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Teachers' Epistemic Cognition in Classroom Assessment

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Epistemic cognition represents aspects of teachers' thinking focused on issues related to knowledge, which may have particular relevance for classroom assessment practices given that teachers must discern what their students know and then use this information to inform instruction. We present a model of epistemic cognition in teaching with a focus on teachers' classroom assessment practices. We argue that teachers' epistemic cognition is inherently more complex than current models developed for learners. Further, we suggest that teachers' epistemic cognition can be supported through the development of reflexivity as an epistemic virtue and that the 3R-EC framework for reflexivity represents one protocol for engaging in reflexive practice that targets epistemic cognition. We close the article with implications for teacher development and with recommendations for further theory and research.

Classroom assessments are the day-to-day assessments designed or selected by teachers to facilitate their ongoing teaching activities (Pellegrino, 2012). Classroom assessment practices involve a complex relationship between teachers' cognition, knowledge, and affect (Fives & Barnes, 2017). In addition, teachers face ongoing tensions between predetermined curriculum goals or national assessment outcomes and their own understandings of how to assess the diverse learners in their classrooms (K-16; Katz, Earl, & Olson, 2001). When engaging in classroom assessment, teachers need to consider their own knowledge of the subject matter, their expectations for the knowledge that students should demonstrate, and which tasks will provide them with accurate representations about what their students know. We argue that these considerations of classroom assessment require teachers to engage in the process of epistemic cognition, and as such teachers' classroom assessment practices provide a meaningful context for exploring this process.

Greene and Yu (2016), building on the work of Chinn, Buckland, and Samarapungavan (2011) and Hofer and Bendixen (2012), defined *epistemic cognition* as the "ability to construct, evaluate, and use knowledge" by drawing on one's "dispositions, beliefs, and skills [to] determine what [is] actually known versus what one believes, doubts, or distrusts" (p. 46). Beliefs about knowledge may take the form of personal epistemologies (e.g., Brownlee, Schraw, & Berthelsen, 2011; Hofer, 2010), multidimensional epistemic beliefs (e.g., Schommer-Aikins, 2004; Schraw, Dunkle, & Bendixen, 1995), or holistic stages of epistemological understanding (e.g., Kuhn & Dean, 2004). Epistemic cognition represents an aspect of teachers' cognition specifically focused on issues related to knowledge (Bendixen & Feucht, 2010). Moreover, teachers must focus on knowledge-related issues with respect to their students and themselves (Buehl & Fives, 2016). Thus, we see classroom assessment as a context in which to explore and understand teachers' epistemic cognition given that one purpose of classroom assessment is for teachers to discern what students know.

A trend in the field of epistemic cognition, both theoretical and empirical, is the strong focus on the beliefs of *learners* engaged in various learning tasks (e.g., Muis, 2007, 2008; Muis & Franco, 2009). Our work shifts this focus to *teachers'* practices (e.g., Schraw & Olafson, 2008). We focus on classroom assessment practices in the context of

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teaching to illustrate that teachers coordinate multiple knowledge-related goals for multiple audiences in order to engage in epistemically informed praxis. By *epistemically informed praxis*, we mean the instructional decisions that result from teachers engaging in epistemic cognition in the process of teaching (Buehl & Fives, 2016). The focus here is not to say that other forms of praxis or teaching goals are not equally or more relevant; rather, if one of the purposes of teaching is for students to construct knowledge, then teachers should consider the nature of what is to be learned. Thus, they must engage in epistemic cognition.

We suggest that one avenue for improving teachers' epistemic cognition for assessment-related practices is through teacher preparation and ongoing professional development (Buehl & Fives, 2016; Greene & Yu, 2016). However, to do this, teacher educators need clear parsimonious models of this kind of thinking applied to real classroom assessment contexts. In this article, we attempt to offer examples of how teachers may engage in epistemic cognition for the planning and facilitating of classroom assessment while recognizing the complexity of the educational context. These examples may inform both teacher education and ongoing research in teachers' epistemic cognition.

To do so, we draw on Buehl and Fives's (2016) framework of epistemic cognition in learning and teaching. This framework integrates Chinn and colleagues' (Chinn et al., 2011; Chinn, Rinehart, & Buckland, 2014) theoretical literature on epistemic cognition with research on teachers' beliefs about teaching knowledge (Fives & Buehl, 2010) to articulate the nature of knowledge justification and knowledge use in teaching (e.g., Greene, Azevedo, & Turney-Purta, 2008). Here we focus particularly on teachers' engagement with classroom assessment activities. Classroom assessment activities are part of an ongoing cycle of reflective practice, where teachers engage in cognition (goal setting), observation (data collection), and interpretation (analyses of student work), referred to as the Assessment Triangle, to guide future instructional actions (Pellegrino, Chudowsky, & Glaser, 2001). Teachers must consider what they want students to learn in order to plan, construct, and use information about students gathered from classroom assessment events[1] to inform teaching and facilitate student learning. As such, a consideration of teachers' epistemic cognition related to assessment practices is important, as classroom assessment events can define perceptions of what knowledge is worth learning and vice versa (Havnes, 2004).

Moreover, we argue that the 3R-EC framework (Reflection-discernment, Reflexive-deliberation, Resolved Action-dedication, for Epistemic Cognition; see Lunn Brownlee, Ferguson, & Ryan, 2017/this issue) can help to refine teachers' dispositions to engage in reflexivity and increase their propensity to explicitly consider the nature of students' learning that is captured during assessment events. We present a theoretical example of Dr. Jones, an educational psychology instructor, to illustrate how epistemic matters manifest in assessment events and how the 3R-EC framework can strengthen teachers' dispositions toward engaging in epistemic cognition. We conclude by discussing implications for theory, research, and teacher education.

THE ASSESSMENT TRIANGLE MODEL FOR CLASSROOM ASSESSMENT

The assessment triangle model explains the teaching processes inherent in classroom assessment (Pellegrino et al., 2001). According to this model, assessment involves the three core elements of cognition, observation, and interpretation, which Pellegrino and colleagues represented as three vertices of a triangle to highlight their interdependency. When teachers attend to issues of *cognition*, they draw on models of how students learn and represent knowledge in order to determine the content and thinking to assess. Teachers evaluate students' performance on an assessment event by comparing it to typical progressions of learning in that content area. This allows teachers to evaluate students' progress in understanding a particular concept or demonstrating a skill. *Observation* refers to how teachers design or select assessment events that will be sensitive enough to provide evidence of the kinds of cognition identified. Teachers consider the scope, quality, and type of assessment event relative to their learning goals to ascertain if a particular assessment event will yield evidence of the desired student competencies. *Interpretation* refers to the processes, methods, or tools teachers use to organize and make meaning from the evidence gathered from assessment events. Despite having access to students' responses to assessment events, teachers often struggle to subsequently transform the information into instructional actions (Little, 2012; Marsh, 2012; Supovitz, 2012). Engaging in interpretation means having strategies or tools to interpret and use results from assessment events in meaningful ways. Thus, according to the assessment triangle, when teachers attend to these three interdependent components, they are more likely to create effective assessment events that are sensitive enough to measure student learning, allow for valid interpretations of the findings, and inform decisions related to teaching (Pellegrino et al., 2001).

