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Using the Conceptual Change Model of Learning as an Analytic Tool in Researching Teacher Preparation for Student Diversity

Douglas B. Larkin, Montclair State University

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Using the Conceptual Change Model of Learning as an Analytic Tool in Researching Teacher Preparation for Student Diversity

Dr. Douglas Larkin  
Department of Curriculum and Teaching  
Montclair State University  
Montclair, NJ 07043  
(609) 575-5093

Please address all correspondence to:  
Email: larkind@mail.montclair.edu
Conceptual change theory has enjoyed remarkable success in science education both as a framework for understanding student science learning and as a guide for designing approaches to teaching science, but has less frequently been deployed to examine issues in teacher learning. In this article, I argue that drawing upon the conceptual change model as commonly applied to teaching and learning in science classrooms (Hewson, Beeth, & Thorley, 1998) is an appropriate and valuable framework for understanding how teachers change their ideas about the pedagogical implications of student diversity (Paine, 1990). Although this work draws upon two data sources for evidentiary support, this paper is primarily conceptual in nature and is intended to promote a particular theoretical approach to studying teacher education for student diversity.

In the first half of the paper, I review the literature and provide a justification for the argument that employing a theory of conceptual change in teacher education for diversity appropriately addresses current shortcomings in the field. I begin by defining the manner in which I use the terms diversity and conception. Second, I examine the literature on preparing teachers for diverse classrooms and draw attention to the atheoretical nature of current teacher preparation efforts in reference to how prospective teachers learn the pedagogical implications of student diversity. Third, I present and contrast two traditions of research in conceptual change. I then introduce the primary
features of the conceptual change model from the field of science education and describe how this approach is commonly used in a science education context.

The second half of the paper offers examples of how the conceptual change model may be deployed for analytical purposes. The research of Hewson and Lemberger (2000) is presented to show how this model has been used as an analytic tool for understanding learning in a science classroom. I then deploy this same conceptual change model to analyze two very different accounts of teacher learning. The first consists of a text content analysis (Bazerman, 2006) of the opening to Vivian Paley’s (1989) book, “White Teacher.” In the second, I draw upon data from an empirical qualitative study (Larkin, 2010) to examine the experiences of a pre-service biology teacher over a period of one semester of full-time student teaching. I then compare and contrast the findings of these cases through the lens of conceptual change. I conclude the paper with a discussion on the conceptual change model as a theoretical framework with explanatory power, and outline the implications such a view has for teacher education.

**Defining terms**

A definition of diversity needs to encompass a range of categorical differences and include—without being limited to—dimensions such as race, socioeconomic class, culture, ethnicity, ability/disability, gender, sexuality, and language. It must also attend to the important and often multiple intersections between these dimensions. For the purposes of this paper, I have chosen to focus primarily on diversity in terms of race, though I assert that the theoretical approach that I advocate here may be employed to examine other dimensions of diversity as well.
In a large-scale national study concerning preservice teacher thinking, Paine (1989) describes four orientations toward diversity: individual, categorical, contextual and pedagogical. Someone with an individual orientation regards diversity as individual difference and does not consider the ways in which social categories might influence this difference. In this view, diversity is seen largely as biological or psychological. Both the sources of and solutions to problems can be located at the level of the individual.

Identifying patterns among individuals produces to an orientation towards categorical difference, where categories such as race, gender, or social class are noted and considered in problem solving. In this view, the construction of the categories themselves and the causes of difference are not considered by the individual. In the contextual difference orientation, the categorical differences are understood to exist because of social context factors. Finally, the pedagogical perspective toward difference attends to the implications of contextual differences on teaching and learning. It is with the development of this particular perspective in preservice teachers that my argument is concerned.

It is important to carefully attend to language in order to ensure that the term diversity is not constructed to be in opposition to an idealized norm. In biology, the word evolution is often mistakenly applied to individuals, when its proper usage should only be in reference to groups or populations. Similarly, the term “culturally diverse” has been applied to individual students, when the term only makes proper sense referring to the fact that multiple cultures may be represented within a given group of students, or in the case of classrooms or schools, a shared social space. Nevertheless, much of the literature refers to the preparation of teachers for “culturally diverse students;” a slippery linguistic

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1 “Individuals develop, but populations evolve. It is this fundamental insight which distinguishes modern evolutionary thought from pre-Darwinian conceptions of evolution, which were developmental in character” (Hahlweg & Hooker, 1989, p. 79).
construction in which it is all too easy for the “s” to be dropped from this inherently plural term. While not quite the proxy for race and class that “at-risk” has become (Ladson-Billings, 1999; Swadener & Lubeck, 1995), I am consciously choosing to use words such as “diversity” and “culturally diverse” in ways that do not function as code for “non-White, non-middle class” students, but refer rather to groups that are genuinely and categorically heterogeneous.

