Guidance for Technology Decisions from Classroom Observation

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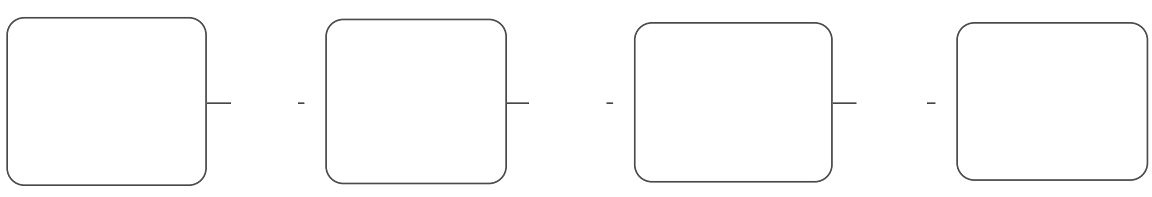
Classroom observation plays a crucial role in program evaluation. Schools can count up technology units installed and hours of professional development as inputs to a program. Surveys and interviews can record student and teacher attitudes about an innovation. Tests and school transcripts can quantify outcomes. But only observation of students and teachers at work can document the learning experience itself. It helps determine whether an intervention has actually been implemented before a program tries to evaluate outcomes (Frechtling, 2002, p. 16). Observation fills the information need required by the middle stages of intervention logic models (Figure 1).

Figure 1. Classroom observations within an educational technology logic model



Background: The present study arose out of questions raised during the evaluation of several educational technology grant programs from 2008-2010. Although the projects varied in specific focus, grade level, and technologies used, they had certain goals in common. There was a common concern for making instruction more engaging. There was also a shared belief in the value of “21st century skills,” or in students’ abilities to not only use technology, but use it in ways analogous to modern work environments: as a tool for information acquisition, analysis, and sharing.

In general, most programs were student-centered-, whether their approach was labeled as such or not. The programs valued “hands-on” use of technology and science tools, inquiry-based pedagogy, and student creation of products. In supporting these approaches, the authors of the grant applications that funded the observed innovations cited such sources as the National Research Council’s “How People Learn” literature (Bransford, et al., 1999) and the National Educational Technology Standards (ISTE, 2000, 2007, 2008). The former supports the use of students’ prior knowledge and preconceptions in teaching as well as the interactive features of technology (Bransford, et al., 1999, 121-124, 194-212.). The latter contrasts traditional “teacher-directed, memory-focused instruction” and “knowledge from limited, authoritative sources” with newer “student-centered, performance-focused learning” and “learner-constructed knowledge from multiple information sources and experiences.” (ISTE, 2008, p. 4).

Anecdotally, ISTE evaluators and program staff noticed that certain technologies tended to be associated with certain teacher and student roles, independent of the stated goals of the program. Questions arose as to the relative impact of the programs and the technologies they sought to implement (i.e., whether the technology tail was wagging the programmatic dog).The present analysis sought to explore these patterns in classroom behavior and technology.

Method

The original context in which the data was collected involved small groups of teachers for whom the focus was the effects of particular professional development. Identities and unique professional development histories of individuals were well known within each program. Looking for patterns within the original studies was not possible because the samples were small and because the presumptive explanation for characteristics of classroom practice was the content of the program itself. Only after the accumulation of records over time did it make sense to look at effects that might operate across programs.

Sample and data characteristics

One hundred and nine teachers from seven different technology projects under U.S. Department of Education and National Science Foundations grants in two states during 2008-2010 were observed using a common structured observation data collection instrument. After two years, the observation database included 189 records from six observers. Observations conducted by trainee observers, that were missing key data, or that had contradictory records were removed, leaving 144 observations from three researchers who had undergone common training: 16 observations from one observer on two programs; 26 from one observer on three programs; 104 from one observer on seven programs. Observations were retained for 85 teachers, with one to seven observations per teacher (mean = 1.69, median=1). Half of the observations were in science classrooms, 16% in language arts, 19% in math, 8% in social studies, and the remaining 6% in various electives or technology. About 3% of observations were in primary grades (K-2), 27% in elementary (3-5), 55% in middle school (6-8), and about 14% in high school (9-12).

For this analysis, individual identifying information was removed, except for arbitrary dummy codes to identify multiple instances of the same teacher or the same observer.

