Title

Toward a Typology of Technology-Using Teachers: A Latent Class Analysis of NCES *FRSS 95*

Key Words

Technology, teachers, latent class analysis (LCA)

Abstract

The purpose of this research is to investigate the extent to which there is a typology of teachers who use technology in their classrooms using the *Fast Response Survey System: Teachers' Use of Educational Technology in U.S. Public Schools, 2009 (FRSS 95)*. The amount of prior research on teachers' technology use is vast and comprehensive; however, there are few studies that describe teachers' technology habits by examining subgroups of individuals. Using latent class analysis (LCA) with a nationally representative dataset (n=1,499), results show that there are four significantly different typologies of technology-using teachers: *Dexterous*, *Presenters*, *Assessors*, and *Evaders*. Furthermore, contextual factors, like the number of students on free/reduced lunch and the number of available classroom computers, are significantly associated with the odds of belonging to some of the groups. Implications of these typologies on school technology cultures, professional learning, and technology leadership in schools will be discussed.

Objective(s) / Purpose

The purpose of this study is to examine teachers who use technology by using latent class analysis (LCA) with a nationally representative dataset. Cultivating educational environments with technology has become a national priority. American policy makers, leaders, and teachers all hope to capitalize on the power of digital tools to help transform key components of education (U.S. Department of Education, 2010). However, considering that educators are just now slowly beginning to integrate technology into their classroom routines (Cuban, 2001; Cuban, Kirkpatrick, & Peck, 2001; Wenglinsky, 2005), this is an ambitious goal. To complicate matters further, there is added uncertainty pertaining the extent to which technology actually affects student learning (Gulek & Demirtas, 2005; Wenglinsky, 1998). Nevertheless, the presence of educational technology is growing, and researchers have worked to capture how teachers use technology in schools.

The majority of research in this domain uses behavior as the unit of analysis to describe and to generalize how teachers use technology. But, little is known about the extent to which there are different groups of teachers who share similar technology usage habits. Therefore, the research questions are:

(1) Using a nationally representative dataset, to what extent are there different types of technology-using teachers?
(2) To what extent are other contextual factors, such as urbancity, percentage of free/reduced lunch, number of classroom computers, and teacher experience, associated with membership in these subgroups of teachers who use technology?

Perspective(s) or Theoretical Framework

Ironically, despite the wealth of research in this area, Bebell, Russell, and O'Dwyer (2004) argue that there is still no clear consensus on how *teacher technology use* is to be defined and

measured. Indeed, it is a complex and ever-changing variable of interest, and scholars have been studying how and why individuals adopt and use technology for decades. Arguably, Everett Rogers (1962) is the first to explore diffusion theory and technology user typologies. Rogers (1962) notes the rate of technology adoption can be divided into five user segments: innovators, early adopters, early majority, late majority, and laggards. While the first three typically adopt innovation, the last two are more reluctant (Rogers, 1962). Early research in the field uses Rogers' diffusion theory to catalyze school-level technological adoption (Dalton, 1989; Dooley, 1999; Stockdill & Morehouse, 1992; Surry & Farquhar, 1997), and more recently, Mishra and Koelher (2006) developed TPACK as a theory of teacher technology use and its diffusion in teacher practice.

Thus, recent research interest in this topic can be divided into two paradigms: (1) The development of factors to explain teacher technology behaviors and how other factors, such as length of tenure, age, and school SES, influence the frequency of these habits (Bebell & Kay, 2010; Bebell et al., 2004; Dede, 2008; O'Dwyer, Russell, & Bebell, 2005; Rowand, 2000; Russell, O'Dwyer, Bebell, & Tau, 2007; Warschauer & Matuchniak, 2010); and, (2) Exploration of teacher *first-order* (i.e., technical infrastructure, planning time, computers) and *second-order* (i.e., instructional beliefs, comfort) mitigating factors when considering why certain teachers integrate technology more than others (Bai & Ertmer, 2008; Ertmer, 1999; Ertmer & Ottenbriet-Leftwich, 2010; Ertmer, Ottenbriet-Leftwich, & York, 2006; Ravitz, Wong, & Becker, 1998; Vannatta & Fordham, 2004). Separately, these studies reveal important insights into teachers' use of technology, and this study seeks to use these findings as a mechanism to explore if a typology of teachers exists.