EPISTEMIC COGNITION IN TEACHING

Assessment-related events are a fundamental part of teaching (Popham, 2017) and should require teachers to engage in epistemic cognition. Buehl and Fives (2016)

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[1] We use the term *assessment event* throughout this article to underscore that specific observations of student performance may take multiple forms including tests, observations, performance assessments, or complex collaborative activities (Supovitz, 2012).

argued that teachers are in a unique position such that they may engage in epistemic cognition for two large categories of tasks, learning and teaching, and this is done with specific domain knowledge (e.g., curriculum, assessment, pedagogy). As learners, teachers engage in epistemic cognition to achieve learning goals for themselves. For example, teachers may want to learn about formative assessment (i.e., domain knowledge of pedagogy); in doing so, they might consider the nature of information on the concept of formative assessment in terms of its source, structure, and justification to develop a meaningful conception of this concept.

As teachers, however, they also need to consider knowledge in order to guide, direct, and assess the learning of others. Thus, when acting as teachers, they extend their consideration of formative assessment beyond personal learning in the domain to the use of formative assessment for teaching a particular subject matter topic to a particular group of students. This requires teachers to integrate multiple bodies of knowledge (e.g., knowledge of pedagogy, subject matter, and students) and to manage learning goals for both their students (i.e., what will students learn from the formative assessment event?) and for themselves (i.e., what will I learn about my students from the formative assessment event?), thereby adding a layer of epistemic cognition that is not present for learners (Fives & Buehl, 2008, 2010).

Figure 1 provides a model of epistemic cognition in teaching informed by the work of Buehl and Fives (2016), Chinn et al. (2011), Chinn et al. (2014), and Greene et al. (2008). In this model, we embed epistemic cognition in pedagogical decision making situated within the task of teaching. We use the term *pedagogical decision making* to indicate the general and wide scope of decisions teachers make as part of the entirety of their professional practice (e.g., Clark & Peterson, 1986; Darling-Hammond, 2016). We provide a nested illustration of epistemic cognition to underscore that not all teaching-related tasks and decisions require or use epistemic cognition (e.g., managing established classroom routines). Moreover, we conceive of teachers' engagement in epistemic cognition as a series of complex iterative processes (Buehl & Fives, 2016). Thus, this process visually depicted and described here as linear, in practice is more recursive, iterative, and multidirectional. In the sections that follow, we describe our model, discuss its alignment with prior perspectives on epistemic cognition, and provide examples of how teachers may engage epistemic cognition for classroom assessment practices (i.e., Buehl & Fives, 2016; Chinn et al., 2011; Chinn et al., 2014).

Figure 1 focuses on the task of teaching. At the top left, we recognize that a specific teaching task occurs in a specific context. We also recognize that multiple bodies of relevant domain knowledge inform all teaching tasks (as
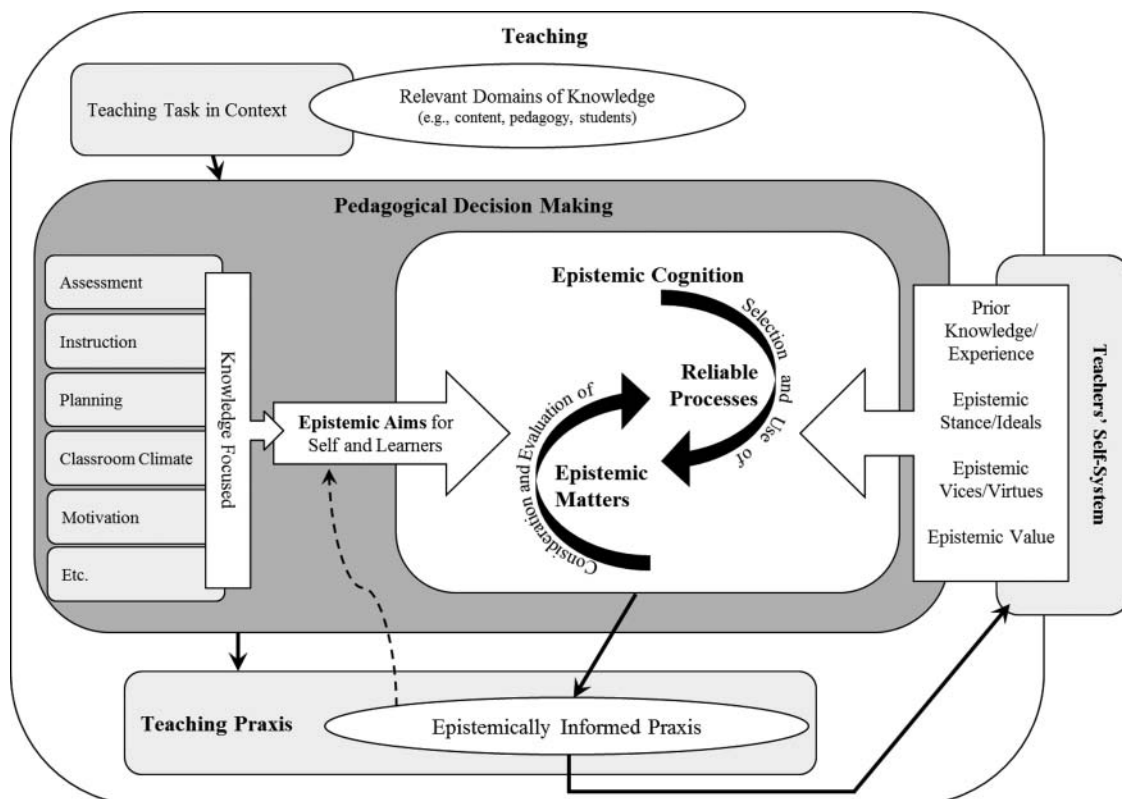

FIGURE 1   Model of epistemic cognition in teaching.

demonstrated in the white oval overlapping the teaching task box). The teaching task, informed by relevant domain knowledge, provides a context for teachers' pedagogical decision making. The central dark gray box of Figure 1 shows some essential topics/tasks that require pedagogical decision making, and embedded here are instances relevant to examining teachers' epistemic cognition. The six light gray boxes on the left side of the pedagogical decision-making box reflect some of the key areas, such as assessment, around which teachers make decisions. The extent to which these decisions are knowledge focused, that is, relating to the construction, use, or justification of knowledge, determines whether epistemic cognition is engaged. Epistemic cognition is predicated on the existence of an epistemic aim (Chinn et al., 2011; Chinn et al., 2014) and involves the selection and use of reliable processes and the consideration and evaluation of epistemic matters. Each of these concepts is discussed in detail in the sections that follow.

