ASSESSMENT

Teaching and Evaluating Skills for Undergraduate Research in the Teacher Education Program

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Abstract

Teacher candidates have lower participation in undergraduate research than students in other disciplines. To enable teacher candidates to develop skills for scholarly activities and to engage them in research activities, teacher education programs utilize diverse approaches. This article describes a strategy to promote undergraduate research among teacher candidates using a systematic course-based infusion of skills necessary for undergraduate scholarship. In addition, it reports on the undergraduate students' performance in research skills such as critical thinking, information literacy, and written communication in scholarly products over a three-year period. The results show an uneven but steady growth in research skills. Also discussed are the course and curricular modifications used by instructors to promote skill development for undergraduate research related to teaching.

Keywords: *critical thinking, teacher education, teacher work sample, undergraduate research*

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To be effective, teachers must develop dynamic pedagogical strategies that are responsive to student's needs. This requires teachers to evaluate the effectiveness of different approaches so that ineffective techniques are reformulated or abandoned, whereas successful techniques are maintained and promoted. As a result, it is expected that teachers act as agents of change, becoming innovators in their profession, continually open to growth, inquiry, and research. One way to support inquiry and research skills is the infusion of scholarly experiences into undergraduate teacher education courses. Unfortunately, the research experience for undergraduate students in education is less prevalent than that offered in undergraduate study in other disciplines, such as math and biology, chemistry, and other natural sciences (Manak and Young 2014, 35).

Although undergraduate research in teacher education is less common than in other fields, a growing number of studies document faculty and student perceptions regarding undergraduate research for teacher candidates and its effectiveness in the United States and other countries (e.g., Dorner et al. 2017; Turner, Wuetherick, and Healey 2008; Yancovic-Allen 2018). Many of these studies focus on the benefits of future teachers' engagement in undergraduate research. These benefits include refined abilities for connecting educational theory and pedagogical practices to real-world implementation as well as the knowledge and skills for designing and interpreting research, inquiry, and collaboration (Madden et al. 2013, 16; White et al. 2016, 38). Despite the benefits of undergraduate research for teacher candidates, numerous obstacles may limit full implementation of undergraduate research in teacher education programs. These obstacles include lack of time and resources, the demands of education course content, and scarcity of faculty with the required research experience (Manak and Young 2014, 37; Munthe and Rogne 2015, 2; Myers et al. 2018, 143).

Though numerous obstacles are acknowledged, the benefits and learning gains seem to outweigh the challenges. Both faculty and teacher candidates (TCs) recognize the positive outcomes of scholarly activities; therefore, teacher educators pilot, implement, and document different approaches for infusing undergraduate scholarship into

their programs (Myers et al. 2018). For example, Slobodzian and colleagues (2016) described a pragmatic model in which TCs engaged in self-analytic research through critical analysis of teaching practices that positively affect student learning. Similarly, action research as an avenue of combining teaching and research has the potential to foster future teaching (Yan 2017). In addition, Vaughan, Baxley, and Kervin (2017) found that the infusion of research assignments into a course was effective for research skill development.

Florida Gulf Coast University (FGCU) recently put a five-year plan into practice with the purpose of fostering and mentoring undergraduate scholarship for all students, including teacher candidates. The university faculty and administration initiated a university-wide educational reform as part of the institution's reaccreditation to improve transferable skills among students (i.e., written communication, information literacy, and critical thinking) through the integration of undergraduate research opportunities into the curriculum of every major. This reform, called FGCUScholars: Think ~ Discover ~ Write, required programmatic revisions to integrate skill-based lessons that introduced students to discipline-specific scholarly approaches. This design ensured that students would take at least three courses that engaged them explicitly in authentic course-based research experience, thereby promoting the development of these transferable skills. Under the FGCUScholars initiative, the teacher education faculty selected courses at the beginning, middle, and end of the teacher preparation program in which they could specifically target and evaluate the development of scholarly skills (critical thinking, information literacy, and written communication) that students could then use in research.

