Individual Effects of a Web-Based Accountability System In a Teacher Education Program

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Abstract

This paper describes the results of teacher education candidates' use of a Web-based assessment system including electronic portfolios. A teacher education program adopted a novel Web-based Accountability Model for assessment and learning. The Web-based Education Accountability System (EAS) was based on the Web-based Accountability Model, and consisted of an electronic portfolio sub-system, an online performance assessment sub-system, and an Accountability Center sub-system. The objective of this study was to experimentally test teacher candidates' views towards using the system. The experiment also examined the effect of the EAS on candidates' cognitive learning. Thirty-one preservice teacher candidates enrolled in teacher certification programs participated in this study in Spring 2002. Questionnaires were presented to candidates as pre- and posttests. Content analysis was employed to qualitatively analyze the electronic portfolio to examine the development of cognitive skills. The content analysis and questionnaire results showed that preservice teachers (1) thought the EAS positively facilitated learning to teach and helped them meet teacher standards over time, and (2) became more engaged in reflective and cognitive activities by using the electronic portfolio over time.

During the last 10 years, performance-based assessment has been increasingly used to assess teachers' competencies with the development of education theory from behaviorism to constructivism (Cannella & Reiff, 1994; Richardson, 1997). Performance assessment is the type of educational assessment in which judgments are made about student's knowledge and skills based on observation of student behavior or inspection of student products (Lam, 1995). Most research in the context of PK–12 settings has

- Explored the relationship between students' achievements and teacher performance (Laczko-Kerr & Berliner, 1999) and
- Developed general accountability models at the national, state, and district level (Lane, Parke, & Stone, 2002).

Some researchers have employed accountability as an incentive mechanism by tying teachers' compensation at least in part to performance (Mathews, 2004; Solmon & Podgursky, 2000).

Portfolio assessment is widely adopted in American education. Nearly 95% of schools and colleges use portfolios to make decisions about candidates (Herman, Aschbacher, & Winters, 1992; Salzman, Denner, & Harris, 2002; Wiggins, 1990). A portfolio is a representative collection of one's work, providing documentation of work in progress, evidence of how work has evolved and how it has been refined (Amber & Czech, 2002). By collecting artifacts to annotate their progress, candidates articulate their learning and adjust their professional goals. By fulfilling these intentions, candidates think and learn more because they are actively and willfully trying to achieve a cognitive goal (Scardamalia & Bereiter, 1993/94; Willis & Tucker, 2002).

In 1999, the National Council for the Accreditation of Teacher Education (NCATE) issued guidelines that associated portfolios with electronic versions of portfolios (Aschermann, 1999), resulting in NCATE-accredited teacher education programs in the United States taking a more focused look at how to deal with the electronic aspect of portfolio development, storage, and presentation. Research on electronic portfolios has focused on implementation issues, and empirical research addressing the effects of electronic portfolios is sparse. Zeichner and Wray (2001) voice the same concern: "Despite the current popularity of teaching portfolios, there have been very few systematic studies of the nature and consequences of their use for either assessment or development purposes" (p. 615).

An electronic portfolio is collected, saved, and stored using the Web (Barrett, 1998). Electronically, a portfolio can be shared among multiple parties simultaneously and can contain multiple media. Systems have been implemented that support the electronic portfolio in teacher education programs. The comparison of paper portfolio and electronic portfolio in surveys of students showed that students prefer the electronic portfolio (Carney, 2001; Franco, Hendrick, Huston, & Kim, 2004). However, no model or system has existed that combines the electronic portfolio learning, the alternative/traditional assessment vehicles, and the Student Information System. Combining and integrating these components might help students, teachers, and administrators manage the educational process, improve organizational operational efficiency, and improve learning outcomes for students. No such combined system has been described in the literature, and this study will present a model for such a system.

This paper presents the findings from two data sources: attitudinal data and cognitive data. Carney (2004) suggests that such attitudinal (self-reported) and cognitive (learning outcome) data are vital to understanding electronic portfolios. First, the Web-based Accountability Model, the software, and the electronic portfolio process are introduced. Second, teacher candidates' views towards using the software are examined. Third, the results of a content analysis study reveal how the teacher candidates' cognitive skills developed through using the software. Finally, conclusions are drawn on how the model addresses accountability and could be generalized in other teacher education programs.

Web-based Accountability Model

The Department of Education (hereafter called the Unit) at the University of Maryland, Baltimore County offers certification programs at the graduate and undergraduate levels in Early Childhood Education (P–3), Elementary Education (1–8), and Secondary Education (7–12), and at the graduate level but not the undergraduate level in English for Speakers of Other Languages (ESOL). All undergraduate teacher candidates complete a major in an academic area and a certification program.

