CHALLENGING PRE-SERVICE STUDENTS' TEACHING PERSPECTIVES IN AN INQUIRY-FOCUSED PROGRAM

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Abstract

Inquiry teaching based on constructivist learning theory has been an emphasis in pre-service education for over a decade. In general, a developmental teaching perspective supports inquiry-based instruction where teachers view learners as constructors of knowledge and teaching as providing questions, problems, and challenges that form a bridge from the learners' prior knowledge to a new, more sophisticated form of reasoning. Since teaching perspectives influence student learning, teacher effectiveness, and teacher attrition, challenging pre-service teachers to overcome experience-based convictions of a transmission perspective is necessary in teacher education. In this study, we examined the teaching perspectives of secondary, pre-service methods students at the midpoint of an inquiry-focused program. Our findings suggest that, despite being introduced to a variety of teaching perspectives, overcoming preconceptions of "good teaching" and considering a perspective counter to one's disciplinary major presents a dilemma for pre-service teachers.

Introduction

The work of psychological theorists like Piaget, Bruner, and Vygotsky underpins the development of constructivist learning theory and the basis of educational reforms toward the end of the twentieth century, which promote a shift from discipline-based, teacher-directed instruction to constructivist-based, student-centered instruction [1]. In general, constructivist teaching involves the facilitation of students actively exploring ideas through inquiry [2]. The National Research Council (NRC) published standards that emphasize developing student abilities of inquiry, learning subject matter disciplines in context of inquiry, and implementing inquiry as instructional strategies, abilities, and ideas to be learned [3]. Most states follow suit by identifying inquiry as a standard to be taught in the curriculum. Thus, the majority of teacher education programs in the twentieth century adopt a constructivist-based inquiry approach to

teaching. Further, the integration of inquiry in secondary science instruction is one of the only topics that the majority of pre-service teaching programs focus on worldwide [4].

For most, the concept of a *teacher* develops from a variety of experiences and interactions to create a schema for characterizing effective and ineffective teaching, with pre-service teachers not being an exception [5]. Pre-service teachers spend their formative school years observing the practices of and interacting with teachers, thereby creating memories that can act as a filter for beliefs and acceptable practices that may or may not be supported by educational theories [5-11]. Since these preconceptions are based on many years of experience, they can be hard to overcome, even though various research suggests some pre-service teachers' beliefs are amenable to change through reflection and teaching [12-18]. Varma, Volkmann, and Hanusci provide evidence indicating that pre-service elementary teachers experiencing inquiry-based pedagogy in a science methods and field experience course develop conceptions of constructivist science teaching [19]. Furthermore, the prospective teachers acquired a comfort with inquiry methodology and an intention to teach via this method. In a similar study, Bleicher and Lindgren found that reflection, discussion, and experience with inquiry-based methods improved pre-service teachers' self-efficacy, scientific conceptual understanding, and intention to use reform-based methods as a classroom teacher [20]. Both studies indicate a change in teacher self-efficacy with implementing inquiry-based pedagogy, but neither presented data to indicate the change in views beyond the methods course.

Despite over a decade of emphasis in pre-service education on inquiry teaching, teachers continue to indicate a comfort preference with didactic teaching methods [3, 21-25]. Parker and Brindley found that graduate pre-service teachers were more likely than undergraduate pre-service teachers to indicate the intention to use reform-based teaching methods, possibly a result of professional experiences; however, their naïve understanding of the high stakes within the current educational context allows an unrealistic idealism that undergraduates do not have because they experienced accountability as a student [26]. Even though teacher preparation programs typically focus on reform-based pedagogy, these ideals can be incompatible with the schema pre-service teachers have created before entering the program [27]. Research studies have indicated that pre-service teachers' beliefs become their actions and behaviors as teachers [28, 29].