Methods, Techniques, or Modes of Inquiry

Latent class analysis (LCA) is a subset of quantitative mixture modeling that researchers have used to determine if there are multiple subgroups within a dataset (Asparouhov & Muthén, 2008; Jung & Wickrama, 2008; Muthén & Asparouhov, 2002). For this study, LCA was selected because it evaluates how groups of individuals differ or relate to one another. Again, studies on teachers' technology use focus on how different individual and school level indicators relate to each other through regression analysis, factor analysis, or even fixed-effect HLM (Ertmer et al., 2006; O'Dwyer, Russell, & Bebell, 2004; Russell et al., 2007; Vannatta & Fordham, 2004). However, research questions here were centered on the teachers. To this end, LCA was the most suitable analytic model.

Following the latent class analysis literature, the study used a three-step LCA structural equation modeling framework (Asparouhov & Muthén, 2014; Muthén & Asparouhov, 2002). First, using the indicator variables, an initial LCA used hypothesis tests to define the number of statistically different types of teachers in the dataset. Next, covariates were added, and LCA used a multinomial logistic regression to estimate the odds of an individual belonging to a group based on the covariates.

Data Sources, Evidence, Objects, or Materials

This is a secondary analysis of the public use data from the *Fast Response Survey System: Teachers' Use of Educational Technology in U.S. Public Schools, 2009* (FRSS 95). This survey was originally collected by the National Center for Education Statistics and had a representative

sample size of 3,159 teachers from public schools across the United States. Response data were weighted so that findings can be generalizable to approximately 2.39 million public school teachers (National Center for Education Statistics, 2009). The dataset on teachers' use of educational technology includes information on the use of computers and Internet access, students' use of educational technology, teacher professional development, and availability of technology resources (Gray, Thomas, Lewis, & Tice, 2010).

Data analysis in this study only focused on teachers who indicated that they used technology in classroom instruction. A total of n=1,499 teachers were included in the final sample. Variables were dichotomized and include various technology usage indicators, like teacher use of technology, disposition towards professional learning, and teacher-directed student use of technology. The covariates in the model included urbancity, percentage of free/reduced lunch, number of computers, and years of experience. All data cleaning was performed in SPSS 22, and all other statistical procedures were conducted in Mplus, Version 7.1 (Muthén & Muthén, 2012). Appendix A has descriptive statistics of the indicator variables (Table 1) and covariates (Table 2) included in the model. Appendix B shows Figure 1, the structural equation model for the LCA, and Appendix G contains the Mplus code used to conduct the LCA.

Results and/or Substantiated Conclusions

The four-class LCA model fit the data well (see Appendix C, Table 3). The four-class model had a high entropy value of 0.732 with AIC = 23831.128 and BIC = 24208.320, and the Lo-Mendell-Rubin adjusted likelihood ratio test was significant (LMR = 291.147, $p < .000$). All of these values indicate good model fit in separating teachers across a four latent class model (Lo, Mendell, & Rubin, 2001). The four groups were named as *Dexterous*, *Presenters*, *Assessors*, and *Evaders*. Appendix D provides the proportions of responses by item and subgroup, and Appendix E shows a line plot of the groups by indicator.

The LCA model identified four groups of teachers who use technology in their classrooms. First, the *Dexterous* group was the largest group with 29% of the teachers (see Appendix E, Figure 2, black dashed line). This group had a high proportion of teachers who indicated that they use technology in activities they prepare for instruction and direct students to use technology with hands-on and discrete tasks, such as preparing written texts, conducting research, developing multimedia presentations, and performing experiments. *Dexterous* teachers also had the lowest dissatisfaction with technology professional learning with only 9% of teachers indicating that it did not meet their goals.