In the year 2000, the Unit started developing plans for an assessment system to meet the NCATE 2000 standards (NCATE, 2000). Historically,

Table 1: Levels and Dimensions of Web-based Accountability Model Effect

Level \ Dimension	Learning	Assessment
Individual	Candidates' learning process and outcomes affected by the Web-based Accountability Model	Triadic assessments on candidates' performance
Organization	Organizational learning regarding operation efficiency and effectiveness	Triadic assessment on the Unit's operation efficiency and effectiveness

the Unit relied on a combination of formal (course grades, test grades, planned observations) and informal assessment (anecdotes and graduate reports). However, the process was time consuming and sometimes inaccurate. Many resources were consumed in gathering paper data to analyze and draw conclusions from that data. The Unit's four academic programs each had peculiar assessment features. Unit-wide assessment was awkward. The demands for accountability from the state and the federal governments and NCATE dictated more systematic assessment.

Web-based Accountability Model

A Web-based Accountability Model was conceptualized in 2001. The implemented information system, which was called the Education Accountability Systems (EAS), was put into use in 2002. The Web-based Accountability Model balanced two dimensions: the learning and assessment dimensions. The design also represented accountability at two levels: Unit (or organization) level and Candidate (or individual) level. The Unit was held accountable for preparing the content knowledge and instructional strategies and supporting candidates to meet teacher licensure standards and develop professionally. Candidates were accountable for meeting standards set by the Unit and demonstrating learning outcomes. The learning and assessment dimensions interacted with the unit and candidate levels. (See Table 1.)

The Web-based Accountability Model had three components:

- Electronic portfolio to facilitate candidates' learning and help advisors assess candidates' learning,
- Performance assessment to assess candidates' learning and program's operation, and
- Accountability Center to contain student information (such as transcripts) and aggregated data from performance assessment, to generate reports based on the aggregated data for program administrators.

The information flow among them integrated assessment and learning into one organic cycle. (See Figure 1.)

Multiple-sourced performance assessment provided the Accountability Center with assessment data to generate guidelines for interventions and improvements in the candidates' learning and teaching process. The Web-based Accountability Model was based on standards from:

- National organizations (such as NCATE, INTASC Principles),
- State guidelines (such as Maryland Redesign of Teacher Education), and
- Specialized professional associations (such as NAEYC, ACEI, and TESOL).

These standards had been adapted and embedded in the electronic portfolio and performance assessment. Performance assessment included the electronic portfolio assessment, field experience assessment, clinical practice performance assessment, Unit and program assessments, and post-graduation assessment.

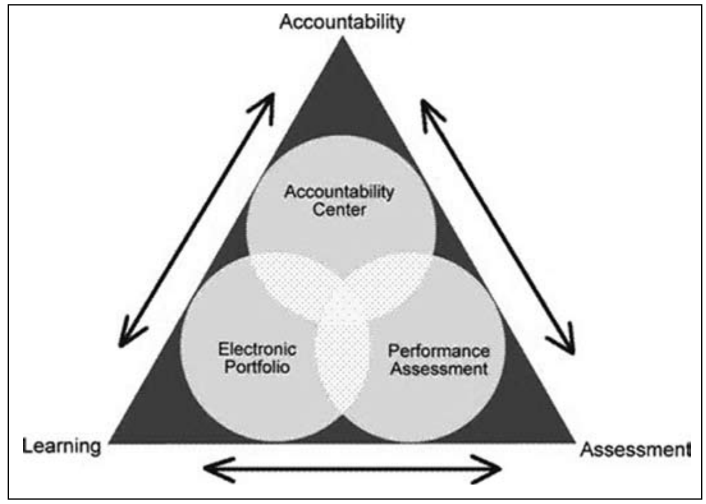

Figure 1: Web-based Accountability Model Conceptual Model: Arrows indicate information flow.

The three production components of the EAS enabled the Unit to generate and evaluate both qualitative and quantitative performance data at each of five benchmarks:

- Program entrance: admission criterion such as passing PRAXIS I, online application, etc.
- Course and Field Experience: foundation and method courses evaluation, early field experience assessments, etc.
- Clinical Experience: seminars and 100-day clinical practice, coursework evaluation, etc.
- Program Exit: pass PRAXIS II, post-clinical practice survey, licensure application, etc.
- Post Graduation: professional portfolio, alumni/employer survey, etc.

At the Unit level, Unit-centralized performance assessment instruments were used to assess how well the Unit was working toward its goal of preparing caring, knowledgeable, thoughtful, and skilled teachers. These assessment results were transformed into organizational learning for further improvement. At the candidate level, the electronic portfolio showcased how candidates integrated what they learned into their internship teaching to meet academic requirements. More detailed information about the model and the system was delineated by Ma and Rada (2005).

Electronic Portfolio Process

The internship consisted of two phases—Phase I and Phase II. This year-long experience took place in the University's Partner Professional Development Schools (PDS). The Phase I internship was a one- or two-day-per-week placement in a PDS that was linked to specific methods courses within programs. Phase II was the full-time teaching experience where teacher candidates were engaged in the activities of planning, implementing, and evaluating learning. As a pilot study, only Phase II interns were required to complete an electronic portfolio because this phase provided teacher candidates extensive internship experience. The electronic portfolio and performance assessment sub-systems were introduced to the candidates at the end of the semester before starting their Phase II internship. They were required to construct an electronic portfolio to document knowledge, skills, dispositions, and learning process to demonstrate standard-based proficiencies. (See Figure 2.) Additionally, interns, mentors, and supervisors conducted performance assessments to reflect interns' learning progress and outcomes.

