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In this literature review, we examine literature regarding pedagogical content knowledge (PCK) in relation to in- and out-of-field teaching experience and pedagogical training in general education subjects, music subjects, and more specifically string music education. Out-of-field teaching has been defined as a lack of fit between teachers' preparation and their teaching assignments (Ingersoll, 1998). Our intention is to highlight the importance of providing non-string specialists who are assigned string classes with the string-specific support they need to help them be successful in their teaching careers.

Hamann, Gillespie, and Bergonzi (2002) reported that 74% of the string openings between 1999 and 2001 were filled with teachers whose primary instrument was a string instrument. However, only 50% of the string openings in the 2008-2009 school year were filled by teachers with a string primary (Smith & Alexander, 2010). Smith and Alexander (2010) speculated a rise in the need for additional string educators in the future based on an aging string educator workforce, an increase in the number of string programs and anticipated strings position openings.

Based on current hiring practices of non-string specialists and the potential need of additional string educators in the future, it may be critical to provide support for non-string specialists who are assigned to teach string classes. Regardless of a teacher's expertise or skill in a specialized music field, teachers who receive degrees in music education can become certified to teach music in 39 states and are considered qualified to teach strings, band, choir, general music, or any other type of music class (May, Willie, Worthen, & Pehrson, 2017). Research has suggested that teachers' subject matter

preparation and pedagogical training are positively related to student learning (Goldhaber & Brewer, 1997; Monk, 1994), and when teachers are assigned subjects outside of their fields of specialty, both their instructional strategies and student learning gains are affected negatively (Goldhaber & Brewer, 1997; Monk, 1994; Ross, Cousins, Gadalla, & Hannay, 1999). A limited amount of research has been conducted on out-of-field teaching experience and training in core content areas; however, the existing research does suggest that teachers with out-of-field training and experience may be less effective in the classroom, and perhaps as a result, are more likely to leave the teaching profession (Ross et al., 1999; Ross, 1998).

Pedagogical Content Knowledge

General Definitions of PCK

The concept of pedagogical content knowledge (PCK) has been defined as “the body of understanding, knowledge, skills, and dispositions that a teacher needs to perform effectively in a given teaching situation” (Wilson, Shulman, & Richert, 1987, p. 106). Although many scholars agree that pedagogical content knowledge is a distinct knowledge domain (see Brown & Borko, 1992), various models have been proposed to explain what specifically constitutes PCK (Cochran, DeRuiter, & King 1993; Fernandez-Balboa & Stiehl, 1995; Grossman, 1990; Magnusson, Krajcik, & Borko 1999; Marks, 1990; Shulman, 1986, 1987). Most scholars’ conceptualizations of PCK are comprised of four common components: (a) knowledge of students’ understanding, (b) instructional strategies and representations, (c) curriculum, and (d) the teacher’s values and beliefs about education

All models of PCK cited above highlight the importance of how teaching context and content-specific knowledge influence the choice of instructional strategies. The Fernandez-

Balboa and Stiehl (1995) model emphasizes the importance of subject-specific PCK, similar to the Magnusson et al. (1999) model, which includes teaching context. There has been a general consensus among scholars that PCK models should include teacher transformation of knowledge (with some form of instructional strategies to teach content knowledge to students), and that the teachers' knowledge of subject matter influences instructional practices in subject areas. Models of PCK by Fernandez-Balboa and Stiehl (1995) and Magnusson et al. (1999) specifically stressed the influence of PCK upon a teacher's instructional decisions and strategies.

Acquisition of Pedagogical Content Knowledge

Grossman (1990) identified possible sources of how teachers acquired PCK, including teacher education experiences, subject matter knowledge acquisition, and teacher observational experiences. According to Grossman (1990), teacher education courses are typically organized so that prospective teachers will acquire subject matter knowledge in content-specific courses and acquire pedagogy in separate courses that focus on how to teach subject matter. Furthermore, teachers' preparation in subject-specific content can influence decisions about content and sequencing, conceptions of what it means to teach a specific subject, and the selection of particular curricula. Other scholars (Gess-Newsome, 1999; Hill, Ball, & Schilling, 2008; Marks, 1990; Veal & Kubasko, 2003) also suggest that teachers' value orientations toward subject-matter content may influence textbook content use, pedagogical strategies, and perceptions of students' instructional needs.

