A Longitudinal Study of Change in Preservice Teachers' Personal Epistemologies

Sue Walker
Queensland University of Technology, sue.walker@qut.edu.au

Jo Brownlee
Queensland University of Technology

Chrystal Whiteford
Queensland University of Technology

Beryl Exely
Queensland University of Technology

Annette Woods
Queensland University of Technology

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S. Walker
J. Brownlee
C. Whiteford
B. Exley
A. Woods
Queensland University of Technology
sue.walker@qut.edu.au

Abstract: There is strong evidence to show that beliefs about knowing and knowledge held by individuals (personal epistemologies) influence preservice teachers' learning strategies and learning outcomes (Muis, 2004). However, we know very little about how preservice teachers' personal epistemologies change as they progress through their teacher education programs. This study investigated changes in personal epistemology and beliefs about learning for a group of preservice teachers as they progressed through the four years of a Bachelor of Education degree. Preservice teachers completed the Epistemological Beliefs Survey (EBS, Kardash & Wood, 2000) when they commenced their course (Time 1) when they were in the 3rd year of their course (Time 2) and then again in the final year of their degree (Time 3). Findings indicated that there were significant changes in preservice teachers' personal epistemologies between course entry and the final year of their course across all but one of the dimensions measured. Results are discussed in terms of the implications for teaching and teacher education.

Introduction

The complexities of the modern world require new ways of thinking about knowledge, knowing and teaching if we are to provide high quality educational experiences for diverse learners. Social constructivist theories in teaching and teacher education advocate pedagogical approaches and strategies that promote deep understanding and higher order thinking (Windschitl, 2002). Within a social constructivist framework, teachers do not merely transmit knowledge to students; rather, they facilitate student learning by supporting students to actively construct knowledge (Brownlee, Schraw & Berthelsen, 2011). However, while it is important that teachers have an understanding of constructivist teaching practices, it is also critical that they have beliefs that support these pedagogical approaches (Brownlee et al., 2011; Windschitl, 2002). Windschitl (2002) refers to a constructivist epistemology which is a necessary prerequisite to being able to think as a constructivist and teach for understanding. Central to this ideal is an understanding of personal epistemology, that is, beliefs about the nature of knowing and knowledge that are held by individuals. Even with the expectation that teachers will support students to construct knowledge, little research has focused upon such beliefs in the preparation of teachers. This study focuses on preservice teachers' personal epistemologies and how these beliefs change with progression through undergraduate teacher education programs.

The term *Personal Epistemology* refers to beliefs held by individuals about the nature

of knowledge and knowing (Hofer, 2010). Generally, it is understood to involve an individual's cognition or thinking about knowing and knowledge (Pintrich, 2002). Although sharing common elements with the term *Epistemological Beliefs*, personal epistemology has an important focus on the individual nature of beliefs (Kitchener, 2002; Sandoval, 2005). Particular paradigms influence views on personal epistemology acquisition. Proponents for the *Epistemological Development* paradigm view personal epistemologies as developing over time (e.g. Belenky, Clinchy, Goldberger & Tarule., 1986; King & Kitchener, 1994; Perry, 1970). That is, individuals move from a simple to a complex evidence-based way of knowing, commonly referred to in the literature as naïve to sophisticated beliefs (Pintrich, 2002). Recently, Kuhn and Weinstock (2002) supported the notion of a developmental trajectory for personal epistemology. Their work suggested that individuals move through categories of personal epistemology, from absolutist, to subjectivist, to evaluativist. Individuals holding *Absolutist* personal epistemologies view knowledge as concrete and unchanging. According to the developmental perspective, over time individuals may develop their beliefs to value personal opinions and view knowledge as tentative and personally constructed, in line with a *Subjectivist* personal epistemology. Finally, individuals may align with an *Evaluativist* personal epistemology, that is, they may view knowledge as constructed and they evaluate information from a range of perspectives.

A second paradigm involving *Epistemological Beliefs* is not aligned with the idea of a developmental trajectory. Researchers in this paradigm view personal epistemology as comprised of independent, multidimensional beliefs which influence learning (Hofer, 2004b). A prominent researcher in this area, Schommer, described personal epistemologies as a set of independent beliefs (Schommer-Aikens, 2004). That is, individuals hold a range of beliefs that may or may not relate to a category of personal epistemology. Comparatively little research has examined personal epistemology and learning in preservice teachers yet such understandings are important for advancing the work of teachers.