ISTE Classroom Observation Tool (ICOT)

The instrument used to collect observations was a computer-based note-taking application developed in 2008 by ISTE with funding from the Hewlett Packard Company (HP). The program, the ISTE Classroom Observation Tool (ICOT), can be used on any Windows or Macintosh computer and is optimized for tablets that allow the user to hold the computer in one arm and write on the screen with a stylus. The ICOT was based on previous observation protocols employed in ISTE program evaluations since 1999 (Kelly, 2003, pp. 111- 133; Kelly & Haber, 2006, pp. 133-148).

ICOT observations typically last for the major part of a class period, during which an observer collects information on setting, student groupings, learning activities, teacher roles, and time and type of technology use. The ICOT prompts observers to estimate levels of student engagement, and the relative need for technology in the lesson.[1]

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[1] The version of the ICOT used in these evaluations also asked evaluators to record evidence of teachers meeting the first edition of the National Educational Technology Standards (NETS) for teachers (ISTE, 2000). In 2010, ISTE revised the ICOT, replacing the 2000 NETS for Teachers with the NETS for Students, 2nd edition (ISTE, 2007). Because observer reliability was low for the original NETS section, and because the first edition of the NETS is no longer widely use, those results are not presented here.

Table 1. ICOT observation variables

Teacher Roles	Lecturing Interactive Direction Facilitate/Coaching Modeling Moderate Discussion	No. Students	Engaged %	
		Student Groupings	Individual Pairs Small Groups Whole Class	
Learning Activities	Give Presentation Create Presentation Run Simulations Research Information Analysis Write Take Tests Drill & Practice Hands-on Skills	Technology-use time	Total minutes observed % of total min. during which teachers used technology % of teacher tech. use devoted to teaching and learning % of total min. during which students used technology % of student tech. use devoted to teaching and learning	
		Need for Technology	Not useful Somewhat useful Useful Essential	
Technologies Used by Teachers and by Students	Blog Calculator Clickers Concept map Database Desktop Digital camera	Document camera Drill & practice Email Graphics Handheld Interactive board Laptop computer	Library database Podcast Presentation Science probe Simulation Spreadsheets Tablet computer	Video camera Video production Videoconferencing Web authoring Web browser Wiki Word processing

ICOT observers try to be in classrooms at or near the start of a class period. Along with initial observations about the setting (number of students, presence of technology, room arrangement, special characteristics of the environment) the observer records a start time. Every three minutes after that, the observer checks boxes to indicate if technology is in use by students and/or teachers, and whether it is used for learning. (A computer that is powered up but unattended does not count as "in use," and looking for lost passwords or playing recreational games does not count as "in use for learning.") At the end of an observation, the ICOT calculates the total minutes observed, the proportions of that time in which technology was used by teachers and students, and the proportions of technology-use time devoted to learning.

A typical structure for a classroom with multiple computing devices was for a teacher to introduce a topic in one of the teacher-directed roles (lecturing, modeling, or interactive direction). This could be the reading of a poem, a review of the periodic table, or a demonstration of a science probe. Then the students would be "turned loose" as individuals or groups to study or create, with the teacher in a facilitating role. This might include conducting research on the web or in a lab, analyzing data, or producing a presentation.

Table 1 shows the ICOT variables. Most of these are check boxes with which the observer notes whether the attribute is present or not during the observation period. Student engagement (anecdotally cited as a benefit of technology by many of the observed teachers), is assessed by observing student behaviors in relation to the three-minute chart. A student distracted from the lesson for any reason over more than a single three-minute period is counted as not engaged. The proportion of students left after subtracting disengaged students is the percent engaged. In most classrooms, engagement as measured by this criterion was quite high. (Mean=.93, standard deviation=.09, or 1-2 students disengaged out of an average-sized classroom of 24 in this sample).

Another variable requires evaluators to rate the unique contribution of technology in comparison to alternatives. “Essential” indicates that the lesson could not have been conducted without the technology. A simulation that analyzes real-time data might be an example. “Useful” indicates that the integrated technology provided distinct advantages over conducting the lesson without the tools. Completing a research and writing project online in two periods that otherwise take a week would probably have this rating. “Somewhat useful” indicates that the technological approach was comparable but not superior to an alternative. Presenting similar content in a slide show that could be presented on a chalkboard or overhead projector would be an example. “Not useful” indicates that the lesson would have benefitted from different media altogether. One example would be projecting a complex relationship (e.g., a complicated chemical reaction or a multi-step math problem) piece by piece, one computer screen at a time, when the entire system could only be illustrated in a larger physical format such as wall-sized chalk or dry-erase board.