The purpose of this article is to describe the course-based infusion of skill development for undergraduate scholarship in teacher education and to share the undergraduate students' performance results related to critical thinking, information literacy, and written communication in scholarly products over a three-year period. In addition, the course and curricular modifications that instructors used to promote skill development for undergraduate scholarship related to teaching are examined. The article concludes by describing how this effort has engaged more students in undergraduate research experiences and provides additional recommendations based on these lived experiences and findings.

Context

The College of Education (COE) at FGCU offers six teaching certification programs, in which core courses are taken by all students in the majors of elementary education, early childhood education, special education, and secondary education (the last composed of three disciplinary-specific programs). To develop a scaffolded effort to master skills for undergraduate scholarship, the following courses were selected: (1) the beginning course (TSL 3080, Foundations of English as a Second Language, or ESOL), (2) the middle course, in the student's major, (RED 4350, Literacy Content and Processes), and (3) the capstone course (EDG 4937, Senior Seminar). In each course, a major assignment, called an artifact, was identified to assess TC skills (see Table 1).

Beginning Course

Upon entering the teacher education program, all TCs take Foundations of ESOL (TSL 3080), which examines issues of language and culture that are relevant for learners of English as a second language. The course creates an initial knowledge base in applied linguistics and cross-cultural communication for future teachers of culturally and linguistically diverse (CLD) students. The assignment Analysis of Family and Student Learning Environment provided opportunities for TCs to directly engage in research while exploring the sociocultural environment of CLD students via interviews and observations. This assignment required TCs to practice basic research skills, such as developing interview questions, analyzing and interpreting relevant sources, and then conducting and using critical thinking to analyze the interviews. Finally, TCs produced a research paper that concluded with recommendations for future teachers. In a scaffolded manner, the beginner TCs put into practice essential content specific knowledge, skills for conducting research, and dispositions to understand CLD students.

TABLE 1. Selected Courses and Artifacts

Course identifier	Title of course	Course artifact/assignment
Beginning course	TSL 3080, Foundations of ESOL	Analysis of Family and Student Learning Environment
Middle course	RED 4350, Literacy Content and Processes	Strategy Application Project
Capstone course	EDG 4937, Senior Seminar	Teacher Work Sample

Note: ESOL = English for speakers of other languages

Middle Course

In the course RED 4350, Literacy Content and Processes, the course scholarly assignment Strategy Application Project was piloted to explicitly develop the skills of critical thinking, information literacy, and written communication. The assignment required TCs to create a thematic unit plan using a total of 10 teaching ideas, which were all activities that employed a reading strategy to support a middle or high school student's comprehension of textual information utilizing relevant high-quality resources (i.e., books or articles). Consequently, the TC instructional decisions were made based on current research literature, taking into consideration the text structure in a content area (social studies, science, etc.). In this artifact, TCs were also required to use an evidence-based rationale for choosing each specific teaching idea, citing research that supported the reading strategy for improving comprehension.

Capstone Course

In this course, a Teacher Work Sample (TWS) was the capstone project for graduation and to meet accreditation and state approval requirements. This assignment also gave TCs the opportunity to demonstrate their ability to conduct research in teaching. The TWS is recognized as a tool for helping TCs to bring together theory and practice and to collect data to demonstrate their ability to positively impact preK–12 student learning (Benton et al. 2012, 370). The TWS represented the kind of planning, implementation, and assessment that should be ongoing in every classroom. It was a reflective narrative of a one- to four-week integrated unit of instruction in one subject area for one class rather than a typical research paper. The TWS included seven sections, beginning with an inventory of situational factors that impacted student learning in the student teacher's placement classroom and ending with a reflection on the entire teaching and learning process. With this artifact, TCs participated in action research as they developed an evidence-based documentation of teacher effectiveness.