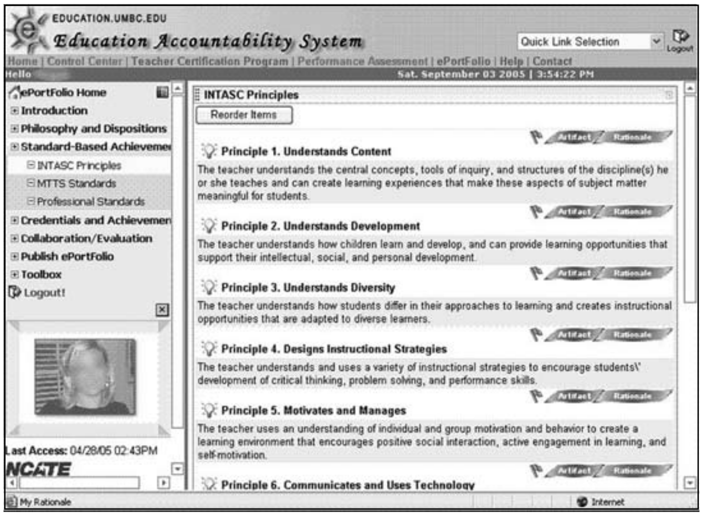

Figure 2: Electronic portfolio: Standard-Based Reflection Framework.

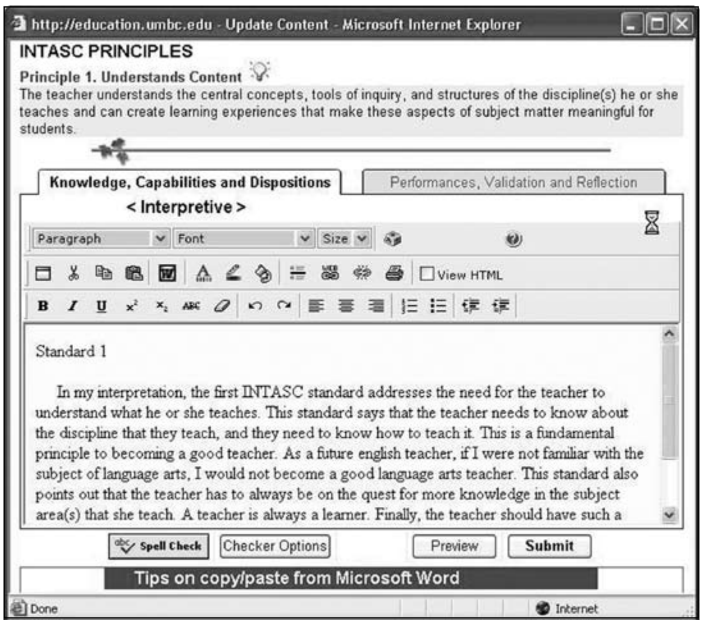

Figure 4: Electronic portfolio: Reflection Editor

All interns enrolled in an internship seminar at the beginning of their internships. They were taught how to develop an electronic portfolio with hands-on training workshops provided by the Unit's professional support team. At the end of their internships, each candidate created a Showcase electronic portfolio for a formal presentation in front of a review team, which consisted of at least one supervisor, one mentor teacher, and one faculty member. The electronic portfolio was reviewed using a set of predefined rubrics for each teacher standard.

In the course of constructing their electronic portfolio, candidates created artifacts in the form of documents, photos, graphics, audios, and videos. The electronic portfolio provided a standard-based framework for assessing candidates' learning. It had three essential functions: evidence collection, selection, and reflection. (See Figure 3.) Evidence was collected from the actual P–12 teaching activities. Other than providing broad guidelines about what artifacts to include in the electronic portfolio, the Unit left specific decisions about the choice of artifacts exclusively to the teacher candidates. The collection and selection of the evidence addressed the question "What did I do?" (Van Wagenen & Hibbard, 1998).

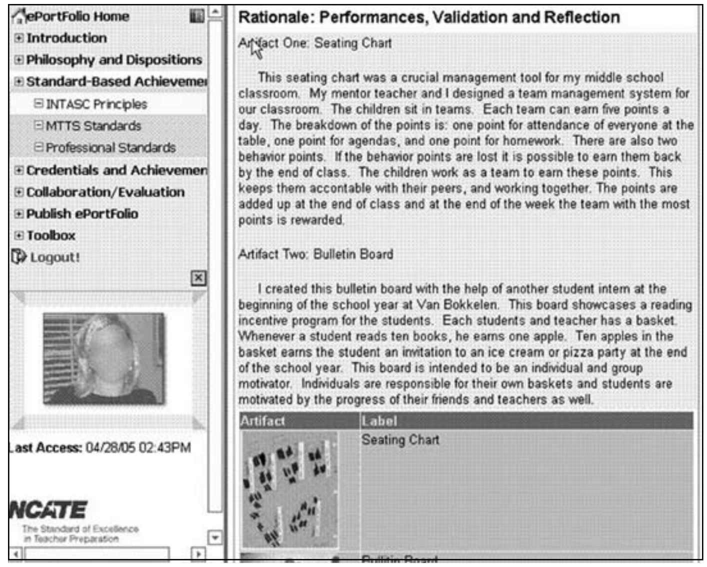

Figure 3: Electronic portfolio: Selected Artifacts and Accompanying Reflective Statements