Since teaching methods and perspectives influence student learning, teacher effectiveness, and teacher attrition, challenging pre-service teachers to overcome naïve, experience-based

convictions and base their teaching on best practices rather than episodic conceptions of good teaching is necessary in teacher education. Exploring pre-service teachers' teaching perspectives allows teacher educators to gauge students' internal teaching models based on beliefs, intentions, and actions. The purpose of this study was to examine the teaching perspectives of secondary, pre-service methods students in an inquiry-focused program. Since education students' teaching perspectives are influenced by their prior experiences in the classroom, many students often exhibit a transmission perspective [23]. The program's inquiry-focused conceptual framework aligns to a more developmental or constructivist approach to teaching, thus providing an obstacle for students to overcome. The intent of this article is to share the results of students' teaching perspectives and thoughts when confronted with different views of effective teaching. The rationale for researching pre-service teachers' thoughts on being challenged to consider different views of teaching is to provide insight into their conceptions of effective teaching. Further, understanding prospective teachers' challenges to consider different perspectives of teaching provides insight into the possibility of broadening pre-service teachers' methods of instruction.

Theoretical Framework

Teaching is a complex and multifaceted endeavor and, accordingly, systematic differences exist in the way teachers view their roles and responsibilities. According to Pratt, a teacher's point of view or perspective "is an expression of personal beliefs and values related to learning and teaching" which is influenced by experiences and reflection [30]. After reviewing thirteen studies conducted between 1983 and 1996 investigating conceptions of teaching, Kember identified five appreciably different views of teaching [31]. Rather than presenting perspectives of teaching on a continuum, Pratt legitimizes each of the five perspectives as a compilation of actions and beliefs [30]. Teaching perspectives are an interrelated set of beliefs and intentions that direct and justify teacher actions, and therefore, provide a lens through which to examine teaching and learning.

Actions, intentions, and beliefs are used as indicators of commitment to a particular perspective on teaching. Actions are the ways in which a teacher helps students to learn the subject content, and are best understood when viewed in terms of intentions or what a teacher is trying to accomplish, and beliefs or why a teacher thinks it is important. Intentions are what gives meaning to actions and, as such, are a direct statement of commitment. Perhaps the most crucial indicator is beliefs because they are central to teachers' core values. Beliefs about knowledge and learning are the most unyielding and least flexible indicator of commitment.

The five perspectives on teaching are transmission, apprenticeship, developmental, nurturing, and social reform. Pratt and Collins provide an overall profile for each perspective based on the many representative people interviewed during their research [32]. While each perspective varies in views of knowledge, learning, and teaching, some overlap of actions, intentions, and beliefs exists. Regardless of some similarities, individual perspectives are fundamentally different in terms of the elements and relationships that dominate in Pratt's general model of teaching (see Figure 1).

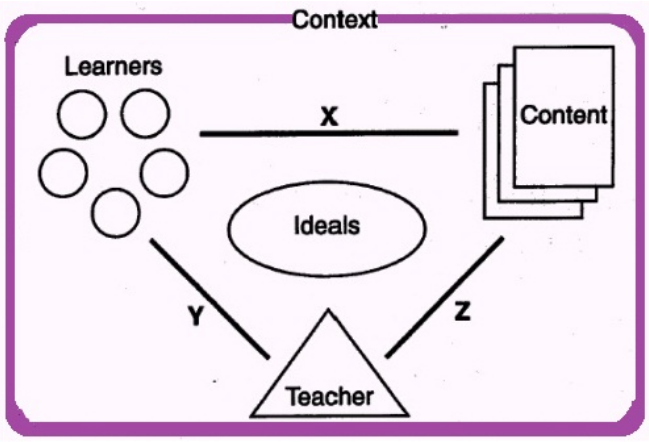

Figure 1. General model of teaching [30].

Transmission Perspective

Teachers with transmission as their dominant perspective think effective teaching involves having mastery over the content and exhibit a commitment to the subject matter. They view knowledge as existing outside the learner, either in texts or with the teacher. It is the teacher's role to provide a common body of knowledge to the learner efficiently and accurately. Effective teachers lead learners to authorized or legitimate forms of content mastery by systematically taking them through a set of tasks. These teachers provide clear objectives, adjust the pace of lecturing, use class time efficiently, answer questions, correct errors, summarize presentations, and provide reviews [33]. By conveying their enthusiasm about their content to their students, they are typically memorable presenters. Referring to the general model of teaching, the dominant elements for the transmission perspective are teacher and context, and the dominant relationship is line *z*, which represents the teacher's concern for and authority over learners [30].