These three courses and the selected artifacts served as milestones for the process and product of skill development for scholarship in teaching. The targeted skills were also embedded in almost every course in the teacher education program to ensure that TCs revisited and practiced these skills on a regular basis. From the beginning of the program, TCs were required to acquire and practice certain research skills and to become more and more independent research scholars as they progressed through the program. In addition to the implementation of this sequence of courses, annual evaluation of skill development and effectiveness for scholarship of TCs has been in place at the undergraduate level.

Evaluation

During the past three years, evaluation focused on the impact of the courses and assignments that were designed to enhance TCs' research skills in critical thinking, information literacy, and written communication. In addition, the instructors' pedagogical decisions regarding the course and assignment modifications were explored in an effort to improve teaching of these skills to students. The evaluation was guided by the following questions:

1. To what extent did the graduating teacher candidates' performance in combined skills change between the beginning, middle, and capstone courses over three years?
2. How did the teacher candidates' performance in critical thinking, information literacy, and written communication change in the beginning course between 2016 and 2018?
3. How did the teacher candidates' performance in critical thinking, information literacy, and written communication change in the middle course in the major between 2016 and 2018?
4. How did the teacher candidates' performance in critical thinking, information literacy, and written communication change in the capstone course between 2016 and 2018?
5. How did the instructors modify their pedagogical decisions and actions based on the evaluation of critical thinking, information literacy, and written communication skills to further foster teacher candidates' ability to complete high-quality undergraduate research?

Evaluation Process

As a complement to the instructor's regular evaluation of the course assignments, an additional evaluation process focusing on the research skills of critical thinking, information literacy, and written communication took place every May. In this annual evaluation, TCs who took the selected three courses between 2015–2016 and 2017–2018 served as the population for the evaluation. All TC artifacts in the selected three courses served as the pool from which a given number of artifacts were randomly chosen for evaluation (see Table 2).

Every May, a panel of education instructors completed the evaluation of artifacts in the beginning course (TSL 3080) and middle course (RED 4350), while a panel of instructors from other disciplines across the university conducted the evaluation of artifacts in the capstone course. The evaluation rubric had seven criteria, divided into three categories, as follows (see Table 3):

Critical thinking
1. Content development
2. Evaluation of information

Information literacy
1. Identification of and ability to access information and evidence
2. Effective use of information to accomplish a specific purpose

TABLE 2. Number of Assessed Artifacts by Course

Courses	2015–2016	2016–2017	2017–2018
Beginning: TSL 3080 Foundations of ESOL	23	12	23
Middle: RED 4350 Literacy Content and Processes	20	9	10
Capstone: EDG 4937 Senior Seminar	28	18	15

Note: ESOL = English for speakers of other languages

Written communication
1. Context and purpose
2. Genre and disciplinary conventions
3. Control of syntax and mechanics

This rubric was created using a modified version of the Critical Thinking VALUE Rubric of the Association of American Colleges and Universities (Rhodes 2010). In all cases, two instructors evaluated each artifact independently with this rubric; if the difference in rubric scores between the two evaluators was more than 4 points out of 28, additional evaluators scored the assignment to achieve high inter-rater reliability.

The evaluation process included the following steps: (1) norming, (2) evaluating artifacts with the rubric, and (3) note-taking concerning additional areas of strengths and/or areas for improvement. During norming, instructors developed a shared understanding of the rubric criteria and how to increase the inter-rater reliability. Then, with the rubric, they evaluated the artifacts with a numeric range of 1 to 4 and took notes about any significant issues regarding the three skills—critical thinking, information literacy, and written communication. These observational notes served as qualitative data that deepened faculty's understanding of the courses' strengths and areas for improvement.

