Large District Systemic Change: Four Years of Professional Development Data and ISTE Standards

Michael S. Radlick
Institute for Research on Learning Technology Visions

Kevin McGillivray
Institute for Research on Learning Technology Visions

Elizabeth T. McNamara
Open Systems, Inc.

Abstract

The effective use of educational technology and the ultimate impact of that use on student learning are influenced by a variety of factors, including the quantity and nature of professional development provided to teachers. This study analyzes four years of data on district-wide professional development within the large-district context of the Heidelberg Model Schools Program (HSMP). The study examines the quantity and patterns of professional development, as well as the relationship of professional development to skill sets as catalogued by the ISTE NETS Standards, as reported by administrators, teachers, and students. In addition to exploring the amount and types of all types of professional development (and the specific sub-set of technology-focused professional development sessions), this descriptive research study also examines the co-teaching aspect of the HSMP, and corresponding levels of focus by teachers on technology integration in their lesson plans.

Background:

This study reports on four years of professional development data in a large district, and the relationship of that data to the ISTE NETS Standards for administrators, teachers and students. The Heidelberg School District is presently one of five districts comprising the US Department of Defense Dependents Schools-Europe (DoDDS-E), and is supported under the Department of Defense Education Agency (DODEA). The Heidelberg district has been in its present configuration of schools since 2001 with 25 schools located on six complexes or bases in the Rhine River region of Germany. The district has approximately 11,000 students and 1,220 staff members, including teachers, administrators, and other educational support staff.

The HSMP (originally called the Hanau Model Schools Partnership after the cluster of schools in which it was first implemented) received funding for the first three years of implementation starting in 1995 through the National Science Foundation. The program expanded to the entire Heidelberg School District (and the schools it encompasses) and so was renamed the Heidelberg

Model Schools Program early in 2001. The following program statement defines the program:

> *The Hanau Model Schools Partnership models ways that school communities can bring technology into classrooms to support the best classroom practices which deepening students understanding of content. The goal is to employ technology to meet the most fundamental aims of systemic reform: (1) to support the implementation of standards-based reform in core content areas (2) to ensure that all students have equitable access to resources and best practices, and (3) to build capacity within schools to sustain reform objectives from within.*
> (From McNamara, Grant and Wasser; 1998)

Professional development for infusion into the classroom is only one of the four pillars of the HSMP, which also includes building a school and community planning process, connecting technology and curriculum, and technology leadership and management. The HMSP has continued for an additional six years to deliver professional development targeting the classroom integration and use of technology beyond the NSF funding, with the program now completing its tenth year. The program incorporates a strong teacher-mentoring component (called co-teaching) which focuses on putting content experts with strong technology skills into classrooms to help teachers understand how to use computer and network tools in the classroom and how to integrate technology into the curriculum. A substantial body of research exists on the planning, implementation, and impact of the HMSP (see www.hmsp.org). Within HMSP, professional development for all staff, including teachers, is delivered in a variety of ways, including a range of classes and co-teaching sessions on-site in schools and specialized sessions at the district's Professional Development Center located at the Rhine Main Base.

A series of electronic files incorporating the entire district's professional development delivery history evolved over the course of the program to capture increasingly more information about the professional development participation of staff. The files for the past four school years, although varying in detail, were the most complete and thus became the basis for this study. During the 2003-2004 school year, a total of 85 different professional development courses were tracked in the database. Of these 85 courses in the database, 44 were focused on technology tool use and software for curriculum specific applications. In the 2002-2003 school year, 88 professional development courses were delivered, of which 23 were specifically oriented towards technology. The 2000-2001 and the 2001-2002 school years included 7 and 13 professional development sessions focused on technology respectively. The total numbers of courses for these first two years were not available, only the technology-related courses.

It should be noted that the professional development data used in this study does not reflect the summer sessions of professional development provided to all staff. These data were excluded, although they involved the majority of district staff members, because the model for professional development during the summer did not include any direct classroom component or co-teaching. These workshops were important in the overall model, because they provided the springboard for co-teaching sessions during the school year. The summer sessions helped teachers to develop skill with the technology software tools, and also introduced teachers to the co-teaching consultants. Depending on the summer, a large percentage of the staff could have received up to an additional four sessions of professional development during the summer time period right before school restarted for the fall.

Theoretical Context:

While recognizing that teachers have generally felt unprepared to use computer tools in their classrooms, and felt even less prepared to integrate those tools into the curriculum (NCES, 2001), we know that professional development can help teachers to develop and deliver high-quality, technology-enhanced lessons that can improve student learning. The success of technology integration and use is dependent on a number of factors; among the most important being on-going professional development for teachers focused on curriculum integration (Becker and Reil, Sivin-Kachala and Bialo, and the ACOT research); and, access by teachers to the technology on a regular, on-going basis (Ringstaff and Kelly, and Norris et al). O'Bannon and Judge also summarized the aspects of professional development that led to successful technology-based learning. The features of success they emphasized from the research included: site-based training, training spread over time, training involving hands-on learning, training directly aligned with curriculum goals, and finally training that allows for follow-up support in the classroom. They also indicated the importance of teacher comfort with the technology and the importance of providing teachers with the opportunity to collaborate with their peers and to explore and reflect upon the use of technology in their classrooms.

All of these factors have been an integral aspect of the HSMP throughout its ten years. The HMSP program is based on a model of professional development and co-teaching which brings teachers together, and then supports and mentors them within their own classrooms as they experiment with new software applications and curricular approaches integrating technology. In its implementation, the HMSP reflects the seven "Factors of Technology Success" (Radlick) characteristic of successful, large-scale technology implementations.

Although the factors of successful professional development are widely known, the research implications of planning, implementing, and supporting a professional development program with these features on a large-scale systemic (district) basis are less clear. Expanding the research view from a classroom or a school to a district makes any research analysis substantially more complex. Furthermore, examining a large school district over multiple years of professional development adds further complexity to the research view. The perspective is only made more challenging by trying to relate this professional development and other school factors to the ISTE Standards. Few researchers have looked at the ISTE administrator, teacher, and student Standards in the kind of context in which this research study reports. Unfortunately, when we look at educational technology through this lens of a larger, district-wide perspective, the resultant view is not always as simple or as clear cut as that of a single classroom or single school lens. However, a systemic, district-level perspective is critical to any research approach that is focused on effecting changes in teaching and learning strategies using technology tools.

Data Sources:

The HMSP has developed a rich array of data relative to the professional development of teachers, as well as most recently the administrator, teacher, and student ratings on ISTE Standards. The following table summarizes the different sources of data used in this study.

Table 1: Data Sources

Type	**Description**
Professional Development Data - 2003-2004 School Year - 2002-2003 School Year - 2001-2002 School Year - 2000-2001 School Year	Individual staff level data on number of all professional development sessions (2003-2004 and 2002-2003), number of technology-related sessions and number of co-teaching sessions of professional development across four years (2000-2001 to 2003-2004). Data included school and complex for each staff member in the database for each year. Note: only technology sessions, along with technology co-teaching, were tracked in 2001-2002 and 2000-2001. Also, two complexes were not part of the Heidelberg District during the first of the four years (Heidelberg and Mannheim), and therefore teachers from schools in these complexes have only three years of data. The database identified a total of 1,041 teachers in the district at some point during the four years, of whom 645 had one or more technology-related PD course.
NETS Survey - Administrators - Teachers - Students o Grade 2 o Grade 5 o Grade 8 o Grade 12	Data collected in spring of 2004. Teacher data are individual responses, but without identification other than school. Administrator data are individual, but then averaged by building. Achievement of Student Standards for Grades 2 and 5 was reported by the teachers at that grade-level. Grades 8 and 12 student data were collected from students. All student results were provided as averages by building.
Lesson Plan Data	Lesson Plans (N=120) optionally submitted by individual teachers (N=89) as a part of their professional development and individually scored against a rubric examining integration of technology. Some teachers submitted multiple lesson plans.
Building Level Background Data	Number of students, number of teachers and number of computers per school building.