Apprenticeship Perspective

Teachers with apprenticeship as their dominant perspective think effective teaching involves being skillful and having expertise in the subject matter. They view learning as a sequential process from simple to complex in an environment of authentic tasks in real settings. Teaching is a process of enculturation, whereby students come to understand social norms and ways of working by observing and then doing. Effective teachers engage students within their "zone of development," and know when students can work on their own and when more guidance and direction is necessary. Over time, teachers provide less direction and give more responsibility to the student helping them to progress from dependent learners to independent workers. Referring to the general model of teaching, the dominant elements are teacher, content, and context, with the teacher and content inseparable within context [30].

Developmental Perspective

Teachers with developmental as their dominant perspective think the learner's point of view takes precedence when planning and conducting lessons. They view learners as constructors of knowledge using what they know to interpret new information. It is the teacher's role to provide questions, problems, and challenges that form a bridge from the learner's previous way of thinking and reasoning to a new, more sophisticated form of reasoning and problem solving. Referring to the general model of teaching, the dominant element for the developing perspective is learners, and the dominant relationship is line *x* which represents learners expanding their ways of knowing the content [30].

Nurturing Perspective

Teachers with nurturing as their dominant perspective think effective teaching involves respecting the learner's self-concept and self-efficacy. They view learners as more productive in a supportive environment free from failure. Central to this view is a commitment to the whole learner and not just their intellectual development. Effective teachers balance promoting a climate of caring, challenging students to do their best while setting clear expectations. Referring to the general model of teaching, the dominant elements for the nurturing perspective are teacher and learner, and the dominant relationship is line *y*, which represents the teacher-student relationship [30].

Social Reform Perspective

Teachers with social reform as their dominant perspective think effective teaching involves pursuing social change in substantive ways. They view teaching as exciting students to

the values and ideologies embedded within the subject matter. Effective teachers are clear and articulate about changes that must take place in society. They focus class discussions of readings on what is and is not said, what is included and excluded, and who is represented and omitted. Students are empowered to take a critical stance and improve their lives. Referring to the general model of teaching, ideas emerge as a prominent element and overshadow all other elements and relationships for the social reform perspective [30].

Research Approach—Program Description

The four-year teacher education program admits undergraduate mathematics and science majors interested in obtaining secondary certification. As part of the degree program, students take a series of field-based experience courses. During the first two credits of introductory education courses, students observe experienced teachers in both elementary and middle schools. They then work in pairs to teach inquiry-based lessons from an age-appropriate science kit. The third course in the program sequence is a three-credit, non-field based educational psychology course where students learn how constructivist learning theory supports an inquiry approach to instruction. After taking these prerequisites, students continue their coursework with two methods courses. During the first methods course, students observe a high school classroom and later design and teach a one-day, interactive lecture-based lesson and a three-day, inquiry-based lesson. Students taking the second methods course observe at a project-based learning school, and design and teach a mini-unit by coherently sequencing four lessons using a project-based approach.

Participants in this study were taking the first methods course, which is centered on a close examination of the interplay between teachers, K-12 students and content, and how these types of interactions enable students to develop deep conceptual understanding. The course builds on the educational psychology course, moving students from a focus on thinking and learning to a focus on teaching and learning. Participants are taught how content and pedagogy combine to make effective teaching. During the course, participants work in teams of two or three to design and teach one-day and three-day lessons. Also in this course, students take Pratt and Collins' Teaching Perspectives Inventory (TPI). The inventory is used to help students to understand different teaching perspectives before challenging them to consider the advantages of each perspective and how they support different educational standards.

During the first four weeks of the course, students explore the interplay between teachers and content by unpacking the standards and developing content learning progressions. The next

four weeks are dedicated to the relationship of K-12 students to content. Participants consider their understandings from educational psychology, and reflect on additional readings about how people learn. By the midpoint of the course, participants design and teach a one-day, Madelyn Hunter model lesson using best practices from a transmission perspective. The third four weeks investigates the interplay between teachers and K-12 students. During the last four weeks of class, students are challenged to design and teach an inquiry-based lesson incorporating best practices from a developing teaching perspective using a 5E (Engage, Explore, Explain, Elaborate, Evaluate) inquiry-model.

