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Assessing Program Outcomes of an M.Ed. Curriculum and Instruction Program: A Comparison of Face-to-Face to Completely Online Deliverables

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Chapter 2

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ABSTRACT

Many mathematics education degree programs, especially at the graduate level, are now transitioning to an online format. There is a need to document how mathematics content and content pedagogy are assessed in an online environment. The objectives of this chapter are to document how a public higher education institution in Texas transitioned their master's degree program for mathematics teachers from a face-to-face program to an online program and how this transition impacted the assessment process related to the learning of content and pedagogical content knowledge.

INTRODUCTION

The National Council of Teachers of Mathematics in their publication, *Principles to Actions: Ensuring Mathematical Success for All* [*Principles to Actions*] (2014), states "developing expertise as a mathematics teacher is a career-long process. The knowledge base of effective mathematics teaching and learning is continually expanding" (p. 102). The Conference Board of the Mathematical Sciences (2012) also noted the need for teachers of mathematics to continue their mathematical content and content-pedagogical knowledge over their career. It is necessary for teachers to demand opportunities

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for professional development and collaboration that improves their pedagogical content knowledge and pedagogical strategies (NCTM, 2014).

There has been a shift in professional development toward an online format. For example, Dede, Ketelhut, Whitehouse, Breit, & McClokey (2009) conducted a meta-analysis of online, face-to-face, and hybrid teacher professional development programs and found that the major foci of research were (1) program design, (2) program effectiveness, (3) program technical design, and (4) learner interactions. Dede et al. stated program effectiveness research focuses on studies which "looked largely at self-reports on participant satisfaction and short-term pedagogical change outcomes" (p. 11). Dede et al. concluded this research "generally involved evaluative studies that derive their findings from course participant surveys (p. 11). This paradigm also applies to online program research in general.

The National Center for Education Statistics (NCES) Integrated Postsecondary Education Data System (IPEDS) defined a distance education program as a program for which all the required coursework for program completion is able to be completed via distance education courses (Miller, Topper, & Richardson, 2017); and considered a distance education course as "a course in which the instructional content is delivered exclusively via distance education. Requirements for coming to campus for orientation, testing, or academic support services do not exclude a course from being classified as distance education" (Miller et al., 2017, p. 11); and, distance education as "an option for earning course credit at off-campus locations via cable television, internet, satellite classes, videotapes, correspondence courses, or other means (Miller, et al., 2017, p. 11). Sener (2010) stated "online education is higher education's chief growth engine and enables higher education to scale rapidly while maintaining its broad array of offerings" (p. 6). Allen & Seaman (2005) found sixty-five percent of schools offering graduate face-to-face courses also offer graduate courses online and among all schools offering face-to-face Master's degree programs, 44% also offer Master's programs online (p. 1). NCES Digest for Education Statistics (2019) fall 2017 enrollment report noted 6,651,536 students were enrolled in distance education courses at degree-granting postsecondary institutions. More specifically, 1,142,919 post-baccalaureate students were enrolled in any distance education course at degree-granting postsecondary institutions with 868,708 post-baccalaureate students enrolled in exclusively distance education courses.

The ability to transition graduate-level mathematics education face-to-face programs to an online format is a complex process. The objectives of this chapter are to document how a public higher education institution in Texas transitioned their master's degree program for mathematics teachers from a face-to-face program to an online program and how this transition impacted the assessment process related to the learning of content and pedagogical content knowledge.

BACKGROUND

Opportunities for mathematics professional development are becoming more prevalent given the move to online delivery models. Many degree programs, especially at the graduate level, are now transitioning to an online format. Research that examines this transition process and online teaching itself is now becoming more prevalent. However, the need to document how mathematics content and content pedagogy are assessed in an online environment continues to be a major area to research.

ONLINE DELIVERY RESEARCH

Researching online instruction from varying perspectives has been a major focus over the past decade. Much of this research has focused on documenting student perspectives, faculty perspectives, and comparing and contrasting face-to-face delivery to online delivery perspectives. Student perspective research has found some consistent ideas about what constitutes 'effective' online learning. For example, Holzweiss, Joyner, Fuller, Henderson & Young (2014) studied student perspectives on what constitutes best learning experiences in an online graduate course. Findings included (1) critical thinking assignments, (2) [varying] instructional technology [strategies in the course], (3) faculty engagement, (4) interactions with peers and instructors, and (5) personal responsibility (p. 314). Lee (2014) surveyed participants who were enrolled in a master's degree in Mathematics and Science Education program to determine satisfaction levels with online learning associated with human (professor/instructor and instructional associate) and design factors (course structure and technical aspects). Participants were in-service teachers or educators from pre-K through grade 12. Lee found instructor(s) needed to be knowledgeable about course materials and provide up-to-date effective strategies/pedagogical knowledge for their content area, provide prompt replies, and have clear assignment rubrics and guidelines.