Epistemic Aims

Epistemic aims are the knowledge-oriented goals and objectives held by individuals. These aims have been described in terms of what individuals hope to achieve or the nature of their learning tasks such as developing knowledge, understanding, explanation, justification, true belief, avoidance of false belief, useful scientific models, and wisdom (Chinn et al., 2011; Chinn et al., 2014). Buehl and Fives (2016) argued that teachers may have multiple, at times competing, aims, some of which may require or engage epistemic cognition. Epistemic aims are only called forth when the pedagogical decision making is knowledge focused, represented by the arrow overlaying the gray pedagogical decision boxes. In addition, epistemic cognition involves the use and justification of knowledge, and for teachers this may require epistemic aims reflective of accurate and meaningful knowledge use, such that epistemically informed praxis may be an aim held by teachers when engaged in pedagogical decision making.

We argue that teachers have epistemic aims for both their students and themselves. The identification or development of a daily lesson objective that embraces issues of knowledge and/or knowledge construction is an epistemic aim that teachers hold for their students, which also have associated epistemic aims for the teacher (Buehl & Fives, 2016). For instance, a teacher may have the epistemic aim for his or her students to develop an explanatory model of electrical circuits. To achieve this aim, the teacher may give students a piece of wire, a battery, a lightbulb from a flashlight, and a piece of tape, and then ask students to make the lightbulb glow. This exploratory task supports students' achievement of the epistemic aim of model building by providing them a tangible experience with a circuit for students. At the same time, the teacher's epistemic aim may be to develop an understanding of his or her students'

conceptual progress, motivation, and failure tolerance. The teacher achieves this aim through his or her observations (assessment) of the strategies and explanations students provide. Thus, this teacher manages multiple epistemic aims. It is worth noting that many teachers are working in contexts with highly prescribed curricula where the lesson objectives are provided for them along with explicit instructional plans. In these situations, the degree to which teachers engage in epistemic cognition for any aspect of teaching may be limited or may require teachers to evaluate materials for the nature of epistemic aims embedded in them by curriculum designers.

Epistemic Cognition

Epistemic cognition involves the reciprocal interaction between the selection and use of reliable processes and the consideration and evaluation of epistemic matters (i.e., "a network of interrelated topics including knowledge, its sources and justification, belief, evidence, truth, understanding, explanation and many others"; Chinn et al., 2011, p. 141; see center of Figure 1). The result of epistemic cognition is an *epistemic end* or *product* described here as epistemically informed praxis (for teaching; Buehl & Fives, 2016). This epistemic end typically reflects the identified epistemic aim. Ideally, epistemically informed praxis influences the refinement or selection of teachers' epistemic aims, represented by the broken arrow leading from epistemically informed praxis to epistemic aims. Teachers' experience with epistemically informed praxis will become part of their self-system (described next) and contribute to future epistemic cognition and decision making, as indicated by the arrow from epistemically informed praxis to the teacher's self-system.

Reliable processes.   *Reliable processes* are the strategies individuals select and enact to meet their epistemic aims (Chinn et al., 2014). Chinn et al. (2014) offered examples of reliable processes for achieving the epistemic aim of true belief. These included appeals to authority, the use of empirical evidence, and reasoned argumentation. Chinn et al. (2014) indicated that there must be alignment between the epistemic aim and the reliable process employed. In our figure, we depict the selection and use of reliable processes in the epistemic cognition box. Thus, if teachers have an epistemic aim, they engage epistemic cognition and must select and use a reliable process that will help them achieve the identified aim. We see the selection and use of reliable processes as recursive with the consideration and evaluation of epistemic matters (described in the next section). For instance, to evaluate the decision to select/use appeals to authority as a reliable process, an individual might consider whether such appeals are viable for achieving the identified epistemic aim and which authorities would be most appropriate for such appeals.

In the context of teaching, teachers may choose to employ teaching-related strategies as reliable processes for achieving the epistemic aims they have set for themselves or for their students. Consider the preceding electric circuit example. To further epistemic aims of model building for students and understanding students' progress for him- or herself, the teacher may choose to have students work on the task in pairs or to explain the process to a partner at intervals during the activity. Thus, the teacher would be emphasizing the reliable process of social interaction to facilitate students' achievement of the aim of model building by having them explain their understandings (Vygotsky, 1962, 1978). At the same time, this activity allows the teacher to pursue his or her epistemic aim of understanding the students because the social interactions make students' thinking public and therefore observable.

There are a host of strategies that can serve as reliable processes, available to teachers to help them support students' attainment of epistemic aims. For instance, teachers may use a cognitive taxonomy (e.g., Revised Bloom's Taxonomy; Anderson & Krathwohl, 2001) and a scope and sequence as reliable processes to guide the development of epistemic aims for learners. If the teacher's epistemic aim for students is to develop a well-supported argument, the teacher may require students to complete an argumentation vee diagram,[2] because this task will be sensitive enough to access the type of cognition identified in the epistemic aim identified for students (Nussbaum, 2008). One challenge for teachers is selecting such processes and ensuring their accurate alignment with the identified aim. When teachers make these decisions about reliable processes for learners, they engage in epistemic cognition, wherein they weigh knowledge about different pedagogical approaches with understandings of the subject matter, learners, and curriculum.

The need to align epistemic aims and reliable processes holds when the teacher sets epistemic aims for him- or herself as well. Consider two possible aims a teacher may identify when evaluating student work: The teacher may want to (a) understand students' cognition or (b) ensure that the grades he or she assigns are sufficiently justified to limit discussions (disagreements) with students' parents. To successfully achieve either aim, the teacher may employ a rubric, scoring guide, or checklist as a reliable process to determine students' performance relative to the learning objective identified for the students. Thus, the teacher's aim informs his or her selection and implementation of these processes. This teacher may better meet the aim of *understanding* by using a single-point rubric[3] that would allow him or her greater flexibility to explore students' work and to provide a wide range of feedback (Mertler, 2001). In

contrast, if the teacher's aim is grade justification to parents, then a more detailed analytic rubric would provide clearer delineation of the levels of performance, and the teacher could point to specific areas where students did not meet the identified criteria in their work. Certainly, the teacher could use either type of rubric to achieve his or her aims, but the selection and implementation of the reliable process needs to align with the teacher's aims for them to be achieved.

Our model allows for the possible refinement of aims as a result of iterations of epistemic cognition, as illustrated by the dashed line from epistemically informed praxis back to epistemic aims for self and learners. In this example, the teacher may start with an aim of grade justification but through the process of using a rubric and considering student work he or she may refine or extend this aim to include an understanding of students. In the context of assessment practices, school curricula and policies often dictate the nature of the evaluation system that teachers must implement. Without consideration of the teacher's aim in relation to the process required, the teacher may find him- or herself at odds with a required tool if it was developed for an aim the teacher does not hold. Thus, teachers also may need to engage in epistemic cognition to identify the extent to which required tools meet or align with their epistemic aims.