I define beliefs by referring to the synthesis by Pajares (1992) that has become a common standard in the field of education research by situating this definition alongside the meaning of a conception drawn from the conceptual change literature (Hewson et al., 1998; Posner, Strike, Hewson, & Gertzog, 1982). Pajares cautions that beliefs are not easily measured and, “must be inferred from what people say, intend, and do” (p. 314), and proposes that a belief is a view “that speaks to an individual’s judgment of the truth or falsity of a proposition” (p. 316). In this way it is similar to the definition of conception as described in the conceptual change literature. A conception in this tradition is a concept (or more commonly, an idea) that plays an organizational or generative role in cognition (Strike & Posner, 1992). While it may be noted that in this construction, a conception may have broader explanatory power and a firmer basis in some sort of phenomenological evidence than a belief, for purposes here, these two words shall be used interchangeably.

It is important to distinguish that the conceptions under discussion in this study are more than just altered beliefs, such as learning that the weather has recently changed. Strike and Posner (1992) note, “conceptual change concerns the alteration of conceptions that are in some way central and organizing in thought and learning” (p. 148). The
importance of these organizing conceptions in learning has been emphasized in recent research on how individuals construct new knowledge (Bransford, Brown, & Cocking, 1999). Preservice teachers’ conceptions about the pedagogical implications of student diversity certainly serve this knowledge-organizing function, and conceptual change in this domain would seem likely to lead to professional growth in practices that improve student learning outcomes.

**Theoretical weaknesses in current efforts to prepare teachers for diverse classrooms**

In regard to preparing prospective teachers for diverse classrooms, the agenda for teacher education research has been primarily concerned with identifying desired outcomes and promising strategies, with good reason. Scholarship in multicultural education (Banks, 1995; Gay, 2000; Irvine & AACTE, 1997; Ladson-Billings, 1995) has been crucial for identifying the knowledge, skills, and attitudes needed by teachers to respond to student diversity in a morally and educationally sound manner. Less attention, however, has been paid to the theoretical mechanisms by which preservice and in-service teachers are presumed to change their minds about the meaning of diversity in their classrooms. What research exists has disproportionately focused on the needs of White teachers (Cochran-Smith, 2000; Sleeter, 2001), though perhaps also with good reason given the demographics of the current teaching force (Irvine, 2003; Ladson-Billings, 2005).
Calls for research in how teacher thinking develops in regards to understanding student diversity are not new. Nearly two decades ago, Grant and Secada (1990) highlighted the need for such research:

A basic tenet of education is that instruction should follow development. Yet we have no maps of how teacher cognitions, beliefs and skills with respect to the teaching of diverse student populations actually develop. We do not know what a beginning teacher really knows versus what successful, experienced, colleagues might know about the teaching of diverse student populations. If we could map how teachers move from the former to the latter, we might be able to plan teacher education programs to help teachers better develop these skills. (p. 419)

Other teacher education researchers have also highlighted the need to better understand the processes by which prospective teachers are effectively prepared to work with diverse student populations (Cochran-Smith, Davis, & Fries, 2004; Hollins & Guzman, 2005; Villegas & Lucas, 2002b; Zeichner, 1996).

Clearly, research on teacher preparation for diversity is enjoying an unparalleled period of vibrancy. Even without the maps called for by Grant and Secada (1990), the teacher education literature is now brimming with valuable examples of culturally relevant or responsive teaching (e.g. Gay, 2002; Ladson-Billings, 1994; Zeichner, 1996), and descriptions of teacher education curricula for preparing learners in diverse classrooms (e.g. Banks et al., 2005; Cochran-Smith et al., 2004; Villegas & Lucas, 2002a). Current definitions of student diversity routinely include references to students with special needs, English language learners, as well as gay, lesbian, bisexual, and transgender students (Grant & Gillette, 2006). There is also a growing literature on teacher learning more generally (Feiman-Nemser, 2001; Hammerness et al., 2005), which informs the design of preparation programs by emphasizing promising practices for strengthening teacher education. Other research has examined and described teacher
education programs that claim a social justice orientation (McDonald & Zeichner, 2009) or teaching for diversity focus (Irvine, 2003; Ladson-Billings, 2001). Yet nearly all of this literature is silent concerning the theoretical mechanisms that are powerful enough to explain and predict how individuals learn to teach for diversity.

