Special Extended Research Note
STEM Teachers' Beliefs and ESOL Professional Development

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Teachers are significant figures for their students' learning and growth. How teachers view teaching and learning is usually termed "teacher beliefs." How these beliefs are defined is somewhat controversial and not always consistent, but generally equivalent to teachers' perceptions, assumptions, judgments, or opinions (Sahin, Bullock, & Stables, 2002). Teachers' classroom instruction is often impacted by these beliefs to a significant degree, and also highly resistant to changes unless the teachers are provided with further professional development opportunities.

Pettit (2011) extensively reviewed the research studies showing how teachers' beliefs about English Learners (ELs) are critical to the education of English learners in mainstream classrooms. This review also discussed teachers' common misconceptions about second-language learning and bilingualism, particularly those who have not received professional development training in English to Speakers of Other Languages (ESOL). Many of the in-service teachers, particularly STEM teachers, are not typically the ones who receive extensive training for language instruction, despite the fact that they regularly teach ELs.

Professional development training received by teachers often provides opportunities to reevaluate and improve their beliefs and knowledge about teaching. It is largely claimed as one of the most effective ways to support and improve teachers' classroom instruction by shifting their views and attitudes (Walker, Shafer, & Iiams, 2004). Also, Freeman (1998) claimed that the teaching portfolios constructed by public school teachers are useful ways to enhance their professional growth. Portfolios often contain teachers' reflections on their actual teaching practice and their sustained or changed beliefs about teaching and learning. For this reason, portfolios are helpful tools to gauge teacher beliefs and any impacts of professional development.

In this research note, I present the findings of the changes in in-service STEM teachers' beliefs about ELs and ESOL education gleaned from the teachers' written reflections in the portfolios submitted at the end of their yearlong participation in an ESOL professional development program. The objectives were to discover how STEM teachers made a self-assessment of what they learned from their ESOL professional development

experience and to further evaluate whether it contributed to changing their views on ELs and ESOL education.

The Study

The ELSTEM (ESOL for STEM Educators) project was a six-year federally funded professional development program (2012-2018) intended to improve secondary STEM teachers' awareness and understanding of ESOL education. This program aimed to design and implement an updated ESOL teacher preparation curriculum that integrated teacher training in STEM and an endorsement in ESOL, an add-on certification to participants' teaching credentials. The ultimate goal of this project was to increase middle and high school STEM teachers' abilities to meet ELs' instructional needs, thereby maximizing ELs' achievement in STEM subjects.

The in-service participants for this project were enrolled in a year-long ESOL professional development program intended to serve the needs of practicing STEM teachers. The program offered graduate-level ESOL endorsement coursework specifically tailored to meet the instructional needs of secondary STEM subjects. The curriculum of this professional development program was aligned with the Oregon state standards for ESOL endorsements.

At the culmination of this yearlong program, the participants submitted their ESOL endorsement portfolios demonstrating their knowledge and competency in teaching ESOL. Primarily using the qualitative research methods of thematic analysis loosely following Bowen (2009), a total of 36 in-service participant portfolios were reviewed to determine whether or not they reflected any changes about their existing teacher beliefs as a result of the program participation. These 36 participants were those who entered and completed the in-service curriculum during the last 3 years of the ELSTEM project after it was substantially modified to better meet the needs of secondary STEM classroom instruction. At the time of their program participation, all of the in-service participants were teaching in school districts with over 10 percent of the student population identified as ELs. Overall, the in-service program participants' teaching experience ranged from 2 years to 11 years.

Findings of the ESOL Portfolio Analysis

Shifts in Perspectives of K-12 English Learner Education

All of the participants' reflections on their program participation included the comments about how their participation in the program had altered or changed their previous teacher beliefs. Commonly observed themes that emerged in their reflections included:

(1) Understanding linguistic structures and second-language acquisition process;
(2) Integrating of academic language in STEM instruction;
(3) Re-evaluating of STEM Instructional Strategies;
(4) Understanding EL students and families;
(5) Implementing of culturally responsive differentiated instruction;
(6) Advocacy for and leadership in EL education.

The participants' narrative reflection included comments demonstrating their changed perspectives such as the following:

> "I did not feel like I [previously] had a good understanding of EL student's situation, nor did I focus on specific ways to support my ELL students. From the readings, the assignments, the reflections from my cohort, I now understand that my children [should have] received all of the parts necessary to be successful as an English language learner in an American school. I learned how all of these pieces (knowledge of L1, prior educational experiences, parental support, bilingual environment, etc.) work together to contribute to L2 learning."

Understanding Linguistic Structures and the Second-Language Acquisition Process

All of the participants specifically reflected on how they gained knowledge about linguistic features and the language acquisition process. They mentioned that the program prepared them with foundational knowledge of linguistic structures of English, which they could apply to their STEM teaching practice. A participant specifically commented: "The program gave me an academic perspective on speech learning and production from birth through adulthood and helped me appreciate the challenges of acquiring proficiency in a second (or third, or fourth) language later than early childhood."

Fifteen participants (42%) also explicitly reflected on the complexity of the nature of language and the language learning process. To them, this part of the program was an opportunity to be awakened to the great challenges that English learners experience in learning new linguistic structures. The reflection included comments such as "I came to see the English language through the eyes of an English learner" and "the coursework opened my eyes to the complexity of the English language."

Integration of Academic Language in STEM Instruction

All of the participants discussed how they came to incorporate more explicit academic language into their STEM classroom teaching as a result of the program participation.

Eighteen participants (50%) also mentioned that they regularly pre-teach vocabulary necessary to understand the planned instruction and use sentence frames to help facilitate ELs' language practice. As for the effectiveness of using sentence frames, a participant mentioned, "I was able to turn low-level questions to higher-level questions with the help of sentence frames."