Research conducted on faculty perspective has found some consistent ideas about the roles of faculty in an online environment. Martin, Budhrani, Kumar, & Ritzhaupt (2019) via online interviews of award-winning online faculty identified five major roles of online instructors: facilitator, course designer, course manager, subject-matter expert, and mentor (p. 190). When asked about their two major responsibilities, participants indicated course design and teaching. Graham (2019) in a phenomenological study of twelve faculty members at a historically black college and university who were transitioning from face-to-face to online teaching found they transitioned from 'lecturer to facilitator, knowledge dispenser to resource provider, and authority figure to advisor" (p. 156). In brief, they noted their new roles as facilitator, resource provider, advisor, and manager/administrator (p. 156).

Face-to-face versus online instruction program aspects have found similarities and differences in these two models. Peterson & Slotta (2009) researched how an instructor adapted a face-to-face course to an online course. Peterson & Slotta found (1) building relationships and creating a class community was a strong component of the online interactions and (2) the online format provided an effective forum for in-depth discussion of the topics and issues, with students demonstrating growth in terms of the depth of their thinking as the course progressed (p. 128).

Cook, Annetta, Dickerson, & Minogue (2011) researched in-service teachers who were enrolled in an advanced methods course in science at two different universities about how their face-to-face vs. online discussions differed during the course. Participants were randomly assigned to differing types of discussion group formats during the online course component, an audio conference group (synchronous spoken communication without video); a text chat group (synchronous written communication); or a discussion board group (asynchronous written communication). Cook et al. found that while the use of asynchronous discussion may be beneficial in online courses, it may not be necessary in blended learning courses where online discussions are not the only means for student-to-student interactions (p. 79). Topper (2007) studied online and paper course evaluation response rates and instructional quality differences between face-to-face and online courses using two years of data from a US regional institution. Participants were enrolled in a M.Ed. degree program focusing on integrating education technology into K-12 teaching. Topper found response rates were similar for both settings and no statistically significant differences were found in instructional quality ratings. Overall, these findings demonstrate there are

specific 'best practice' components that are needed in terms of faculty-student interactions and course design. The ability to integrate these ideas into best practices for online instruction for mathematics teachers is needed.

MATHEMATICS PROFESSIONAL DEVELOPMENT & PEDAGOGICAL CONTENT KNOWLEDGE EXPECTATIONS

NCTM's *Principles and Standards for School Mathematics* [*Principles and Standards*] (2000) states 'teachers need in-service and graduate education that help them grow mathematically and as practitioners" (p. 378). *Principles and Standards* additionally posits "teachers must know and understand deeply the mathematics they are teaching and be able to draw on that knowledge with flexibility in their teaching roles" (p. 17). *Principles to Actions* further refines this idea to state "highly effective teachers become master teachers over time by continually improving their mathematical knowledge for teaching, mathematical pedagogical skills, and knowledge of students as learners of mathematics" (p. 103). Charalambous (2016) researched teaching practice differences between elementary school teachers, preservice elementary school teachers, and university students studying in mathematically intensive departments. Charalambous concluded:

Teacher knowledge should not be regarded as a static entity. Rather, it should be seen as constantly evolving and as being malleable to changes throughout teacher preparation and career. Inevitably, the real bet is to design courses and professional development programs that create a platform for (pre-/inservice) teachers to expand and refine their knowledge for teaching. (p. 232)

Face-to-Face and online delivery models for advanced degrees for mathematics teachers need to incorporate professional development best practices and mathematics education organizations' recommendations. Garet, Porter, Desimone, Birman & Yoon (2001) in their meta-analysis of over 200 peer-reviewed published mathematics and science professional development studies found in order for successful professional development to occur these four principles must be addressed: content based/content focused, active learning, linked to other teacher experiences (coherence), and sustained follow-up occurs. DeMonte (2013) found that principles of effective professional development (1) aligns with school goals, state and district standards and assessments, and other professional-learning activities, (2) focuses on core content and modeling of teaching strategies for the content, (3) includes opportunities for active learning of new teaching strategies, (4) provides the chance for teachers to collaborate, and (5) includes follow-up and continuous feedback. Resier (2013) in an analysis of effective professional development concluded that professional development (1) should be embedded in subject matter, (2) needs to involve active learning, (3) needs to be connected to teachers' own practice, and (4) needs to be part of a coherent system of support where teachers explore what a coherent system of student learning, classroom teaching, assessment, and curriculum materials needs to achieve, and work on changes across these corresponding parts of a system. The Association of Mathematics Teachers Education (AMTE) *Principles to Guide Doctoral Programs in Mathematics Education* (2002) provides overarching foci for advanced degrees: mathematics content, research, educational contexts, learning, teaching and teacher education, technology and curriculum and assessment. While a master's degree does not need to focus

on in-depth learning in each of these areas, a master's degree does need to help provide some of the foundations upon which a doctoral degree will build.