Personal Epistemology and Learning

A large body of literature is emerging which suggests preservice teachers' personal epistemology directly influences their learning strategies and outcomes (Muis, 2004). Considering personal epistemologies as a 'filter', the filter type determines the students' experience of learning in their undergraduate course (Many, Howard & Hoge, 2002; Muis, 2004; Peng & Fitzgerald, 2006; Yadav & Koehler, 2007).
Preservice teachers with sophisticated personal epistemologies are likely to have meaningful approaches to learning. These deep approaches to learning reflect what Windschitl (2002) described as strong acts of constructivism where students make links to prior knowledge, connect ideas and evaluate information (Ramsden, 2003 in Thompson, Pilgrim & Oliver, 2005). In support of this notion, Bondy et al. (2007) investigated the relationship between preservice teachers' approaches to learning and personal epistemology. Using data from 14 interviews with preservice teachers, a relationship between personal epistemology and approaches to learning was found. Specifically, preservice teachers with sophisticated personal epistemologies were more likely to be open to multiple perspectives and to make connections between ideas. These results were similar to those of Braten and Stromso (2006). Their research suggested first year Norwegian preservice teachers' personal epistemologies about the speed of knowledge acquisition influenced their capacity to engage in critical thinking. That is, these studies suggest that preservice teachers' personal epistemology directly relates to learning strategies and outcomes.

Personal Epistemologies and Teaching

It is an expectation that teachers will encourage students to become constructors of knowledge. That is, it is expected that students will have the opportunity to acquire sophisticated personal epistemologies. It is of concern, therefore, that more is known about personal epistemologies and learning than about the relationship of personal epistemologies with teaching (Kang, 2008). Recently, however, a body of research has emerged investigating personal epistemologies and teaching.

Cady, Meier and Lubinski (2006) investigated personal epistemologies and teaching practice as preservice maths teachers entered their teaching careers as beginning teachers. They noticed that preservice teachers regressed to traditional teaching beliefs in their first year of teaching, but became more constructivist in nature over time (if they had previously held sophisticated personal epistemologies). The researchers noted that if teachers held objectivist personal epistemologies then they were less able to pay attention to mathematical thinking and were less likely to accept a range of solution strategies or algorithms that were invented by children. The findings indicate that first year teachers may require extra support during this transition phase.

In other research, links between personal epistemologies and practice have been demonstrated in the context of special education. Jordan, Schwartz and McGhie-Richmond (2009) investigated Canadian preservice teachers' personal epistemologies in the context of special education. In particular, they found relationships between personal epistemologies, beliefs about ability/disability and teaching practices. Schwartz (2008 in Jordan, Schwartz & McGhie-Richmond 2009) showed that teachers with more sophisticated beliefs (learning is not quick, knowledge is constructed by taking on others' perspectives) were more likely to use dialogue to promote thinking in children with disabilities, except for students deemed to be at risk. Conversely teachers who held more naïve personal epistemologies (knowledge is absolute and can be passively received) used more teacher-centered, traditional approaches to teaching. In general these studies show that sophisticated personal epistemologies are linked to constructivist teaching practices.

Similar links have been noted in the context of literacy teaching. Yadav and Koehler (2007) found that personal epistemologies were linked to preservice teachers' views about what constitutes effective teaching in literacy. Preservice teachers who believed that learning was innate were more likely to advocate for the teacher modelling of reading followed by children sharing stories with their peers by using the modelled reading strategy. Preservice teachers who did not believe in innate ability were more likely to endorse teaching strategies in which children are encouraged to find answers for themselves and believe that children's errors provide effective learning experiences for literacy learning. If preservice teachers thought that knowledge was simple then they advocated for teaching practices that placed a strong emphasis on behaviour management (e.g., students read aloud together) while those who viewed knowledge as complex were not so concerned with losing control of the class and were more tolerant of students working things out on their own.

Kang (2008) investigated teaching practice and personal epistemologies with 23 science preservice teachers by investigating personal epistemologies, teaching goals and instructional practice. She noted that goals for teaching were related to preservice teachers' personal epistemologies (Kang & Wallace, 2005) and that personal epistemologies were related to their practices in classrooms to achieve these teaching goals. Preservice teachers who held constructivist personal epistemologies also espoused teaching goals that were related to social constructivist teaching in science classrooms.