Table 2: Name and Total Number of Each of the Four Strata along with Number of Sample

Strata	Population (N)	Sample (n)
Early Childhood	6	3
ESOL	8	4
Elementary	20	10
Secondary	28	14

The reflection answered the questions: "What did I learn?," "How does this evidence support the learning?," and "What will I do next?" (Van Wagenen & Hibbard, 1998). The electronic portfolio provided a Web editor accompanying each standard so that candidates could enter their reflections adjacent to the standard. (See Figure 4.)

Survey Study

Two levels of effect of introducing the EAS into the Unit were analyzed: candidate effect and organization effect. Only candidate effect was examined in this paper. First, teacher candidates' views and beliefs towards using the EAS system were tested. Second, the effect of EAS usage on reflective and cognitive activities was explored.

Subjects

Sixty-two teacher candidates were doing internships in the teacher education program in the spring of 2002. Each candidate was paired with one or two mentor teachers in the local schools where they performed the internship, and one supervisor who was either from the Unit's faculty or from local schools. Each intern was in one of four programs: Early Childhood, Elementary, ESOL, and Secondary. The subjects for the survey study were drawn from these four strata. The four strata, with the total number of potential subjects in parentheses, are: Early Childhood (6), ESOL (8), Elementary (20), and Secondary (28). Proportional stratified sampling was used to generate a sample size of thirty-one subjects. (See Table 2.) The subjects were selected through a systematic random sampling of fifty percent of the total population for each individual stratum. A total of thirty-one candidates were thus chosen for this study.

Table 3: Pre- and Posttest of EAS Belief Survey Results from 31 Subjects during their Internship

Survey Questions / Hypotheses		Pre M	Pre SD	Post M	Post SD	Paired t-test
Electronic portfolio	Time constraints were my main concern in developing electronic portfolio	3.60	.503	3.05	.686	.002*
	Electronic portfolio increased my technology skills	4.05	.510	4.25	.550	.163
	Electronic portfolio increased my awareness of effective technology integration into classroom	3.90	.447	4.15	.489	.056
	Electronic portfolio increased my content knowledge	3.80	.523	4.05	.510	.056
	Electronic portfolio helped me meet MTTS Standards	3.85	.489	4.55	.605	.003*
	Electronic portfolio helped me meet INTASC Principles	4.00	.562	4.50	.513	.002*
	Electronic portfolio will be useful to me after graduation	3.90	.308	4.05	.394	.083
Performance assessment	Performance assessment helped my self-assessment	3.75	.444	3.95	.510	.104
	Performance assessment facilitated my learning to teach	4.05	.510	4.70	.470	.000*
	Unit made fair assessment on my learning and teaching based on information collected by the performance assessment sub-system	4.20	.523	4.35	.489	.267

P< .05

Note: 1=Strongly Disagree, 2=Disagree, 3=Not Sure, 4=Agree, and 5=Strongly Agree. Pre M means Mean of the Pretest and Pre SD means Standard Deviation of the Pretest.

All teacher candidates participating in this study were required to have an electronic portfolio. Only Early Childhood candidates used a paper portfolio before using the electronic portfolio. The focus of this exploratory study was the teacher candidates' views towards using the EAS.

Instrument and Procedure

The EAS Belief Survey was developed to measure students' views toward using the EAS. The survey instrument was analyzed by two faculty members in the Unit, as well as two outside experts in the same field, to determine whether the questions were valid. The final instrument consisted of 10 questions divided into two separate sections. Section I addressed candidates' views towards using the electronic portfolio sub-system and section II addressed candidates' views towards using the performance assessment sub-system. Section I had seven questions, including: "Electronic portfolio increased my technology skills," "Electronic portfolio increased my content knowledge," and "Electronic portfolio helped me meet INTASC Principles." Question two had thirteen sub-questions, which were adapted from the survey by Barrett (2003) to evaluate multimedia skills gained by developing an electronic portfolio. (See Table 4.) A respondent would check one item if he/she considered the electronic portfolio development has helped him/her to gain such a skill. Section II had three questions: "Performance assessment helped my self-assessment," "Performance assessment facilitated my learning to teach,",and "Dept. made fair assessment on my learning and teaching based on information collected by the performance assessment sub-system." The EAS Belief Survey used a Likert scale ranging from one (Strongly Disagree) to five (Strongly Agree).