In contrast, about 23% of the teachers were in the *Evaders* group (see Appendix E, Figure 2, black solid line). This group of teachers indicated that they neither directed students to use technology to complete discrete or hands-on tasks, nor did they use technology to administer tests (22%) or use skill and practice software (24%) with students. In fact, *Evaders* also indicated low technology use for productivity, like student record management (69%) or email with parents (53%). Although teachers in all four groups had high levels of engagement in learning about technology, *Evaders* reported the most dissatisfaction with technology professional learning and indicated the lowest level of preparation to use technology.

Likewise, the LCA model also identified two groups of teachers who use technology for specific pedagogies. About 20% of the sample, the majority of teachers in the *Presenters* group (see Appendix E, Figure 2, light gray dotted line) reported using technology for classroom presentations (91%) and for instructing their students to use technology for their presentations (83%). The *Presenters* group is similar to the *Dexterous* when it pertains to using technology to produce written texts and to conduct research, but they are aligned with the *Evaders* group as well, rarely using technology to learn basic skills or solve problems.

The *Assessors* (see Appendix E, Figure 2, dark gray solid line) make up 27% of the sample. This group indicated that they direct their students to use technology when practicing basic skills through drill and practice programs. Again, the *Assessors* group share the inclination to use technology to practice basic skills with the *Dexterous* group, but they do not use technology to have their students create presentations, conduct research, or even prepare written texts, similar to the pattern reported by the *Evaders* group.

Finally, the covariates were examined to estimate the odds of a teacher belonging to a particular group. *Dexterous* is the largest group, and it is reference category. Results show that when a school has more than 50 percent of students on free and reduced lunch, teachers are two times more likely to be an *Assessor* than *Dexterous* and are 2.56 times less likely to be a *Presenter* than *Dexterous*. In terms of first-order barriers, with one computer, teachers are 1.24 times less likely to be an *Evader* than *Dexterous* and 1.07 times less likely to be an *Assessor* than *Dexterous*. Table 5 in Appendix G outlines the means and odds ratios described above.

In the final paper, we will discuss a further informed model that will explore how these results inform theory and practice, particularly in teacher professional development and adult learning.

Scientific or Scholarly Significance of the Study or Work

In addressing the 2016 AERA annual meeting theme, "Public Scholarship to Educate Diverse Democracies," this study prioritizes the use of publicly available datasets to explore larger questions about technology's role in diverse educational environments. This study is a unique and significant contribution to the public scholarship in educational technology and attempts to combine theory, a public, nationally generalizable dataset, and contextual covariates in order to gain a more meaningful, accessible understanding of the types of teachers who use technology and what factors predict membership in those groups. As past scholars have noted, there is no clear consensus on what factors influence teacher technology use. Yet, the results of the study provide statistically significant evidence of contextual factors that predict membership in the technology-using groups and provide a meaningful scholarly contribution for constructing theory and influencing practice on teacher technology use. Additionally, the latent class analysis (LCA) identified four significantly different groups of technology-using teachers. This is the first time LCA has been used to describe technology integration in schools, and it is one of a small number of studies to provide typologies of individuals instead of behaviors.

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Appendix A – Descriptive Statistics for LCA Indicator Variables and Covariates

Table 1

Descriptive Statistics of Indicator Variables for Teachers Who Use Technology in Their Classrooms