The perception of teacher education as a “weak intervention,” (Richardson, 1996; Zeichner & Gore, 1990) in efforts to prepare teachers for diversity also points to the need for a stronger theoretical basis for how individuals develop pedagogical orientations to student diversity. In teacher education, many of the approaches to the in-service and pre-service preparation of teachers intended to explore issues of student diversity (racial autobiographies, cross-cultural tutoring experiences, single-group studies, etc.) are employed because of perceived success empirically, and are only loosely anchored in theoretical understandings about how people learn. Though often supported by programmatic social structures with a strong theoretical basis (e.g. communities of practice, program coherence), the justification for these approaches at the level of the individual appears to be rooted primarily in cognitive dissonance models of psychology (Festinger, 1957). These models operate from the assumption that people are sensitive to inconsistencies between actions and beliefs, and posit that individuals work to resolve this dissonance by modifying their beliefs, actions, or perceptions of actions. A smaller group of studies (Chubbuck, 2004; 2009; Gomez, Black, & Allen, 2007) employ frameworks for learning the pedagogical implications of diversity that appeal to identity development models to adequately explain the data, but these appear to have little predictive power or pragmatic utility for teacher educators.
Other efforts in teacher education for diversity often rely on similar descriptions and models of racial identity (e.g. Helms, 1990; Sleeter, 1993; Tatum, 2003), and emphasize how such models might influence teacher education and professional development (McAllister & Irvine, 2000; Singleton & Linton, 2006). Teacher education is well-served by these models, because they help to describe where individuals are and where we wish them to be in their understandings about the various dimensions of categorical and contextual diversity.

I contend however that much of this work is atheoretical in regard to how individuals change their conceptions regarding the pedagogical implications of student diversity. This body of scholarship is emphatic about the need for preservice and in-service teachers to change their conceptions about cultural diversity, but many of the conclusions and calls for action are drawn from what would be called empirical generalizations in the scientific disciplines (Conant, 1951). That is, they are suggestions based upon observations of what seems to work in practice, and are less embedded in theories about how individuals learn.

**Competing traditions of conceptual change theory**

To address the above critique, this article presents the argument that that conceptual change theory offers an appropriate mechanism for understanding teacher learning in regard to diversity. In order to make this theoretical claim, it is necessary to first address the different approaches to theories about conceptual change in the literature, and I do so here by examining two traditions of conceptual change research: the first is
located within the field of science education, and the second represents a tradition represented by work in the field of educational psychology.

Within science education there is a strong tradition of viewing learning as a process of conceptual change (Anderson, 2007), with roots in an influential model of conceptual change learning (Posner et al., 1982) that draws upon Piagetan developmental psychology and the history and philosophy of science. Within this tradition, attention is paid primarily to the conceptions themselves, as well as the justifications learners offer for holding on to them. More on this will be said below.

Sinatra (2005) notes that within this tradition, three particular strands of work have been prominent: identifying the ways in which learners’ prior knowledge is represented, examining knowledge restructuring from a developmental perspective, and instructional strategies for promoting conceptual change. All three of these lines of research continue to enjoy a robust existence. The first is well-represented by the “Students' and Teachers' Conceptions and Science Education” bibliography compiled and maintained by Reinders Duit (2009) that now contains over 8000 research studies and as a program of research shows little sign of declining interest. The second strand has dovetailed nicely with the rise of learning progressions as a generative field of research in science education (e.g. Anderson, 2007; Berland & McNeill, 2010; Duncan & Hmelo-Silver, 2009). The third has become productively embedded within the renewed attention toward assessment in science education, and fits well with strategies that emphasize the “assessment for learning” approach advocated by Black and Wiliam (1998) and is evidenced by a well-received set of practitioner publications (e.g. Keeley, Eberle, &
Farrin, 2005) and continued attention to strategies for teaching for conceptual change (Duit & Treagust, 2003; Scott, Asoko, & Leach, 2007).

However, another tradition of research within the field of educational psychology has made valuable contributions towards understanding the processes of conceptual change, and has developed largely outside of the above lines of work in science education. Initiated by a revised model of conceptual change offered by some of the original model’s proponents (Strike & Posner, 1992) and followed by a landmark review of the affective influences on conceptual change (Pintrich, Marx, & Boyle, 1993), this perspective on conceptual change criticized the conceptual change models from science education as overly-rational and “cold,” because they did not attend to motivational factors such as goal-setting, interest, self-efficacy and control beliefs related to learning. Initiating a flurry of studies in the following decade, this tradition of conceptual change research sought to link affective factors in the form of carefully crafted psychological constructs to conceptual change, and has become a remarkably generative topic of research in educational psychology in its own right (Sinatra & Pintrich, 2003; Vosniadou, 2008). In comparison with the science education tradition of conceptual change research, the actual composition of the conceptions were considered of less interest than the cognitive processes by which the change occurred.

Consequently, the revised models of conceptual change have grown larger, ever-more complex, and in light of the earlier criticism, “warmer” (Sinatra, 2005). These revised models often include affective factors along with attention to epistemological beliefs (Andre & Windschitl, 2003; Mason, 2002), as well as social and contextual aspects of learning (Dole & Sinatra, 1998; Gregoire, 2003). The critique by Gregoire
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(2003) that the cognitive mechanisms for change remain unidentified in the original conceptual change model is valid if one is referring to cognitive mechanisms described within the educational psychology tradition of conceptual change. As detailed below, the mechanisms for change in the science education tradition are largely conceptual, and primarily concern the status with which conceptions are held. Such a situation does not prevent the theory from having utilitarian value as an analytical or pedagogical tool.