In week one, candidates were introduced to electronic portfolio development and completed an assigned task in electronic portfolios. In week two, the EAS Belief Survey was administered among twenty subjects as a pretest. Then after ten weeks of electronic portfolio development, the EAS Belief Survey was again given to the subjects for the posttest. Thirty-one preservice teachers' responses to the EAS Belief Survey were analyzed using the paired sample *t*-test.

Results

All subjects submitted the pre- and posttest of the EAS Belief Survey; responses were reported with mean scores and standard deviations. (See Table 3.) Comparisons between pre and post results of each question were analyzed using dependent samples *t*-tests. Each question was treated separately as an individual null hypothesis in the analysis. Based on the *p* value of *t*-test, results were discussed in two groups: significant and nonsignificant. Then the discussion about two groups was provided.

Significant Results

The response to the question "Developing electronic portfolio helped me to meet Maryland Teacher Technology Standards" was significantly different between the pre- and posttest ($t = 3.390, p < .05$). The significant increase suggested that the preservice teachers gained knowledge and understanding of the teacher standards that they had not fully anticipated prior to specifically using electronic portfolio to address them. The same rationale applied to the item "Developing electronic portfolio helped me to meet INTASC Principles" ($t = 3.684, p < .05$). It also indicated that, as a direct result of this experience, the preservice teachers felt that meeting teacher standards mandated by nation and state were greatly facilitated by the development of the electronic portfolio. More important, their responses also indicated an increased acceptance of using these standards to guide their teaching practice. This supported the theory of embedding teaching standards into the electronic portfolio, which was one of the important principles underpinning the development of electronic portfolios in the Web-based Accountability Model.

Another significant difference was found between pre and post responses to the question "Performance assessment facilitated my learning to teach" ($t = 4.333, p < .05$). Pre survey responses to this statement were comparatively low ($M = 4.05, SD = .510$), but post survey responses showed an increase in perceived importance ($M = 4.70, SD = .470$). Performance assessment was designed to deliver timely feedback to candidates. Candidates considered feedback from supervisors and mentors very helpful. The timely feedback was provided by the dynamic assessment report module featured in the performance assessment sub-system. The feedback reminded candidates what competencies were required of the profession of teaching. The performance assessment might help teacher candidates adjust their learning and teaching process, by which they achieved the competencies to be a teacher.

The final item showing a significant difference between pre and post results was the item regarding the "time constraints of the electronic portfolio development", which decreased measurably ($t = -3.584, p < .05$) from pre ($M = 3.60, SD = .503$) to post ($M = 3.05, SD = .686$) survey. Prior to constructing electronic portfolios, the preservice teachers reported concerns over time constraints in completing electronic

Table 4: Multipart Technology Skills Sub-Questions

Multipart Technology Skills Sub-Questions: This table shows the technology skills in the leftmost column, the range of responses in the upper row, and the percent of candidates choosing a response in the cells of the table.				
Multipart Questions of Technology Skills	Before	After	Do not know	No Response
Set up folders to organize files on computer hard drive	93	0	0	7
Use the File Transfer Application to transfer files between University, school, and home.	3	3	94	0
Use Web Page Editor such as Microsoft FrontPage /Macromedia Dreamweaver	19	10	61	10
Use advanced features of Microsoft Word (Document Map, Hyperlinks, etc.)	42	29	19	10
Use advanced features of Microsoft PowerPoint (slides animation, drawing, etc)	42	29	26	3
Use a digital camera to take pictures	74	10	16	0
Scan images with a desktop scanner	29	29	19	23
Edit images such as resizing/cropping	10	10	51	29
Transfer video to a computer for editing (in lab)	0	3	78	19
Edit a digital video on PC/Mac	0	0	90	10
Record digital audio to the computer with a microphone	52	3	0	45
Create and edit Adobe Acrobat files from a variety of computer applications	23	16	39	22
"Burn" a CD/DVD	39	23	23	23

portfolios. However, by the completion of electronic portfolios, it was much less of a concern. Electronic portfolio completion, in itself, may have alleviated their concerns about having enough time for completion. However, this finding may also suggest considerations beyond the obvious. For example, the preservice teachers' concerns about their ability to complete electronic portfolio in the provided time may be an indirect result of their apprehensions about working with this tool for the first time, tight schedule of student teaching, uncertainty in their technology skills, or a variety of other factors that served to reduce their confidence and inversely increase their concerns over completing the electronic portfolio in the allocated time.

Nonsignificant Results

No significantly different outcomes were found to the question "Electronic portfolio increased my technology skills." The multipart technology skills questions in the survey, which asked about the change in technology proficiency, showed that preservice teachers had already mastered some of the technology used in this pilot study, such as word processing and digital photographing. (See Table 4.) Other factors accounting for this result included:

- First, the electronic portfolio provided built-in templates. On one hand the templates made the electronic portfolio easy to use; on the other hand, the templates possibly discouraged candidates from developing the technology skills that were embedded in the templates. A case in point could be the low percentage of skill-gaining using a web page editor. (See Table 4.) The electronic portfolio rendered content using a pre-selected template. Therefore, the Web editing tasks were almost invisible to the candidates who only filled in blanks without setting font or color.
- Second, the portfolio lab staff reported spending most of their time doing things for the candidates. Although it was their job to help candidates overcome technology obstacles, they did much of the technology tasks for the candidates. When asked why, one staff member said it would be faster to do it herself than teaching the candidates how to do it.
- Third, some technologies listed in the survey were not required to use in this pilot study.