Research Approach—Participants

Twenty students who were enrolled in an inquiry-focused methods course consented to participate in this study. After providing the results of the 45-question TPI, four case study participants ("Jess," "Quanda," "Kristina," and "Valerie") who best represented the different mean values of the various students' teaching perspectives agreed to provide additional qualitative data. Jess co-planned with "Andrea" and "Mandy," but partnered only with Andrea to teach their chemistry lessons during the course. Quanda did not have a partner to design and implement her mathematics lessons. Jess and Quanda's self-reported TPI was representative of the majority (45%) of the participants. "Kristina" paired with "Marcus" to design and teach biology lessons. Kristina's self-reported TPI was representative of about 30% of the participants. Valerie partnered with "Emily" to design and implement their biology lessons. Valerie's self-reported TPI was representative of 10% of the participants.

Research Approach—Data Collection

A sequential exploratory, mixed-methods strategy informed the design of this study [34]. Drawing on teaching perspectives as our framework, we first collected and analyzed the quantitative TPI data to determine participants' teaching perspectives. This data informed the selection of the three representative case study participants from which to collect and analyze qualitative data. Qualitative data consisted of students' lesson plans, blog postings, and individual interviews. Both authors first met to create start codes for analyzing lesson plans, and then independently examined the data for characteristics of best practices within the five teaching perspectives: transmission, apprenticeship, developmental, nurturing, and social reform. The coders then met again to compare their findings [35].

After teaching their sequenced, inquiry-based lesson, participants responded on a blog to the following questions:

- After finding out your dominant and recessive teaching perspectives in addition to learning about the six different perspectives, did it challenge your views on teaching?
- When designing your lesson plan, did you consider trying to integrate any characteristics of any teaching perspective? If yes, what perspective and why?
- Reflecting on your teaching experience, do you feel you taught using your dominant perspective?
- Do you feel you taught using your recessive perspective?
- What influenced your teaching perspective?

Responses to the questions helped to inform the degree to which participants may have been challenged to consider teaching perspectives when designing and teaching.

Analysis of blog post responses helped with designing personalized, semi-structured interview questions. The following starter questions were used to guide case study participant interviews:

- How do you interpret your preferred teaching perspective?
- What aspects of your lesson showcased this perspective?
- What are the differences in the way you taught the one-day and the three-day teach, if any?
- Why did you include or not include social reform perspective in the lesson you taught?
- What do you think influences your teaching perspective?

Participant responses to these questions provided further insight into the development and challenge of teaching perspectives.

Findings—Teaching Perspectives Inventory Data

The TPI is a 45-item, 5-point Likert survey containing fifteen statements each on beliefs, actions, and intentions. After taking the on-line survey, participants submitted a report presenting their global perspective scores for each of the five teaching perspectives. Perspectives with scores one or more standard deviations above the mean of the five are considered dominant, and perspectives with one or more standard deviations below the mean of the five are considered recessive [23]. According to student-reported TPI data, 55% of the participants did not have a dominant teaching perspective and about 30% of the participants showed a dominant teaching perspective of nurturing. Eighty-five percent of the participants, including all case study

participants, revealed a recessive teaching perspective of social reform. Tables 1 and 2 present participants' overall TPI results.

Table 1
Descriptive Statistics and Teaching Perspectives of Participants (n=20)

Perspective	Transmission	Apprenticeship	Developmental	Nurturing	Social Reform	None
Mean	35.28	37.22	36.33	38.22	29.78	
Std. Dev.	2.987	4.052	5.520	4.319	3.228	
Range	26 - 39	29 - 42	25 - 44	33 - 45	25 - 36	
Dominant	0	1	2	6	0	11
Recessive	0	0	2	0	17	1

In Table 1, descriptive statistics are presented for each participant's survey results with respect to each of the five teaching perspectives. Dominant and recessive provides the total number out of the twenty participants with a dominant or recessive teaching perspective for each category as identified by the TPI.