The question of whether these new models themselves exemplify either a modification or an overturning of the original model of conceptual change fittingly echoes the Piagetan distinction between assimilation and accommodation. To resolve this question is beyond the scope of this article, but it is likely the answer concerns the use to which such theoretical models are eventually put. I suggest that the original model of conceptual change learning described by Posner et al (1982) and explicated by Hewson et al (1998) still works rather well in helping to understand the processes by which individuals choose between competing conceptions, much in the same way that Newtonian mechanics still works quite well for objects traveling well below the speed of light despite the more correct and comprehensive predictions of relativistic calculations.

The proposal by Strike and Posner (1992) to expand what factors get considered as part of the influence on the conceptual change process is a reasonable one, and ought to include an accounting of the degree to which the change is “hot” or “cold.” As detailed below in the discussion of Gregoire’s (2003) model, one way of doing this is to ascertain the extent to which a new idea “implicates self,” (p. 164).

Such an expansion conveniently reflects a similar synthesis within theories about learning to teach that include aspects of learning communities, identity development,
situated cognition, and developmental progression models (Hammerness et al., 2005; Putnam & Borko, 2000; Wideen, Mayer-Smith, & Moon, 1998). Yet before venturing further to explore the relationship between teacher learning and conceptual change, it is necessary to describe the features of the conceptual change model and portray its operation as an analytic tool for understanding learning.

**Features of the Conceptual Change Model**

The conceptual change model under consideration here, often referred to as the “CCM” in the literature (e.g. Gregoire, 2003), offers both explanatory and predictive power in regard to learning. For the purposes of this article, the concepts of *status* and *conceptual ecology* are of greatest interest. *Status* refers to how strongly a person knows an idea and accepts it to be true, and this construct has been referred to as the “hallmark for conceptual change learning,” (Hewson & Lemberger, 2000); while the notion of a *conceptual ecology* underscores the need to think of all the knowledge a person has as linked in some way.

The status of a particular idea held by an individual can be described by three related measures, and here I use the terminology of *intelligibility, plausibility, and fruitfulness*, introduced by Posner et al. (1982). An idea is intelligible if the learner can understand it, even if one does not agree with it or believe it. An idea is plausible if it seems likely to be true, or is at least consistent with what one already knows. An idea is fruitful if it seems to have broad explanatory power. For any given individual, an idea must first be intelligible before it can be considered to be plausible or fruitful. Generally, ideas must also be plausible to an individual before they can be considered to be fruitful,
but there are cases such as quantum mechanics, where the broad explanatory power of an idea can be appreciated before its plausibility is accepted (P. Hewson, 2010, personal communication).

In this model, conceptual change is considered to take place if the status of an idea changes, such as in the case of the status of a new conception becoming greater than a previous one. The lowering of a conception’s status may also occur if new evidence creates dissatisfaction with a current conception, though it is common for evidence to be dismissed or conceptions to be modified slightly in order to maintain a conceptual status quo, or what might be considered a conceptual ecology in equilibrium.

In science classrooms where there is teaching for conceptual change, science ideas are introduced as ideas that compete for status with those already held by the learner. The aim of the teacher in such a class is to provide students with the opportunity to compare their own conceptions with these accepted science ideas in such a way that students find the science ideas more intelligible, plausible, or fruitful than competing explanations. That is, the goal is for students to judge scientific conceptions as having a higher status. While perhaps it is not always this straightforward in practice, this conceptual change model draws attention to the metacognitive nature of this process, and emphasizes the necessity for learners to evaluate competing ideas in order to determine and offer a justification for which has higher status (Hewson et al., 1998). Such a model is fully compatible with constructivist theories of learning.

There are a number of studies that detail what teaching for conceptual change in science looks like in the classroom. For example, Minstrell (1982) describes a method for teaching the “at rest” condition of an object in which he begins by explicitly eliciting
students’ ideas about motion and equilibrium. Then, presenting a science idea as a candidate for comparison, he offers learning experiences with which they may evaluate the status of those ideas. Hewson and Hewson (1988) first showed that learning gains were evident in a science classroom using a conceptual change approach to teaching. Many subsequent studies indicate that teaching for conceptual change, whether explicitly using status language or not, is effective in realizing students learning gains (see for example, Abd-El-Khalick & Akerson, 2004; Duit & Treagust, 2003; Watson & Konicek, 1990).