Observer Reliability

Chi-square frequencies were computed for ratings by observers for 12 teachers who were observed by each of the three observers in a total of 36 different occasions. No significant differences ($p<.05$) were found in the frequencies of most variables (i.e., in most cases, no observer appeared to be systematically stricter or more lax in coding an attribute as present). A comparison of mean estimates of student engagement also showed no significant differences across observers. Significant variation in coding was observed for five technologies: databases, graphics, simulations, wikis, and word processing. Difficulties in coding were related to the converging nature of the technologies. For instance “word processing,” once synonymous with a dedicated computer program, is now a common function within many other applications. Some observers only recorded its presence when a dedicated program was running; others checked the technology whenever any text editing function was in use. Coding of these particular technologies in this data set may not be reliable. Obviously, additional definitions of technology applications will be necessary as hardware and software evolve. Reliability may also be improved by additional group training as recommended in ICOT support materials (ISTE, 2008).

Data Analysis

The analysis looked at seven types of variables within the ICOT: (1) Teacher roles, (2) student groupings, (3) student learning activities, (4) the amount of time technology was used, (5) the types of technology used, (6) the need for technology use, and (7) student engagement. The constructivist theory behind the programs for which these data were collected emphasized increasing hands-on, creative, student-directed activities versus teacher directed knowledge-transfer pedagogy. The ICOT includes two student-centered teacher roles (facilitation and moderation) and three teacher centered roles (lecture, interactive direction, and modeling). Within student activities, the ICOT includes six that are primarily student-centered creation and study (creating/delivering presentations, writing, research, information analysis, and running interactive simulations), and three that are primarily teacher-directed (tests, drill and practice, and hands-on skill training). (Table 2).

Table 2. Teacher roles and learning activities by type.

Focus of Observation	Roles and Activities	Type
Teacher Roles	Facilitation	Student-centered
	Moderated Discussion	
	Lecture	Teacher –centered
	Interactive Direction	
	Modeling	
Student Learning Activities	Creating Presentations	Student directed
	Presenting	
	Writing	
	Information Analysis	
	Research	
	Simulations	
	Drill & Practice	Teacher-directed
	Hands-on Training	
	Taking Tests	

This study looked at the relationships between these types of roles and activities and the technology and engagement variables. For the purpose of extracting correlation patterns, the analysis ignored other variables that were of interest in the original program evaluations. The role of professional development and the growth of individuals over time—the goals of the original grants—were not considered. Observations were treated as unique examples of pedagogy and technology, regardless of how those examples came about.

There were 118 observations with complete data sets for these variables. The correlation of attributes across these patterns gives an indication of common associations. Table 3 presents the correlations between groupings, teacher roles, and activity types, along with amounts of technology use by teachers and students and observer estimations of student engagement and of the need for technology in the lesson.

Table 3. Correlations between groupings, roles, technology use and need, and student engagement.

	indiv	prs / sm. grps	whole class	student-centered	teacher-centered	teacher-directed	student-creative	student-study	student % tech use	teacher % tech use	% engaged	tech need
Indiv	1.000											
prs / sm groups	**-0.451***	1.000										
whole class	**-0.674***	**0.467***	1.000									
student-centered	0.106	**0.236***	-0.160	1.000								
teacher-centered	0.069	0.113	0.128	**-0.257***	1.000							
teacher-directed	-0.126	0.131	0.017	0.070	0.064	1.000						
student-creative	0.057	-0.069	0.053	-0.089	-0.013	**-0.488***	1.000					
student-study	**0.223***	0.173	**-0.177***	**0.370***	0.057	-0.154	-0.034	1.000				
student % tech use	**0.262***	0.126	**-0.340***	**0.350***	-0.011	0.162	-0.151	**0.373***	1.000			
teacher % tech use	**-0.345***	-0.143	**0.290***	**-0.445***	0.062	0.105	0.027	**0.432***	**-0.439***	1.000		
% engaged	0.119	0.089	-0.119	0.153	-0.051	0.012	-0.104	0.123	**0.216***	**-0.208***	1.000	
tech need	**0.305***	0.048	**-0.304***	**0.274***	0.014	0.000	0.104	**0.389***	**0.509***	**-0.326***	0.146	1.000

*Correlation significant, *p*<.05.