Table 2
Teaching Perspectives of Participants

Dominant Perspective	Recessive Perspective	Percent of participants	Case Study Participants and Partners
No significant dominant perspective	Social reform	45	Jess, Quanda, Emily
Nurturing	Social reform	30	Kristina, Andrea
Developmental	Social reform	10	Valerie
Apprenticeship	Social reform	5	Mandy
No significant dominant perspective	Developmental	10	Marcus

In Table 2, Jess, Quanda, and Emily are representative of 45% of study participants who held no dominant perspective and a social reform recessive perspective. Kristina and Andrea are representative of 30% of study participants with a nurturing dominant perspective and a social reform recessive perspective. With a developmental dominant perspective and a social reform recessive perspective, Valerie is representative of 10% of study participants. Mandy represents 5% of study participants with an apprenticeship dominant perspective and a social reform recessive perspective. Marcus is representative of 10% of study participants with no dominant

perspective and a developmental recessive perspective.

The scores of participants in this study are consistent with the findings of Jarvis-Selinger, Collins, and Pratt on students seeking secondary-school certification in mathematics or science [23]. The mean score for nurturing perspective of participants is highest while the mean score for social reform perspective is lowest. Theoretically, participants' scores on the five TPI scales are a 36-point range from nine to forty-five. Scores for participants in this study ranged from twenty-four to forty-four, which is also consistent with the findings of the study by Jarvis-Selinger, Collins, and Pratt [23]. According to the TPI analysis, the participants in this study have actions, beliefs, and intentions consistent with similar pre-service students seeking secondary certification in mathematics or science.

Qualitative Case Studies—Jess

Jess self-reported no dominant, but a recessive social reform teaching perspective. Her partner, Andrea, reported a dominant nurturing and a recessive social reform teaching perspective. While Mandy taught her lesson separately, she co-planned with Jess and Andrea. Mandy reported a dominant apprenticeship and a recessive social reform teaching perspective. An analysis of their 5E lesson plan on states of matter revealed best practices for both a transmission and developing orientation. They provided students with exploratory stations and opportunities to discover content while she related the activities to real-life meaningful examples. However, it appears that Jess and her co-planners maintained control of the classroom and activities via transmission strategies. For example, they provided clear objectives by having students "follow directions for activities," and correcting errors by "clarifying student misconceptions/misunderstandings." Elements of developmental best practices included bridging knowledge by "asking probing questions" throughout the activities and "relating back to example" of a real-world application.

After teaching the lesson, Jess blogged that learning about teaching perspectives did not change her views on teaching. At this point in her coursework, she isn't comfortable changing her perspective. While the different teaching perspectives made her "more aware of the different styles," she stated, "I would not purposefully try to change my perspective just because a different one looks or sounds better." Her blog also revealed a misunderstanding she has about her own teaching perspective being apprenticeship. While her self-reported highest teaching perspective was apprenticeship, she in fact had no dominant perspective because transmission, developing, and nurturing were statistically equally as high. According to Jess, the inquiry-

learning focus of the program fits best with apprenticeship teaching and that her coursework to date have influenced her perspective greatly. Jess failed to recognize that inquiry-based strategies align best with a developmental teaching perspective.

Jess's interview revealed apprenticeship perspective as being "caring nurturing towards the kids, but like you kind of scaffold them the entire way and it works well with like science and math." She views apprenticeship as "inquiry-based," and that this was showcased by "starting the lesson without really telling the students anything, doing mini-labs, giving worksheets and having them work together and discuss with each other about what they were learning ... we [Jess and Andrea] helped them along." When asked about not including social reform perspective in her lesson, Jess responded that "social reform isn't something I think about a lot and it's nothing I've ever had in my classroom experience that I know of, so it's not something that I think about like, 'oh let me add this to my lesson plan because it will help the students social,' like, it's never been a priority of mine." According to Jess, "our one-day teach was just 'this is how you do it, now go ahead and do it.' [For the three-day teach] we reversed it: 'do this and now what did you find?'"