**Conceptual change as a theory for understanding teacher learning**

Dewey (1904/2008) understood the importance of focusing on what he termed the “mental movement” of the student, and it is illuminating to read his words today with teachers in diverse classrooms in mind:

> Only by beginning with the values and laws contained in the student's own experience of his own mental growth, and by proceeding gradually to facts connected with other persons of whom he can know little; and by proceeding still more gradually to the attempt actually to influence the mental operations of others, can educational theory be made most effective. Only in this way can the most essential trait of the mental habit of the teacher be secured — that habit which looks upon the internal, not upon the external; which sees that the important function of the teacher is direction of the mental movement of the student, and that the mental movement must be known before it can be directed. (p. 793, 2008)

Making room for the “values and laws” of student experience is no easy job for new teachers, and is an added challenge in classrooms where not all meanings are shared. Yet, the significant long-term impact of one’s initial experiences as a classroom teacher give this task even greater urgency during teacher preparation, as teacher educators seek to begin with the “values and laws” within the experiences of prospective teachers.
The question of what teachers should know about their students, about particular racial, ethnic, and cultural groups, and their orientation towards positive social change has been a prominent theme in the multicultural education literature of the last few decades (Cochran-Smith et al., 2004; Grant, Elsbree, & Fondrie, 2004). Anti-racist and anti-discrimination efforts within the field of multicultural education have targeted individuals, institutions, and social structures with similar fervor. For good reason, multicultural education research has long been concerned with outcomes.

Yet throughout the history of multicultural education, change at the unit of the individual has been viewed as somewhat idiosyncratic and driven by cognitive conflict, an explanatory framework that fails as often as it succeeds. Furthermore, the current discourse in teacher education for diversity includes the enigmatic construct of “dispositions” as difficult-to-detect belief patterns that are often resistant to external efforts to change them (e.g. Villegas, 2007). It is time for multicultural education, particularly in the preparation of teachers for diverse classrooms, to be offered some useful theoretical mechanism for changing people’s minds that can be leveraged into existing programs. I believe that the theory of conceptual change is as likely a candidate as can be found.

The notion that conceptual change theory could be used to inform teacher learning was suggested by Hewson (1992) and served as the underpinning for a program of research concerning new and experienced teachers’ conceptions of teaching science (Hewson & Hewson, 1988; Hewson & Hewson, 1989; Hewson, Kerby, & Cook, 1995; Hewson, Tabachnick, Zeichner, & Lemberger, 1999; John Lemberger, Hewson, & Park, 1999). Much this research was dedicated towards the construction of analytical tools and
methodological approaches for studying the conceptions held by teachers. One large scale NSF-funded study within this program of research at the University of Wisconsin-Madison (Hewson, Tabachnick, Zeichner, Blomker, et al., 1999) examined changes in prospective biology teachers’ conceptions about their subject matter as well as their conceptions about teaching, with a focus primarily on the epistemological commitments and subject matter knowledge of the participants. Both the Wisconsin study and a similar study at Monash University in Australia (Gunstone, Slattery, Baird, & Northfield, 1993) found that many of the preservice teachers’ conceptions about teaching were quite resistant to change.

Others have also offered conceptual change approaches to understanding teacher learning in regard to understanding the nature of science (Abd-El-Khalick & Akerson, 2004), developing pedagogical content knowledge in science (Crawford, Zembal-Saul, Munford, & Friedrichsen, 2005; Dana, McLoughlin, & Freeman, 1998; Dhindsa & Anderson, 2004; Stofflett, 1994), analyzing teacher decision-making (Feldman, 2000), and professional development (Bell & Gilbert, 1996; Loucks-Horsley, Hewson, Love, & Stiles, 1998).

Beyond the boundaries of science teacher learning, conceptual change theories have been deployed to analyze teacher learning across the professional continuum, though not always in terms of frameworks provided by the models of conceptual change discussed above (e.g. Alger, 2009; Chapman & Heater, 2010; Smagorinsky, Cook, & Johnson, 2003). However, the work of Gregoire (2003) and Dooley (2008) in particular are valuable to discuss here because of their contributions to studying teacher learning for student diversity.
Gregoire (2003) provides a useful review of five theories of belief change, including the conceptual change model described above (Posner et al., 1982) and proposes the Cognitive-Affective Model of Conceptual Change (CAMCC) that draws upon the strengths of each of these theories. While the CAMCC is designed to account for how teachers interpret and deal with reform messages for teaching, one useful feature of this model that is relevant to the present discussion is an assessment by the individual as to whether or not the received reform message “implicates self,” (p. 164). Gregoire proposes that the answer to this question determines the extent to which the message undergoes cognitive processing. While empirical support for this claim is limited to messages of reform explicitly presented to teachers (e.g. Ebert & Crippen, 2010), the broader notion of identifying the target of a conception (self, school, students, etc) is a useful one because it serves to clarify an important feature of the way in which the conception is held, and I have chosen to incorporate this into the analyses below.