The database for the four school years encompasses 1,349 different staff members (1041 teachers), reflecting six complexes or clusters of schools, plus the district office (DSO), which in turn is comprised of 25 schools plus an “other” category for the educational technologist staff. The individual unit records were from staff members serving all the various functions within the district, including: teachers, administrators, education liaisons, and educational technologists. Since staff moved between schools and complexes (as well as entering or leaving the district during the course of four years), the number of staff members in any particular school year (as well as the total across the district) varied at any point in time. As a result, data for some staff members may be missing for some school years. For analyses by location, unless otherwise noted, data reflect the last (most current) posting of the individual. For purposes of the detailed analyses, only teacher data were used.

Methodology:

Copies of the district-wide Microsoft Excel staff database information were obtained for each school year. Following an initial editing and updating of the individual records to eliminate duplicates and address other obvious inconsistencies and errors in the data which resulted from inconsistent entry of names, data were entered into SPSS 12.0 for analysis. Data from the other sources were also entered into SPSS and ultimately merged into larger files.

During the spring of 2004, a paper-based survey of ISTE Standards was administered to all administrative and teaching staff, asking them to rate their respective technology skills based on the ISTE Standards. Separate administrator and teacher surveys were used. In addition, special surveys of second grade, fifth grade, and eighth grade were conducted relative to their perception of their students’ technology skills. Students in Grades 8 and 12 completed their own surveys.

Both the administrator and teacher surveys had six separate sub-sections reflecting the six major ISTE goals. The administrator survey had a total of 31 questions and the teacher survey had 23 questions. Individual teacher survey responses were made available, but without identification other than the school in which the respondent was teaching. Because individual and administrator survey results were provided, it was possible to calculate reliability coefficients for both surveys. The Cronbach Alpha for the Administrator ISTE Survey (N=51) was .934, while the Cronbach Alpha for the Teacher ISTE Survey (N=670) was .966. Both measures indicate very high reliability between items on the respective instruments.

Principal components Factor Analysis (Verimax Rotation) was used to examine the loadings of questions from both surveys. The results from the Administrator Survey factor analysis produced eight components, explaining 75.6% of the variance, while the Teacher Survey factor analysis produced three components, explaining 68.8% of the variance. Unlike the Administrator Survey, where most of the eight components or factors each had reasonable loadings, the Teacher Survey had a single component which explained 32.3% of the variance.

Responses to multiple questions were averaged together to form a measure for each of the six respective ISTE Standards, and a total score was also computed across all the questions. Each of the student surveys for each grade level had ten questions, and these ten responses were averaged and then all student responses in a grade within a school were averaged to create one score per building per grade level survey. Results from the separate surveys (administrator, teacher, student-grade 2, student-grade 5, student-grade 8 and student-grade 12) were aggregated by school in order to preserve anonymity of respondents. Because the ISTE data were not available at the individual staff level in a way that could be linked with the professional development data (due to confidentiality restrictions established by the district) the type of statistical analyses that could be used were constrained. A multivariate analysis with the teacher as the unit of analysis would have been the preferred methodological approach for all aspects of this study. However, this option was precluded because some key data elements were only available at the building level and not at the individual teacher or student levels. Analyses of individual teacher data were possible using building level categorical variables created from variables such as amount of professional development.

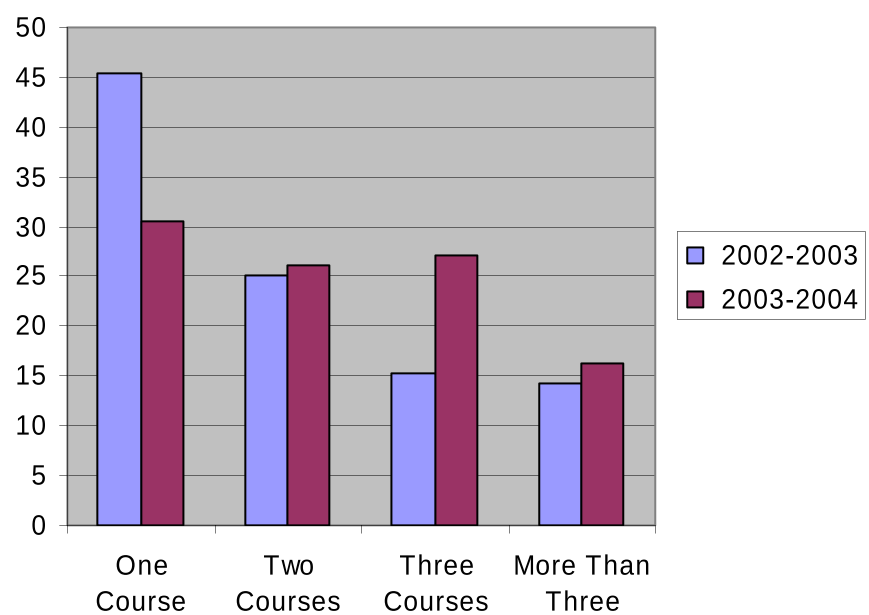
In order to examine relationships at the school level, means for key individual teacher data (where available) were created for each school, and then the rankings of those means were used in conjunction with the rankings of other school level measures to compute their correlated rankings (by calculating Spearman Correlation Coefficients) to examine the relationships between each pair of school level (N=25) variables reflecting the rank of the school.

Results

Research Focus 1: How much teacher professional development took place in the Heidelberg District over a four year period, and what was the pattern of that professional development?

Looking across four years of school-year HMSP teacher-focused professional development (2000-2001 to 2003-2004), we find the following results. First, the average number of <u>all teacher professional development courses or sessions</u> (which were typically one day and covered all topics, including technology-focused courses) delivered in 2002-2003 was 2.09 (N=447) and in 2003-2004 was 2.42 (N=617). Teachers took a total of 935 professional development sessions (technology and non-technology) during 2002-2003, and 1,495 sessions in 2003-2004. Based on the data, 341 or 36.4% of the 935 sessions in 2002-2003 and 829 or 55% of the 1,495 courses in 2003-2004 were technology focused. In 2002-03 of all teachers taking PD courses, 45.4% took one course, an additional 25.1% took 2 courses, and an additional 15.2% took 3 courses. The remaining 14.3% took more than 3 courses. The distribution of total courses in 2003-04 was 30.6% with one course, 26.1% with two courses, 27.1% with three courses, 8.1% with four courses, and 8.1% with more than four courses. Figure 1 below graphically presents these distributions.

Figure 1: Percent of Teachers Taking One or More than One PD Course by Year



The following table presents the view of technology-related professional development course sessions across four years of the HMSP.

Table 2: Average Number of PD Sessions for Technology and Technology Co-Teaching

	Average in 2000-01	Average in 2001-02	Average in 2002-03	Average in 2003-04	Average Across Four Years
Total Tech PD Courses	0.23	0.62	0.53	1.28	2.67
Number of Tech Co-Teaching Sessions	0.19	0.02	0.23	0.56	0.78

The low average number of courses taken in the 2000-2001 is not surprising, given some administrative changes in the district itself, and given the limited number of technology courses actually offered. However, the slight dip in 2002-03 may be due to other factors in the district, such as the shift away from the use of substitute teachers and release time for professional development. In addition during the 2000-2001 year, two complexes were just being integrated into the new Heidelberg district (Mannheim and Heidelberg), and therefore had very limited participation in the HMSP. The data show that during the four year period, the average number of years that teachers took at least one technology course was 1.4 years. We also see a highly positive and statistically significant correlation ($r=.690$, $p<.001$) between the number of years of professional development and the total number of technology professional development for teachers, suggesting that most professional development was spread out over multiple years. Teachers took courses over multiple years as they extended their knowledge and skills. The correlation between the number of technology professional development sessions and the number of co-teaching sessions is also positive and statistically significant ($r=.489$, $p<.001$), suggesting that only with increased professional development do teachers begin the process of co-teaching.

Examining the technology PD session results by complex and by school, we see significant differences at both levels (complex and school) and across years. Figure 2 presents the means and confidence intervals by complex, and Figure 3 presents the same data by school.