Shulman (1986) identified three categories of content knowledge: (1) subject matter content knowledge, (2) pedagogical content knowledge, and (3) curriculum knowledge. Subject matter content knowledge is comprised of the "amount and organization of knowledge per se in the mind of the teacher" (p.9). Pedagogical content knowledge is comprised of "subject matter knowledge for teaching" (p. 9). Curriculum knowledge is

represented by the full range of programs designed for the teaching of particular subjects and topics at a given level, the variety of instructional materials available in relation to those programs, and the set of characteristics that serve as both the indications and contraindications for the use of particular curriculum or program materials in particular circumstances. (p. 10)

Schoenfeld and Kilpatrick (2000), using Shulman's thesis, posited there are two components of subject matter content knowledge, (1) mathematics content knowledge and (2) mathematics pedagogical content knowledge. Ball & Bass (2003), also building on Shulman's thesis, posited there is a "mathematical knowledge for teaching (MKT)" (p. 5) paradigm. Ball, Thames, and Phelps (2008) considered that MKT consists of two main domains, pedagogical content knowledge (PCK), and content knowledge (CT). PCK consists of the following constructs: knowledge of content and students, knowledge of content and teaching, and knowledge of content and curriculum. CT consists of these constructs: common content knowledge and specialized content knowledge. Hill, et al. (2008) researched the relationship between mathematical knowledge and mathematical quality of teaching using the MKT framework. Hill et al. found there is "a powerful relationship between what a teacher knows, how she knows it, and what she can do in the context of instruction" (p. 496). Therefore, online advanced degrees for mathematics teachers must focus on integrating these best online course development practices, mathematics learning constructs, and mathematics teaching constructs to create meaningful and successful programs.

DESIGNING AND EVALUATING ONLINE PROGRAMS

Woo & Reeves (2008) posited that the major component of successful online courses is meaningful interactions. More specifically, interactions that contribute to student growth and learning (p. 183). These interactions can occur via (1) modeling, (2) dividing the class into small groups, (3) giving appropriate feedback, (4) encouraging reflection, and (5) using authentic activities (p. 185). Gadanidis (2002) stated "[d]espite major differences in course delivery and focus, I suggest that critical experiences, whether they are online or face-to-face, or whether they are designed for teachers or students of mathematics, are essentially similar in one important aspect, namely, in their focus on good mathematics" (p. 99). Teachers or students of mathematics need to have four critical experiences: (1) confront their beliefs about mathematics, (2) have aesthetic experiences with mathematics, (3) engage in practical inquiry, and (4) consider pedagogical implications in the context of relevant mathematics education literature.

Moore (2005) identified five principles or pillars for evaluating asynchronous learning networks: "learning effectiveness, cost effectiveness and institutional commitment, access, faculty satisfaction and student satisfaction" (p. 2). For the purposes of this chapter, we will only focus on the learning effectiveness principle. Moore contended that one of the strategies for determining program learning effectiveness

is by direct assessment of student learning. Salih (2016) recommends an "objectives-oriented evaluation strategy for distance education [online] programs that have highly defined objectives, and the purpose of the evaluation is to determine if, and to what extent, these objectives have been met" (p. 40).

Portfolios or E-Portfolios are used in evaluating student mastery of program objectives. Reese & Levy (2009) posit 'e-portfolios can help address the call to facilitate and document authentic learning experiences" (p. 3). Reese & Levy also stated e-portfolios can lead to "deeper reflection on programmatic goals and objectives" (p. 4). Hubball & Burt (2007) studied the implementation and effectiveness of program-level learning outcomes for a 4-year bachelor of science pharmacy degree program and found that e-portfolios are an effective way to demonstrate and integrate program learning outcomes. Hubball & Burt concluded "[e]ssentially, the portfolios provided a framework, in electronic or paper format, for students to reflect on and record their professional and practice development" (p. 7). Orland-Barak (2007) also found "portfolios can have a central place in the evaluation of practitioners' performance in teacher education programs and, in particular, in the evaluation of experienced teachers and mentors at advanced levels of professional expertise" (p. 40). Orland-Barak also stated "that the mere construction of a portfolio automatically yields critical levels of reflection" (p. 40). Hence, the portfolio needs to support critical reflective processes.

TRANSITIONING A MATHEMATICS EDUCATION ADVANCED DEGREE

Overview and History of Program

The mathematics and science education program went through a complete delivery transformation due to the merging of two universities, shifting from a face-to-face program to an online delivery. One legacy institution had a strong and vibrant face-to-face Master's in Education in Curriculum and Instruction (M.Ed. in C&I) and the other legacy university did not have as vibrant a program. In both cases, the legacy programs were face-to-face. The program's goals and mission from the first legacy university were incorporated into the online, asynchronous program. The major goal was to prepare mathematics and science teacher leaders. The graduates often obtained positions as mathematics coaches, mathematics supervisors, or lead teachers in mathematics or science.

Transitioning Program Standards and Evaluation

The original program consisted of 36 semester hours. There was a thesis option and a non-thesis option. The student learning outcomes in the face-to-face program are provided in Table 1.