Variable	Min	Max	Mean	SD	FRSS 95 Variable
Use of technology for instruction					
Making presentations	0	1	0.72	0.449	Q6G; 0=Never/Rarely, 1=Sometimes/Always
Administering tests	0	1	0.52	.0500	Q6H; 0=Never/Rarely, 1=Sometimes/Always
Drill, practice programs, tutorials	0	1	0.58	0.494	Q6J; 0=Never/Rarely, 1=Sometimes/Always
Preparation to use technology					
Professional learning activities	0	1	0.97	0.165	Q9C; 0=Not at all, 1=To some extent
Training from technology staff	0	1	0.97	0.181	Q9D; 0=Not at all, 1=To some extent
Independent learning	0	1	0.98	0.123	Q9E; 0=Not at all, 1=To some extent
Disposition toward professional learning					
Technology PD met goals	0	1	0.18	0.381	Q11A; 1=Disagree or strongly disagree
Use of technology for productivity					
Email or listserv with parents	0	1	0.65	0.477	Q8A1; 0=Never/Rarely, 1=Sometimes/Always
Email or listserv with students	0	1	0.28	0.451	Q8A2; 0=Never/Rarely, 1=Sometimes/Always
Student record management	0	1	0.85	0.362	Q6D; 0=Never/Rarely, 1=Sometimes/Always
Teacher-directed student use of technology for discrete skills					
Preparing written text	0	1	0.64	0.479	Q7A; 0=Never/Rarely, 1=Sometimes/Always
Learning/practicing basic skills	0	1	0.72	0.451	Q7C; 0=Never/Rarely, 1=Sometimes/Always
Conducting research	0	1	0.71	0.455	Q7D; 0=Never/Rarely, 1=Sometimes/Always
Solving problems, analyzing data, performing calculations	0	1	0.47	0.499	Q7H; 0=Never/Rarely, 1=Sometimes/Always
Teacher-directed student use of technology for hands-on tasks					
Developing and presenting multimedia presentations	0	1	0.46	0.498	Q7J; 0=Never/Rarely, 1=Sometimes/Always
Creating art, music, movies, or webcasts	0	1	0.26	0.436	Q7K; 0=Never/Rarely, 1=Sometimes/Always
Conduct experiments or perform measurements	0	1	0.27	0.444	Q7I; 0=Never/Rarely, 1=Sometimes/Always
N	1,499				

Appendix A – Descriptive Statistics for LCA Indicator Variables and Covariates

Table 2

Descriptive Statistics of Covariates for Teachers Who Use Technology in Their Classrooms

Variable	Min	Max	Mean	SD	FRSS 95 Variable
School urbanicity					
City	0	1	0.213	0.409	URBAN; 1=City
Town	0	1	0.145	0.352	URBAN; 1=Town
Rural	0	1	0.308	0.462	URBAN; 1=Rural
Students eligible for free or reduced lunch	0	1	0.436	0.496	POVST; 1=More than 50%
Number of computers in classroom	0	33	4.83	6.227	Q1A1_TOP
Years of teaching experience	1	41	13.75	9.553	Q15_TOP
N	1,499				