Patterns of classroom arrangements

"Study activity" occurs more frequently with individual work and is negatively correlated with whole-class organization, while "whole class" and Group work often occur together. Group work is correlated with student-centered teacher roles. Student -centered teacher roles tend not to occur in the same period as teacher-centered orientations. However, student-centered teacher roles tend to appear in the same periods with student-study activities. Teacher-centered roles are negatively related to student-centered teacher roles. While these relationships may seem obvious, consider some of the relationships that do not occur: The appearance of teacher centered instruction is likely to appear across all observed student groupings and learning activities.

Teacher-directed activities and student creative activities are negatively related. Otherwise, these activities may occur in conjunction with any other student grouping or learning activity.

Patterns of technology use

The amounts of time that technology is used by students and teachers are related to individual and whole class groupings, student-centered teacher roles, and student study activities. In the case of groupings and roles, the relation between teacher and student technology use is reciprocal. Observers saw relatively more student technology use and less teacher technology use in classrooms with an emphasis on individual student work and student-centered teacher roles. (This same pattern was observed for small-group classroom organization, but the difference was not significant.) A lower proportion of time with student technology use and a higher proportion of teacher use were observed in classrooms with whole-class organization. Student and teacher technology use are negatively correlated. Student study activities were associated with more time spent in teacher and student technology use.

Technology need and technology use

Observers' ratings of the need for technology within a lesson approximated the size and direction of the various correlations with proportion of time in which students used technology. In classes where students were observed to use technology more, work as individuals, work with teachers who adopt student-centered roles, and engage in study activities, observers tended to rate the technology use as more essential to the lesson. In classrooms that emphasized whole-class instruction with the teacher using technology for a larger proportion of time, observers tended to rate technology use as less necessary to learning.

Student engagement and technology use

There is an inverse relationship between the amount of time teachers and students use of technology. Further, observers tended to rate engagement higher as student technology-use time increased and lower as teacher technology-use time increased. To make this more concrete, Table 4 lists the most common hardware and software—those observed in at least 10% of classrooms—along with the correlations between each technology's use and the other variables discussed so far.

Table 4. Correlations of hardware and software with context and technology use.*

Technology used by teachers (T) and students (S)	indv	sm. grps	whl. class	std-cent	tch-cent	tch-dir	std-creat	std-stud	std% time	tch% time	% eng	tech need
Presentation-T	-0.02	0.13	0.16	-0.04	0.06	-0.05	0.15	0.05	-0.04	0.05	-0.15	**0.23***
Presentation-S	0.04	-0.02	-0.05	0.07	0.06	**-0.22***	**0.29***	0.07	0.12	-0.10	0.11	0.15
Graphics-T	-0.02	0.03	0.01	-0.11	0.03	-0.10	0.11	0.02	0.06	**0.23***	0.02	0.16
Graphics-S	0.04	0.04	-0.10	-0.07	0.01	-0.12	0.18	0.02	0.16	-0.04	0.16	0.12
Word Proc.-T	-0.07	**0.30***	**0.25***	0.09	0.15	0.13	0.14	**0.35***	0.08	-0.16	-0.10	**0.17***
Word Proc.-S	0.09	0.13	0.03	0.11	0.12	0.04	**0.21***	**0.26***	0.14	**-0.27***	-0.02	**0.30***
Whiteboard -T	**-0.20***	-0.15	**0.26***	**-0.26***	0.07	0.11	-0.14	**0.31***	**-0.35***	**0.69***	**-0.19***	**-0.32***
Whiteboard -S	**-0.24***	-0.11	0.15	**-0.26***	0.02	**0.24***	**-0.22***	**0.36***	**-0.30***	**0.57***	-0.12	**-0.24***
Response Sys-T	-0.09	0.01	0.08	**-0.21***	0.07	**0.32***	**-0.31***	**0.20***	0.15	**0.31**	-0.03	-0.12
Response Sys-S	-0.06	-0.01	0.05	-0.12	0.08	**0.39***	**-0.33***	**0.22***	**0.17***	**0.35***	-0.02	-0.14
Web Browser-T	**0.31***	0.05	**-0.24***	**0.19***	0.12	**-0.22***	**0.28***	**0.50***	**0.36***	**-0.42***	-0.04	**0.42***
Web Browser-S	**0.21***	0.17	-0.05	0.15	**0.20***	0.00	**0.24***	**0.37***	**0.27***	**-0.21***	-0.04	**0.43***
Simulation-T	0.14	0.09	-0.02	**0.18***	0.13	0.09	-0.03	**0.31***	0.11	**-0.23***	-0.07	**0.25***
Simulation-S	0.08	0.15	0.03	**0.20***	0.17	0.04	0.10	**0.42***	**0.18***	**-0.33***	-0.01	**0.28***