Figure 2: Mean Technology PD Across 4 Years By Complex
(With 95% Confidence Interval of Mean)

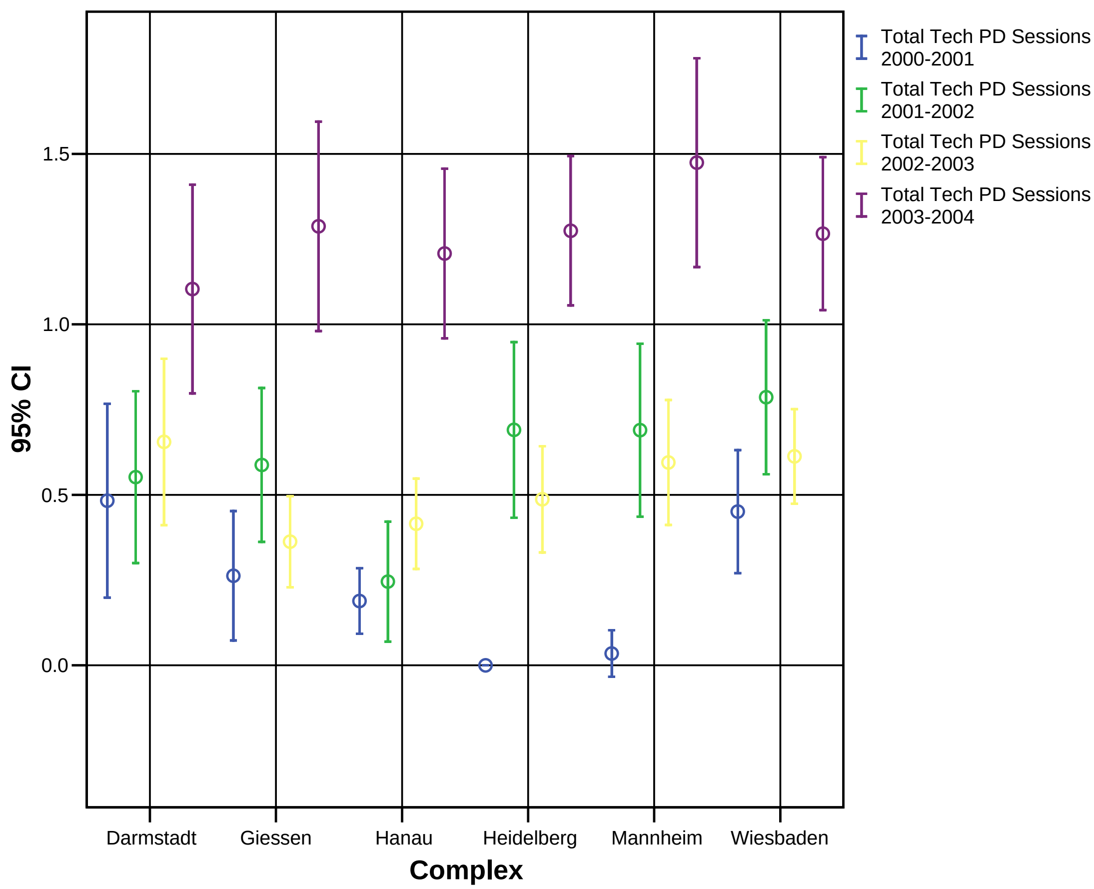
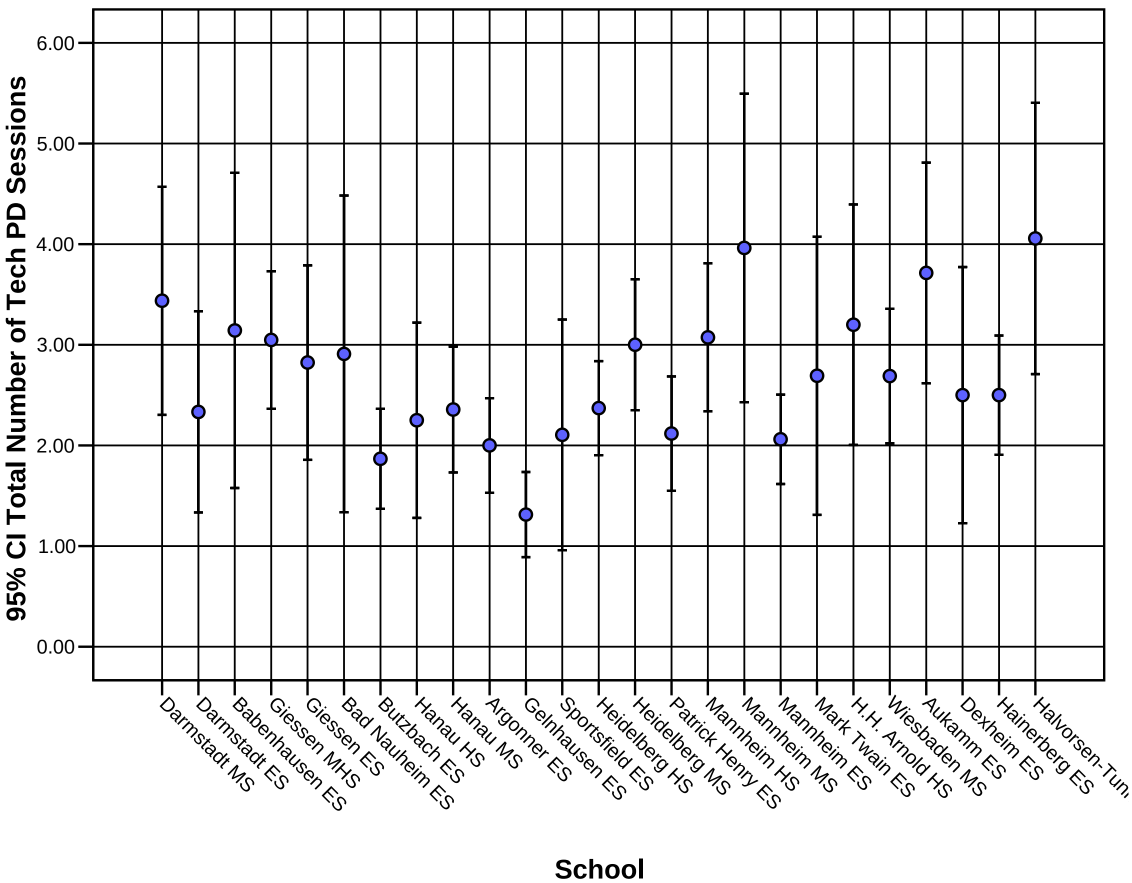


Figure 2 displays the means and 95% confidence intervals for all teachers taking technology professional development across four years. As shown, there is a wide variation between complexes. Figure 3 below presents teacher technology PD information overall, but by building. The buildings are arranged by complex. Again there is wide variation in the means between schools. An ANOVA run on the means for complex and schools shows that the differences are statistically significant for both complex (p =<.01) and school (p<.01). Examination by complex of the total number of years of professional development and the total number of co-teaching sessions show statistically significant differences by complex for years of professional development, but not number of co-teaching sessions. Examination of total years of professional development and total number of years of co-teaching by school indicated significant differences for both (p<.01).

Figure 3: Mean Technology PD Across 4 Years By School Building
(With 95% Confidence Interval of Mean)



There were also statistically significant differences between the means of elementary level schools and secondary level schools in terms of total number of PD courses taken in 2003-2004 (but not 2002-2003), number of years of technology-related professional development, total number of technology related professional development sessions, and number of co-teaching sessions. The means for the elementary schools were higher for both the total number of professional development in 2003-2004 and the total number of years of technology related professional development. The means for the secondary level schools, however, were higher for both the total number of technology-related professional development and the total number of co-teaching sessions.

Research Focus 2: What was relationship between ISTE Survey Results for Administrators, Teachers and Students? How do the ISTE results relate to other variables such as professional development and lesson plan data?

As noted, there were three separate ISTE surveys administered in the spring of 2004 to administrators, teachers, and students (or for grades 2, 5 and 8 teachers on behalf of students). The Individual, self-reported teacher surveys addressed the following six ISTE Standards:

1. Technology Operations and Concepts.
2. Planning and Designing Learning Environments and Experiences.
3. Teaching, Learning, and the Curriculum.
4. Assessment and Evaluation.
5. Productivity and Professional Practice.
6. Social, Ethical, Legal, and Human Issues.