These outcomes were assessed through coursework. For example, the first student learning outcome relates to research/inquiry, and it was assessed in the Introduction to Research course where candidates had to demonstrate their ability to interpret and critique published reports of empirical research in education through (1) an inquiry project in educational research or (2) a literature review project on a topic in educational research. Outcome two was assessed in a socio-cultural foundations course where the candidates had to demonstrate an understanding of culture and cultural influences in education by compiling reflective journal entries composed of weekly written responses to course readings on aspects of culture and cultural influences on education. Outcome three reflects knowledge of curriculum and instructional design. Candidates had to create and deliver standards-based, mini-lessons and develop

Table 1. Face-to-face M.Ed. in C&I student learning outcomes (SLOs)

Number	Student Learning Outcomes (SLOs)
1	Interpret and critique reports/articles of empirical research in education.
2	Explain how culture affects teacher-student expectations and interactions, especially in regard to ethnicity, class, gender, sexual orientation, religion, ability, and language.
3	Integrate learning principles and theories into classroom curriculum and instructional design and practice.
4	Analyze curricular programs designed to address the needs of all learners, including second language learners, culturally diverse and migrant students, special education, gifted and talented, at risk students, and students with reading difficulties

final learning projects. Outcome four addresses knowledge of meeting the needs of diverse learners by completing a Curriculum Analysis Project based on a current curriculum in the area of their professional interest and expertise in mathematics education. These four outcomes represent a distillation of the program's coursework.

The above assignments were a part of an assessment process for continuous improvement. The culminating task, required for graduation, was a successful rating on a comprehensive examination for those who chose not to take the thesis option. During the final semester of coursework, and upon the recommendation of the faculty advisor, the candidate had to request to take the final comprehensive examination. The purpose of the comprehensive examination was to evaluate: (1) the knowledge of the salient theories and literature that are a part of the major program of study; (2) ability to synthesize knowledge and to apply it in analyzing and solving related problems; and (3) the ability to communicate effectively in writing at a professional level. The form of the examination was specified in the candidates' Program of Study and may have included one or both of the following: (1) An examination prepared by the graduate faculty under the guidance of the Faculty Advisor and scheduled by the Graduate Office. The examination was evaluated by the Faculty Advisor and two graduate faculty members; (2) Thesis defense and appraisal of research competence by the student's graduate research committee, chaired by the Faculty Advisor.

The comprehensive examination was a typical one where candidates had to report to a location, and were given four hours to respond, by writing essays, to three broad questions that addressed pedagogical content knowledge, curricular knowledge, and research/inquiry knowledge. Candidates were provided preparation materials on-line through videos describing the examination and how to go about writing an excellent essay. Candidates were required to write logical, coherent responses, and provide evidence from the literature to support their arguments. Below is an example of one comprehensive examination question.

Describe the National Council of Teachers of Mathematics standards for teaching algebra and how they compare to the state standards for teaching algebra in the elementary school. In your discussion, include the researcher(s)/theorists from the Current Issues and Research course who laid a foundation for these standards; for example, Kaput and his representation theory, Sfard for her research on how algebra is understood. Also, include a discussion on how algebraic thinking is fostered in middle school mathematics, and within this discussion describe three important misconceptions related to algebraic thinking.

As a mathematics curriculum director, you are to work with elementary teachers to design a scope and sequence for developing algebraic thinking. Provide a rationale and describe topics and tools that you would include in the curriculum and support your design with the literature.

The responses were rated by two faculty members in the program. The above goals were condensed into two criteria. The rubric is presented in Table 2. However, there are several weaknesses related to the rubric. One is that the rubric is not clear as to what the ratings indicate other than the candidate met standards or did not meet the standards, and that there are no specific criteria tied to the standards in the rubric. The intent was to rate candidates on whether the response illustrates that they have acquired the necessary knowledge in relation to the four student learning outcomes presented above.

The last administration of the comprehensive examination occurred during the summer semester of 2015. This was the year that the merging of the two universities occurred. Table 3 presents the average ratings of the six candidates who took the comprehensive examination. Two candidates were on target while three candidates passed the examination with weaknesses, although those weaknesses cannot be determined and two candidates did not have a passing rating. These students were re-administered an alternative version of the examination. The alternate version occurred in the subsequent semester following the same format as the original examination. Consequently, the assessment informed faculty of how many students were on target, how many passed with weaknesses and the number who did not pass. There are few other conclusions that can be made given the design of the rubric. However, if one is concerned about the specific student learning outcomes mentioned above, then a faculty member would have to examine the candidates' artifacts associated with a particular student learning outcome.

As the merger of the two institutions was occurring, discussions were held to determine how the M.Ed. in Curriculum and Instruction with emphasis in mathematics education would be conducted. It was agreed to move the program to an online format due to the potential of increased enrollment because the enrollment at the graduate level, in the college of education, was lower than prior to the merger.

Table 2. Comprehensive examination rubric

Criteria	Scoring		
The response demonstrates knowledge of subject matter to established standards. (Pedagogical Content Knowledge)	1=Not Met	2=Met With Weakness	3=Target
The response demonstrates proficiency to plan and communicate instruction or other professional practice that makes content meaningful. (Application of Knowledge)	1=Not Met	2=Met With Weakness	3=Target

Table 3. Summer 2015 comprehensive examination ratings

Student	Pedagogical Content Knowledge Average Rating	Application of Knowledge Average Rating
1	2.5	3
2	2.7	2.7
3	2.8	2.8
4	3	3
5	3	2.8
6	1	1
7	1	1

However, there were efforts to increase graduate enrollment in each of the colleges at the university. The university administrators thought that it would help increase graduate enrollment in the M.Ed. in C&I program by having a fully on-line, asynchronous program (Sener, 2010).