In the only other study that explicitly connects teacher learning for student diversity and conceptual change theory, Dooley (2008) uses the notion of “microtransformations” from Alexander (1998) to describe the changes that occur for teachers over the duration of a methods course in multicultural literacy teacher education. The literature on teacher education for diversity is cautious about claims for significant short term change as a result of a single course (Hollins & Guzman, 2005) and Dooley is similarly careful to bound claims of conceptual change to almost definitional ones. While it might be a stretch to characterize these microtransformations as true conceptual change as defined in the literature, Dooley’s portrayal of changes is quite consistent with notions of the changes in status of particular conceptions.
From this review, three themes emerge that ought to inform research on conceptual change in teacher learning. Firstly, many studies tend to conflate the conceptual change of individuals with those of groups. I contend that in order to be useful, studies of conceptual change need to use the thinking of individuals as the unit of analysis. Secondly, researchers ought to be able to examine conceptual change that happens in a manner that may not be consistent with the intended outcomes of a teacher education program. Understanding all conceptual change, not just change in preferred directions or from particular messages, ought to be the goal of conceptual change research in regard to teacher learning. Third, the parameters of what is considered conceptual change are not always specified or defined. Simplistic proxies for conceptual change, particularly pertaining to issues of diversity, are questionable given the weight of research that suggests such concepts are deeply resistant to change (Hollins & Guzman, 2005). Claims regarding short-term interventions producing conceptual change must be treated skeptically, and require multiple sources of evidence to confirm that shifts in thinking have actually occurred.

**Deploying the conceptual change model as an analytic tool in science education research**

Hewson and Lemberger (2000; J. Lemberger, 1995) analyzed student discussions in a high school genetics class, illustrating the changes in status that occurred as a group of students considered various ideas in an attempt to develop a model of inheritance among fruit flies in a computer simulation. Using a set of status analysis categories drawn from the work of Thorley (1990), they identified changes in the intelligibility,
plausibility, and fruitfulness of student conceptions. They also noted that the status of an idea was sometimes lowered without necessarily being exchanged for another conception. In one case, models of inheritance previously learned by the students could not explain a crossing of two fruit flies that generated four wing shape variations. Hewson and Lemberger describe the change of the idea’s status in the following manner; “The lack of power in their conception demonstrated its lack of fruitfulness; this created dissatisfaction and the need to look for a different solution,” (p. 116). In the status analysis category, this was represented as (–POWER), with the minus sign indicating the lowered status of this conception. An abbreviated version of Hewson and Lemberger’s status analysis categories is shown below in Table 1.

As a result, a clear understanding of how the status of students’ ideas changed over time emerged for the researchers, and by the end of the unit the students had developed a model of inheritance quite consistent with scientific models. More importantly, they engaged in a process of sifting through ideas in a way that allowed them to choose explanations that offered the greatest explanatory power. The role of the teacher, in addition to planning the curriculum, was to facilitate this choice-making process as students thought through their ideas, as well as to offer new ideas for consideration. For example, the teacher suggested both the concept of multiple alleles and an accompanying triangular representational tool to the students. In this class, confirmation of a model’s correctness lay in its explanatory power for students, and the intellectual work of the class is one of continual model-refinement, a practice at the heart of current science education reforms (Duschl & Grandy, 2008; Windschitl, Thompson, & Braaten, 2008). This approach contrasts with those found in many other science classes,
in which the end goal of certain activities is simply the confirmation of disciplinary knowledge (Windschitl, 2003).

There are a few notable features of the above example that are important to consider before deploying the conceptual change model for other purposes. The first relates to the grain size of the analysis. The descriptions of the genetics students’ conversations clearly capture their tentative concepts about fruit fly inheritance, and there is reliable evidence to establish when and why these concepts change. This highlights the fact that conceptual change operates at the level of the individual (though it may certainly be facilitated by social interactions), and that this particular model is not intended to analyze large groups of learners as a whole. The second is that by using a computer simulation, students were able to test their ideas rather easily. In a sense, they were able to gather evidence about the consequences of their conceptions. Given that the students were working toward the goal of constructing a model for their data, seeing these consequences gave students the impetus to change their ideas when the results were unsatisfactory. One last feature of the genetics activity was the general absence of concepts that were personally threatening. While students may have hesitated to put forward an idea out of fear that they might be personally ridiculed (this did not appear to be the case at all in this genetics class), the idea itself that a gene may have three or four alleles would seem to have no effect on a people’s conceptions about themselves, their families, their culture, or their worldview. Though the same cannot be said for learning to teach for diversity, the conceptual change model is still a valuable tool for studying teacher learning, as I demonstrate below.
Adapting the conceptual change model as a tool for the study of teacher learning

Within the well-established literature on teaching and learning are many examples describing individuals who have come to understand the pedagogical implications of student diversity resulting from their own education as a teacher (e.g. Brown, 2004; Cochrans-Smith, 2004; Landsman, 2008; Nieto, 1999; Ross & Smith, 1992; Stalvey, 1989). In order to examine whether the conceptual change model of learning in science is applicable in this aspect of learning to teach, one would need an account of a teacher’s development that offers a window into how a particular teacher’s ideas about teaching have changed over time. It would also be necessary that the language of this account offer insights as to the status of individual conceptions at various points in time.