Consideration and evaluation of epistemic matters for task and domain.   Consideration and evaluation of epistemic matters refers to the contemplation of information, knowledge, and knowing (identified by the task and domain) with respect to the dimensions of knowledge, namely, source, structure, certainty, and justification (Buehl & Fives, 2016; Hofer, 2016). Our model of epistemic cognition in teaching begins with a specified task and relevant domain knowledge. If the teacher's task is to assess students' comprehension of text, and the teacher identifies an epistemic aim related to this task, then he or she must consider multiple domains of knowledge: reading, the specific text, assessment strategies, the students, and so on, and contemplate the nature of that knowledge relative to his or her aim. Knowledge may be evaluated on a range of continua, but most approaches include considerations of the (a) source of knowledge as derived from authority or personal construction (e.g., Hofer, 2000); (b) certainty/stability of knowledge perceived as certain and unchanging or tentative and evolving (e.g., Schommer, 1990; Schraw et al., 1995); (c) structure of knowledge as discrete and simple or as integrated and complex (e.g., Buehl, Alexander, & Murphy, 2002); and (d) justification of knowledge through appeals to authority, personal justification, and the personal

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[2]An AVD is a prewriting tool that is used to identify and evaluate arguments and counterarguments and develop creative rational opinions (Nussbaum, 2008).

[3]A single point rubric delineates the parts of an assignment into distinct evaluative criteria and then defines only the target level for each criteria (Fluckiger, 2010).

evaluation of evidence to determine if knowledge requires revision or if the claim stands (e.g., Greene et al., 2008; Hofer, 2000).

For instance, if students are reading *Romeo and Juliet* by William Shakespeare (domain) and the teacher is interested in assessing their comprehension of the major themes in the play (task), the teacher needs to consider the nature of this play, the certainty of common interpretations of this text, and the justifications available for alternate interpretations. The teacher must also consider relevant domain knowledge related to assessment, instruction, and learning progressions as the teacher makes decisions about how to assess students' understanding of themes. The teacher must weigh the collection of these perspectives in tandem. If the teacher determines that the themes of *Romeo and Juliet* are relatively certain, stable, and simple, then assessment events that tap into such knowledge should be employed as a reliable process for him or her to develop an understanding of students' conceptions of themes. In contrast, if the teacher sees these themes as tentative, evolving, and complex, then demonstrating comprehension may require a different set of assessment events. Essentially, for the teacher to select an assessment event that would provide information allowing for valid inferences regarding students' understandings, the teacher needs to consider the epistemic nature of content knowledge and qualities of various assessment strategies in relation to that knowledge. To do all of this, the teacher needs to engage a reliable process to support his or her thinking about these matters. This example of selecting an assessment event illuminates the iterative and interdependent nature of these components of epistemic cognition at play, represented by the two arrows leading into each other in the center of the epistemic cognition box. Moreover, for Buehl and Fives (2016), specific forces within the individual's self-system influenced this process.

Teachers' self-system.   Bandura (1978) defined self-system in the context of social learning theory as comprising "cognitive structures and sub-functions for perceiving, evaluating, and regulating behavior" (p. 344). Epistemic cognition is tempered by a variety of influences in the teacher's self-system including his or her prior knowledge/ experience, epistemic ideals/stance, epistemic vices/virtues, and epistemic value (Chinn et al., 2011; Chinn et al., 2014). In Figure 1, we represent the elements of the self-system thought to directly influence epistemic cognition as a white arrowed box leading into epistemic cognition.

Prior knowledge and experience.   Teachers' existing knowledge of subject matter, curriculum, pedagogical practices, and students all serve to inform their epistemic cognition (Buehl & Fives, 2016). For example, a teacher may be accustomed to using the analytic rubric that accompanies the textbook publisher's materials, and in the teacher's experience this tool has been adequate for evaluating his or her sixth grade students' knowledge of the causes of the U.S. Civil War. The teacher's prior knowledge and experience inform his or her selection and use of the rubric as a reliable process to meet the teacher's aim of understanding students' learning.

Epistemic stance/ideals.   *Epistemic ideals* are the criteria or standard by which individuals assess the products of epistemic cognition (i.e., epistemic ends; Chinn et al., 2014). That is, epistemic ideals reflect the individual's perspective on the requirements or parameters of knowledge and include perspectives on the structure and justification of knowledge. People use these ideals as a guide to help make decisions about the quality of knowledge they have established and to judge claims presented to them.

In their earlier work, Chinn et al. (2011) posited that one product of epistemic cognition could be an *epistemic stance*, described as a position on the certainty of knowledge claims. Buehl and Fives (2016) argued further that *epistemic stance* reflects "the constructed meaning about the idea, concept, or information as situated within the knower's cognitive schema . . . as well as the perspective one holds about the nature of that knowledge" (p. 259). Here we use both terms *stance* and *ideal* as a key influence on teachers' epistemic cognition in order to emphasize the holistic set of beliefs about knowledge that can be used to judge and evaluate knowledge claims, information, and related decisions.

Teachers use their established epistemic stance/ideals to facilitate their epistemic cognition for teaching. If our *Romeo and Juliet* teacher has a stance that includes the belief that the play includes three discrete themes (structure) and the teacher is highly confident in this (certainty) because he or she wrote about these themes in his or her college senior thesis (justification), then when the teacher contemplates how to evaluate students' understanding of the play, he or she makes decisions about assessment options based on this stance. The teacher may (or may not) engage in epistemic cognition about the play itself, but as he or she seeks to achieve the epistemic aim of understanding the students' understanding, the teacher uses this existing stance to make judgments about the nature of the assessment event he or she might administer.

Teachers also engage their epistemic ideals to judge the construction of new knowledge by their students. For instance, when evaluating a student's persuasive essay in favor of solar energy, a teacher may bring forth the epistemic ideals of his or her content domain. As such, a science teacher may focus on the quality and source of the empirical evidence presented in the essay, whereas a writing teacher may focus on the quality and structure of the argument to evaluate the extent to which the student has

achieved an epistemic aim (e.g., understanding, explanation, justification).

Epistemic vices and virtues.   Epistemic vices/virtures reflect individuals' developed habits for thinking, which may facilitate (virtue) or hinder (vice) effective epistemic cognition. Chinn et al. (2014) offered honesty and open-mindedness as examples of epistemic virtues and closed-mindedness and gullibility as epistemic vices. Thus, we see a reflective disposition, a habit of thinking about their teaching practices with epistemic aims in mind, as an epistemic virtue that supports teachers' use of epistemic cognition (e.g., Giovannelli, 2003; Helm, 2006; Reiman, 1999; Schon, 1983). We describe this in more detail later in the article.

Epistemic value.   Epistemic value refers to the relative importance of some knowledge over others and is an indication of what knowledge a learner intends to pursue or understand in a particular situation (Chinn et al., 2014). Teachers assign differential value to an array of knowledge needed for teaching (e.g., knowledge of theory, students, learning, content, instructional practices, and classroom assessment; Fives & Buehl, 2008). The value that teachers attribute to subject matter or knowledge of their students can potentially frame how they engage in epistemic cognition (Buehl & Fives, 2016). For instance, a teacher with a value toward understanding the students' reading fluency may be more likely to assess with a miscue analysis during a read aloud than a teacher who has greater value for students' comprehension skills.