The current M.Ed. asynchronous program strives to adhere to Hammerness, Darling-Hammond, & Brandford's (2005) framework, which was also used in the face-to-face program, describing what teachers need: (1) a vision for practice; (2) a set of understandings of subject matter, teaching, and learning; (3) dispositions about using this knowledge; (4) practices that allow them to act on their intentions and beliefs, and (5) tools that support their effort.

Faculty reviewed the courses offered at the two legacy institutions and selected the courses that met the required outcomes or objectives. The current program consists of 30 semester hours. There is no thesis option in this accelerated program which prompted the development of the electronic portfolio. In this accelerated program, there are five courses in the general curriculum and instruction component. They include a course in educational research, cognition and learning theory, classroom assessment, curriculum design and development, and socio-cultural foundations of education. There are five courses in mathematics education. The primary focus of the course work is on teaching mathematics for understanding (Fennema & Romberg, 1999) and more recently, implementing the *Principles to Actions* (National Council of Teachers of Mathematics, 2014). These courses are designed to ensure success in mathematics for all students. Aspects of mathematics instruction supported by the principles are establishing clear learning goals, fostering procedural fluency through conceptual understanding, developing problem solving skills, allowing for productive struggle, communicating ideas, and assessment. Consequently, the program has eight standards (see Table 4).

During the transition, faculty received training in how to develop asynchronous courses using the Quality Matters (QM) rubric. Each of the ten courses in the program were blueprinted and submitted to the Office of Distance Education for review and approval. The program coordinator led discussions as to determining a method for assessing candidates' knowledge of the eight standards. The faculty agreed to have all candidates develop an electronic portfolio in order to graduate. Newly admitted candidates enrolled in the asynchronous, online program were required to submit an electronic portfolio. They are informed of the requirement upon admission and are provided with the following hyperlink: https://medciportfolio.wordpress.com which contains instructions and guidelines for constructing the portfolio in the platform and uploading artifacts, the rubric for which it will be assessed, and requirements to demonstrate knowledge for each standard. It is worth noting, that since the program was initially guided by the corporation, Academic Partnership, the courses are offered in seven-week modules. Candidates can take four courses per 14-week semester; thus, the program is an accelerated one. This is the reason that candidates are informed of the requirement as soon as possible. Each of the candidates' electronic portfolios are rated by at least two raters. The Student Learning Outcomes (SLOs) are indicated for each of the eight standards. The rubric is presented in Appendix A.

Appendix B provides the most recent candidates' e-portfolio ratings for the spring 2019 semester which presents the average ratings for each standard and an overall rating for each standard. There were 23 candidates who submitted an electronic portfolio during the spring 2019 semester. Two strengths are revealed in the data. One strength is related to Standard Three, pedagogical content knowledge, which has the highest overall rating. Candidates demonstrated an ability to teach content meaningfully to students. They can describe concepts, theories, and carry out processes that best reach students in the content area by focusing on content pedagogical strategies. With some candidates showing a high level

Table 4. Asynchronous M.Ed. in C&I program standards and student learning outcomes (SLOs)

Number	Program Standard	Student Learning Outcomes (SLOs)
1	Curriculum Knowledge	Program completers will demonstrate advanced ability to design, implement, and evaluate curriculum that promotes student learning.
2	Instructional Knowledge	Program completers will demonstrate advanced ability to plan, implement, and evaluate instruction to facilitate student learning.
3	Pedagogical Content Knowledge	Students will demonstrate advanced depth and breadth of knowledge and skills in the academic discipline and its pedagogy
4	Student Knowledge	Program completers will demonstrate advanced knowledge of the student as influenced by cognitive, physical, emotional, social, cultural, environmental, and economic factors
5	Inquiry and Research Knowledge	Program completers will demonstrate ability to use research to promote student learning and to contribute to the teaching profession
6	Assessment Knowledge	Program completers will demonstrate advanced knowledge of assessment and the ability to use multiple sources of assessment for maximizing student learning
7	Professional Practice	Program completers will demonstrate high standards for professional practice
8	Integration of Technology with Instruction	Program completers will demonstrate ability to integrate current technology into instruction and communications/collaboration activities where appropriate

of pedagogical knowledge through their e-portfolio document(s) that indicated evidence of exceeding expectations by clearly explaining concepts, theories, and processes that foster a learning community.

A second strength is Standard Five, Research/Inquiry. Candidates' demonstrated that they were able to write a scholarly paper with minor errors in grammar that has enough detail to indicate sufficient knowledge and skills related to educational research, and showed an understanding of basic concepts of educational research and critiquing studies. Some students (1) demonstrated a high level of understanding of educational research processes such as the distinction between quantitative and qualitative research methodology, (2) were able to conduct a literature review, and (2) design and implement a study such as, an action research study.