Two such accounts are now presented for consideration. The first is drawn from Vivian Paley’s (1989) book, “White Teacher,” which I have chosen for analysis here because of its familiarity to many teacher educators. I focus on Paley’s reflections concerning changes in her teaching practice to illustrate how the conceptual change model is useful in understanding this type of learning. The second source is drawn from a longitudinal multiple case study about preservice teacher learning in regard to the pedagogical implications of student diversity (Larkin, 2010). The case of Tyler, a prospective biology and physics teacher, is examined to show how the theory of conceptual change can be deployed to understand the changes in his thinking during the course of his program. While any of the cases from the larger study could have been chosen for this analysis, I selected the case of Tyler because in many respects, he and Paley began in a similar place in terms of their conceptions regarding student diversity.
In the genetics classroom described above, it was obvious that a model of inheritance was always the target of the conception. In Paley’s and Tyler’s accounts below however, determining the target of a conception was not always so straightforward. Quite often, a conception is related to knowledge about oneself as a teacher, though it may also concern the school, students, parents, learning, culture, society in general, or any combination of these. It is also the case that sometimes a change of status in one idea affects the status of others, shaking the whole interconnected web of a teacher’s conceptual ecology.

Case #1: A text content analysis of conceptual change in teacher learning

Vivian Paley’s (1989) reflective account of changes in her practice as a teacher is useful in illustrating how the conceptual change model helps understand how her knowledge about teaching in diverse classrooms developed with time. For the purposes of this analysis, I subjected the preface and first two chapters of the book to a text content analysis (Bazerman, 2006), in which I sought to categorize the status of Paley’s conceptions about the pedagogical implication of student diversity as expressed in her writing as either intelligible, plausible, or fruitful. I also examined the text closely for descriptions of dissatisfaction with or changes in a particular idea regarding the pedagogical implications of student diversity. Paley’s conceptions are stated throughout the text both implicitly and explicitly, and I used the context of the narrative, as well as the statements themselves, in order to identify and describe instances of status change. For clarity, I have changed Hewson and Lemberger’s (2000), notation slightly. . In their work, a plus (+) sign indicated an increase in the status of a tentative conception, and a
minus (−) sign represented a decrease. I have changed the notation of these signs to up and down arrows to better indicate elevation or decline of a given conception’s status, taking advantage of a vertical spatial metaphor to aid understanding (Lakoff & Johnson, 1980).

In describing some of the changes she experienced as a teacher, a common thread that winds through her narrative is one of Paley continually refining the way she views “difference” in her classroom. Early in her career, she did not know how to value or even talk about anything that was “different” about a student, and held the belief that all children should be treated the same way. Over time however, her experiences with parents, students, and other teachers led her to find dissatisfaction with these conceptions.

Table 2 illustrates the change in status of Paley’s ideas that occurred over time about teaching her culturally diverse class of students. Paley’s greatest changes in this account relate to her ability to notice and acknowledge the pedagogical implications of student diversity in her classroom. After a particularly frank conference with an African American parent, she began to change her self-image as a person who was “enlightened” about issues of race, and was able to recognize the fact that she ignored student difference. Only then did she observe her own difficulty in mentioning race, and subsequently identify her differential expectations between White and Black students. During all of these changes, the notion that she treated all students the same became less and less plausible.

Paley’s process of learning how to teach in diverse classrooms may be viewed though the lens of the conceptual change model, and the role played by the status elements in this analysis is crucial. At the outset of her account, Paley thought that she
was quite enlightened about issues of race. This idea was quite plausible to her, and was consistent with other parts of her conceptual ecology that included both her personal and professional identity. Had someone pointed out to her at that time that she was unable to mention color in this classroom, she likely would have dismissed it out of hand. Such an idea would not have made sense to her then; it would not have been intelligible.

Only after Paley’s conception of herself as enlightened about issues of race became less plausible, did the fact of her inability to mention color in class become intelligible. Understanding this idea was Paley’s key to opening a different collection of ideas about recognizing color as a positive and interesting difference. One main lesson to take away from this analysis is that conceptual change is a complex and multi-step process that requires not only the dissatisfaction with a current conception, but the presence of an alternate conception that is both intelligible and plausible to the learner. In this respect, the example here from Paley’s narrative is entirely consistent with the conceptual change model of learning as commonly articulated in the field of science education.