Data Analysis

To determine how this curricular reform affected learning gains among TCs (questions 1–4), ANOVA permutation tests were used to compare assessment results of written artifacts produced by students in the beginning, middle, and capstone courses. All statistical analyses were run in R (R Core Team 2017). ANOVA permutation tests with a maximum of 5,000 iterations were run in the lmPerm package of R (Wheeler and Torchiano 2016). Statistically significant patterns were described based on an alpha of 0.05. The package ggplot2 was used to create all figures (Wickman 2016). To answer question 5 regarding the instructors' pedagogical decisions and actions, the courses' syllabi, assignment descriptions, and instructors' reflections were analyzed qualitatively, following the data analysis spiral described by Creswell (2003).

Results

Graduating TCs showed significant improvements in the development of transferable skills associated with undergraduate scholarship across the three selected courses. Graduating seniors performed significantly better than lower-level students in the beginning and middle courses (see Figure 1). Graduating seniors showed a 21-percent improvement when scores were averaged across the seven assessed criteria of critical thinking, information literacy, and written communication. As would be expected by the overall increase, the number of TCs who succeeded in demonstrating the desired learning gains also changed across the three courses. The percentage of students who scored between a 3 and 4 on the rubric increased from 13 percent in the beginning course to 29 percent in the capstone, whereas the percentage of students that performed poorly, scoring between a 1 and 2, declined from 37 percent of students in the beginning course to only 7 percent in the capstone.

Overall, TCs showed better written communication skills than either critical thinking and information literacy skills (see Figure 2). However, students showed the greatest improvement in their critical thinking skills, improving by roughly 27 percent from the beginning to capstone courses. TCs showed similar improvements in their written communication and information literacy performance between the beginning and capstone courses, with 17.7 percent and 17.4 percent improvement respectively.

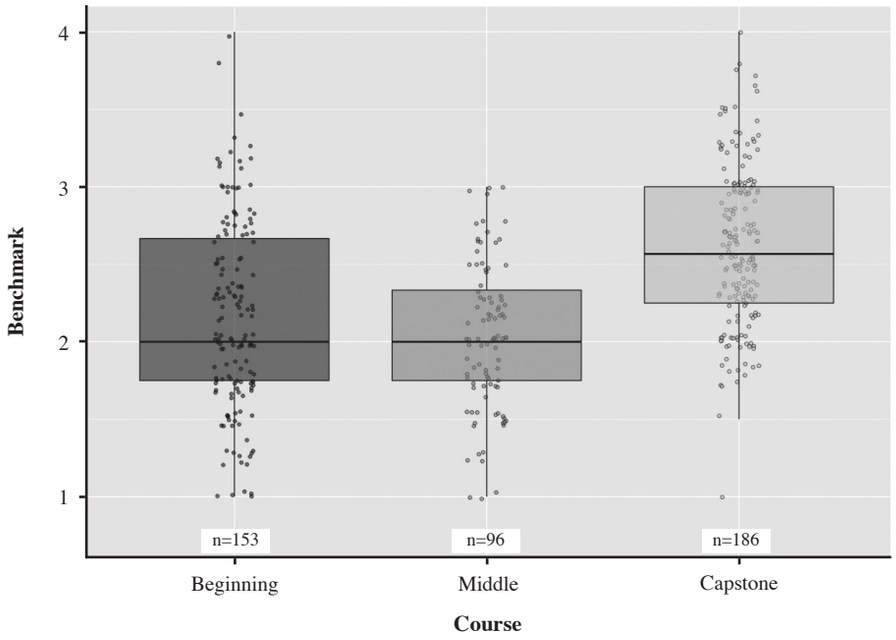
TCs showed variable learning gains among the associated courses during the three years of the program (see Figure 3). Graduating TCs made consistent learning gains in the capstone course during each year of the program, performing 5 percent better in year 3 than in year 1 of the intervention. In addition, students showed similar, although variable, learning gains in the beginning course, earning assessment scores that were 12 percent higher in the third year relative to the first year. However, TCs showed the highest learning gains during the second year of the program, before dipping during the third year. Although students performed better in the beginning and capstone