One weakness was indicated by the scores in Standard 4, Student Knowledge. Most of the candidates did meet the standard as the mean rating was 2.36 which means that they had the knowledge or understanding of the influences that impact students' ability to learn and provided descriptions of at least two factors that impact student learning. So, they can recognize factors that influence student learning in K-12 schools. There is room for improvement. One other weakness identified was the integration of technology with instruction, Standard 8. Overall, from these data it can be ascertained that the candidates were at least meeting the program standards' requirements.

Tables 5 and 6 present a comparison of the student learning outcomes for the accelerated program and the former face-to-face program. The electronic portfolio offers an opportunity to assess outcomes with more detail. The comprehensive examination rubric collapses multiple outcomes. For example, the comprehensive examination questions holistically assessed current program curricular knowledge, instructional knowledge, pedagogical content knowledge and student knowledge standards. The one rating for this category makes it difficult to ascertain strengths and weaknesses. Essentially, the comprehensive

Table 5. Alignment of comprehensive examination with E-Portfolio program artifacts expectations

Comprehensive Examination Categories	E-Portfolio Rubric Criteria
Mathematics Education Pedagogical Content Knowledge	1, 2, 3, 4
Curriculum	1, 4, 6
Educational Research	5

Table 6. Comparison of comprehensive examination rubric with E-Portfolio rubric criteria

Face-To--Face Rubric Criteria	E-Portfolio Rubric Criteria
Pedagogical Content Knowledge	2, 3, 4, 6, 8
Application of Knowledge	1, 2, 3, 5, 7

examination assessed similar outcomes but in a more aggregated method which makes identifying strengths and weaknesses difficult. It was more of a pass or fail assessment that offered little program feedback.

DISCUSSION

Overall, many of the spring 2019 candidates in the program met the standards. This findings is indicated by the average ratings for each standard being above a two. Candidates demonstrated in Standard Three, strong pedagogical content knowledge. In addition, the ratings indicated other standards where candidates demonstrated strong ability, e.g., inquiry and research knowledge (Standard 5), and those that were weak, e.g., integration of technology with instruction (Standard 8). The strength in the inquiry and research knowledge standard indicated that the program is doing well in teaching candidates the foundations of educational research and its application of research to practice. The lower rating for Standard Eight demonstrates that more can be done to guide students in the integration of technology for teaching mathematics.

The rating process allows faculty to look at individual students as well as the overall results. For example, there are very few candidates who scored below an average rating of two; similarly, there are very few who were rated a three, and this is to be expected. Not all candidates will be outstanding and not all will meet the standard rating. Currently, there is no consequence for those who score below meeting the standard rating. The e-portfolio is primarily used to provide information about the courses and the program. This lack of consequence may have impacted candidate scores.

The electronic portfolio has several advantages as an assessment tool over the comprehensive examination. Given that the program is asynchronous, the electronic portfolio is visible to all faculty members who teach in the program. They can access actual student work samples. As a result, can discriminate learning outcomes needed for mastery as well as see an overall rating. The electronic portfolio is personalized so that candidates can, choose their own samples with justifications that best represent their work in relation to the standard. Through these samples, faculty are better able to make course-related changes. Having multiple raters allows for more objectivity and fairness in rating. The use of the electronic portfolio as a program evaluation tool supports Reese & Levy's (2009) contention that the use of e-portfolios can

lead faculty to reflect more deeply on both programmatic goals and objectives. Through this reflective process faculty can evaluate outcomes as Hubball & Burt (2007) found in that e-portfolios are effective in demonstrating program learning outcomes. Furthermore, the implementation of the electronic portfolio allows for both faculty and students to reflect on learning outcomes. For example, reflecting on Standard Seven permitted candidates, as Hubball & Burt concluded, to reflect on and record their professional development, and practice.

One e-portfolio drawback has to do with time. Each portfolio must be read thoroughly, and each artifact examined in relation to the prompts for reflection. Faculty have reported that it takes much of their time to rate the portfolios. The benefits outweigh the drawback in a great deal of information about the program is provided through the review process.

In comparison to the electronic portfolio evaluation tool, the comprehensive examination of the face-to-face program provided a one-time analysis of candidates' abilities to provide scholarly responses to the three questions. The examination looked at a limited number of program outcomes. The rubric was weak in that it was unclear what exactly the rubric was measuring and the extent of knowledge the candidate possessed in relation to designing curriculum or mentoring other mathematics teachers. Although there were also multiple raters of the responses, the rubric's design failed to provide adequate feedback about the program. The transition to the asynchronous program precipitated the use of the electronic portfolio. Lessons learned from the previous assessment process were used to design the electronic portfolio's rubric clearer regarding the measurement of learning outcomes.

FUTURE DIRECTIONS

The implementation of the electronic portfolio provided an avenue to assess program outcomes using artifacts from the candidate's coursework experiences. Program faculty are involved in the rating process and thus become an integral component of the assessment system. Faculty are better able to assess the strengths and weaknesses of the program. One area for improvement in the assessment system is the need to further refine the electronic portfolio's rubric. It would be best to hone it to better reflect more specifically the program outcomes. In addition, more work can be done to examine and rate the candidates' artifacts. An avenue for further research is to design a rubric that can essentially provide feedback as to the quality of the responses rather than an overall view. Continuous improvement can be facilitated by more closely examining artifacts for details regarding candidate knowledge and skills in relation to the standards.