Changes in preservice teachers' personal epistemology

This body of research provides some evidence that personal epistemologies influence

both learning and teaching in preservice teachers. This provides an important foundation for understanding possible 'filters' that preservice teachers use when engaging in teacher education courses. Of concern, then, is that little is known about preservice teachers' personal epistemologies and change as they progress through teacher education programs.

A few studies have contributed important knowledge to this area of research. Bendixen and Corkhill (in press) used a cross sectional research design to examine personal epistemologies in teachers at various stages of their careers. They investigated personal epistemology in beginning and final year preservice teachers and in beginning and experienced teachers. Results suggested beginning teachers were likely to hold naive beliefs in regards to certainty and simplicity of knowledge compared to experienced teachers. Conversely, they were likely to hold more sophisticated beliefs about innate intelligence when compared to experienced teachers. A longitudinal research design may have captured more in-depth information to inform changes in personal epistemology.

In another study, Brownlee (2003) examined personal epistemological changes in preservice teachers during a one year Graduate Diploma in primary teaching through to their early years of teaching. The sample included 29 preservice teachers who were interviewed at the beginning and end of their teaching course and 11 teachers who were re-interviewed in their third year of teaching. Although results indicated change amongst these participants (seven teachers had more evaluativist personal epistemologies and two regressed) the process of changing beliefs amongst these participants as they progressed through their course was not addressed.

The current study, therefore, will be unique to this field of research. It will be the first study to provide longitudinal data of preservice teachers' personal epistemology changes throughout their preservice teacher education course.

Method

There were two main research questions addressed in this study:
1.   Do changes take place in preservice teachers' personal epistemologies as they progress through their university degrees?
2.   What do students perceive as the reasons for reported changes in personal epistemologies?

Participants and Context

This paper reports on data from Time 1, Time 2 and Time 3 of a longitudinal study examining preservice teachers' beliefs as they complete their university degree. In 2007, 2009 and 2010, students from two teacher education courses at an Australian university were invited to participate in a survey and semi-structured interviews about their beliefs about knowing and learning. Participants were enrolled in either a Bachelor of Education (Primary) or Bachelor of Education (Early Childhood) degree. The Bachelor of Education (Primary) is a four year Education degree preparing preservice teachers to teach children five years to twelve years of age. This preservice cohort is divided across two campuses. The Bachelor of Education (Early Childhood) is a four-year Education degree preparing preservice teachers to teach children from birth to eight years of age. Participation in this research was voluntary, with an option to withdraw at any time without comment or penalty. All participants gave informed consent on participation. Time 1 data ($n = 430$) was collected in 2007 during the opening weeks of the first semester of study. Time 2 data ($n = 242$) was collected in the third year of study, in 2009. The final phase of data collection, Time 3 ($n = 178$), occurred in the

fourth and final year of the undergraduate program, in 2010.

Epistemological Beliefs Survey

Students were invited to complete the EBS (Epistemological Beliefs Survey, Kardash & Wood, 2000). This measure assesses beliefs about the structure of knowledge (integration of knowledge), speed of knowledge acquisition (learning is quick or not at all), knowledge construction (learning takes place through a process of constructing personal meaning), characteristics of student success (e.g., views about innate ability), and attainability of truth (the certainty of knowledge). Responses are scored on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) with higher scores representing more sophisticated beliefs. Factor scores from these items were calculated following Kardash and Wood, providing a summary score on the subscales of Structure (= .76), Speed (= .77), Knowledge Construction (= .64), Success (= .67), and Truth (= .53).

Semi-structured Interviews

After students completed the surveys they were all invited to participate in the follow up interviews. A total of 20 preservice teachers participated in the interviews at each of the three phases. These interviews took between 40 to 60 minutes and were later transcribed verbatim. These scenario based interviews were designed to measure students' personal epistemologies at each of the phases. While the belief changes evident in the interviews are noteworthy and the subject of further analysis (Brownlee et al, in preparation), the focus in the current study is on what preservice teachers perceived as reasons for these changes. To investigate perceptions of changes in beliefs about knowing, preservice teachers were asked if the way they viewed the role of experts in their learning had changed over time and, if so, why these changes might have occurred. They were also asked about the nature of knowledge, for example: "Sometimes people talk about there being 'right answers' or 'truth'. What are your views?'' and if and why these beliefs had changed over time. Finally they were asked to reflect on how they went about learning, if their beliefs had changed and why they thought they had changed. These responses were analysed inductively using thematic analysis. The categories of responses that emerged and exemplars are presented in the Findings section in Table 2.