TABLE 3. Evaluation Rubric for Assessing Teacher Candidates' Learning Gains

Critical thinking	Capstone 4	Milestone 3	Milestone 2	Benchmark 1
Content development	Uses appropriate, relevant, and compelling content to illustrate mastery of the subject, critical analysis, and synthesis skills that convey the writer's understanding.	Uses appropriate, relevant, and compelling content to explore ideas using critical thinking skills within the context of the discipline.	Uses appropriate and relevant content to develop and explore ideas through most of the work.	Uses appropriate and relevant content to develop simple ideas in some parts of the work.
Evaluation of information; conclusion	Skillfully analyzes and evaluates information and evidence related to thesis; conclusion is insightful, logical, and justified based on a skillful evaluation of evidence.	Adequately analyzes and evaluates information and evidence related to thesis; conclusion is logical and justified based on evaluation of evidence.	Attempts to analyze and evaluate information and evidence related to thesis and use evidence in order to justify conclusions.	Takes information at face value (little or no attempt to evaluate quality of information or evidence, relationship to thesis, or support of conclusions).
Information Literacy	**Capstone 4**	**Milestone 3**	**Milestone 2**	**Benchmark 1**
Identification and access of information and evidence	Demonstrates skillful identification and access of high-quality, credible, relevant sources to develop ideas that are appropriate for the discipline and genre of the writing.	Demonstrates consistent identification and access of credible, relevant sources to support ideas that are situated within the discipline and genre of the writing.	Demonstrates an attempt to identify and access credible and/or relevant sources to support ideas that are appropriate for the discipline and genre of the writing.	Has difficulty identifying and accessing sources to support ideas in the writing.
Effective use of information to accomplish a specific purpose	Skillfully communicates, organizes, and synthesizes information from sources to fully achieve a specific purpose, with clarity and depth.	Communicates, organizes, and synthesizes information from sources. Intended purpose is achieved.	Communicates and organizes information from sources. The information is not yet synthesized, so the intended purpose is not fully achieved.	Communicates information from sources. The information is fragmented and/or used inappropriately (misquoted, taken out of context, or incorrectly paraphrased, etc.), so the intended purpose is not achieved.
Written Communication	**Capstone 4**	**Milestone 3**	**Milestone 2**	**Benchmark 1**
Context of and purpose for writing (Includes considerations of audience, purpose, and the circumstances surrounding the writing task[s].)	Demonstrates a thorough understanding of context, audience, and purpose that is responsive to the assigned task(s) and focuses all elements of the work.	Demonstrates adequate consideration of context, audience, and purpose and a clear focus on the assigned task(s) (e.g., the task aligns with audience, purpose, and context).	Demonstrates awareness of context, audience, purpose, and the assigned task(s) (e.g., begins to show awareness of audience's perceptions and assumptions).	Demonstrates minimal attention to context, audience, purpose, and to the assigned task(s) (e.g., expectation of instructor or self as audience).
Genre and disciplinary conventions (Formal and informal rules inherent in the expectations for writing in particular forms and/or academic fields.)	Demonstrates detailed attention to and successful execution of a wide range of conventions particular to a specific discipline and/or writing task(s) including organization, content, presentation, formatting, and stylistic choices.	Demonstrates consistent use of important conventions particular to a specific discipline and/or writing task(s), including organization, content, presentation, and stylistic choices.	Follows expectations appropriate to a specific discipline and/or writing task(s), including basic organization, content, and presentation.	Attempts to use a consistent system for basic organization and presentation.
Control of syntax and mechanics	Uses eloquent language that skillfully communicates meaning to readers with clarity and fluency, and is virtually error free.	Uses straightforward language that generally conveys meaning to readers. The language in the portfolio has few errors.	Uses language that generally conveys meaning to readers with clarity, although writing may include some errors.	Uses language that sometimes impedes meaning because of errors in usage.