Music PCK

Ballantyne and Packer (2004) defined music PCK as “knowledge of music teaching techniques, engaging students with music in a meaningful way, implementing

the music curriculum effectively, assessing students' abilities in the various aspects of music, explaining and demonstrating musical concepts" (p. 302). According to Millican (2007), PCK includes the analogies, illustrations, examples, explanations, and demonstrations and the ways of representing or formulating instructional strategies to teach music technique and skills. In other words, both content knowledge and pedagogical knowledge are used to represent the musical concepts in relation to the conceptions and misconceptions students have in regard to concepts. Forrester (2017) suggested that instrumental music teaching requires a specialized form of knowledge reflecting the integration of both teaching and conducting. This specialized instrumental music teacher knowledge includes the ability for in-the-moment decision making, judgments, decisions, and communication with students and the ensemble as a whole.

The PCK theoretical framework has been used to examine music and learning (Bauer, 2012; Chandler, 2012; Forrester, 2017; Gohlke, 1994; Grieser, 2014; Haston & Leon-Guerrero, 2008; Millican, 2007, 2013, 2014, 2017; Raiber & Teachout, 2014, Venesile, 2011). For example, Millican (2013) categorized expert band teachers' comments using previous models of pedagogical content knowledge in other subject areas in order to understand how music teachers use these skills. The author found that effective instrumental music teachers used PCK to identify student performance problems and interact with students in such a way that will help improve their performance skills. Additionally, Millican (2017) studied how specific elements of pedagogical content knowledge are used when teaching specific concepts to beginning-band students. Millican suggested that a teacher's pedagogical content knowledge reflect core teaching practices that may be useful for music teacher educators to understand and develop.

Acquisition of PCK in Music Teacher Education Programs

The effectiveness of music training programs has been examined in regard to music methods courses and pedagogical content knowledge (Ballantyne & Packer, 2004; Conway, 2002; Gohlke, 1994, Haston & Leon-Guerrero, 2008). According to past research, pre-service teachers appear to gain more general pedagogical knowledge rather than subject-specific knowledge from their music methods courses (Ballantyne & Packer, 2004; Conway, 2002; Millican, 2014). This may be of concern, because knowledge and skills pertaining specifically to the teaching of music in the classroom have been found to be the skills rated most important to early-career teachers (Ballantyne & Packer, 2004).

Music educator positions often include a variety of music teaching subjects; however, instrumental music mentor teachers and administrators have expressed concern about the lack of preparation of new music educators to teach outside of the content area in which they specialized (Conway, 2002). Millican (2014) investigated the PCK of 206 undergraduate music education students and found that preservice educators had difficulty identifying specific pedagogical approaches to improve or rectify beginning band students' performance skills. Based on the findings of the study, the design of instrumental music method courses at various universities may not have provided the PCK needed for teaching instrumental music. These findings are consistent with the results of Ballantyne and Packer (2004) regarding the importance of PCK, in that early-career music teachers expressed a need for increased support in their development of pedagogical content knowledge and skills.

According to Millican (2007), PCK, content knowledge, and general pedagogical skills have been identified as the three most important sources of knowledge in the

professional success of teaching secondary school instrumental music. Millican (2007) examined the relative importance of knowledge and skills to professional success. The author used the PCK framework modeled after the work of Shulman (1986, 1987) to organize the categories of content knowledge, general pedagogical knowledge, curriculum knowledge, knowledge of learners and their characteristics, pedagogical content knowledge, knowledge of educational contexts, and administrative knowledge. Content knowledge and PCK were consistently rated as the most important knowledge and skills. These findings support the applicability of Shulman's model to music education in that content knowledge of subject matter and pedagogical knowledge are of utmost importance for music teachers, as they are for teachers of other subjects.