Findings
Epistemological Beliefs Survey

Comparisons between groups of preservice teachers are made with respect to the factor scores on the EBS. Paired sample t-tests were used to examine differences in scores between each phase of data collection.

Structure of Knowledge

Paired sample t-tests were used to investigate changes in preservice teachers' beliefs about the structure of knowledge from Time 1 to Time 2, from Time 2 to Time 3 and from Time 1 to Time 3. Means and standard deviations are presented in Table 1. Overall results indicated there were significant differences between Time 1 and Time 2, $t(136) = -2.28$, $p = .015$, between Time 2 and Time 3, $t(77) = -2.750$, $p = .007$, and between Time 1 and Time 3, $t(72) = -2.75$, $p = .008$, scores on this subscale. These results indicate that as preservice

teachers progressed through their teacher education degrees they were more likely to believe that knowledge is integrated rather than consisting of a series of facts.

Speed of Knowledge Acquisition

Paired sample t-tests were used to examine changes in preservice teachers' beliefs about the speed of knowledge acquisition from Time 1 to Time 2, from Time 2 to Time 3 and from Time 1 to Time 3. Means and standard deviations are presented in Table 1. Overall results suggested that there were significant differences between Time 1 and Time 2, $t(136) = -4.17$, $p = .000$, and between Time 1 and Time 3, $t(68) = -4.33$, $p = .000$, on this subscale. These results indicate that final year preservice teachers were more likely than first year preservice teachers to believe that learning might take time. There was no significant difference between Time 2 and Time 3 $t(75) = -1.86$, $p = .066$ on this subscale.

Knowledge Construction

Paired sample t-tests were used to examine changes in preservice teachers' beliefs about knowledge construction between Time 1 and Time 2, Time 2 and Time 3 and Time 1 and Time 3. Means and standard deviations are presented in Table 1. There were no significant differences between Time 1 and Time 2, $t(136) = .698$, $p = .49$, Time 2 and Time 3, $t(74) = -1.13$, $p = .262$, or Time 1 and Time 3, $t(71) = -.78$, $p = .438$, on this subscale. This suggests that final year preservice teachers were no more likely than first year preservice teachers to view knowledge as personally constructed.

Characteristics of Student Success

Paired sample t-tests were used to investigate changes in preservice teachers' beliefs about the characteristics of student success between Time 1 and Time 2, between Time 2 and Time 3 and between Time 1 and Time 3. Overall results indicated that, although there were no significant differences between Time 1 and Time 2, $t(138) = -1.06$, $p = .29$, there were significant differences between Time 2 and Time 3, $t(78) = -2.01$, $p = .047$, and between Time 1 and Time 3, $t(70) = -3.01$, $p = .004$. That is, results suggest that as preservice teachers progressed through their undergraduate course, they were more likely to believe that the characteristics of successful students include more than innate ability.

Attainability of Truth

Paired sample t-tests were used to investigate changes in preservice teachers' beliefs about attainability of truth between Time 1 and Time 2, between Time 2 and Time 3 and between Time 1 and Time 3. Means and standard deviations are reported in Table 1. Results indicated that there were significant differences between Time 1 and Time 2, $t(138) = -2.03$, $p = .044$, and between Time 1 and Time 3, $t(71) = -3.43$, $p = .001$, but not between Time 2 and Time 3, $t(77) = -1.01$, $p = .314$. This suggests that fourth year preservice teachers were more likely than first year preservice teachers to believe that knowledge is uncertain.

	Time 1 M (SD)	Time 2 M (SD)	Time 3 M (SD)
Speed	4.02 (.41)$_a$	4.09 (.45)$_b$	4.09 (.5)$_b$
Structure	2.98 (.49)$_a$	2.98 (.5)$_b$	2.94 (.54)$_c$

Construction	3.65 (.38)$_a$	3.67 (.38)$_a$	3.69 (.38)$_a$
Success	3.57 (.56)$_a$	3.6 (.63)$_a$	3.69(.62)$_b$
Truth	3.51 (.66)$_a$	3.54 (.67)$_b$	3.58(.69)$_b$

Table 1. Means and Standard Deviations – EBS Subscales

Note. Means with the same subscript are not significantly different from each other ($p < .05$).