EPISTEMIC COGNITION IN CLASSROOM ASSESSMENT: DR. JONES, THE EDUCATIONAL PSYCHOLOGY INSTRUCTOR

In this section, we provide an example of an educational psychology instructor's potential use of epistemic cognition when engaged in assessment-related practices. Specifically, we seek to highlight the iterative nature of epistemic cognition in classroom assessment and illustrate a number of opportunities for epistemic cognition that exist when teachers use the assessment triangle to inform their practice (Pellegrino et al., 2001). In this example, we focus on the potential use of epistemic cognition in assessment practices; however, we recognize that many decisions that teachers make are not guided solely by epistemic aims. The complexity of teaching practice in classrooms involves multiple aims, many of which are not epistemic in nature.

Our hypothetical instructor, Dr. Jones, teaches an introductory undergraduate course in educational psychology. She is currently facing the specific teaching task of *assessing students' understanding of learning theories* including Piaget's Cognitive Constructivism, Vygotsky's Social Constructivism, and information processing theory. To accomplish this task, Dr. Jones engages in the three components of the assessment triangle model, which should require epistemic cognition. She (a) considers students' cognitions, (b) determines the nature of the observations needed to assess cognitions and develops the assessment event, and (c) engages in interpretation of her students' work and provides feedback. Because we see epistemic cognition as a fluid and dynamic process, we also recognize that decisions related to one teaching task or subtask can serve as the catalyst for change or reason for stability in the overall process and praxis.

Consider Students' Cognitions

When teachers consider students' cognitions, they need to determine the content/skills to assess in light of their understanding of how students learn and represent knowledge in that subject area. One way teachers can do this is through identifying or reevaluating learning objectives for students. When related to what students *should know* and *how they know it*, the development of learning objectives for students is the tangible act of identifying epistemic aims *for learners*. When teachers develop or select learning objectives, they are identifying what students should pursue through their (the students') epistemic cognition.

When Dr. Jones sets out to identify learning objectives for her unit on learning theories, she must consider the epistemic features of her subject matter. Perhaps for her lesson (s) on Piaget she needs to determine whether to teach Piagetian Stages. To do so, she considers the source, structure, certainty, and justification of Piagetian Stages given the research and theory in this area (see Lourenço, 2016; Wadsworth, 1996). She may find herself deliberating on the importance of this content as a historical context for modern learning theories in relation to the empirical and theoretical support for these stages. She may conclude that because of the controversy around the existence of these stages (Dawson-Tunik, Fischer, & Stein, 2004) she will focus her lesson on Piaget's conceptualization of adaptation, organization, and equilibration, which served as the basis for much of modern constructivism (Flavell, 1996; Lourenço, 2016). Thus, to determine an epistemic aim for her learners, Dr. Jones engages in epistemic cognition about the content to be taught, comparing the content to her epistemic ideal that empirical support supersedes historical context, and subsequently renders a decision about *what* students should know.

To address the cognition component of the assessment triangle, Dr. Jones also needs to focus on *how* students come to know, that is, the depth of their thinking and the structure of the knowledge of interest. One set of tools available to teachers to construct learning objectives is cognitive taxonomies, such as the Structure of the Observed Learning Outcome (SOLO) taxonomy (Biggs & Collis, 1982) or the Revised Bloom's Taxonomy of the Cognitive

Domain (Anderson & Krathwohl, 2001). Here we describe the use of the SOLO taxonomy as a reliable process to support Dr. Jones's construction of learning objectives that are also epistemic aims. The SOLO taxonomy classifies students' learning into stages from simple (*unistructural*: one idea/concept; *multistructural*: several independent ideas/concepts) to more complex (*relational*: several integrated ideas/concepts; *extended abstract*: generalized ideas/concepts that go beyond material presented) levels of understanding (Biggs & Collis, 1982; Biggs & Tang, 2007). As Dr. Jones considers the nature of her subject matter, she considers her learners, particularly the kinds of knowledge construction she thinks they are capable of and wants them to experience based on typical progressions of learning in educational psychology. Dr. Jones might determine that a knowledge-focused, lower level, multistructural learning objective whereby students construct an understanding of several relevant independent ideas (e.g., adaptation, organization, equilibration) may be appropriate for the initial introduction of the topic; however, later in the instructional sequence she may want students to attain a relational learning objective by being able to explain how these innate tendencies interact and can be used to analyze a learning sequence. Consequently, to capture the epistemic aims she has for students, Dr. Jones writes the following objectives: (a) students will be able to explain the innate basic tendencies of Piaget's theory, and (b) students will be able to explain how the innate basic tendencies interact to facilitate knowledge construction in a video-recorded lesson. The use of the SOLO taxonomy and learning progressions to frame student thinking are reliable processes that support Dr. Jones's consideration of the content knowledge she is teaching along with her knowledge of her specific students' cognitive capabilities.

Determine and Develop the Observations

At some point in her practice, Dr. Jones needs to determine the nature of her observations, that is, the classroom assessment events that align with students' cognitions. In deciding how to assess her students, Dr. Jones needs to weigh the potential value of different kinds of assessment events and the kind of information each might elicit. She needs to consider the purpose(s) and parameters of her assessment events. That is, she must determine if her assessment events serve formative, summative, or both purposes, and whether criterion-referenced or norm-referenced scoring is appropriate for the epistemic aims she has identified for learners. Within the context of these decisions, she must also weigh the strengths and weaknesses of specific observation formats. For instance, she may consider whether a traditional summative test that includes multiple-choice and essay items can measure students' achievement of her learning objectives. In doing so, she might recognize that multiple-choice items could be particularly useful for assessing unistructural and multistructural levels of knowing where items assess for one correct answer, whereas essays or short-answer items are more likely to assess students' understanding of relational knowledge such as comparing and contrasting theories.

Alternatively, she might consider having students create concept maps, design a lesson, or evaluate a video case study for underlying learning theories, each of which would require students to demonstrate interrelations (relational level) and possibly engage in theorizing and abstracting ideas (extended abstract level) represented in the course content. Many of these decisions rely on her engagement in epistemic cognition, wherein she compares specific observation formats to the epistemic ideals she has for the content knowledge to be assessed. However, it is worth noting that issues of practicality (e.g., ease of scoring a multiple-choice test) may direct some of these decisions rather than the epistemic ideal held by the teacher. As illustrated in Figure 1, not all pedagogical decision making is knowledge focused.