Because the program is accelerated and asynchronous, it is important to constantly evaluate the program. Standard Seven on Professionalism could be further examined as to the extent to which the program fosters opportunities for candidates to be mathematics teacher leaders. The limited time in which this process can occur is an important consideration in trying to design a program that promotes mathematics teacher leadership.

CONCLUSION

This chapter presented a description of how one university transitioned its assessment system for a Master's in Curriculum and Instruction with an emphasis in mathematics education program from a face-to-face

to an accelerated, asynchronous program. The most recent program candidates demonstrated meeting expectations in each of the eight program standards, especially in pedagogical content knowledge. The program is successful at helping candidates develop advanced pedagogical content knowledge (Standard 3). The key to an excellent assessment system is the tool used to assess students. The capstone assessment for the face-to-face program changed from administering a comprehensive examination to an electronic portfolio. This change resulted in an improved assessment system for the asynchronous Master's degree in Curriculum and Instruction. Faculty became more integral to the assessment process rather than having just one or two faculty members writing a comprehensive examination question; several program faculty became involved in rating candidates' work samples. The electronic portfolio, when compared to the comprehensive examination, is better able to reveal the strengths and weaknesses of the program's standards or learning outcomes by providing more data for making judgements about the program. As a result, faculty become more adept at recognizing what needs to be improved. The electronic portfolio is an important aspect of an accelerated, asynchronous master's in education program. Given the face paced nature of an accelerated program, the tool allows for immediate reflection and assessment of program outcomes. The program is effective in preparing mathematics education leaders who have strong pedagogical content knowledge, can conduct research/inquiry, using the needs of diverse learners to design and implement curriculum, and have a high level of professionalism. As more universities and colleges are moving toward on-line programs, the electronic portfolio is an important element of a successful assessment system.

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KEY TERMS AND DEFINITIONS

Asynchronous: A distance education modality where learners engage in course content without direct guidance from an instructor outside the constraints of time and place.

Distance Education: An education program where the students learning experiences are conducted using an electronic platform such as Blackboard, synchronously or asynchronously.

E-Portfolio: A collection of candidates' work samples that are housed on a website to document their knowledge and skills relative to student learning outcomes as a form a final capstone assessment.

Pedagogical Content Knowledge: The special nature of subject matter knowledge needed by teachers who understand both the content as well as strategies for effective communication of that content.

Student Learning Outcomes: The program's objectives that each candidate is to meet.

APPENDIX A

Table 7. Table Rubric for the Accelerated, Asynchronous M.Ed. in C&I Electronic Portfolio

Student Learning Outcomes	1-Not Met	2-Met	3-Beyond Expectations
1. Curriculum Knowledge- Program completers will demonstrate advanced ability to design, implement, and evaluate curriculum that promotes student learning.	Narrative does not provide detail, has severe grammatical and spelling errors; the artifact is not clearly connected to the SLO and fails to demonstrate competency. Evidence of rudimentary ability regarding curriculum processes.	Narrative meets the requirements; minor errors in grammar; enough detail is provided that indicates sufficient knowledge and skills in the discipline; the artifact clearly indicates disciplinary knowledge and skills.	Same as for a 2, but extensive evidence is provided that indicates a high level of disciplinary knowledge and skills, evidence of synthesis and evaluation of knowledge.
2. Instructional Knowledge Program completers will demonstrate advanced ability to plan, implement, and evaluate instruction to facilitate student learning.	Narrative does not provide detail, has severe grammatical and spelling errors; the artifact is not clearly connected to the SLO and fails to demonstrate competency. Instructional strategies tend to focus on teacher-centered practices, poor understanding of evaluating instruction to promote learning.	Narrative meets the requirements; minor errors in grammar; enough detail is provided in documents such as lesson plans, unit plans and or scope and sequence that indicate clear knowledge and skills in curricular and pedagogical knowledge related to student centered instructional practices. Technology is used to develop concepts.	Same as for a 2, but extensive evidence is provided that indicates a high level curricular/ pedagogical knowledge; document(s) indicate evidence of exceeding expectations with clear learning goals, assessment plan, and student centered instructional practices that foster a learning community.
3. Pedagogical Content Knowledge- Students will demonstrate advanced depth and breadth of knowledge and skills in the academic discipline and pedagogy.	Narrative does not provide detail, has severe grammatical and spelling errors; the artifact is not clearly connected to the SLO and fails to demonstrate competency. Evidence of poor knowledge regarding the teaching of content in a variety of ways, differentiation, and meeting student needs.	The artifact demonstrates your ability to teach your content meaningfully to students. Describes concepts, theories, processes that relate to how best to reach students in the content area, focusing on content pedagogical strategies.	Same as for a 2, but extensive evidence is provided that indicates a high level pedagogical knowledge; document(s) indicate evidence of exceeding expectations with clear concepts, theories, and processes that foster a learning community.
4. Student Knowledge- Program completers will demonstrate advanced knowledge of the student as influenced by cognitive, physical, emotional, social, cultural, environmental, and economic factors.	Narrative does not provide detail, has severe grammatical and spelling errors; the artifact is not clearly connected to the SLO and fails to demonstrate competency. Few student factors are identified with weak connections to student learning.	Evidence indicates knowledge or understanding of the influences that impact students' ability to learn; and provides descriptions of at least two factors that impact student learning.	Same as for a 2, but extensive evidence is provided that indicates a high level knowledge of factors that impact student learning; document(s) indicate evidence of exceeding expectations.
5. Inquiry and Research Knowledge- Program completers will demonstrate ability to use research to promote student learning and to contribute to the teaching profession.	Narrative does not provide detail, has severe grammatical and spelling errors; the artifact is not clearly connected to the SLO and fails to demonstrate competency. Little indication of how research is used to promote student learning. Poor understanding of the research processes.	Narrative meets the requirements; minor errors in grammar; enough detail is provided that indicates sufficient knowledge and skills related to educational research the artifact clearly indicates understanding of basic concepts of educational research and critiquing studies.	Same as for a 2, but extensive evidence is provided that indicates a high level of understanding of educational research processes such as distinction between quantitative and qualitative research methodology; conducted a literature review; and carried out a study such as an action research study.