The ISTE Teacher Survey was comprised of 23 questions, with each ISTE Standard structured to have two to five questions probing each of the six ISTE Teacher Standards. Teachers responded to each question on a 1 to 5 scale (1-Never, 2-Seldom, 3-Occasionally, 4-Frequently, and 5-Consistently).

Results from 670 classroom teachers, representing the 25 school buildings, were collected and analyzed. Only building-level identification was provided on the survey form, not grade level or unique teacher identification.

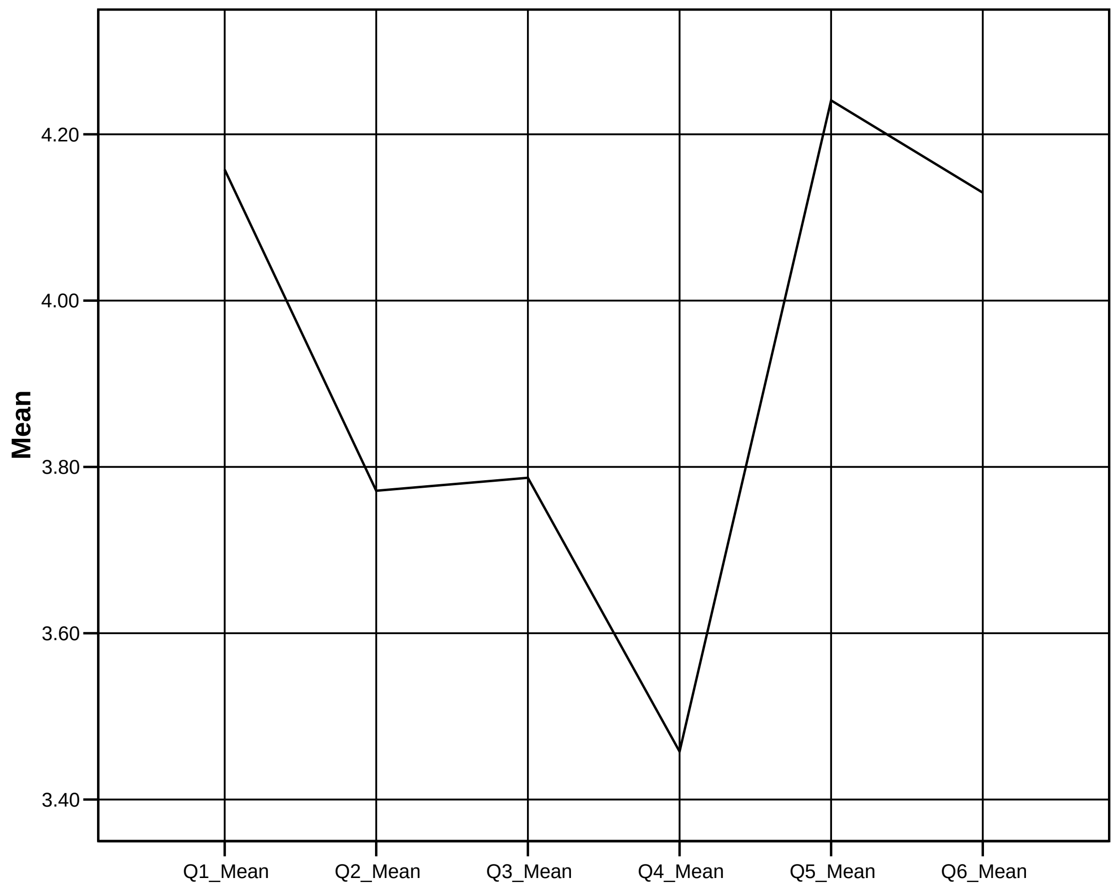
Examining the results from 670 ISTE Teacher Surveys, we see an average response between 3.4 and 4.46 across the 23 questions, and inter-item correlations between .353 and .840. The following presents these item statistics:

Table 3: ISTE Teacher Survey-Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	3.926	3.403	4.464	1.061	1.312	.100	23
Item Variances	.969	.646	1.377	.731	2.131	.044	23
Inter-Item Covariances	.535	.269	1.013	.743	3.759	.023	23
Inter-Item Correlations	.554	.353	.840	.487	2.381	.012	23

Calculating the mean response for teachers by Standard (based on the 1 to 5 response scale for related groups of questions), allows us to examine the relative positioning of teachers in terms of their development on a particular Standard. Figure 4 below displays the mean responses for the entire group of 670 teachers by ISTE NETS Standard (Displayed as S1 to S6 for Standards 1-6).

Figure 4: Mean ISTE Teacher Survey Results By Standards 1-6 (Q1-Q6)

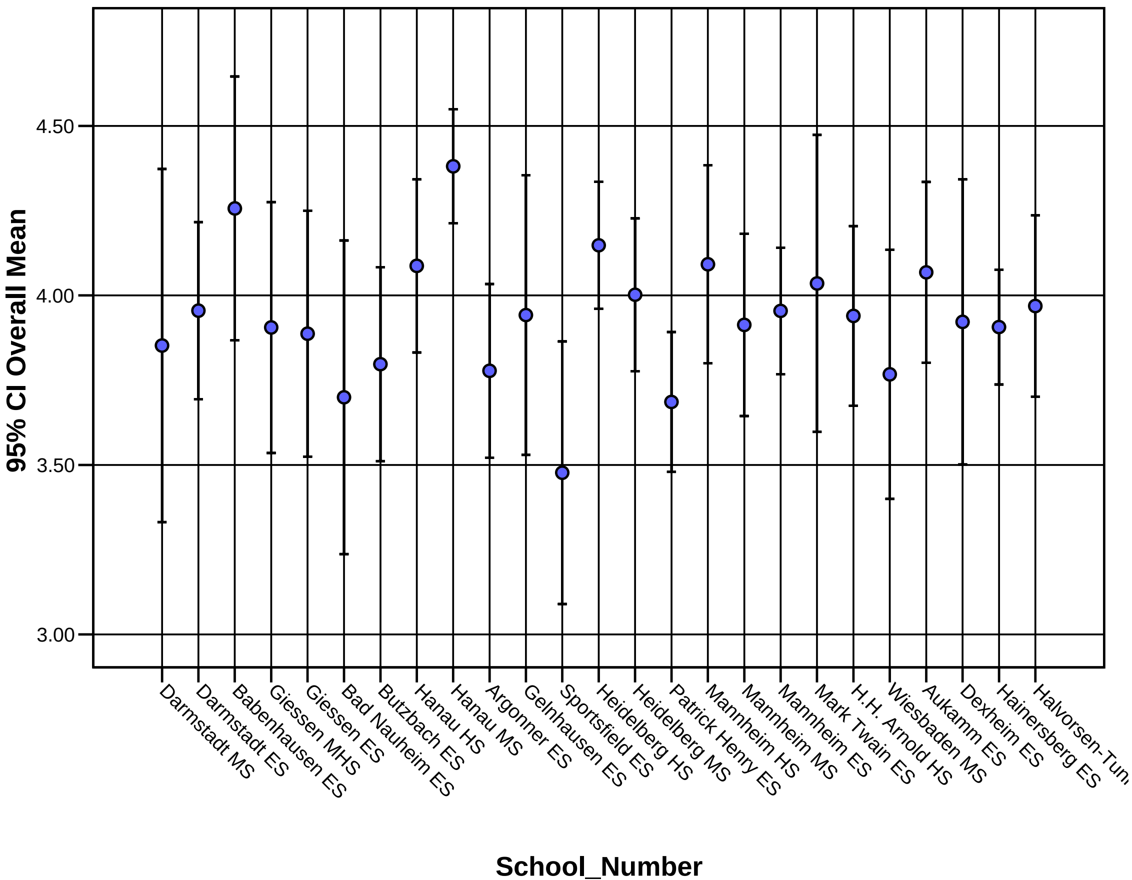


1. Technology Operations and Concepts.
2. Planning and Designing Learning Environments
3. Teaching, Learning, and the Curriculum.
4. Assessment and Evaluation.
5. Productivity and Professional Practice.
6. Social, Ethical, Legal, and Human Issues.