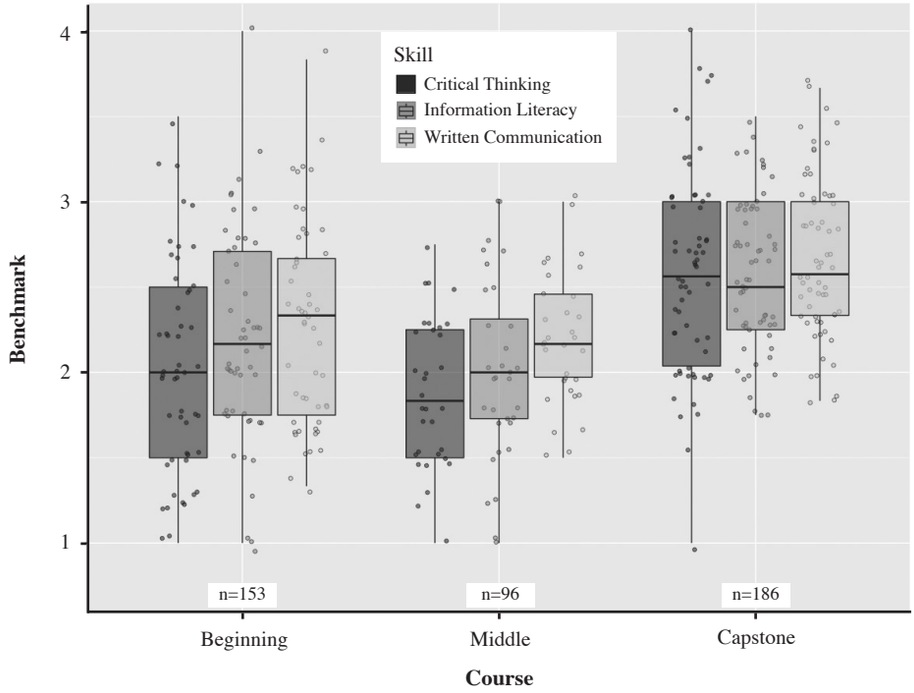
Note: This rubric is a modified version of the Association of American Colleges and Universities (AAC&U) Critical Thinking VALUE Rubric (Rhodes 2010).

FIGURE 1. Assessment Data Collected on Teacher Candidates (2015–2018)



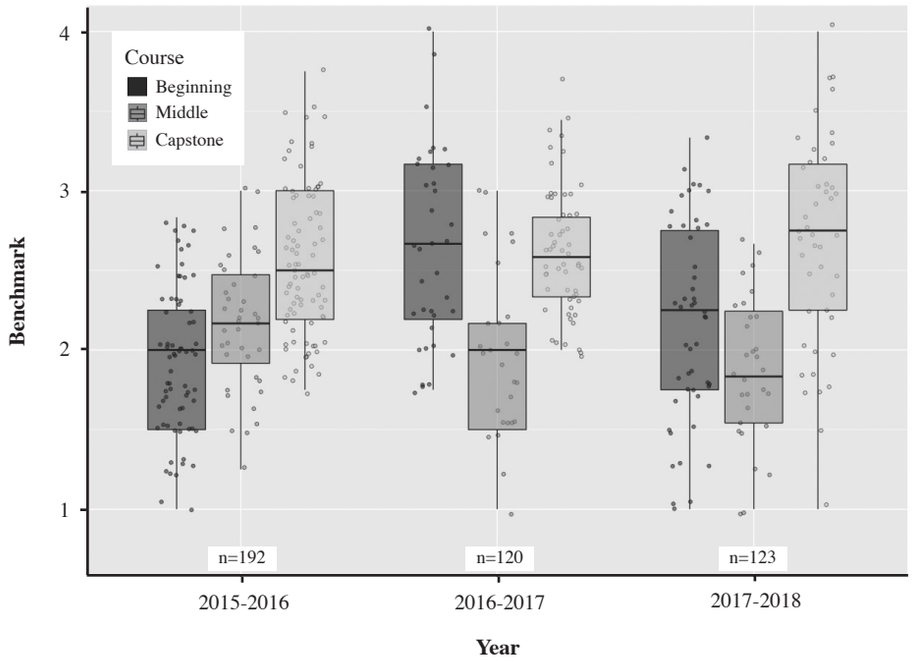
Note: The data represent the average score of seven criteria used to evaluate development of three transferable skills (critical thinking, information literacy, and written communication); individual student scores are represented by points. Students showed significant learning gains across the three scaffolded courses (ANOVA permutation test: $F = 47.5$; df = 2, 432; $p < 0.001$).