The participants also mentioned that they now think about the aspects of academic language necessary to understand STEM content when planning their instruction and how they should provide support for ELs' more active participation in class discussion.

Re-Evaluation of STEM Instructional Strategies

Twenty-three participant reflections (64%) included comments on how their STEM instructional strategies have changed as a result of their program participation. These participants commented on their changed practice towards more intentional, pre-planned differentiation for ELs' ample language practice. In addition, they came to explicitly incorporate language-learning objectives in lesson planning, specifically addressing Oregon English language proficiency standards for K-12 EL education.

A participant specifically mentioned how his teaching practice fundamentally changed as follows:

> "In a way, the program has given the tools for me to revamp my unit and lesson plans for all my classes. Determining specific language goals, and being sure to teach them, alongside your course goals, will become just another facet of my lessons. I have been given the language necessary to identify weaknesses in the curriculum and correct it. I could probably lead a pretty good workshop about the reasons and ways to differentiate properly for your EL students."

Understanding EL Students and Families

This aspect of shifts in teacher beliefs was a topic that all of the participants discussed most extensively in their portfolios. They reflected at length on how they came to have increased understanding and awareness of EL students' and their families' needs. They also acknowledged that they were awakened to the special challenges of EL students in secondary schools as a result of program participation. A participant commented: "The most significant shift has been an increased awareness of culture in my classroom and a conscious effort on my part to be responsive to my students' needs in relation to their language and culture."

Embracing and celebrating cultural diversity was another aspect the participants came to view in a new light as well. The participants commented that their beliefs about cultural diversity were further strengthened and renewed by having an opportunity to closely attend to EL students' learning needs during their program participation.

Implementation of Culturally Responsive Differentiated Instruction

Along with an increased level of awareness and understanding of EL students and families, all of the participants also discussed how their beliefs and teaching practices have changed towards more culturally responsive differentiated instruction. They shared comments on their appreciation of diversity among students and how they came to make greater efforts to understand various learning needs. One participant described his understanding of differentiated instruction as follows:

> "Some students can use the stairs, other students may need to use the
> ramp, and other students may need a push up the ramp by me or by a
> peer.   Whatever the route a student may take, all of my students end up in
> the same location. Through various degrees of scaffolding, I can get all of
> my students to understand chemistry concepts and improve on their
> English language abilities."

Advocacy for and Leadership in EL Education

All of the participants acknowledged that they learned about how ESOL and bilingual education became a part of K-12 education in the U.S. The program equipped them with history and knowledge of the current situation of ESOL and bilingual education, which led to their realization of how they should engage in teaching practice with an equity lens. The following quote from a participant highlights this new teacher belief:

> "Before I started this program, I was very misguided as to what my role
> was in supporting ELLs [English Language Learners] in my classroom. I
> used a single teaching approach for all students with little or no
> differentiation. I reduced some of the workload for the SPED [Special
> Education] students who required modified work but made no
> accommodations for ELLs. It was not because I did not want to support
> ELLs or felt they needed to be immersed, I just did not have the insight or
> the training. I assumed ELLs received all of their support in their ESL
> class. Among other things, I now realize content teachers must support
> ELLs in content areas. The ESL teacher cannot support all content areas
> in one class."

Generally, the participants felt that they came to recognize and advocate for EL students more after the program participation. Five participants specifically mentioned how they became a leader in their own schools for matters pertaining to EL education and established themselves as a resource for other teachers.

Discussion and Conclusion

The analysis of the ESOL portfolios shed some light on the participants' shifted beliefs and their newly gained knowledge and skills of teaching as a result of the participation in this professional development program. The program seemed to offer a wealth of new information and knowledge to the participants who had not previously had such extensive professional training on teaching EL students. In addition, the program appeared to have significantly changed the participants' views about what their role is as a teacher and how their teaching practice should be adapted to support EL students' learning, particularly in STEM subjects.

As discussed in Li, Hinojosa, and Wexler (2017), positive teacher beliefs are critical to ELs' academic success. Further, teachers' positioning and attitudes towards ELs can have a substantial impact on learners' motivation and classroom behavior (Yoon, 2008). In that regard, this ESOL professional development program appeared to have a positive impact on shifting the participants' existing beliefs, which could potentially lead to EL students' success.

There were commonly observed themes in the participants' reflection. A majority of the participants specifically reflected on the growth in their understanding of linguistic structures and the second-language acquisition process, integration of academic language in classroom instruction, and various instructional techniques and strategies. These observations showed that the participants gained foundational knowledge and instructional competence conducive to facilitating ELs' language and academic content learning. However, the most substantial discussion on the participants' shifts in perspectives was about their increased understanding of EL students and families, culturally responsive differentiated instruction, and advocacy for EL education. It appeared that although the participants indeed gained a great deal of knowledge and instructional skills pertaining to EL education, the most powerful impact of the six-year program was on the participants' increased cultural competence and advocacy for EL students and families.

Pettit (2011) emphasized that teachers should be provided with adequate professional training to implement culturally responsive instruction with the understanding that

language and culture are closely interconnected. Indeed, it appeared that the participants of the present study have most greatly benefited from the program in raising their level of understanding of not only cultural diversity but also the challenges and difficulties that EL students face in mainstream classrooms.

The participants' reflections consistently pointed to how they came to view EL education through a different lens as a result of the program participation. Obviously, it was beneficial in gaining new knowledge and a new perspective of EL education.

This study has potentially contributed to giving some insight into designing and implementing an effective professional development program to prepare practicing teachers to meet the needs of ELs. In the future, a follow-up research study would hopefully look into whether these ESOL-trained teachers continue to maintain their improved teaching practice and advocate for EL students.

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