Qualitative Case Studies—Quanda

Quanda, like Jess, self-reported no dominant, but a recessive social reform teaching perspective. Unlike the other participants in this study, Quanda planned and taught her lesson alone. An analysis of her 5E, inquiry-based lesson plan on exponential graphs and functions revealed a majority of her best practices aligning to a transmission approach. For example, she provided clear objectives when beginning the lesson by "explaining to the class that they will be exploring exponential graphs." She sequenced tasks to lead learners to content mastery beginning by initially demonstrating the lab experiment to the class, and modeling so students' work would "look similar to the teacher's example." Quanda included a developmental approach of bridging knowledge when commenting on how exponential graphs "happen in everyday life."

While the majority of the ideas Quanda presented in her lesson plan were transmission oriented, she blogged about not believing that she "taught this way [transmission oriented] because it does not really go well with the 5E method of teaching." She also explained that discovering her teaching perspectives, "didn't challenge [my] views on teaching as much as it did clarify [my] ideas," and made her conscious of the ideas of teaching she wants to use. Furthermore, she mentioned that her "previous teachers in high school" and "teaching role models" impacted how she wants to act as a teacher. In her interview she confirmed this, explaining that her "teaching perspective was more representative of the teachers I liked in high

school" and "it would be kind of what I want to be." In explaining why she thinks her social reform score is so low, she remarks that she is "not trying to change the world," and though she "would like to see change," she does not think as a teacher she has the power to do so. Moreover, she explains that the coded lesson plan had more inquiry elements and an earlier lesson plan that was more transmission oriented was "so much easier" and she "got to stick to the lesson plan," which made her enjoy that experience more.

Qualitative Case Studies—Kristina

Kristina self-reported a dominant nurturing and a recessive social reform teaching perspective. Her partner, Marcus, self-reported no dominant perspective, but being recessive in the developing teaching perspective. An analysis of their 5E, inquiry lesson plan on classification of organisms revealed best practices more aligned with a transmission-oriented teaching approach. Their lesson included delivering content accurately and effectively by asking students to "follow along, take notes, and answer various questions as the teacher discusses the different classifications of organisms." Kristina and Marcus also included tasks that led to content mastery by "providing a set of questions that asks students to compare organisms" and having students "describe characteristics and to classify seven organisms into correct categories." By "going over answers with students and reviewing the material" to close the lesson, they provided timely feedback. Additionally, they provided clear objectives during the lesson when "introducing the major objectives and concepts" and "going over the discussions for the activity."

Also in the lesson were a few examples of best practices from a nurturing perspective. Kristina and Marcus provided encouragement and support when "going around the room to help students with questions" multiple times during the lesson, and making an explicit point to both greet and encourage students. Included in the lesson plan were two specific instances of best practices from a developing perspective. First, they provided an opportunity for learners to think and reason when asking students to respond with "why they chose the answer they chose" and second, an occasion for bridging knowledge by providing meaningful examples, such as including examples students "might encounter daily or have previous knowledge about."

Kristina blogged, after teaching the lessons, that teaching perspectives challenged her views to an extent, believing that all "views are important to incorporate when teaching because they are all important at different times in the classroom." She did not "consider trying to integrate any characteristics of any teaching perspective," stating that if any view was integrated "it would be transmission because our main focus was just trying to 'transmit' the information to

students through *PowerPoint* presentations and other activities." Kristina also provided a rationale for not using her dominant perspective, which was nurturing, commenting that she "did not know the students enough to be able to give them the 'nurturing' environment." According to Kristina, a nurturing environment requires a teacher to personally know her students.