Appendix B – LCA Structural Equation Model

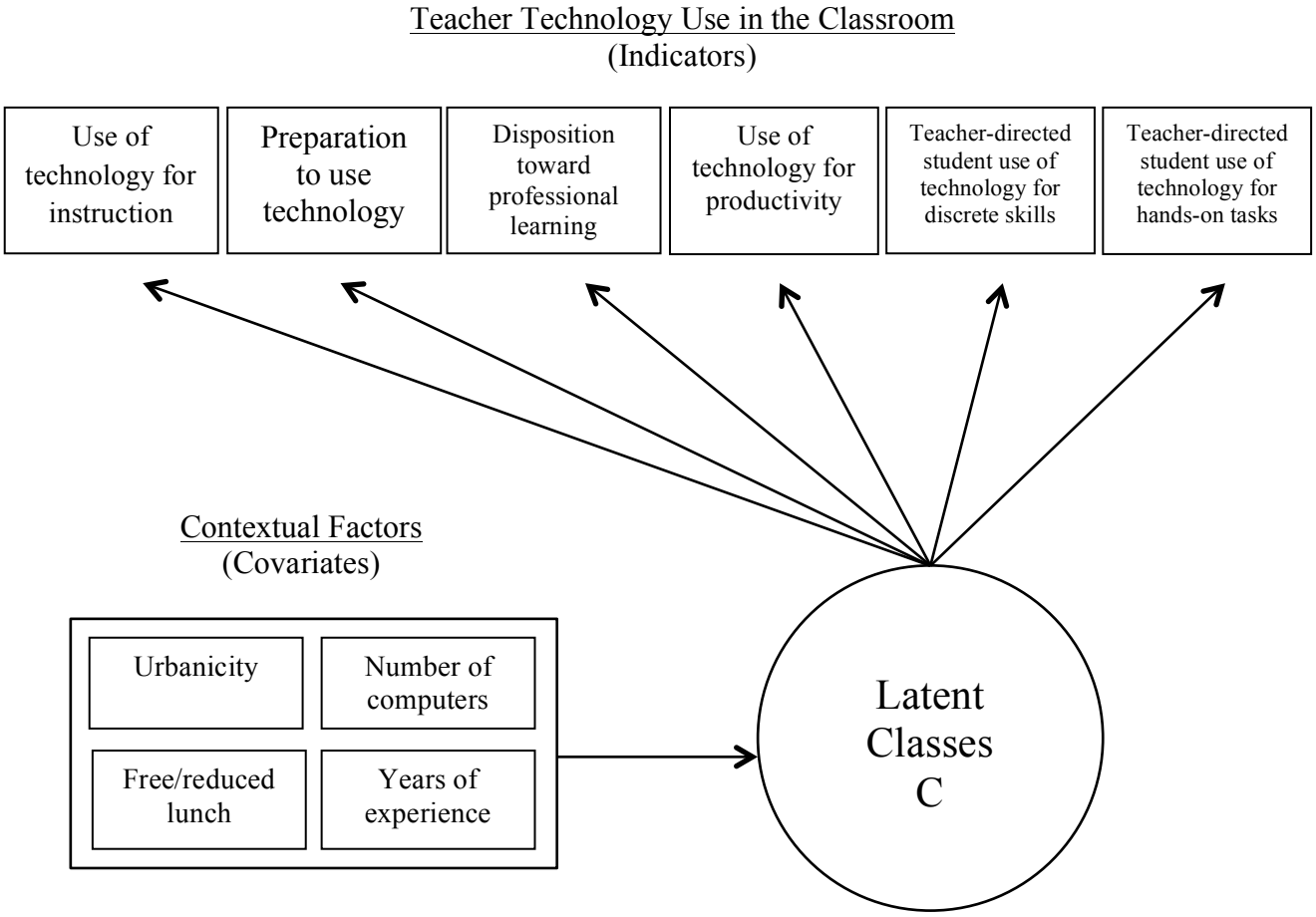

Figure 1. Structural and Conceptual Equation Model of the Latent Class Analysis of Teachers Who Use Technology in Their Classr

Appendix C– Fit Statistics and Model Selection

Table 3

LCA Results and Fit Statistics for Teachers Who Use Technology in Their Classrooms

Model	AIC	BIC	-Log Likelihood	LMR Test for k-1 classes	*p*	Entropy
Two classes	24443.653	24629.593	12186.827	2131.513	0.000	0.786
Three classes	24088.487	24370.053	11991.244	388.217	0.007	0.775
Four classes	23831.128	24208.320	11844.564	291.147	0.000	0.732
Five classes	23740.158	24212.975	11781.079	126.014	0.051	0.750

Note: AIC = Akaike information criteria; BIC = Bayesian information criteria; LMR = Lo-Mendell-Rubin adjusted likelihood ratio test

Appendix D – Proportions by Item and Subgroups

Table 4

Proportion of Teachers Who Use Technology in Their Classrooms by Item and Subgroup

Variable	**Dexterous (29.4%)**	**Evaders (23.8%)**	**Assessors (26.8%)**	**Presenters (20.0%)**
Use of technology for instruction				
Making presentations	0.939	0.488	0.544	0.908
Administering tests	0.786	0.219	0.552	0.422
Drill, practice programs, tutorials	0.795	0.239	0.803	0.364
Preparation to use technology				
Professional learning activities	0.991	0.939	0.994	0.953
Training from technology staff	0.977	0.923	0.982	0.979
Independent learning	0.996	0.955	0.990	0.996
Disposition toward professional learning				
Technology PD did not met goals	0.088	0.305	0.129	0.215
Use of technology for productivity				
Email or listserv with parents	0.798	0.537	0.580	0.662
Email or listserv with students	0.503	0.151	0.134	0.315
Student record management	0.937	0.697	0.847	0.884
Teacher-directed student use of technology for discrete skills				
Preparing written text	0.924	0.236	0.513	0.886
Learning/practicing basic skills	0.905	0.401	0.951	0.492
Conducting research	0.957	0.294	0.632	0.939
Solving problems, analyzing data, performing calculations	0.934	0.137	0.462	0.191
Teacher-directed student use of technology for hands-on tasks				
Developing and presenting multimedia presentations	0.870	0.051	0.080	0.830
Creating art, music, movies, or webcasts	0.503	0.026	0.082	0.397
Conduct experiments or perform measurements	0.688	0.053	0.144	0.082