Depending on the assessment event Dr. Jones selects, there are a variety of tools available for her to use as a reliable process for considering the epistemic nature of her subject matter in the construction of her observation (assessment event). A Table of Specifications (TOS) is one tool that teachers can use to develop traditional summative tests that can also serve to support their epistemic cognition. A TOS is a table that helps teachers to align learning objectives with class time and expected cognitive levels of understanding (DiDonato-Barnes, Fives, & Krause, 2013). Teachers can use this tool to determine the number and nature of items to include on an assessment event such that multiple cognitive levels (low and high) are appropriately reflected on the test. Alternatively, if Dr. Jones decides to develop a performance or authentic assessment, there are a variety of protocols she can use as a reliable process. For example, the GRASPS protocol (goal, role, audience, situation, product or performance, standards for success) prompts the teacher to consider the goal of the performance assessment and the evaluation criteria to determine performance (Wiggins & McTighe, 2008). Moreover, this tool guides the teacher to develop a storyline for the task including the role students will assume; the specifics of the situation students are in, including the intended audience; and the product or performances students will create.

In constructing a TOS or using the GRASPS protocol, Dr. Jones again considers the learning objectives she identified for students, which if guided by a cognitive taxonomy should reflect epistemic aims. In this process, Dr. Jones is afforded the opportunity to reconsider the nature of her epistemic aims and possibly revise them based on her experience of epistemically informed praxis.

Engage in Interpretation of Student Work

Once students complete the assessment event (e.g., test, concept map), Dr. Jones will need to interpret students'

work, make judgments about it, and provide feedback. As Dr. Jones reviews students' responses to essay items or performance assessments, she must revisit the epistemic aims she had for students and provide feedback targeted toward those aims. Moreover, she must consider the accuracy of the information provided by students as well as the depth of their explanations and the soundness of their justifications for claims made. This is inherently an epistemic endeavor for teachers as they engage in evaluating the knowledge representation of others. Dr. Jones needs to simultaneously reflect on her own knowledge of learning theories, including the epistemic ideals she assigns to that knowledge, and compare that to the information presented by students in order to assign a grade and devise feedback that is appropriate to students' developing conceptions. She engages her epistemic ideals as she determines if students' responses have fatal flaws in their understanding of the content as opposed to naïve but accurate conceptualizations appropriate for learners in an introductory course. Dr. Jones can create a rubric as a reliable process to support both the evaluation of student work and the direction of feedback. A rubric can help ensure that she targets her feedback to her identified epistemic aims.

Teachers must also engage in epistemic cognition when reviewing selected-response[4] assessment information. Although scoring multiple-choice items does not require epistemic cognition, teachers can conduct item analyses to identify trends in incorrect responses and to identify potentially problematic items. Once teachers identify such trends or items, they must engage in epistemic cognition to make decisions about the quality of test items or students' understanding of the material. For instance, if Dr. Jones notices that most of her students incorrectly responded to the same item by selecting the same distractor, then she would need to closely review that item in relation to her epistemic aims and ideals; consider the possible reasons for that trend and what it tells her about her students' thinking; and then make a decision about whether the item should be included in the calculation of students' grades, as it may not be providing sound information about their understanding. Such evaluation of items following students' completion of a test requires Dr. Jones to once again consider the certainty and justification of subject matter knowledge in relation to her expectations for her students.

THE 3R-EC FRAMEWORK AS A MEANS TO HARNESS A REFLEXIVE DISPOSITION AS AN EPISTEMIC VIRTUE

The example of Dr. Jones's assessment practices illustrates a complex cognitive process that requires extensive

cognitive resources (Feldon, 2007). We theorize that the likelihood of Dr. Jones (or anyone) routinely engaging in epistemic cognition may rest in the extent to which that individual has the epistemic virtue of a reflexive disposition, that is, a habit of thinking about his or her assessment (and other teaching) practices with epistemic aims in mind (Giovannelli, 2003). Reflexivity refers to the mental ability of individuals to engage in an internal dialogue as they think of themselves relative to their social context (Archer, 2013). It includes determining an important goal, issue, or aim (i.e., discernment), considering individual and contextual concerns (i.e., deliberation), and taking action (i.e., dedication). In the teacher education literature, reflexivity is akin to acting as a reflective practitioner (Schon, 1983). Thus, although we consider reflexivity a tool or process for developing teachers' reflection, we also recognize the longstanding tradition of reflective practice and see these two approaches to understanding and facilitating reflection as complementary with the potential to inform and support each other.

The 3R-EC framework (Cyprus ASC, 2015; Lunn Brownlee et al., 2017/this issue) represents one protocol for fostering a disposition toward reflexive practice that targets epistemic cognition. The 3R-EC Framework integrates the 3R Framework for Reflexivity (Lunn Brownlee, Schraw, Walker, & Ryan, 2016) with Chinn and colleagues' AIR model (Chinn et al., 2011; Chinn et al., 2014) to illustrate the distinction between reflection (subject–object) and reflexivity (subject–object–subject) in relation to teachers' epistemic cognition. The 3R-EC framework involves three interconnected cyclical steps. Step 1 requires reflection on classroom practice, where teachers discern specific issues and identify teaching practices to address such issues. In addition, Lunn Brownlee and colleagues (2017/this issue) argue that the initial step of the 3R-EC framework requires teachers to identify the epistemic aims embedded in the identified teaching practices. Step 2 involves reflexive thinking or deliberation on the extent to which the teaching practices identified in Step 1 might prove to be reliable processes for achieving the embedded epistemic aims. This second reflexive step is more complex than the reflective process involved in the initial step, as the teacher is required to engage in internal negotiations to calibrate his or her own teaching practices with reliable processes for achieving the identified epistemic aims. Lunn Brownlee and colleagues define this complex process as epistemic reflexivity. Finally, in Step 3, the teacher engages in decision making to enact changes in his or her classroom based on that teacher's epistemic reflexivity. Due to the cyclical nature of the 3R-EC framework, learning or teaching outcomes resulting from the teacher's epistemic reflexivity (referred to as epistemically informed praxis in Figure 1) would then inform his or her future reflections on classroom practice (Step 1).

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[4]Refers to assessment items in which the student selects an answer from the choices provided rather than writing his or her own response. Examples include multiple-choice or true–false items.

Reflexive Disposition as an Epistemic Virtue

Dispositions can be defined as "trends in teacher judgments and actions" in ill-structured contexts that develop over time (Johnson & Reiman, 2007, p. 677). Thus, dispositions reflect teachers' typical practices and judgments they make while engaged in their work. Dispositions go beyond beliefs to include typical actions associated with those beliefs (Rike & Sharp, 2008). Some argue that dispositions are just as important for teaching as knowledge or skills (e.g., Wayda & Lund, 2005). Scholars and teacher educators have identified key dispositions for teachers that include initiative, fairness, decency, pro-social behavior, honesty, humility, trust, empathy, and healing (e.g., Arnstine, 1990). It should be noted, that in our model of epistemic cognition (see Figure 1), a disposition was deemed to be a vice or virtue based on the influence of the disposition on the individual's appropriate pursuit of epistemic aims. Thus, although we recognize a wide range of key dispositions for teachers to hold for their full practice, in the context of teachers' epistemic cognition it seems that a disposition toward reflection/reflexivity is necessary.