Subject-Specific Knowledge and Teacher Efficacy Belief

According to self-efficacy theory, individuals with higher beliefs in their abilities to accomplish specific tasks are more likely to persist in an activity and to choose individually-challenging activities to support further growth (Bandura, 1997). Conversely, those with lower efficacy beliefs are more likely to give up after repeated failure, or to choose activities that are less challenging. It follows, then, that non-subject specialists may choose less challenging instructional strategies to avoid teaching with a lack of task-specific confidence. Subject-specific knowledge in both content and pedagogy may lead to higher confidence in subject-specific teaching, as well as the utilization of more effective and more challenging teaching strategies. Confidence and use of effective teaching strategies will, in turn, promote one another.

Bandura (1997) asserted that a teacher's "sense of instructional efficacy is not necessarily uniform across different subjects. Thus, teachers who judge themselves

highly efficacious in mathematical or science instruction may be much less assured of their efficacy in language instruction and vice versa” (p. 243). Research by Ross et al. (1999) supports Bandura’s assertion, in that secondary school teachers had high perception of their abilities to teach courses within their subject area, but that perception of ability was lower for courses outside of their subject area.

Teachers with higher efficacy beliefs may be more willing to implement teaching strategies that stretch their own teaching abilities than those with lower beliefs (Ross, 1998). According to Ross et al. (1999), “teachers with high levels of teacher efficacy anticipate they will be successful. They choose more challenging goals, are more likely to take responsibility for outcomes, and persist in the face of failure” (p. 785). Because enactive mastery of challenging skills leads to further efficacy belief (Bandura, 1997; Hendricks, 2016), we surmise that subject-specific specialists would continue to develop further self-promoting beliefs and subsequent accomplishments beyond their non-specialist counterparts, provided the non-specialists were left without necessary support.

Regarding string teaching specifically, non-string specialists have exhibited lower task-specific confidence levels in demonstrating rehearsal techniques. McCormick (2008) studied the perceptions of string trained and non-string trained music educators demonstrating rehearsal techniques for beginning, intermediate, and advanced students in a string class. String-trained teachers rated themselves as having more confidence in demonstrating rehearsal technique for beginning and intermediate strings when compared to non-string trained teachers. However, in advanced rehearsal techniques, 47% of non-string trained teachers rated themselves as having *no confidence* in demonstrating advanced rehearsal techniques.

Subject-Specific Teacher Qualifications and Student Achievement

Pedagogical content knowledge, as it relates to teacher efficacy beliefs and subsequent selection of instructional strategies, leads to a discussion of how student learning may be affected by a teacher's level of subject-specific preparation. Teachers' subject matter preparation, measured by the number of field-related courses taken as well as pedagogical training, has been related to positive student learning outcomes in math and science content areas (Goldhaber & Brewer, 1997; Monk, 1994). Educational researchers have argued that knowledge of subject matter and pedagogical methods, as well as the level of mastery to teach different subjects, are important predictors of teaching quality and student learning (Darling-Hammond & Hudson, 1990; Murnane & Raizen, 1988). Additionally, results from various studies have indicated that teachers' qualifications in the subject taught are an important component of teacher performance (Greenwald, Hedges, & Laine, 1994; Hedges, Laine, & Greenwald, 1996).

String Specialists' and Non-String Specialists' Content-Specific Knowledge

Music skills and knowledge are developed through the progression of specific skill areas and at increasing levels of ability. The progression of specific music skills is organized within a curriculum that includes a scope and sequence of skills (Benham et al., 2011). According to the *ASTA Curriculum: Standards, Goals, and Learning Sequences for Essential Skills and Knowledge in K-12 String Programs* (Benham et al., 2011) string-specific skills such as shifting, vibrato, and spiccato bowing should be introduced and developed in the strings class.