As exhibited in Figure 4, the lowest mean response by teachers was on Standard 4, followed by Standard 2 and Standard 3. The highest mean response was shown in Standard 5, followed by Standard 1 and then Standard 6. The lowest rated Standards (4, 2, and 3) deal with instructionally related actions in the classroom--Assessment and Evaluation (4), Planning and Designing Learning Environments and Experiences (2), and Teaching, Learning and the Curriculum (3) respectively and are all rated in the 3 range, which is at or slightly above

"Occasionally." Conversely, the more general skills and understandings reflected in Standard 5 (Productivity and Professional Practice), Standard 1 (Technology Operations and Concepts) and Standard 6 (Social, Ethical, Legal and Human Issues) were rated much more highly (above a value of 4- "Consistently" and approaching 5, which was identified as "Frequently"). The same order (with Standard 4 being the lowest, and Standard 5 being the highest) relative to the other standards remained, when analyzed by school, by grade level and by computer-to-student ratio groupings.

Figure 5: Mean ISTE Teacher Survey Results and Confidence Intervals by Building



An Analysis of Variance (ANOVA) was computed on the means for the teachers in the 25 buildings. The results showed a statistically significant difference between buildings relative to the Over Mean calculated across all six Standards ($p <.01$) as well as individual Standards 1, 2, 3 and 4). Standard 5 was statistically significant at the .05 level, but the difference in means between schools on Standard 6 was not statistically significant. An analysis of the means for complexes (groups of schools) indicated no statistically significant differences in means for any of the individual Standards or for the overall mean of teachers.

Other Factors

As noted earlier, the ISTE Teacher Survey data were provided at the teacher level, but without any identification other than school. To examine differences in the ISTE Teacher Survey results, a variety of school-level categorical measures were created from a number of the other variables, including grade level divisions, amount of computers, ISTE Administrator results, and ISTE Student results.

Grade Level Analysis: The 25 schools were divided into two groups (elementary level and secondary level-MS and HS), and then the mean ISTE Teacher Survey results were examined relative to these two levels. The ANOVA results show a statistically higher mean result (p. <.01) for the Overall Survey Results for the secondary level schools, as well as for results on five of the six individual ISTE Standards (Standards 1-5). There was no statistically significant difference between grade level means for Standard 6. The results show that teachers at the secondary level rated themselves significantly higher in terms of the ISTE survey than their colleagues at the elementary levels.

Amount of Computers: The number of computers and the ratio of students to computers were collected for each school in the HMSP. The computer data represented the computer count as of the summer of 2004, and showed a total of 4,434 computers available for 10,430 students, and creating an overall student to computer ratio of 2.32 to 1. The student to computer ratio varied across the district from 1.26 to 1 all the way to 3.21 to 1 with higher ratios indicating more students for each computer. The schools were divided into four groups or quartiles, based on the ranking of computer to student ratio for the school (best being ranked lowest and worst being ranked highest), and then these four groupings were used to compare teacher results on the ISTE Teacher Standards. An Analysis of Variance of the means for the Six Standards, as well as the Overall Teacher Mean across all questions on the ISTE Teacher Survey indicated no statistically significant differences based on the student to computer ratios in schools. Restated, the results show that the means responses for teachers in schools with either higher or lower student to computer ratios did not differ in terms of their self-reporting on the ISTE Teacher Survey.

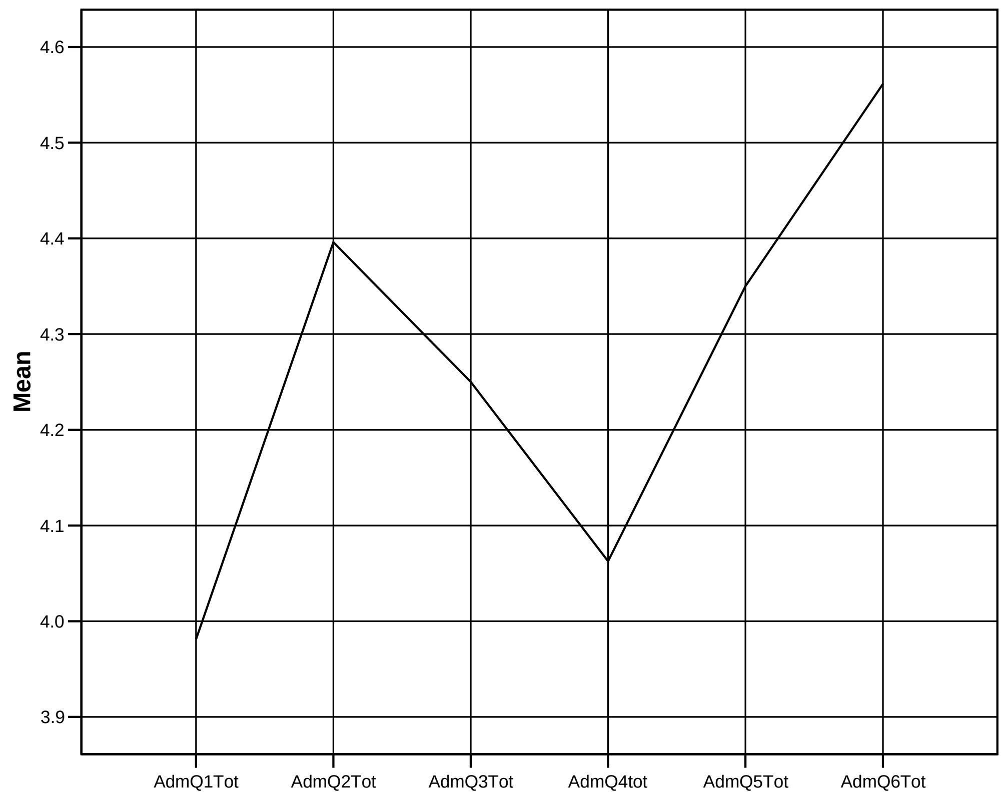
ISTE Administrator Survey: The ISTE Administrator Survey was comprised of 31 questions (with a rating scale of 1=Never, 2=Seldom, 3=Occasionally, 4=Frequently and 5=Consistently) addressing the following Six Standards:

1. Leadership and Vision (AdminQ1A-F).
2. Learning and Teaching (AdminQ2A-E).
3. Productivity and Professional Practice (AdminQ3A-F).

4. Support, Management and Operation (AdminQ4A-E).
5. Assessment and Evaluation (AdminQ5A-D).
6. Social, Legal and Ethical Issues (AdminQ6A-E).

For analysis purposes, results from each individual administrator's questions were averaged by ISTE Standard, as well as overall. The following figure presents these summary results by ISTE Administrator Standard, across all buildings. Standard 1 (AdmQ1Tot) is the lowest and Standard 4 is the second lowest (AdmQ4Tot). As noted above, administrators in the 25 buildings rated themselves, on average, between "Occasionally" and "Frequently" on all the Standards except for Standard 1.

Figure 6: ISTE Administrator Survey Results.



1. Leadership and Vision (AdminQ1).
2. Learning and Teaching (AdminQ2).
3. Productivity and Professional Practice (AdminQ3).
4. Support, Management and Operation (AdminQ4).
5. Assessment and Evaluation (AdminQ5).
6. Social, Legal and Ethical Issues (AdminQ6).

In order to conduct an Analysis of Variance on the ISTE Teacher Survey Means (using the ISTE Administrator Survey results as the independent variable) the administrator results were averaged by administrator per building for each ISTE Standard, and then converted into an administrator quartile value from 1 to 4 with 1 being the lowest and 4 being the highest. The administrator quartiles were then used as the independent variable to examine the means for ISTE

Teacher Survey results for each of the Six Teacher Standards (and Teacher Overall). The results of these multiple ANOVAS exhibit a general trend of increasingly higher mean ISTE Teacher Survey results for each higher ISTE Administrator quartile. That is, the higher the administrative self-rating, the higher the teacher rating. In addition, many of these differences were statistically significant. Examining the Overall ISTE Teacher survey results in terms of the quartiles for the overall ISTE Administrator survey results, we see the lowest Mean ISTE Teacher survey results at the lowest ISTE Administrator quartile (3.78), with the other three ISTE Administrator quartiles at a value of 3.9 or higher. This difference is statistically significant ($p<.05$). The only exceptions to this pattern are the quartiles for ISTE Administrator Standard 4 which demonstrate very similar means (and no statistical difference) on the ISTE Teacher Survey across all of the ISTE Teacher Standards (1-6 and Overall). Using the same Overall ISTE Administrator quartiles to examine the means of the individual ISTE Teacher Standards, we see the same general pattern (higher teacher survey results in the higher administrator quartiles) and statistical significant differences ($p<.01$) for ISTE Teacher Standards 1, 2, and 4.