Interview data

Preservice teachers were asked to describe why they thought their beliefs had changed over time. These categories of responses are presented and exemplified in Table 2.

Category of response	Description of category. Students indicated that their ….	Example
Gaining further knowledge (*n*=7)	beliefs had changed because they had increased knowledge	Honestly, experience plus this huge repertoire of knowledge that I have now, in terms of early childhood and that's I've changed my beliefs.
Exposure to university experiences (*n*=4)	beliefs changed because generally they had attended university (no specific reason).	Just being involved in an academic institute, like uni, has changed my opinion.
Developed a deeper understanding (*n*=7)	beliefs changed because they were now able to think deeply about issues and /or were more motivated to learn for understanding.	I guess I've changed my beliefs because I am more able to engage with the experts' opinions. I think I'm interested in what I do. I can see a point to doing all the learning now.
Experiencing contradictions in theories and opinions (*n*=5)	beliefs changed because they had experienced opinions/ theories that were contradictory.	When you start hearing well, there's this method or there's that method, or this theory or that theory, then - and sometimes when they contradict you really have to think about why and which one would you agree with.
Maturation (*n*=4)	beliefs changed due to maturation.	As I've matured and developed through uni and become more aware of different things.
Engaging in reflection (*n*=10)	beliefs changed because they were now more able to reflect on issues and work things out for themselves.	I think just nutting out a few things, and reflecting, and stuff like that has really helped me change and modify beliefs, I guess, yeah.
Practical experiences in the field (*n*=10)	beliefs changed because generally they had attended university.	Experience, like working with kids who - like out at my two different schools. Seeing how things actually play out in the field, when what they say in the text books is completely opposite. So you kind of take it with a grain of salt sometimes, but yeah. I think just a lot of reading and experience. Applying it to the field can really modify what you believe.

Table 2. Students' Reported Reasons for Belief Change

Some responses indicated that participation in University life, experiencing practicum or maturation prompted belief change. However, there are a number of categories of responses which suggest that it is the nature of the learning experiences that has an impact on their beliefs. Engaging in reflection, experiencing contradictions in theories and opinions, developing a deep understanding, and gaining further knowledge are categories which suggest that challenging, meaningful learning experiences seem to have an impact on preservice teachers' personal epistemologies.

Discussion

This is the first longitudinal study of preservice teachers' personal epistemologies spanning the duration of their undergraduate course. Given the clear links between personal epistemology and teaching and learning it is clearly a construct of importance in teacher education. While there has been a range of studies which have suggested that preservice teachers may not hold very sophisticated beliefs (Joram, 2007 in Olafson & Schraw, 2010; White, 2000), our study shows that the preservice teachers' beliefs became more sophisticated over the course of their degree. The results showed that over the course of their degree the preservice teachers were more likely to believe that:

- knowledge is integrated rather than consisting of a series of facts,
- learning might take time,
- characteristics of successful students include more than innate ability, and
- knowledge is uncertain.

These data are encouraging for teacher educators who wish to promote deep approaches to learning in teacher education courses. When personal epistemologies become more sophisticated over the course of a teacher education program, it suggests that preservice teachers are more likely to conceive of learning in a deep-holistic way and engage in meaningful approaches to learning (Muis, 2004). For example, Ravindran, Greene and DeBacker (2005) showed that beliefs in simple knowledge were linked to surface learning (in Fives & Buehl, 2010) and Sinatra and Kadash (2004 in Fives & Buehl, 2010) showed that beliefs about knowledge as integrated and speed of knowledge determined how receptive they were to teaching through persuasion.

The data showed general changes towards more sophisticated personal epistemologies with the exception of the dimension of *Knowledge construction*. Final year preservice teachers were no more likely than first year preservice teachers to view the process of knowing as based on personal construction. This is of interest considering that there were clear shifts in their views about the nature of knowledge (certainty and integration) and learning (learning might take time, characteristics of successful students include more than innate ability). Why were they more likely to change their beliefs about the nature of knowledge rather than the process of knowing? Of interest here is that some dimensions of knowing and learning (e.g., Speed and Truth) showed significant changes early in the course whereas other dimensions (e.g., Speed and Success) did not show significant changes until later. Is this part of a trajectory of beliefs? Might these beliefs change further as they entered the teaching professions? Further longitudinal research is needed to see what changes may or may not take place to this other dimension of personal epistemology.