Research has indicated that non-string specialists might need particular guidance and training in regard to teaching string-specific content (Grieser, 2014; Jenkins 1995;

Mishra 2006; Sckipp, 2010). For example, non-string specialists who teach strings classes have been shown to lack content-specific knowledge in string technique, literature, and pedagogy. For example, in a survey of 42 non-string specialists, Sckipp (2010) found that 71% of participants reported having little or no knowledge of shifting, 60% reported having little or no knowledge of vibrato, and 60% reported having moderate to no knowledge of bowing technique.

In a different study, Jenkins (1995) assessed job status, training, and attitudes toward string teaching through a questionnaire sent to members of the National School Orchestra Association. The study included 346 respondents with string backgrounds and 119 respondents with non-string backgrounds. Jenkins found a significant difference in reported level of preparation between string specialists and non-string specialists in string-related items, including knowledge of string method books, young orchestra literature, right and left hand holding position, holding a string instrument correctly, bowings, shifting, vibrato, rehearsal techniques, instrument care, and philosophy of school orchestra and selecting instruments to purchase. Additionally, Mishra (2006) found that non-string students who completed a survey at the completion of a string methods class commented on their lack of experience and knowledge in all string instruments, indicating a general feeling of uncertainty about teaching a strings class.

Allard (1992) observed 53 beginning string classes to compare differences in string teaching effectiveness between string specialists and non-string specialists. Although the author found no significant differences between string specialists' and non-string specialists' uses of performance time, non-performance time, preparation time, tuning time, music organization time, announcement time, performance teaching time, or

off-task behavior, performance quality of string specialists' students was significantly higher than those of non-string specialists.

Grieser (2014) examined the pedagogical content knowledge of music teachers who teach in or out of their field of expertise. The findings from the study suggest that non-string specialists had a limited understanding of string-specific skills. Additionally, the non-string specialists' content knowledge of string specific skills had more misconceptions, more misunderstandings, and a less organized understanding of the content when compared to string specialists. Together, these studies highlight the need for additional supports for non-string specialists, including the need for preservice and professional development curricula to include comprehensive preparation in both content-specific and pedagogical-specific knowledge for teaching strings.

Conclusion and Implications

Pedagogical content knowledge, which incorporates both pedagogical knowledge and content knowledge, has been found to be necessary for the appropriate selection and use of teaching strategies in general education settings. Furthermore, utilizing PCK can lead to high teacher and student self-efficacy beliefs, resulting in further effective teaching and learning. While relatively less research has been done regarding PCK in music settings, research has shown that music teachers rank content knowledge and PCK as the most important knowledge or skill they can attain; however, they also report that teacher preparation is lacking in subject-specific PCK.

Research on the effectiveness of string-specialists versus non-string specialists implies that string-specific training for teachers is critical for the overall success of their students. Music teacher education programs might reconsider the effectiveness of string

method classes and how string-specific PCK is integrated into the string method courses for non-string specialists. Based on current teacher certification practices for music educators it is imperative that pre-service music educators are prepared to teach music classes outside of their specialized content area. Further studies are needed to examine the effectiveness of string method coursework music and music certification practices, to determine how and to what extent non-string specialists are adequately prepared to teach string music classes.

In addition to the obvious need for additional string-specific PCK support in teacher preparation programs, other supports might be implemented for non-string specialists including (but not limited to) professional development workshops, community-university partnerships, and mentorships. Professional memberships in organizations might offer workshops, guidance, and networking for such partnerships and mentorships. Community collaboration between universities with string education programs, professional music organizations, string specialists, and non-string specialists may also be critical in creating partnerships to support and guide string educators who teach outside of their specialized subject area.

To date, research of string-specific pedagogical content knowledge has been limited. In addition to studying the preparation, needs, and concerns of non-string specialists who teach strings classes, further research is needed to examine the effectiveness of the aforementioned professional development programs and partnerships. Such research might help to determine best practices for effectively preparing and supporting a potentially increasing number of string teachers, and may inform ways in which strings teachers from a variety of backgrounds can develop the pedagogical

content knowledge and associated confidence they need to be successful in their careers.

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