Therefore, further study was needed to examine the effect of electronic portfolio construction on the development of technology skills.

Responses to the question "Electronic portfolio increased my content knowledge" did not show significant difference between pre- and posttests. Although the evidence collected from the electronic portfolio showed that learning took place through candidates' teaching practices, most of the candidates felt that they already learned enough about the subject matter from the previous courses. Accordingly, the electronic portfolio development was not considered a way to acquire content knowledge.

The question "Electronic portfolio will be useful to me after graduation" reflected candidates' perspectives of using electronic portfolio in the future. The *t*-test result was not significant. This nonsignificant result might be explained in several ways. Some candidates voiced concerns that they might not get a teaching position and could switch to another career track. Some candidates might have thought that the electronic portfolio system would not be readily accessible to them in the future or that their colleagues in their future workplaces might not appreciate the usefulness of the electronic portfolio.

No significant difference was found for the question "Performance assessment helped my self-assessment." The performance assessment sub-system was designed primarily to help unit administrators. The design perhaps needed to be reconsidered as regards to helping candidate's learning process.

Candidates' views on the question "Dept. made fair assessment on my learning and teaching based on information collected by the performance assessment sub-system" were not significantly different in the pre- and posttest. The candidates did not consider the introduction of the performance assessment sub-system to significantly affect the Unit's decision making about their teaching and learning. Further study would focus on investigating the reliability and validity of the performance assessments employed in the performance assessment sub-system.

Discussion

The EAS Belief Survey revealed that the EAS could positively facilitate candidates to meet teacher standards and learn to teach. The electronic portfolio sub-system provided consistent opportunities for the candidates to reflect on their teaching experiences and examine the gap between their beliefs and real teaching. These were fundamental to the success of their concurrent student teaching experiences. The performance assessment sub-system was considered to facilitate candidates learning to teach in that it provided timely feedbacks to candidates. These feedbacks could

Table 5: Analysis Framework: Cognitive Skills (Adapted from Bloom, 1956)

Cognitive Skills	Definitions	Indicators
Description (Bloom's knowledge level)	Observing or studying a problem; Understanding of content, pedagogy of teaching; Mastery of subject matter;	Simply describing the subject matter; Identifying relevant element; Reformulating the problem;
Explanation (Bloom's comprehension level)	Understanding information; Grasp meaning; Interpret facts, compare, contrast; Order, group, infer causes; Predict consequences;	Understand, explain and interpret education theory; EX. Paraphrase a theory rather than simply recite it
Application (Bloom's application level)	Proposing coordinated actions for the application of a solution.	Use methods, concepts, theories in new situations; Solve problems using required skills or knowledge;
Inferencing (Bloom's analysis and synthesis level)	Induction and deduction; Organization of parts; Recognition of hidden meanings; Identification of components; Relate knowledge from several areas; Translate knowledge into new context;	Break down a situation into its component parts; Distinguish between facts and inferences; Drawing conclusions; Making generalizations;

be accordingly used by the candidates to adjust their teaching strategies. The performance assessment sub-system fostered an electronic education community including the university and local schools.

Preservice teachers' views toward computers and their technology skills can be improved by integrating technology into the teacher education coursework (Kumar & Kumar, 2003). But the improvement was limited if teacher candidates were not provided opportunities to learn and apply skills and strategies in real-world settings (Strudler et al., 1998). This study has revealed other confounding factors with regards to increasing technology awareness and application. Using the EAS to develop an electronic portfolio provided the candidates an opportunity to apply technology into real tasks. However, the results of the survey showed that candidates did not consider that EAS usage helped them increase technology skills. The electronic portfolio development only took one semester for this pilot study. The candidates might not have had enough time to develop new technology skills in this short time frame. The electronic portfolio development might be introduced earlier and across multiple courses.

A modified approach for using the electronic portfolio was developed based on this study's results. The approach gave candidates more time to get familiar with the system and to start thinking about collecting evidence from their early field experience. This approach was used in multiple methods courses and started in Phase I of the internship.

Another challenge emerged from this survey was the duplicity of purpose embedded in the electronic portfolio development. The tensions between balancing the learning focus and the ever-present accountability issues continued to exist. Assessment and learning represent two ends of a continuum. The EAS, based on the Web-based Accountability Model, was designed to integrate both ends trying to strike a balance. As the survey results suggested, teacher candidates' expressed positive attitudes towards using the EAS to facilitate learning, while not so positive with regards to the assessment. The good thing about it was the performance assessments used in the EAS seemed to improve candidates' learning. This echoed what Wiggins (1993) said, "...assessment should be designed to *improve* performance, not just *monitor* it" (p. 6, emphasis in original).