FIGURE 2. Average Results of Assessment Data Collected from Teacher Candidates (2015–2018)



Note: Scores represent the average score for a student's critical thinking, information literacy, and written communication skills. Individual student scores are represented by points. Overall, education students showed significantly higher written communication skills than critical thinking and information literacy skills (ANOVA permutation test: $F = 47.5$; df = 2, 432; $p < 0.001$). However, students showed the greatest improvement in critical thinking skills, increasing by 27 percent between the beginning and capstone courses.

FIGURE 3. Changes in Teacher Candidates' Learning Gains (2015–2018)



Note: These data represent the average scores of assessed artifacts for seven criteria for critical thinking, information literacy, and written communication. Individual student scores are represented by points. Teacher candidates showed variable learning gains among the associated courses during the three years of the program (interaction between course and year: $F = 9.79$; df = 4, 426; $p < 0.001$).

courses, they showed consistent learning declines in the middle course; these students performed 13 percent worse in year 3 than in year 1 of the program.

Modifications

The yearly assessment results were shared and discussed with the instructors; based on the results they made pedagogical decisions to strengthen TCs in the targeted areas of critical thinking, information literacy, and written communication. The following modifications were implemented to address the areas needing improvement.

Beginning Course

In this course, additional instruction and guidance in proper research procedures, such as generating research questions, interviewing skills, and analyzing qualitative data, and increased scaffolding of academic writing were implemented. Relevant topics embedded in class content included a grammar review series, the use of exemplary articles from scholarly research papers using APA style, a workshop on how to navigate the library and locate articles in refereed journals, and information on developing research questions. As a result, the course expanded TCs' cross-cultural understanding and added more depth to the inquiry related to perceptions, beliefs, and framing of education from diverse perspectives, as generated by research questions.

Middle Course

The faculty teaching this course recommended modifying the pilot assignment, which resulted in the creation of a separate assignment in the form of a literature review. This change was determined to be a more effective approach to using literature and preparing TCs for the Teacher Work Sample in the capstone course. Furthermore, this new literature review was broken down into two parts: (1) the teaching idea or instructional routine, and (2) description and rationale of the research supporting the reading strategy utilized for the teaching idea, or explanation of how research had shown it to improve comprehension. By focusing on only two parts of this unit assignment, TCs developed their writing, critical thinking, and information literacy to foster discipline-specific comprehension. Additional instruction in specific writing competencies, citing research in APA style, and evaluating and synthesizing scholarly information was infused.

Capstone Course

The first-year evaluators of the Teacher Work Sample had a challenging time recognizing the presence of critical thinking within the large document of 60–100 pages produced in the capstone course. Although each TWS relied on a rich variety of resources, the artifacts did not reflect the information literacy typically found in a research paper. Therefore, the TWS was modified to enhance the TCs' ability to make

effective use of the literature in this action research. TCs embarked upon a typical research-paper project investigating evaluation of teacher effectiveness in US schools. For candidates' future success as classroom practitioners, understanding teacher evaluation processes, its components, and the forces affecting evaluation processes was relevant and increased essential knowledge. To gain information about and understanding of the evaluation of teacher effectiveness, TCs read a series of articles by Darling-Hammond (2010, 2014), Goe (2013), and Minnici (2014). Seminar discussions on the measurement of teacher effectiveness and background information from the articles helped TCs identify their research topic and formulate research questions. Teacher candidates then embarked upon individual explorations of evaluating teacher effectiveness. A part of this exploration was a concise literature review to support their thesis and provide information to answer research questions and discuss their findings. Their explorations of effectiveness led to a deeper understanding of the importance of being proactive participants in their professional development and evaluation of their classroom practice.