During Kristina's interview, she commented that "inquiry-based is more student-centered and transmission is more teacher-centered." Her inquiry-based lesson was on classification and she "felt like we really couldn't make that student-centered too much without the teacher first giving them all the information first … using *PowerPoint* and stuff like that." She stated, "It would be more difficult with the time allotted to have [it be] more student-centered, I felt it would be easier to just kind of like give them information." Thus, Kristina believes that teaching from a transmission perspective is easier and more efficient. Kristina defines her dominant perspective, nurturing, as creating a "caring environment letting the student know that they can always come to the teacher," and, "the nurturing teacher makes it so the students can raise their hands at all times, come to the teacher after class, and a very caring environment." Kristina commented that to create a more nurturing environment in her three-day teach she would "have tried to let the students know us [her and Marcus] more so they could feel free to talk to us one-on-one." Kristina acknowledged that "the one-day teach was supposed to be more direct teach and the three-day teach more inquiry-based," but, "we wound up teaching the three-day teach very similar to the one-day teach using *PowerPoint*; it was very similar."

Qualitative Case Studies—Valerie

Valerie self-reported a dominant developmental and a recessive social reform teaching perspective. Her partner, Emily, self-reported no dominant, but a recessive social reform teaching perspective. An analysis of their 5E, inquiry lesson plan on evolution revealed best practices mostly matching a transmission-oriented teaching approach. Several examples of delivering content accurately and effectively included having students "listen, take notes, and discuss," explaining "Darwin's observations," mentioning "artificial selection is when humans choose who mates with whom," and providing answers to students' questions. Also in the lesson were tasks that led to content mastery, such as looking at projected pictures and discussing questions in small groups, think-pair-share about textbook terms, a brainstorm of how animals have changed over time, class discussion of dominant traits, and a "short film on natural selection."

Valerie and Emily also included several best practices from a developing perspective. They helped students to develop increasingly complex cognitive structures for comprehending the content by asking students to "draw conclusions from observations," picturing similar bacteria with varying genetic makeup, and "assessing how well students have understood and can apply the material." In addition, Valerie and Emily incorporated two examples of bridging knowledge through providing meaningful examples by relating material to the real-world environment and including "how traits that were not favored in society died off." A few best practices included in the lesson from a nurturing perspective were not sacrificing self-esteem for achievement through encouragement and asking students unable to answer a question to give an example instead. Another involved assessing individual growth, as well as absolute achievement, by using a ticket-out-the-door asking students to "write one thing they did not understand, they would like us to elaborate on the next day, or a question they have that we can address the next day."

Valerie blogged that teaching perspectives challenged her views by making her think more as she taught her three-day lesson. As an example, she stated, "when my partner and I taught antibiotic resistance, I tried to put myself in the students' place and see how they understood it. It also led me to ask them a couple more questions about a topic they may have had misconceptions about." Valerie insightfully mentioned that she tried to become her dominant perspective, but believed incorporating other perspectives was also important. According to Valerie, her past experiences, as well as experiences she never had, attributed to her teaching perspective. She states that she "tried to entertain the students…and teach the students by showing enthusiasm about the topic because the most influential teachers were the ones who loved what they were doing and teaching." Clearly, Valerie believes that her high school teachers greatly influence her practice.

Summary

Participants of this study overwhelmingly held social reform as a recessive teaching perspective and the majority reported a dominant teaching perspective of either none or nurturing. In comparing the lesson plans of all four case study participants, social reform was not incorporated in any of their lesson plans. As a rationale, Jess didn't consider social reform anything she thought about and not a priority. Quanda was not trying to change the world and did not think teachers had the power to do so. While most participants held no dominant teaching perspective, nurturing, on average, was participants' highest self-reported teaching perspective.

Despite designing lessons using a 5E inquiry template intended to be more consistent

with a developmental perspective, participants' instructional plans mostly maintained elements of best practices from a transmission orientation. Some participants, like Kristina and Valerie, incorporated multiple teaching perspectives into their lessons contrary to their preferred teaching perspective. Some participants, like Kristina and Quanda, reverted to a preferred one when the lesson was not succeeding. Both Kristina and Quanda commented that teaching from a transmission perspective was easier and, Kristina added, more efficient. Valerie considered incorporating multiple perspectives to be valuable.

Case study participants suggested an awareness of different teaching perspectives and a resistance toward challenging their preferred transmission perspective. Valerie stated best what appears to influence participants most as being both past experience and lack of experience with different teaching perspectives. Participants considered former high school teachers as prominent in their development, emulating lessons after teachers they liked. Jess added that the inquiry-based focus of the program has had the greatest impact on her.