Although the views of teacher candidates regarding their use of the electronic portfolios system provided an important perspective, as Carney (2004) states, we also needed to consider the learning outcomes of candidates who completed electronic portfolios. The next section addressed student learning outcomes through a direct measure of the teacher education candidates' electronic portfolio content.

Content Analysis

The specific cognitive skills that candidates demonstrated were categorized and measured in a content analysis of their electronic portfolios. The content analysis enabled the researcher to search for structures and patterned regularities in the text and make inferences on the basis of these regularities. The population from which the sample was chosen was the same as used for the above survey study. Four candidates were randomly chosen from each of four programs for the cognitive skills investigation.

Instrument and Procedure

Cognitive skills demonstrated in the electronic portfolios were analyzed within a taxonomy framework. Bloom's (1956) taxonomy for the cognitive domain described progressively higher levels of cognitive activity from factual information at the knowledge level to judgment and rating of information at the evaluation level (Bonk & Sugar, 1998). For this study, an analysis framework was adapted and modified from this taxonomy to categorize and code the electronic portfolio content into four levels of cognitive skills for reflection. (See Table 5.)

The electronic portfolio content was collected from candidates' reflective statements for INTASC Principles. Content analysis was used to analyze the text. The researcher plus two graduate assistants read each posting. The raters read the text and categorized them using the above established analysis framework. Two graduate assistants participated in five hours of training to learn to code the text. The raters coded independently of each other. The raters coded two sample candidates' electronic portfolio to establish inter-rater reliability. After this initial categorization of the data, a 79% agreement rate was found among the three raters. Once inter-rater reliability was achieved, four subject candidate's electronic portfolio text was coded by the three raters. Average rater reliability was attained at 81%. Conflicts were resolved by having three raters re-examine the paragraph in question until 100% agreement was reached. Some paragraphs, however, clearly demonstrated more than one cognitive skill and were coded as such.

Results

Content analysis of subjects' electronic portfolio reflective statements demonstrated subjects' cognitive skills development with the help of electronic portfolios. As stated above, the analysis framework identified four categories related to cognitive dimension: (1) description, (2) explanation, (3) inferencing, and (4) the application of strategies. All of

Table 6: Percentage of Each Cognitive Skill Type Exhibited in Four Subjects' Electronic Portfolios Over Time

Checkpoint	Description	Explanation	Inferencing	Application
Week 3	39% (9)	30% (7)	17% (4)	13% (3)
Week 6	29% (14)	32% (15)	21% (10)	18% (9)
Week 10	25% (21)	36% (30)	20% (17)	19% (16)
Avg.	31%	33%	20%	17%

Note: The number of occurrences is indicated in parentheses; the bottom row indicates the average percentage over three checkpoints. The computed numbers are to two significant digits and the percents in a row do not necessarily sum to 100%.

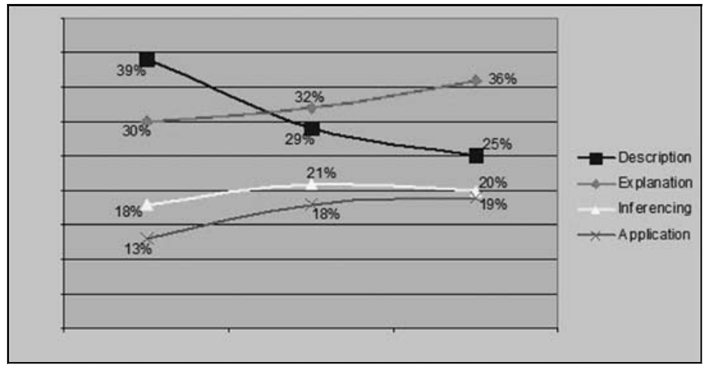

Figure 5: Percentage of occurrences (independent of subjects) of each cognitive skill demonstrated over time

these cognitive skills were identified in candidates' electronic portfolio reflective statements. The total occurrences of each cognitive skill in all subjects' writings were summed and converted to percentage to present an overall pattern. (See Table 6.)

Description of a technical or theoretical aspect of teaching appeared an average of 31% of the time in subjects' completed electronic portfolios. An example of this type of reflection would be:

> A chief principle of ESOL education is to teach material that is comprehensible and interesting to students ... To help children learn, teachers need to develop a solid understanding of the way in which they grow, both intellectually and personally.

This type of reflection stated that preservice teachers' opinion of a specific teaching theory or activity, but did not justify or interpret it for any specific behavior.

The most frequent type of cognitive reflection was explanatory content (average at 33% over the time). Its percentage among all cognitive skills demonstrated in the reflection has been steady over time. An example of this type of reflection would be:

> ...Keeping an open, empathetic mind can help a teacher to bond with a student or group of students, and will enrich instruction for all.

This type of reflection suggested that candidates saw the logic behind theory and could rationalize the success or failure of the instruction. Much of this type of reflection helped candidates comprehend how teaching theory could be applied during practice.