Looking at individual Administrator Standards shows that administrator vision (Standard 1) exhibits a statistically significant link to Teacher Standards 2, 3, 4 and Overall ISTE Teacher($p<.05$). Administrator Standard 3 is significantly linked to ISTE Teacher Standard 1, 2,3,4,5, and Overall ($p<.01$). The quartiles for Administrator Standards 5 and 6 also present the same kinds of statistically significant differences in ISTE Teacher Survey means with a similar increase in means from lowest to higher quartiles.

Student Data: Surveys related to the ISTE Student Standards were administered across all the buildings. The student data for Grades 2 and 5 were reported by the students' teachers at that grade-level. The Grade 8 and Grade 12 ISTE Student data were collected from students themselves. All ISTE student results were provided for this research as a building average. Since the grade level patterns varied across buildings, some schools had multiple levels of survey results (e.g. Grades 2 and 5). To examine the relationship of ISTE Teacher Results with those of students, each group of grade-level survey results was divided into quartiles. These quartiles were then used in an ANOVA test of means across the quartiles-generating four sets of analyses (grade 2, grade 5, grade 8, and grade 12). To address the problem associated with small numbers of schools at any grade level, an Overall Student ISTE Standards measure was created by taking all the survey results across all grades and transforming them into the same quantitative scale through a linear transformation. Where multiple grade level surveys were available for a school, they were averaged by grade level results into a single building level measure. Quartiles were created from this Overall Student ISTE Standards measure, and were used as the categories in an ANOVA test of means of the Teacher ISTE Survey results.

The average ISTE Teacher results examined by quartile for Grade 2 Student show higher teacher survey results corresponding to higher quartiles of the Grade 2 ISTE Student results for each of the six ISTE Teacher Standards, as well as for the Overall ISTE Teacher survey results. However, none of the differences were statistically significant. Grade 5 ISTE Student results exhibit less clear relationships, with a few of the lower quartiles of Grade 5 student results exhibiting higher ISTE Teacher results. There was a statistically significant difference between means of ISTE Teacher Standard 4, based on the quartiles for ISTE Student Grade 5 (p. $<.05$). Grade 8 ISTE Student results presents a different pattern, with the ISTE Teacher Survey means displaying an inverse relationship with the lowest Teacher Survey means generated for the highest Grade 8 ISTE Student Survey quartiles. There were statistically significant differences ($p <.05$) in the Teacher ISTE Survey means for Standards 3, 4, 5, 6 and Overall in terms of the Grade 8 Student quartiles. Differences in the mean ISTE Teacher Survey results for quartiles of Grade 12 ISTE Student Survey results have a mixed pattern as well, although the highest Teacher Means across all six Standards and Overall are exhibited in the lowest quartile for Grade 12 ISTE Student results. In no case was the difference between means of ISTE Teacher Survey results statistically significant, however.

Examining the Overall ISTE Student Survey created across grade levels, we again see that the mean ISTE Teacher Survey results across all six ISTE Teacher Standards, as well as ISTE Teacher Overall, was highest for the lowest quartile of the Overall ISTE Student results. However, the relationship is not linear, since the highest quartile of Overall ISTE Student results also had relatively high Teacher Survey means. The differences between means of ISTE Teacher Survey results were statistically significant ($p<.01$) across Overall Student quartiles for all ISTE Teacher Standards (1-6) as well as for the Overall ISTE Standards for Teachers. It appears that the relationship between Overall ISTE Student Survey results and ISTE Teacher results is not positive and not linear. Unfortunately, the limitations of the data preclude more detailed investigation of this pattern.

School Level Analyses

The second methodology used the school as the unit of analysis (N=25) and examined the relationship between the ranking of the buildings on all the professional development, ISTE survey, and other data. The analysis generated a nonparametric statistic called a Spearman correlation coefficient. This statistic (call rho or *ρ)* defines relationships between pairs of variables, and is similar to a traditional Pearson correlation. Like the Pearson, the Spearman ranges from -1.0 to +1.0. Although less powerful statistically than the Pearson correlation, the Spearman correlation makes no assumptions about the normality of the data. The reason for using this methodology was to more closely examine linkages or relationships between variables, something that cannot be done with statistical tests of means such as the ANOVA. This approach also circumvented, at least partially, the problem of data at multiple levels (individual and building). Rankings were based on either a school measure itself or a mean of the variable (in instances where there were actually multiple measures per school such as the ISTE Teacher Standards results). The rank order variables were then used to calculate Spearman correlation coefficients to define the relationships between variables.

Examining the variables representing amount of educational technology related professional development delivered over the prior four years with the ISTE Teacher Survey Results, we found positive and modest Spearman correlations (defined as rho or *ρ*) in the range of .31 or higher for ISTE Teacher Standards 1, 2, 3, and 5. However, these correlations were not statistically significant ($p > .05$). The amount of educational technology related professional development was significantly correlated with the amount of co-teaching in the school ($\rho = .879$ $p < .01$), that is schools in which there was more professional development focused on technology also had more co-teaching activities occurring in them.

There was a high positive correlation between the total amount of professional development (technology and non-technology) in 2002-2003 and the ISTE Teacher Standards, with two of the relationships being positive and statistically significant—Teacher Standard 1 and 2002-2003 Total Professional development ($\rho = .507$ $p < .01$) and Teacher Standard 5 ($\rho = .500$ $p < .01$). This relationship is understandable since these two standards reflect the two most focused upon areas of professional development, basic operation and productivity related uses of technology such as administrative applications—which were a large focus in the district.

In examining the relationship in schools between the ISTE Teacher Survey results and the ISTE Administrator results we see a majority of modest to large positive correlations, many of them statistically significant, including the Overall Teacher Survey Mean and Overall Administrator Survey Means which were positively correlated at .400 ($p < .05$). This result confirms that administrators that rated themselves higher on the ISTE Administrator Survey also had teachers who rated themselves highly on the ISTE Teacher Survey. The Overall Teacher Survey Mean was also correlated positively with many of the individual Administrator Survey Standards (except for Administrator Standards 4 and 6 which had very small, but negative correlations). Administrator Standard 3 was statistically significant ($\rho = .406$, $p < .01$) with the Overall Teacher Survey Mean. The Overall Administrator Survey mean was correlated positively with all of the individual Teacher Standards, and Teacher Standards 2 and 4 were correlated at .397 and .588 respectively (statistically significant at least at $p < .05$). Administrator Standard 1 (Leadership and Vision) had a statistically significant ($p < .05$) positive correlation with Teacher Standard 2 ($\rho = .420$) and Standard 4 ($\rho = .566$, $p < .01$). Administrator Standard 3 (Productivity and Professional Practice) had a statistically significant correlation ($p < .01$) with Teacher Standard 1 ($\rho = .486$) and Teacher Standard 2 ($\rho = .480$, $p < .01$), as well as with Teacher Standard 4 (ρ=.420), Teacher Standard 5 (ρ=.406) and the Overall Teacher Survey (ρ=.408). Administrator Standard 5 (Assessment and Evaluation) was correlated positively and significantly ($p<.05$) with Teacher Standard 4 (ρ=.452, $p<.05$).