In terms of teaching, the changes in personal epistemologies demonstrated in these preservice teachers are also encouraging. Research indicates clear links between sophisticated personal epistemologies in preservice teachers and teaching practices which engage children in meaningful learning. For example, Yadav and Koehler's (2007) study showed that preservice teachers who believed that children's learning was innate were more likely to advocate for the teacher modelling of reading followed by children sharing stories

with their peers by using the modelled reading strategy. Those who believed that learning was not innate supported the use of teaching strategies that enabled children to construct their own solutions to literacy problems. Further, more preservice teachers who held strong beliefs in the nature of knowledge as simple (not integrated) tended to have a stronger focus on behaviour management (e.g., students read aloud together) in teaching strategies.

Fives and Buehl (2010) suggest that teachers' beliefs about teaching knowledge may determine how effective teacher education and in-service courses may be. They indicate that: beliefs about the stability or source of knowledge may influence teachers' responses and receptivity to professional development opportunities. Beliefs about the structure of teaching knowledge may effect the extent to which new information is elaborated on and connected to prior knowledge. Beliefs about ability to teach may determine how master teachers, cooperating teachers and administrators respond to student teachers and struggling new teachers (p. 476).

The current research has shown changes have taken place in beliefs about knowing and learning over the teacher education course. It is of interest to note what the preservice teachers perceived to be reasons for these changes. While maturation is perceived to play a role in the development of some preservice teachers' personal epistemologies (n= 4), preservice teachers reported that other factors related to the teacher education course itself caused changes in their beliefs. That is, they commented on how experiences in the practicum (n=10), an increase in general knowledge (n=7) and the university experience in general (n=4) promoted changes in their beliefs. The other reasons for change included engaging in reflection (n=10), experiencing contradictions in theories and opinions (n=5) and engaging in deeper understanding (n=7) and these reasons suggest that the academic requirements of the course may have facilitated the belief change that was noted in the survey data.

The notion of experiencing contradictions in theories and opinions as a reason for belief change is an interesting one. It is supported in recent research into the use of refutational texts. The use of refutational text in higher education is a process by which students are provided with contradictory, evidenced-based information. In a study of German psychology and teacher education students (Kienhues, Bromme & Stahl, 2008), students were randomly assigned to one of two groups. The first group experienced a refutational text intervention in which they were introduced to two texts. The first text described how DNA fingerprinting was effective while the other text provided contradictory information about the success of DNA testing. The second group of students experienced a non-challenging text intervention. These students were only presented with some uncontested facts about DNA fingerprinting. Students who held naïve personal epistemologies and experienced the refutational text became more sophisticated in their beliefs about the complexity and stability of knowledge. Gill, Ashton and Algina (2004) found similar results with a group of 161 preservice teachers. They also randomly allocated students to an augmented activation/ refutational text or an expository text intervention. Augmented activation is a process of providing students with preliminary information that prepares them for the possibility of conflicting text and to focus on any ideas that they might disagree with. The students in the expository, traditional text group did not experience the same degree of change in personal epistemologies as was experienced in the augmented activation/ refutational text group. It is clear that even short-term interventions which focus on contradictory texts and critical thinking can influence changes in personal epistemologies.

Personal epistemologies may also be influenced by promoting explicit reflection on the process of critical thinking (Valanides & Angeli, 2005). One group of preservice teachers participated in an *Infusion* intervention. They were required to discuss a text, write an overview for a paper on the topic, reflect on their thinking about the issue, attend a short lecture, and participate in a conversation with the researcher about their topic. The other group, who experienced less change in their personal epistemologies simply attended lectures on the topic and participated in a discussion of an article as preparation for writing a paper.

These studies show that a focus on critical thinking and the processes of critical thinking can have an impact on changing personal epistemologies.

The study presented here has provided evidence that preservice teachers' personal epistemologies changed through the course of their preservice teacher education courses. It has also reported on why preservice teachers perceived these changes had taken place. These reported reasons for change are important for understanding how we, as teacher educators, might promote further changes in personal epistemology. Teacher education needs to support changes towards more sophisticated personal epistemologies in order to promote meaningful approaches to learning in preservice teachers and to facilitate approaches to teaching which can help children to learn in meaningful ways.

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