Appendix E – Dot and Line Plot of Indicator Variables by Subgroup

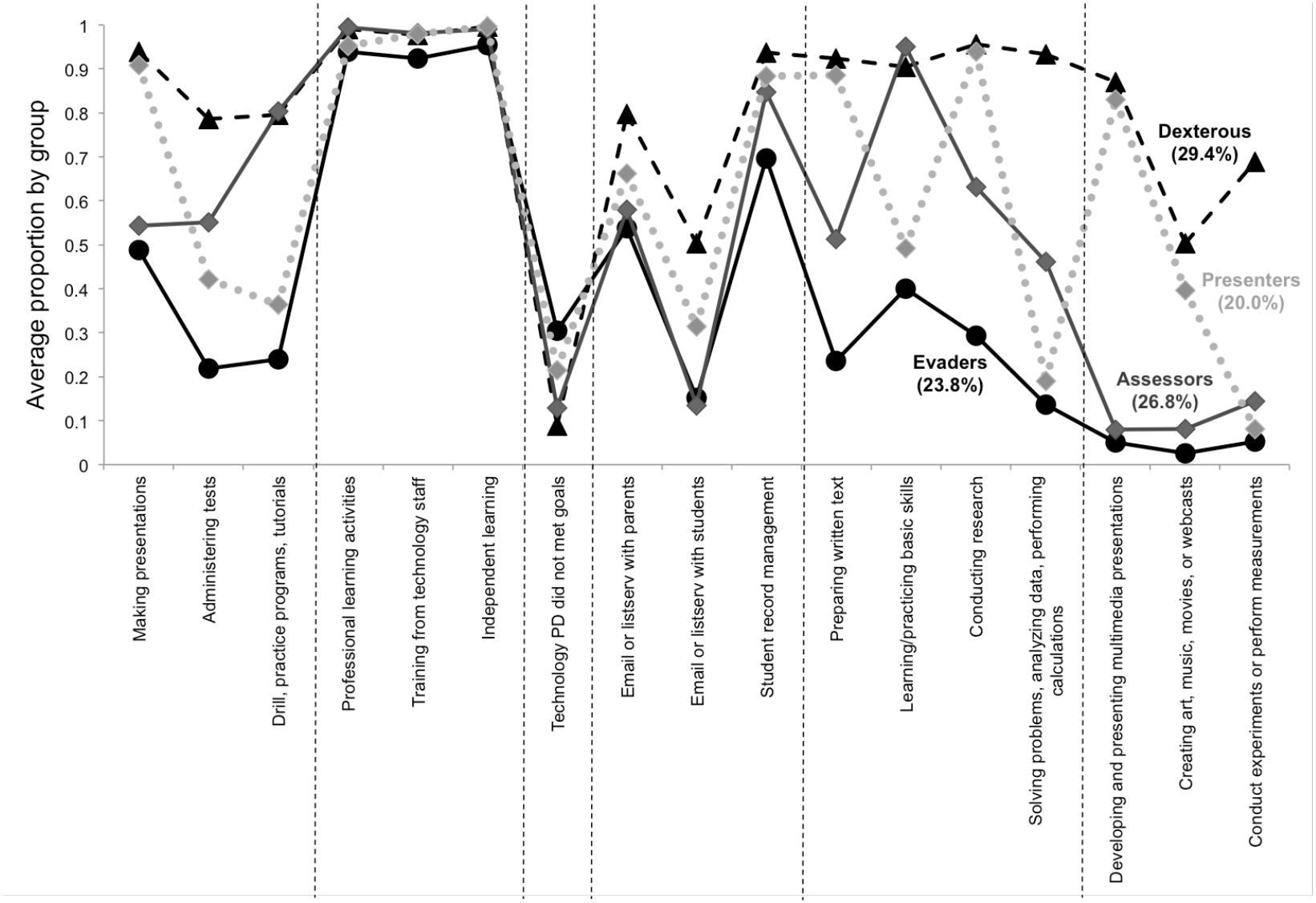

Figure 2. Indicator Plots of Latent Class Analysis Results by Subgroup

Appendix F – Means and Odds Ratio for Covariates Included in the LCA Model

Table 5

Means and Odds Ratios for Covariates with Dexterous Teachers Who Use Technology as the Reference Group

	Dexterous (29.4%)		**Evaders (23.8%)**			**Assessors (26.8%)**			**Presenters (20.0%)**		
Variable	Mean	Odds Ratio	Mean	Odds Ratio	*p*	Mean	Odds Ratio	*p*	Mean	Odds Ratio	*p*
School urbanicity		—									
City	0.205	—	0.217		0.926	0.207		0.559	0.226		0.169
Town	0.159	—	0.118		0.119	0.146		0.392	0.159		0.533
Rural	0.307	—	0.318		0.874	0.319		0.931	0.291		0.698
Students eligible for free and reduced lunch	0.438	—	0.425		0.861	0.548	1.917***	0.000	0.294	0.390***	0.000
Number of computers in the classroom	6.65	—	3.01	0.805***	0.000	4.03	0.931***	0.000	5.38		0.145
Years of teaching experience	14.03	—	13.20		0.310	14.55		0.273	12.90		0.080