In teacher education, the process of reflective practice is considered essential for teachers to make meaning from the complex and multidimensional practice of teaching (e.g., Feiman-Nemser, 1990; Freese, 2006; Munby & Russell, 1990; Reiman, 1999; Zeichner, 1996). A reflective disposition has been operationalized in research as the process of "making decisions and formulating ideas about educational goals, practices, and outcomes that are subject to careful reconsideration in light of information from current theory and practice" (Giovannelli, 2003, pp. 300–301). Such a disposition was associated with effective teaching in preservice teachers (Giovannelli, 2003). Giovannelli's (2003) description of a reflective disposition seems well aligned with Ryan and Bourke's (2013) application of reflexivity to teacher thinking. Specifically, both approaches emphasized the importance of considering and reconsidering educational objectives/aims in relation to teaching practice for action in the classroom. Such careful, iterative reconsideration of classroom goals, events, and outcomes is also evident in our model of epistemic cognition in teaching (Figure 1).

When we position these notions within a goal for epistemic cognition (as illustrated in Figure 1) we can make some general conclusions. First, a reflexive disposition developed in teachers can be seen as a virtue for epistemic cognition. That is, the habit of mind of reflection that teachers develop over time may support their continued, intentional, or implicit consideration of epistemic matters in that teachers who engage in epistemic cognition on a routine basis in their work must be reflexive. In this case then, a reflexive disposition becomes an epistemic virtue on those occasions when teachers engage in epistemic cognition. Third, although teachers may well have a reflexive disposition, there is no guarantee that their reflexive activities will consider epistemic issues, despite their relevance to the situation. Therefore,

we suggest that the 3R-EC framework represents one protocol for engaging in reflexive practice that teachers can use when considering the epistemic aspects of their assessment practices as depicted in Figure 1.

Supporting a Reflexive Disposition Toward Assessment Using the 3R-EC Framework

Reflexivity is dependent on the actions of the individual and requires teachers to initiate the process and act on their findings (Ryan & Bourke, 2013). At the same time, ongoing reflexivity for epistemic cognition may be taxing on teachers due to limitations of working memory combined with the complexity of teaching, which may inhibit the teacher's willingness or ability to engage in the epistemic cognition processes depicted in our model (e.g., Feldon, 2007). Research in preservice teachers' assessment strategies suggests that in the absence of recommended strategies, teachers will devise their own routines and strategic processes that may be ineffective (Fives & Barnes, 2017). The 3R-EC framework can serve as a reflexive guidance tool for teachers to use when engaging in assessment or other teaching tasks related to issues of knowledge.

The 3R-EC framework applied to classroom assessment events prompts teachers to use their epistemic reflexivity by contemplating a current classroom assessment practice (object) in relation to the epistemic aims they hold for their students (subject). This initial step, reflection, involves a process of discernment where the teacher can be open to information provided by his or her self-system, including the teacher's prior experience implementing the classroom assessment practice. The teacher may ask him- or herself the question, "How do my assessment practices connect or align with the knowledge goals (epistemic aims) I have for my students?" In Step 2, reflexive deliberation, the teacher expands his or her thinking about the issues that emerged during discernment to brainstorm, weigh, and consider a variety of epistemically informed potential actions (i.e., deliberation). At this point, the teacher is responding to the internal question, "How can I better align my teaching goals, classroom assessment practices, and self-system?" Step 3 of the 3R-EC framework, resolved action, indicates that the result of Steps 1 and 2 is deliberate informed action (i.e., what we describe as epistemically informed praxis, when guided by epistemic cognition). In this step, the teacher not only answers the question "What will I do?" but that teacher enacts the decision in his or her work, which becomes a new experience on which the teacher can reflect.

FOSTERING REFLEXIVE EPISTEMIC COGNITION ON ASSESSMENT EVENTS WITH THE 3R-EC FRAMEWORK: A SECOND LOOK AT DR. JONES

Earlier in this article, we used the hypothetical Dr. Jones example to describe the importance of epistemic cognition

in teachers' thinking and decision making related to various assessment practices. Our model (Figure 1) provides an overarching conceptualization of how epistemic cognition may, could, or potentially should take place in teachers, but it does not offer a mechanism for facilitating this process. Here we briefly describe how Dr. Jones can intentionally engage in epistemic cognition during assessment events by actively engaging the 3R-EC framework.

Step 1: Reflections on Classroom Practice (Discernment)

Recall that Dr. Jones's task was to *assess students' understanding of learning theories*, specifically students' ability to explain how the innate basic tendencies proposed by Piaget interact to facilitate knowledge construction using an essay prompt. Using 3R-EC, first Dr. Jones reflects on the epistemic aim she identified for students (subject) and determines that she has a *relational* aim (as described using the SOLO taxonomy). This aim is epistemic in nature because Dr. Jones is concerned with the depth of students' explanations and the soundness of their justifications for claims made. After reflecting on her aim, Dr. Jones considers whether using an essay item is the best way for students to demonstrate that they have an understanding of and can explain the innate basic tendencies (object). She might ask herself, "Does this prompt show if students can explain and use evidence to discuss the similarities and differences between these concepts?" Thus, the first phase of 3R-EC requires Dr. Jones to engage in subject–object reflection to determine the extent to which her epistemic aim for students can be evaluated through the use of a particular assessment event.

Step 2: Reflexive Deliberation

Next, Dr. Jones "bends back to self" to engage in a subject–object–subject reflection. To do so, she engages in internal negotiations as she considers and weighs how this assessment practice will provide information about students' understanding. As part of this process she thinks about her selected assessment event from multiple points of view. For example, she may consider the wording of the prompt to ensure that it explicitly asks students to support their assertions with evidence while also taking into account time constraints and other practical concerns that may limit the extensiveness of students' responses. Dr. Jones may also deliberate on the reliable processes selected to help her achieve her aim. She may question whether the scoring rubric she constructed is sensitive enough to discern the complexity of students' explanations and the accuracy of the justifications students use to support their arguments. She may realize that it is necessary to modify her assessment practices to better achieve her epistemic aims. Dr. Jones's use of critical thinking as part of her epistemic reflexivity allows for explicit consideration of how her own

epistemic cognition (subject) guides effective assessment practices (object) to meet the epistemic aims she identified for her students (subject).

Step 3: Resolved Action (Dedication)

In the final step of the 3R-EC protocol, Dr. Jones takes action. This critical aspect of reflexivity involves Dr. Jones engaging in epistemically informed praxis and subsequent action cycles. The resulting action can lead Dr. Jones to revise her epistemic aims for students. For example, she may realize that students understand and are able to provide explanations for similarities/differences among the innate basic tendencies, and she may decide to have them use this knowledge to analyze a video case study. Conversely, through the process of reflexive deliberation, Dr. Jones may realize that her assessment practices are not effectively achieving the identified epistemic aims. Dr. Jones choice of resolved action will become part of an ongoing reflexive cycle that will inform her future assessment approaches (leading back to Step 1).