The relationship of the ISTE Administrator and ISTE Teacher survey results with the student results presents a less clear picture. The correlations between the Grade 2 Student results and the Administrator results display positive, but non-significant, relationships. The correlations between ISTE Administrator survey results and all other grade levels (5, 8, and 12) are negative, except for that between Administrator Standard 1 and Grade 12 Student Results and between Administrator Standard 6 and Grade 12 Students, both of which are large, positive correlations, but not statistically significant. The correlations between both Administrator Standards 2 and 3 and Grade 12 Students are large and statistically significant ($p<.05$) negative correlations (-.913 and -.884 respectively). Examining the ISTE Overall Student results, we find small negative (but non-significant) relationships with all the ISTE Administrator results, including Standards 1-6 and the Overall ISTE Administrator correlations.

Examining the relationship between the ISTE Teacher Survey results and the ISTE Student results, we see a pattern similar to that between the ISTE Administrator Survey results and the ISTE Student results discussed in the prior paragraph, with some correlations being negative. Most of the Grade 2 and Grade 5 results were positively correlated with the Teacher Survey Results for Standards 1-6. However, the majority of correlations for Grades 8 and 12 with the Teacher Standards were negative. The only statistically significant ($p<.05$) relationships were Teacher Standard 3 and Grade 8 Student Survey (-.841), Teacher Standard 6 and Grade 8 Student Survey (-.773), and Overall ISTE Teacher Survey and Grade 8 Student Survey (-.786, $p<.05$). It is difficult to explain why the correlations for grades 8 and 12 were almost uniformly negative, suggesting that the higher teachers in the school ranked, the lower their students ranked. Because the reduced number of schools (N) used in the calculation of the Spearman Correlation of any of the ISTE Student variables (due to missing grade levels) these relationships are highly variable and their statistical use is limited.

The relationship (correlation) of the overall student ranking on the ISTE Student Standards with the overall ISTE Teacher Survey results is negative (ρ = -.342), but not statistically significant. The Overall ISTE Student results were also negatively correlated with all Six ISTE Teacher Standards, with the correlation with Standard 6 being statistically significant (ρ= -.412, $p<.05$).

Although not statistically significant, there were modestly high, negative correlations between the ranking of schools in terms of their computer-to-student ratios and other teacher related variables such as the amount of professional development, amount of technology related professional development, and the ISTE Teacher Survey results. The direction of this relationship suggests that as teachers have more computers they do take more professional development and also reflect higher ISTE Survey results. Conversely, the correlations between computer-to-student ratio rankings and both ISTE Administrator Survey results were modestly high, and uniformly positive, but not statistically significant. Correlations with all the ISTE Student measures were generally very low and varied between positive and negative.

Lesson Plan Data

As an integral part of their technology-related professional development, teachers were encouraged to submit lesson plans which they intended to use in the classrooms. These lesson plans were intended to reflect the technology integration and tool use emphasis that were integral to all the professional development in the HMSP. Lesson plans were reviewed and rated by an independent evaluator, and then the ratings were used for analysis. A total of 89 teachers submitted 120 lesson plans, with 10 people submitting 2 plans, 4 submitting 3 plans, and 1 person submitting 4 plans.

Selecting only the subset of teachers submitting at least one lesson plan we find modest, positive, and in some cases statistically significant, correlations between the number of lesson plans submitted and the number of years of technology professional development (ρ =.227 <.05), amount of co-teaching (ρ =.181 NS) and total number of technology professional development sessions (ρ=.242, p<.05). The correlations between the lesson plan integration ranking were of modest size and positive (and statistically significant as noted) for the following variables: Overall ISTE Administrator Survey ranking for building (ρ =.218, p<.05), ISTE Teacher Standard 1 ranking for the buildings (ρ=.185, NS), Grade 2 ISTE Student Survey Results for building (ρ =.307, p<.05), Discussion, and Grade 8 ISTE Student Survey ranking for the building (ρ =.476, p<.01). The relationships between the lesson plan ranking were negative, but not statistically significant, in terms of the correlation with the number of number of years of technology professional development (ρ =-.124, NS), number of technology-related professional development sessions (ρ =-.004, NS), and number of co-teaching sessions (ρ =-.128, NS).

Of course, this subset of lesson plan data, representing such a small group of teachers (N=89), makes it difficult to base any strong statement about either professional development or ISTE Standards.

Discussion

Any examination of a large school district system, with the size of and complexity of Heidelberg, is wrought with substantial challenges. Similar to many urban districts, Heidelberg must address a highly transient student population, along with an organization that can be quickly and severely impacted by changes in world events. This complexity is particularly true in a study of this type that is looking at administrator, teacher and student survey data in conjunction with four years of professional development data and other building level factors – teacher mobility between buildings, as well as within and outside the district, for example. Despite these complexities, this study is clearly supportive of (or at a minimum suggestive of) a number of key relationships between professional development, ISTE Standards, and other school factors.

Four Years of Longitudinal Professional Development Data

First, over the four year period and during the regular school year, teachers in the Heidelberg District took increasing numbers of professional development sessions focused on technology. The average of 2.67 sessions per teacher across the four years may seem low, but over the course of the four years, 1,041 teachers taught in the district, and of those, 645 took at least one technology-related professional development course. The data also show that over the course of four years the average number of school years that technology-related courses were taken was 1.4 years. We can also see that increasingly, teachers opted to take more technology-related courses as they were offered.

Second, we can see that as more technology-related professional development courses were offered, teachers were increasingly willing to co-teach their lessons. There was a high and statistically significant correlation between the number of technology-professional development sessions that a teacher took and number of co-teaching sessions in which teachers participated ($r=.489$, $p<.01$). This is not surprising, since teachers typically want to feel comfortable with the technology and how to integrate it into their lessons before they bring a colleague/mentor into their classroom.

Third, there were statistically significant differences in the mean number of technology related professional development taken by teachers (as well as number of co-teaching sessions) based on the complex and school in which they were teaching. Similarly, there were statistically significant differences between the means of elementary and secondary grade level divisions of the teachers' total number of professional development courses (2003-2004), as well as the number of years of technology professional development, total number of technology-related professional development sessions, and total number of co-teaching sessions. Teachers in the secondary-level schools clearly took more technology-related courses and also co-taught more than their elementary counter-parts. At least in the last year (2003-2004), elementary teachers took more overall professional development, including, but not limited to technology courses.

ISTE Survey Results and Other Variables

First, in examining the ISTE Teacher Survey results by Standard, we see that the lowest means across all teachers was on Standard 4 (which focuses on Assessment and Evaluation), followed by Standards 2 and 3 (Planning and Designing Learning Environments and Teaching Learning and the Curriculum). All three of these ISTE Standards related to concrete concepts and practices involving computers in the classroom. The other, higher rated Standards deal with more general areas, or the use of technology for teacher productivity, with Standard 5—which was the highest rated Standard. These results confirm the typical progression of teachers from a focus on computer use for personal tasks (Standard 5) and using basic operations and practices (Standard 1) and then moving on, based on on-going professional development, to the integration and use of technology within the classroom teaching and learning environment.

Second, an analysis of the ISTE Teacher Survey results shows statistically significant differences between the means for teachers analyzed by school but not by complex for the Overall Teacher Mean, as well as for Standards 1 through 5. These standards are related more directly to operation and integration of the computer. There were no differences between schools on Standard 6 (which is focused on more general policy issues related to social, ethical and legal uses of the computer).

Third, statistically significant differences were also found between the mean ISTE Teacher Survey results (across the ISTE Overall and Standards 1-5), based on grade level divisions (elementary/secondary). Secondary level teachers consistently rated themselves higher in terms of the ISTE Standards. As noted above, secondary level teachers also took more professional development defining a positive relationship or linkage between the amount of professional development and the ISTE Teacher Survey results.

Fourth, in terms of the number of computers in a school (student-to-computer ratio) and the ISTE Teacher Standards, there was no relationship identified. The mean results for the ISTE Teacher Standards across four quartiles of student-to-computer ratios show no statistically significant difference between the quartile levels. Within the Heidelberg District, regardless of the differences between sites in terms of the amount of computer access available to teachers (ranging from 1.26 student to computer to 3.21 students per computer), there was no difference seen in ISTE Teacher Survey results.

Fifth, relative to ISTE Administrator Standards survey results we see a general pattern of higher ISTE Administrator results (on all but Administrator Standard 4) for a building being linked to higher ISTE Teacher Survey results.