Overall, modifications in the three courses targeted a gradual progression of skill development through which TCs became increasingly independent in the research process.

Conclusions

Research-based teacher education is an emerging trend in the United States and worldwide as part of strengthening teacher preparation in the twenty-first century (Afdal and Spernes 2018, 216). These research-based teacher education programs focus on learning experiences that foster skills such as critical thinking, analysis, and critical reflection skills (Cochran-Smith and Fries 2005). When teachers possess these transferable skills, they are able to continuously renew their pedagogical approaches and act as creators of knowledge rather than as solely recipients or transmitters of knowledge (Darling-Hammond 2017, 294).

The teacher education program in this study is currently completing the fourth year of the five-year educational reform, using the prior years' evaluation data for continuous improvement. In this study, the systematic yearly evaluation of teacher candidates' skill development has indicated that the course-based scholarly activities infused throughout the teacher preparation program impact TCs' skills and competency in conducting research. These findings substantiate the results of the study by Vaughan, Baxley, and Kervin (2017), in which they found positive outcomes that included increased research skills and emerging teaching dispositions because of the course-based infusion of research skills. Through these experiences, teacher candidates gradually transform from consumers of research to producers of research that offers insights into critical issues emerging from their teaching practices (Yancovic-Allen 2018, 490).

By the completion of the capstone course, teacher candidates showed an increase in research skills, although there was some fluctuation in performance across the courses. The lack of clear linear increase in evaluated skills from the beginning to the middle courses can be explained by the different nature of the course artifacts: a research paper (first year) versus a literature review (second year). Such variation among courses across different years may also be partially explained by the use of a single assessment instrument that aligned with some assignments better than others. Evolving assignments, particularly in the beginning and middle courses, may explain some of the differences observed in years 2 and 3 of the program, during which students appeared to perform better in the beginning course than the middle course. Overall, these findings indicated that teacher candidates had better research skill performance when engaged in the complete research process, rather than only a literature review. However, there is improvement in skills demonstrated in the capstone project, likely the outcome of extensive practice in the development of the literature review required in the middle course. The positive change that was documented in the capstone project reinforces the need for a program-wide infusion of scholarly skills for undergraduate research, starting at the beginning of the program and continuing to and through the capstone course.

Eventually, these course-based scholarly activities allowed the TCs to share their research experiences beyond the classroom and disseminate their studies to a wider audience. These research events were the result of the five-year university-wide educational initiative that shed light on the importance of undergraduate research and generated more scholarly activities conducted by undergraduate students. For TCs, a recently established COE research symposium hosted numerous scholarly presentations delivered by undergraduate researchers. Other examples included but were not limited to a community-engaged research project with the Wonders Garden in Bonita Springs, a faculty-student publication on a family literacy program for immigrants, a joint publication on games as assessment tools, and research presentations at regional conferences. These outcomes of the infusion of research skill development in courses are notable when it has been uncommon for teacher candidates to share their research experiences within the university community and beyond (Manak and Young 2014, 37).

The infusion of research skills into courses and their systematic evaluation have the potential for positively impacting the overall teacher education program. The education faculty's participation in the evaluation at the undergraduate level allows them to reflect on the courses and assignments that target and document scholarly skill development. Furthermore, the faculty's pedagogical decisions regarding the courses, skills, and assignments are based on the yearly evaluation data, which generates

intentional curricular modifications for further program improvement. Overall, these efforts serve as ongoing professional renewal for faculty (White et al. 2016, 47). Therefore, it is argued that the efforts to create and maintain research-based teacher education programs can generate benefits for both teacher candidates and teacher education faculty. These positive outcomes will ultimately serve students in preK–12 classrooms as new teachers enter the profession with a more scholarly mind-set.

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