continues on following page

Table 7. Continued

Student Learning Outcomes	1-Not Met	2-Met	3-Beyond Expectations
6. Assessment Knowledge-Program completers will demonstrate advanced knowledge of assessment and the ability to use multiple sources of assessment for maximizing student learning.	Narrative does not provide detail, has severe grammatical and spelling errors; the artifact is not clearly connected to the SLO and fails to demonstrate competency. Evidence shows a lack of knowledge of assessment processes and strategies. A focus on one or two types or strategy of assessment.	Evidence clearly demonstrates knowledge or understanding of assessment in the mathematics or science classroom including formative and summative assessment. Indications of understanding the need to vary assessment strategies and processes.	Same as for a 2, but extensive evidence is provided that indicates a high level knowledge of assessment processes and strategies with indications of instructional decisions made as a result.
7. Professional Practice-Program completers will demonstrate high standards for professional practice.	Narrative does not provide detail, has severe grammatical and spelling errors; the artifact is not clearly connected to the SLO and fails to demonstrate competency.	Evidence indicates that the candidate has participated in professional practices in at least one area such as mentor/coaching, sharing knowledge as in presenting to colleagues, participating in curricular development, after school programs, etc.	Same as for 2, but a greater level of professional practices is indicated by multiple activities.
8. Integration of Technology with Instruction-Program completers will demonstrate ability to integrate current technology into instruction and communications/collaboration activities where appropriate.	Narrative does not provide detail, has severe grammatical and spelling errors; the artifact is not clearly connected to the SLO and fails to demonstrate competency. Evidence is lacking regarding the use of technological tools to develop conceptual understanding, primarily used for presenting information.	Clear indication of the use of various types of technological tools, attempt made to use them for conceptual development, communication, and/or collaboration.	Same as for 2, but for consistent use of the tools for conceptual development, communication, and collaboration.

APPENDIX B

Table 8. Candidates' electronic portfolio average ratings for each standard

Student	S-1	S-2	S- 3	S-4	S-5	St- 6	S-7	S-8
1	2.5	2.75	2.75	2.5	2.75	2.5	2.5	2.5
2	2.75	2.95	3	2.75	2.75	3.0	3.0	3.0
3	3	3	2.75	2.85	2.85	2.85	2.95	3.0
4	2.5	2.5	2.5	2.45	2.3	2.2	2.45	2.6
5	2.4	2.4	3	2.5	3	2	2	2.5
6	2.5	2.5	2.5	2	2.45	2.4	2	2.5
7	1.9	2	2.45	2.5	2.5	2.25	2	2
8	2.25	2.5	2.75	2.5	2.35	2.4	2.1	1.95
9	2.5	2.45	1.95	2.45	2.5	2.5	3	2
10	3	2.5	2.2	2.15	2.4	2.45	2.5	2.5
11	1.85	2.4	2.5	2	2.5	2	2.5	2.4
12	2.67	2.67	3	1.67	2.93	2.3	3	2.3
13	2.9	2.9	2.9	3	3	3	3	2.95
14	2.35	2.35	2.5	2.25	2.75	2.5	2	2.5
15	2.9	2.9	3	3	3	3	2.9	2.9
16	2.77	2.57	2.57	2.17	2.83	2.17	2.33	2.33
17	2.17	2.5	2.67	2.67	2.5	2.83	2.33	1.83
18	3	3	3	3	3	3	3	3
19	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
20	1.50	2.00	2.00	1.00	2.00	1.50	2.00	2.00
21	2	2	2	2	2	2	2	2
22	2	2	2	2	NR	NR	NR	NR
23	3	3	3	3	3	3	3	3
Average for each Standard	2.43	2.49	2.54	2.34	2.58	2.43	2.46	2.42

NR = Not Rated