Sixth, the patterns of ISTE Student results by grade level and overall were unclear. The two lower grade levels (2 and 5), which were teacher-reported data, show some evidence of a positive relationship with ISTE Teacher Survey results based on the means of the teacher surveys, analyzed by quartile of student result. However, the student results from the higher grade levels (Grades 8 and 12), which were student reported, show a general inverse relationship, with higher mean ISTE Teacher Survey results at the lowest quartiles of ISTE Student results. The Overall ISTE Student quartiles (based on all student surveys, equalized to the same scale across grade levels, and ignoring the fact that grades 2 and 5 were teacher reported) show the same statistically significant and inverse pattern across all ISTE Teacher Standards 1-6 and Overall. Explaining why teachers who rate themselves higher on the ISTE Teacher Standards should have students who rate themselves lower on the ISTE Student Standards, or converse, teachers who rate themselves lower should have students who rate themselves higher is perplexing. Without individual student survey data results, it is impossible to pursue the question statistically. Perhaps teachers who rate themselves lower on the ISTE Teacher Standards are being more self-critical because they know more. Or possibly, as teachers start to integrate and use technology more, their students become more aware of what could be done in the classroom and look at technology with a more critical eye.

Seventh, the lesson plan data show general relationships in a positive direction (more professional development with technology and more co-teaching resulting in higher rated lesson plans). There was also a positive and statistically significant relationship between the Overall ISTE Administrator ranking for the building and the ranking of the lesson plans for that building. The relationship between the Overall ISTE Teacher ranking and the lesson plan rankings was positive, but not statistically significant.

The strong positive relationship between the ISTE Administrator Overall rankings and the ranking of lesson plans suggests a leadership function at the school level, perhaps for encouraging teachers to be more actively engaged in their own professional development. The lack of significant relationships between ISTE Teacher rankings and also rankings of the amount of professional development does raise some question about how the step to develop lesson plans is mediated. The positive (but not statistically significant) relationship between ranking on co-teaching and lesson plan ranking is more in line with the expectation that teachers who take more technology professional develop, and who co-teach, will develop more lessons that integrate technology.

Conclusions

The Heidelberg Model Schools Program exhibits many of the characteristics of a large-scale systemic initiative to change teaching and learning. The data show substantial increases in technology-related professional development, and the positive linkage of that professional development with co-teaching and number of lesson plans generated. Positive relationships were also uncovered between ISTE Administrator results and ISTE Teacher results. Clearly there were differences in ISTE Teacher and ISTE Administrator results relative to schools, but these differences were not attributed to the number of computers available in the school. More likely, it is the result of the community and administrator factors that make up the texture of the school itself and the planning and implementation of technology in that school. The ISTE Student results were more equivocal. Following the administration of the same surveys this year across all grade levels and involving all student responses at grades 5 and above, the individual student data for a school will be made available for analysis. These individual student responses by student, by school, will allow more detailed review.

Additional research into how professional development is delivered, and how teachers participate in the professional development, is crucial to our understanding of how school districts can effect changes in teacher classroom strategies and approaches. The hope is that with this next year's data, it will be possible to better understand the relationships and how they ultimately impact teaching and learning.

Limitations of this Study

There were a number of data-related limitations of this study that precluded certain options for statistical inquiry and follow-up. The lack of individual ISTE Survey data that could be linked to the professional development data was one of the most significant limitations. Similarly, the requirement to use means for student data at the building level, made additional analyses impossible. Some inconsistencies of individual records in the professional development database, particularly within the first two years (2000-2001 and 2001-2002) made analysis challenging. The fact that the ISTE data represented a single point in time was another limitation, although the re-administration of the surveys (Administrator, Teacher and Student) across the district this spring will provide a stronger opportunity to make comparisons and to show changes within and across buildings.

Contributors

Michael S. Radlick (Ph.D.) is an educational technology researcher with his own independent consulting practice. He is president of the Institute for Research on Learning Technology Visions, Inc., a not-for-profit organization (501c3) committed to research on educational technology. He has had a long career working with technology in education, and served as the Director of Planning, Evaluation and Technology for the New York State Education Department for 16 years in addition to teaching and school administration experience. His interests include planning, researching, and writing about the impact of large-scale technology implementations. He is also working with Open Systems, Inc. as a consultant on a number of technology planning and research projects. He can be reached at mradlick@learntechvisions.com

Kevin McGillivray (M.A.) is an independent consultant and the former Educational Technology Director of the Heidelberg Model Schools Program in Germany, and a former teacher. Presently, he is a director on the board of the Institute for Research on Learning Technology Visions, Inc. He is working with both Open Systems, Inc. and ISTE on a number of projects related to the implementation and use of educational technology. He can be reached at Kevin@mcgillivray.org

Elizabeth T. McNamara (Ed.D.) is an educational technology consultant working with schools across the northeast. She is the Vice President for Educational Programs at Open Systems, Inc. She was formerly with TERC and served as the project director for the HSMP under the original NSF funding. She has remained involved with HMSP up to the present as a project director and researcher. She can be reached at emcnamara@ostnet1.com

References

ACOT-Apple Computers, Inc. Changing the Conversation About Teaching, Learning & Technology—A Report on 10 Years of ACOT Research. Available: http://www.apple.com/education/k12/leadership/acot/pdf/10yr.pdf.

Becker, H.J. & Reil, M. (2000) Teacher Professional Engagement and Constructivist Compatible Computer Use. (Report No. 7). Irvine: University of California, Irvine Center for Research on Information Technology and Organizations. Available: http://www.crito.uci.edu/tlc/findings/report_7/report7.pdf.

Davidson Wasser, Judith. (No.3, February 1998). Using Technology to Support Systemic Education Reform. Research Monograph TERC, Cambridge, Massachusetts.

Davidson, Judith; McNamara, Elizabeth; McGillivray, Kevin. (Sept. 1999) Broad and Deep: Achieving Full-School Change with Technology, "Electronic Schools. Available from Electronic Schools: http://www.electronic-school.com/199909/0999f5.html

McGillivray, Kevin. (1999). The Tool Kit: An Innovative Approach to Technology Integration in Networked Schools, "Learning & Leading With Technology."

McGillivray, Kevin. (November/December 1998; No.6) Critical Components of Technology Professional Development, "LNT Perspectives," http://www.edc.org/LNT/news/Issue6/feature.htm - Hanau.

McGillivray, Kevin. (Sept., Oct., Nov., 2000). The Educational Technologist as a Curriculum Specialist, "Learning &Leading with Technology,"
Available from Learning & Leading with Technology in 3 parts - .pdf format.
Part 1 - Help Outside the Classroom
Part 2 - Help Inside the Classroom
Part 3 - Help Beyond the Classroom

McNamara, Elizabeth; Miles Grant, Cathy; and Davidson Wasser, Judith (March, 1998). Using Technology to Support Systemic Education Reform. Research Monograph, TERC, Cambridge, Massachusetts.

National Center for Educational Statistics. (2001). Teacher preparation and professional development. Washington, D.C. http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2001088

Norris, C.; Sullivan, T.; Pirot, James; and Soloway, Elliot. (2003, Fall). No Access, No Use, No Impact: Snapshot Surveys of Educational Technology in K-

12. Journal of Research on Technology in Education. Pages 12-27. Vol 36, No.1. 2003.

O'Bannon, Blanche; and Judge, Sharon. (2004). Implementing Partnerships Across the Curriculum with Technology. Journal of Research on Technology in Education. Pages 197-216. Vo 37, No. 2.

Radlick, Michael S. (1998). In *The Superintendent of the Future—Strategy and Action for Achieving Academic Excellence*. Spillane, Robert R. and Regnier, Paul (editors). Aspen Press.

Ringstaff, Cathy and Kelley, Loretta. (2002) The Learning Return on Our Educational Technology Investment. A Review of Findings from Research. WestEd. Available: http://www.WestEd.org/online_pubs/learning_return.pdf

Sivin-Kachala, Jay and Bialo, Ellen. (2000). 2000 Research Report on the Effectiveness of Technology in Schools—7th Edition. Software Information Industry Association. Washington, D.C. Available http://www.siia.net.