by using it to give

the simulation of the actual user/process on the topic. In this way, we can help the students better their understanding of the subject."

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