IMPLICATIONS FOR FUTURE RESEARCH AND CONCEPTUALIZATIONS OF TEACHERS' EPISTEMIC COGNITION

In this article, we have expanded on and refined prior work in epistemic cognition in three ways. First, we extend the complexity of epistemic cognition in teaching. Teaching is a complex process in which teachers have multiple goals and engage in a variety of processes, some of which are epistemic in nature. Teachers' work may be more generally defined as "teaching," or it could refer to specific instructional moves such as conducting a 3-min book introduction for a struggling reader in a one-on-one setting. Similarly, the relevant knowledge teachers draw on while engaged in the task could also vary with regard to its complexity and specificity. Second, the knowledge, beliefs, and practices that are part of the teacher's self-system influence the processes of epistemic cognition. For example, the extent to which a teacher values an epistemic aim may influence his or her engagement in epistemic cognition, his or her teaching praxis, and ultimately the epistemic ends achieved. Third, although we agree with Chinn et al. (2014) that epistemic cognition includes an epistemic aim, a reliable process, and some aspects of the teacher's self-system, we add that for teachers epistemic cognition also requires a disposition (virtue) toward reflection. Given these new assertions, further theorizing on the parameters of epistemic cognition and empirical testing to verify the claims is needed. For instance, researchers may explore the extent to which reliable processes align with identified epistemic aims. If the issue is one of alignment, then more effort needs to be made with teachers and learners to better calibrate their epistemic aims and reliable processes.

In teachers' practice, the use of epistemic cognition is multifaceted and iterative. Such reciprocal and dynamic interactions are reminiscent of Feucht's (2010) pyramid-shaped, educational model of personal epistemology, which specified the reciprocal interactions between learners' epistemic cognition, teachers' epistemic cognition, instruction, and educational materials that contribute to a classroom epistemology or epistemic climate. In our work, we focused specifically on teachers' epistemic cognition with a particular emphasis on assessment, essentially highlighting one portion of Feucht's (2010) model and exploring intricacies and nuances involved in teachers' decision making. As we worked through the example of Dr. Jones, it became obvious that one epistemic decision has an effect on the next. Further, as one considers teaching practice the nature of decisions seems to form a spiral that moves from more general decisions (e.g., epistemic aim for students to understand) to very specific ones (e.g., the construction of a single test item to assess that aim).

An implication of our work for future research is the use of our proposed model and example of assessment as an a priori lens to analyze teachers' epistemic cognition in practice. In particular, teachers' assessment-related activities, from the selection/construction of epistemic aims to the design and interpretation of assessment events, could be observed in real-time, authentic contexts through think aloud protocols to ascertain the ways that teachers' epistemic cognition is engaged and influenced. Thus, classroom assessment events may offer a unique way to explore teachers' epistemic cognition.

Scholars in learning sciences and educational psychology who are concerned with epistemic cognition need to expand their theories and research to the practice of teaching. Of importance, they need to look closely at other concepts in teacher education such as curriculum development, lesson planning, and instructional practices to identify places where epistemic cognition is a *hidden practice*. In this article, we argued that learning objectives are (or should be) epistemic aims for learners. However, curriculum, planning, and assessment texts do not explicitly mention the kind of thinking that teachers must do with respect to the epistemic nature of their content in order to develop learning targets or essential questions. Thus, the need for epistemic cognition seems hidden from the explicit practice of teachers. Scholars in this area need to find ways to make epistemic cognition visible for teachers, to support their ability and willingness to critically reflect on epistemic issues in their practice.

IMPLICATIONS FOR TEACHING, TEACHER EDUCATION, AND TEACHER DEVELOPMENT

Despite the need for additional developments in the conceptualization and empirical investigation of teachers' epistemic cognition, there are educational implications for teachers and teacher educators in the current work. Most notably, our model of epistemic cognition in teaching draws awareness to the role of epistemic cognition for teaching in general and for classroom assessment more specifically. By highlighting the process of epistemic cognition in teaching, we provide teachers and teacher educators with a framework and vocabulary to describe and understand the complex and recursive set of actions involved in teaching. Thus, explicit attention can be devoted to the specific components of the model in teacher preparation and professional development experiences.

For instance, our model indicates that epistemic aims are necessary to engage in epistemic cognition. Consequently, teachers need to be aware of the nature of the aims they hold for themselves and their students. As we previously noted, teachers commonly hold various epistemic and nonepistemic goals, perhaps simultaneously. When teachers recognize that they have epistemic aims for themselves or their students, this should help them to take up more deliberate use of epistemic cognition in the selection of reliable processes and consideration of epistemic matters.

In addition to helping teachers distinguish between epistemic and nonepistemic aims, it is important for teacher educators to explicitly teach reliable processes for teaching in general and assessment more specifically. As noted throughout this article, there are various reliable processes that teachers can use in the assessment process. However, they need opportunities to use, discuss, and reflect on how such processes relate to specific epistemic aims. Similarly, teachers need experience considering and evaluating epistemic matters as they select those processes.

Given that instruction and assessment practices will continue to evolve beyond what is taught during one's teacher education program and that the context varies by teaching task, it is essential that teachers are able to independently engage in epistemic cognition (i.e., actively select and use reliable processes aligned with epistemic aims). As we have discussed, a reflexive disposition is an epistemic virtue or habit of thinking that may promote epistemic cognition. The 3R-EC framework offers a specific protocol to guide teachers through a specific set of steps that may support epistemic cognition. By explicitly teaching this protocol, teacher educators may provide teachers with a tool for engaging in epistemic cognition across teaching tasks and contexts.

Finally, the recursive and dynamic process of teachers' epistemic cognition described in our model offers multiple entry points to study this process and attempt to affect change. That is, teacher educators may target specific components of the model (e.g., developing epistemic aims or learning about reliable processes) that may help to bring about change in the entire system. However, for instruction to be most effective for long-term sustained change, it is likely that over time multiple components need to be addressed and a disposition toward reflexivity needs to be fostered and supported throughout a teacher's career.

CONCLUSION

In this article, we provided a descriptive model of epistemic cognition in teaching as situated in classroom assessment practices. We proposed that epistemic cognition occurs when teachers actively consider the nature of knowledge to achieve an epistemic aim, through the use of reliable processes and consideration of epistemic matters, which are influenced by their self-system. Therefore, when teachers consider the nature of subject matter content, instructional strategies, and curricular goals to design a classroom assessment event, they are engaging in epistemic cognition. Next, we argued for the use of the 3R-EC framework as a potential protocol to facilitate epistemic cognition in teachers' assessment practices. Our efforts to provide a model describing epistemic cognition in teachers illuminates the complex, interactive nature of this kind of cognition when applied to the profession of teaching, which requires consideration of epistemic issues not only for the teacher's personal learning but also for the learning of others.

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