Summary—Discussions

Collins and Pratt found through a decade of studies using the teaching perspectives inventory that nurturing is the most common dominant teaching perspective and social reform is the most common recessive perspective when considering all instructional levels worldwide [36]. Participants in this study were representative of mathematics and science teachers, in that social reform was overwhelmingly their lowest teaching perspective score, yet many did not have a dominant teaching perspective score [23, 36]. This is similar to a finding of Deggs, Machtmes, and Johnson [37]. According to Pratt, the teacher's views of knowledge, learning, and teaching are what determine each fundamentally different perspective [38]. For this reason, 90% of over two thousand teachers who have to take the TPI report one or two perspectives as their dominant view of teaching. Pratt cautions teachers who suggest using multiple perspectives at different times. He contends that many methods of instruction are common within each perspective and what is important is the intent behind the method.

In this study, we attempted to challenge participants to deliver a 5E, instructional lesson sequence using best practices from a developmental perspective. However, participants mostly taught lessons from a transmission orientation. Participants' schema for the qualities of effective teaching were primarily based on previous experiences as learners, even though they acknowledged being taught alternative ways of presenting curriculum. Fajet, Bello, Leftwich, Mesler, and Shaver found similar results when surveying and interviewing students about the

features of effective and inadequate teachers [6]. Our pre-service mathematics and science teachers struggled with reconciling an inquiry-focused course with their view of teaching perspectives within the discipline. Despite being introduced to a variety of teaching perspectives, overcoming preconceptions of "good teaching" and considering a perspective counter to one's disciplinary major presents a dilemma.

This study confirms the importance of prior learning experiences in determining views on teaching [6, 8-11]. Providing early field experiences and reflection opportunities with caring elementary teachers may have contributed to nurturing as the most dominant teaching perspective of study participants. However, university field experience supervisors comment on the difficulty in providing cooperating teachers that model inquiry-based practices during the first three field-based courses, which includes the course involving this study. The second 3-credit course in our inquiry-focused program introduces project-based learning (PBL) where participants' field-based experiences occur in PBL schools with experienced inquiry-based, cooperating teachers. During this course, participants are challenged to prepare and teach a mini-unit that includes best practices from a developmental perspective and are encouraged to incorporate aspects of a social reform perspective. By definition, PBL is an inquiry-based teaching approach to provide questions, problems, or challenges that form a bridge from the learner's previous way of thinking and reasoning to a new more sophisticated form of reasoning and problem solving; precisely how Pratt defines developmental perspective [30]. Further research is needed to determine if an entire sequence of pedagogical courses can expand perceptions of effective teaching.

Inquiry learning from a developmental perspective has been a consistent emphasis in science education programs. However, transmission teaching continues to be a prevailing viewpoint among mathematics and science teachers, especially in secondary and vocational teaching environments [23, 36]. The time to challenge perspectives on teaching is during pre-service teacher education programs before they continue to use the pedagogy they felt was effective as a student. To best serve potential teachers, teacher educators must be aware that broadening teaching perspectives is a difficult task. While the reflection within our study did make students consider their perspectives on a deeper level, a more intensive reflection process, perhaps on a weekly basis, could better challenge pre-service teachers' teaching perspectives [39, 40]. Melville, Fazio, Bartley, and Jones provided data to suggest that experience with and reflection of inquiry-based pedagogy help pre-service teachers identify and cope with potential implementation challenges, rather than eliminate inquiry pedagogy due to commonly conceived misconceptions [41]. Further, they posit that without actual experiences with inquiry teaching,

reflection is undermined and without reflection, identifying areas of weakness and solution to problems is difficult, which leads to a much greater challenge with nontraditional teaching perspectives. In helping pre-service and in-service teachers move from traditional pedagogy to an inquiry-based practice, current perspectives, which can be a limiting factor, must be considered. Considering alternative perspectives of teaching can be a difficult shift because reform-based pedagogy can conflict with current perspectives and therefore require rigorous and continuous professional development, or teachers may revert to traditional instructional methods when reform-based methods are difficult to implement [42, 43].

Biographies

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