Reflections that addressed the inferencing aspect of teaching accounted for 20% of occurrences over three checkpoints in all identified text. An example of this type of reflection would be:

> Observation and assessment is essential to understanding young children's development. Having a strong partnership with families and other professionals can positively influence the child's learning. Parent input can be very helpful with informal assessments. The child's parent may be seeing different things then you are seeing.

This kind of reflection showed that candidates made connections between concepts from coursework and internship teaching experiences. It encouraged preservice teachers to create their own teaching philosophy and incorporate effective teaching strategies into teaching practice.

Additionally, the application level of reflection occurred in 17% of coded terms over three checkpoints. (See Figure 5.) An example of this reflection would be:

> In October, I was observed and my supervisor noted that due to the students' inability to exercise self-control, I needed to exhibit stronger classroom management procedures. I reflected on this experience and greatly changed my demeanor in the classroom to enforce consequences while also frequently praising students for positive behavior.

The electronic portfolio provided the opportunity for preservice teachers to document when and how theory was realized through practice. This could be demonstrated by its consistent increase over time. (See Figure 5.)

Discussion

In week three, candidates had developed their electronic portfolios for two weeks to collect artifacts and reflect on their internship. The cognitive skill of description appeared most frequently in this week (See Table 6), followed by explanation, inferencing, and application. As development of electronic portfolios came to week six, the changed distribution of cognitive skills revealed a transformation from being descriptive to being explanatory, which continued to week ten. Also, candidates were engaging in more application level cognitive activities at this stage. The electronic portfolio was successfully accepted by candidates as a cognitive tool to document and reflect candidates' learning and teaching process. One candidate commented, "Writing explanations and rationales gave me a chance to see what I really knew and to see how far I've come since starting the education program. It was a tool for me—to reflect." Further work should address in more detail what are the focus of these reflective statements, be it technical, situational, or sensitizing (Tsangaridou & O'Sullivan, 1994).

The total percentage of cognitive skills at application level increased steadily from 13% at week three to 19% at week ten. (See Figure 5.) Overall, inferencing type of reflection (i.e., drawing conclusions and forming generalizations) stayed almost unchanged. The longitudinal content analysis confirmed that keeping their reflections organized in the electronic portfolio enabled candidates to reflect and revise continuously. The electronic portfolio gave candidates the advantage of easily seeing how their standard-meeting activities changed over time, which would be hard for a paper portfolio to capture (Aschermann, 1999).

The content analysis also confirmed the findings discussed in the survey study. Candidates reported learning the pedagogy by using the EAS. The electronic portfolio reflection served as a story-telling tool and enabler for candidates to learn from the teaching experiences. This was consistent with the literature suggesting portfolio development may support reflection.

Conclusion

This study proposed employing an electronic portfolio and performance assessment for accountability purposes in a teacher education program. A Web-based Accountability Model was established and an EAS was successfully implemented based on this model. The Web-based Accountability Model represented a cycle of learning and assessment at both individual (teacher candidates) and the organizational (Unit) level. The Web-based Accountability Model combined assessment results from question-based instruments and electronic portfolios to direct the interventions to teacher candidates' learning process.

The findings of the survey and content analysis study were consistent with the literature that portfolio development could facilitate learning. The self-reported survey data were triangulated with the content analysis results to demonstrate that the electronic portfolio could help candidates learn to teach. The electronic portfolio provided an opportunity for candidates to collect artifacts in multiple formats, modify artifacts with the development process, critically examine their practices by reflection, and connect evidence to standards. In particular, the electronic portfolio facilitated candidates' understanding of standards because EAS emphasized standards criteria. Content analysis confirmed that the candidates' cognitive skills were improved in the electronic portfolio development course.

Based on the findings in this pilot study, the EAS was considered useful for Standard 2 of the NCATE accreditation requirements: assessment system and unit evaluation. The electronic portfolio together with performance assessment helped the Unit make changes based on candidates' data. The EAS played an important role in reshaping the Unit's processes and operations. Summaries of data on candidate performance, program quality, and Unit operations were reported to and interpreted by the Unit's faculty. The Unit's NCATE Steering Committee conducted Unit-level reviews and made recommendations for change. The Unit's Assessment Committee implemented the change and monitored impact. As a result, the Unit changed candidates' internship requirements, created multiple checkpoints based on the electronic portfolio and performance assessment, and re-organized the Unit's supporting and administering facilities.

Future research will address various concerns. The survey results suggested that further research was needed. For instance, candidates did not report gaining technology skills in this study. This might be due to a variety of factors, such as laboratory assistants performing complex tasks for candidates and candidates not having enough time to explore new technology. Some other worthy research directions are: What is the organizational effect of the EAS? What degree of balance between assessment and learning is appropriate to maximize teacher candidates' self-regulated learning and reflective teaching while serving accountability purposes? Conducting longitudinal studies on relationships among assessments, licensure examinations, and on-the-job performance will provide further evidence and guidance for program quality improvements.

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