Note: *$p < .05$; **$p < .01$; ***$p < .001$

Appendix G – Mplus Code

```
TITLE:    Teacher Tech Use LCA, FRSS 95 2009

DATA:     FILE = FINAL_LCATeacherTechUse.dat ;

VARIABLE:
     NAMES = Q6G Q6H Q6J Q9C Q9D Q9E Q11A Q8A1 Q8A2 Q6D
          Q7A Q7C Q7D Q7H Q7J Q7K Q7I CITY
          TOWN RURAL FREELUNCH Q1A1_TOP Q15_TOP ;
     USEVARIABLES = Q6G Q6H Q6J Q9C Q9D Q9E Q11A Q8A1 Q8A2
          Q6D Q7A Q7C Q7D Q7H Q7J Q7K Q7I ;
     CATEGORICAL  = Q6G Q6H Q6J Q9C Q9D Q9E Q11A Q8A1 Q8A2
          Q6D Q7A Q7C Q7D Q7H Q7J Q7K Q7I ;
     CLASSES = c(4);
     AUXILIARY = (R3STEP) CITY
          TOWN RURAL FREELUNCH Q1A1_TOP Q15_TOP ;

ANALYSIS:
     TYPE = MIXTURE;
     STARTS = 200 20 ;

PLOT:
     TYPE = PLOT3;
     SERIES = Q6G Q6H Q6J Q9C Q9D Q9E Q11A Q8A1 Q8A2
          Q6D Q7A Q7C Q7D Q7H Q7J Q7K Q7I (*) ;
SAVEDATA:
     SAVE = CPROBABILITIES ;
     FILE = CPROBS-KG-004.dat ;
     FORMAT = FREE ;
     ESTIMATES = MIXEST-KG-004.dat ;

OUTPUT:
     TECH11 TECH14 ;
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AERA AMERICAN EDUCATIONAL RESEARCH ASSOCIATION

Reviews

Summary of reviewers notes and ratings on criteria.

Toward a Typology of Technology-Using Teachers: A Latent Class Analysis of NCES FRSS95

Sub Unit: SIG-Technology as an Agent of Change in Teaching and Learning

Review Worksheet (3/3)

Review #1063139

Criteria	Rate
Objectives or purposes	5 / 5
Perspective(s) or theoretical framework	2 / 5
Methods, techniques, or modes of inquiry	3 / 5
Data sources, evidence, objects or materials	4 / 5
Results and/or substantiated conclusions or warrants for arguments/point of view	4 / 5
Scientific or scholarly significance of the study or work	4 / 5
Alignment with the TACTL Mission: Promotes the development and evaluation of preservice & inservice programs intended to transform teacher education, to prepare technology-proficient educators to meet 21st century learners' needs.	5 / 5

Comments to the Author/Submitter

This paper is about categorizing the ways in which teachers implement technology into their daily classroom practice. I would be interested to read an articulation by the authors on the limitations of the modes of inquiry. While using publicly available data is important, classroom-based observations would go far in elucidating the findings of the LCA.

Review #1063140

Criteria	Rate
Objectives or purposes	3 / 5
Perspective(s) or theoretical framework	3 / 5
Methods, techniques, or modes of inquiry	4 / 5
Data sources, evidence, objects or materials	4 / 5
Results and/or substantiated conclusions or warrants for arguments/point of view	4 / 5

Scientific or scholarly significance of the study or work	3 / 5
Alignment with the TACTL Mission: Promotes the development and evaluation of preservice & inservice programs intended to transform teacher education, to prepare technology-proficient educators to meet 21st century learners' needs.	3 / 5

Comments to the Author/Submitter

This is an interesting paper about a large scale representative study among teachers. The theoretical framework is not very deep; and to some extent slightly old literature has been used (e.g. referring to literature from 2001 arguing that teacher are just beginning to use technology - that is nearly15 years ago) . The large data set is is interesting. I was wondering to what extent the subset of 1499 students is still representative (technology using teachers are about 50% of the whole sample; that is a finding as such!). The the indicators the authors use are rather superficial. The authors found four different groups of technology users and relate the probablity to belonging to a group to some school conditions. It would be helpful if the authors reflect on these findings a bit more. However authors investigated A minor remark: There are some typo's in the spelling of authors' names (Koelher instead of Koehler; Ottenbriet instead of Ottenbreit;

Review #1063138

Criteria	Rate
Objectives or purposes	3 / 5
Perspective(s) or theoretical framework	2 / 5
Methods, techniques, or modes of inquiry	2 / 5
Data sources, evidence, objects or materials	2 / 5
Results and/or substantiated conclusions or warrants for arguments/point of view	1 / 5
Scientific or scholarly significance of the study or work	2 / 5
Alignment with the TACTL Mission: Promotes the development and evaluation of preservice & inservice programs intended to transform teacher education, to prepare technology-proficient educators to meet 21st century learners' needs.	2 / 5

Comments to the Author/Submitter

"However, considering that educators are just now slowly beginning to integrate technology into their classroom routines (Cuban, 2001; Cuban, Kirkpatrick, & Peck, 2001; Wenglinsky, 2005), this is an ambitious goal." Claim is that "educators are just NOW slowly BEGINNING to integrate technology . . ." but the supporting citations are 10-15 years old. Not clear how the names were assigned to the groups (what was the process for naming the groups and how do we judge whether the names are appropriate?). Perspective/Theoretical framework was not used effectively to guide data analysis or explain results.

Review Worksheet (1/1)

Review #1065929

Criteria	Rate
Objectives or purposes	5 / 5
Perspective(s) or theoretical framework	4 / 5

Methods, techniques, or modes of inquiry	5 / 5
Data sources, evidence, objects or materials	4 / 5
Results and/or substantiated conclusions or warrants for arguments/point of view	4 / 5
Scientific or scholarly significance of the study or work	5 / 5
Alignment with the TACTL Mission: Promotes the development and evaluation of preservice & inservice programs intended to transform teacher education, to prepare technology-proficient educators to meet 21st century learners' needs.	5 / 5

Comments to the Author/Submitter

Great research study and this does align with the TACTL mission. If possible, you should add the 95% confidence intervals (CI) to your result table. The 95% CI information could be useful for other researchers to see.