*Correlation significant, $p<.05$.

The strongest positive relationships are between interactive white boards and teacher technology use (i.e., teachers with white boards use them a lot). Other strong associations are between web browsers and lessons in which observers rated technology use as valuable, and lessons that emphasized student study behavior. That is, web-based resources are student-centric tools that present opportunities that are difficult to duplicate by other means. As might be expected, the web technology correlations were mirrored by negative correlations with teacher technology use.

Interpreting data: The interactive whiteboard example

Care is warranted in interpreting these correlations. The data on interactive whiteboards is illustrative. Teachers told observers they were very appreciative of interactive boards. One of the programs being evaluated was devoted to providing the boards and associated training throughout several school districts. As might be expected, given that the boards are a presentation medium, they are positively associated with whole class instruction by the teacher. They are negatively associated with student-centered, individual, creative activities and with student use of technology in general. Typical use involved teacher lectures and demonstrations and student presentation of work. Some of their special features (hide/show of images and integration with student response systems) made them effective as formative assessment tools. Teachers who used the boards invariably cited the greater engagement of students compared to alternative forms of presentation.

Why then the negative correlation with engagement in Table 4? In classrooms with interactive boards, there is often no alternative. The board is typically mounted on top of an older dry-erase or chalk board. Once in place, it is used for everything from interactive simulations to the daily lunch menu. Observed engagement with effective lessons was sometimes offset by observed distraction during mundane activities that used the technology. Thus observers often rated the board as only “somewhat useful: other approaches would work as well”—when in fact no other approach was practical.

On the other hand, Table 5 does accurately represent the facts that whiteboards were primarily used by teachers and that high levels of teacher technology use, a variable associated with lower levels of student engagement (Table 3). Engagement was generally higher in dispersed-technology classrooms (labs or conventional classrooms with laptops) in which students were more likely to use the technology than were teachers.

This is not to say that technology necessarily dictates practice. Observers encountered a few whiteboard-equipped classrooms in which the teachers turned over operation of the technology to the students and then facilitated group use of these resources. This occurred in classrooms where teachers had at least one year of experience with the technology. Some of these instances involved interactive slates that allow the board to be operated from anywhere in the room. This tended to make the board more of a shared work space than a forum for “stand-and-deliver” presentations. These experiences suggest that flexibility in teaching with technology can be increased with experience and with more sophisticated tools.

However, there seems to be a path of least resistance with any technology. Whiteboards are designed for presentation, just as laptops are designed for use by individuals. Alternative uses require additional technology and/or more energy in terms of classroom management and lesson planning. If a particular technology is the only tool available, the path of least resistance will be all the more compelling.

Discussion

This analysis suggests a heuristic for decision-makers: If they choose a particular pattern to technology integration, it will put pressure on the learning environment to assume a certain configuration. Changing that configuration is possible, but alternatives may require further investment of time, money, and expertise.

Educational planners need to be aware of these pedagogical pressures, and relate them to their own priorities. A technology implemented in response to one need (e.g., formative assessment by the teacher) may have unintended consequences (e.g., reduced time or technology available for mastering hands-on technology skills.

A final note about this analysis is that it does not rely on exotic methodology, only on time spent observing and recording classroom events. The recording template is free and now operates on a common spreadsheet platform (http://istelearning.org/groups/icot-users-group/). The correlational statistics could conceivably be run within the same spreadsheet, and they are extremely easy to carry out within any dedicated statistical package. A school or district could replicate this study to identify its own instructional trends, evaluate the effects of new equipment or professional development, and otherwise support important decisions about technology in learning.

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