Case #2: Analysis of conceptual change in empirical data from a study of teacher learning

As one might expect, Paley’s account of her own learning is quite linear, and having had the benefit of hindsight she is able to construct an appealing narrative structure for writer and reader alike. The case of Tyler, originating in an empirical qualitative study of

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2 All names of individuals and institutions in this section are pseudonyms.
learning to teach, is not privileged in this way and is certainly less tidy as a result. Tyler’s case is instructive however, in terms of understanding how the conceptual change model can be deployed in a different situation toward the goal of understanding how and why teachers’ ideas regarding student diversity change with experience.

Tyler, a White male in his early twenties, was a student teacher during the time he participated in a research study investigating teacher learning for student diversity (Larkin, 2010). He was enrolled in a teacher preparation program in a mid-sized public university in the midwest of the United States, and was seeking certification in both biology and physics. The study in which he participated did not attempt to intervene in his teacher preparation program in any way. His student teaching placement was in a large urban school where the student population was identified in state reporting documents at the time as 55% White, 23% Black, 11% Asian, 10% Hispanic, and 1% American Indian. The students in the biology classes in which Tyler had been placed for student teaching generally reflected this demographic profile. The data below was obtained mostly from interviews, but is also supported by classroom observations and questionnaire data drawn from the larger study. Interview and questionnaire protocols, as well as a full description of the empirical study may be found in Larkin (2010).

At the beginning of his student teaching, Tyler was very concerned with the possibility that discussions involving race might lead to trouble or conflict of some sort. When asked how he might respond to a hypothetical scenario— involving a Van de Graaff generator—in which a student asks, “This only works on white people’s hair,
right?” he first tried to think out loud about whether that was true or not before coming to the conclusion that effects of the generator on hair would probably depend on the individual. Then, when pressed on what an observer would see him do or hear him say, he stated:

For me actually, I would diffuse it, I wouldn’t touch that. I’d say it’s a difference in individuals. If I were feeling particularly adventurous, which I don’t...like I said, the issue of race is especially touchy for me because out of everybody, if anybody’s going to get a finger pointed at them for racism, it’s a white middle-class male...I hate to say it, I’d almost be tempted to sacrifice a little bit of good science to protect myself. I do view this as a very, [pause], I don’t want to lose my job, quite frankly. (Tyler interview, 10 September 2008)

Tyler’s view of race talk early in his fieldwork was that it was uncomfortable and potentially dangerous, even within the context of the subject matter. He was comfortable with the idea of talking about the scientific basis for skin color in his biology class because there were answers that were “straightforward and uncontroversial,” and once described how the distribution of skin color among the human population could be represented by a gradient of light to dark with chalk on a chalkboard. However, he was prepared to shut down the discussion and redirect the conversation if it turned in a “scary direction.” One example of such a direction would be if a student raised ideas about “racial purity” or said something to the effect of, “Caucasians are disappearing” (Tyler interview, 10 September 2008). To Tyler, such topics were fraught with danger and could have personal repercussions on his employment as a teacher. Even affirming his race as

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1 The Van de Graaff generator is an apparatus commonly used to demonstrate electrostatic principles in high school physics classes. It consists of a large metal sphere that sits atop a non-conducting base, and static charge is transferred to the dome by a moving rubber belt inside the base. High school physics textbooks commonly display a photo of a White student holding a hand on the dome, while the student’s long and straight hair appears to defy gravity and extend outward from the scalp in all directions. The explanation for this phenomena fits well within the study of electrostatics: excess electrons from the dome accumulate on the surface of individual hairs, and because all electrons have a negative charge, they repel one another quite strongly, making the hair stand up.
White on a questionnaire was perceived as potentially threatening. His preference was to remain “colormute” (Pollock, 2004). Tyler reaffirmed this interpretation after reading an early written draft of his case (Larkin, 2010).

The notion that race talk could have unpredictable consequences had been reinforced for Tyler earlier in his teacher education program, when one of his instructors had called him a racist during a discussion of the article, “The Silenced Dialogue,” (Delpit, 1988). To Tyler, this was both disturbing and puzzling, because his conception of racism required malicious intent. Therefore, he was certain that the label of racist did not apply to him. The lesson he drew from this incident was that perceptions—and accusations—of racism could be unwarranted, or at the very least, might occur as a side effect when a person is not completely mindful or purposeful in their actions. The idea that there could be a sort of inadvertent or collateral discrimination as a result of poor teaching seemed quite plausible to Tyler. King (1991) refers to such a stance as “dysconscious” racism, but to Tyler this was not racism at all due to the absence of malicious intent.

As a result, he felt that it was plausible that minority students might interpret a situation as “a racial issue” when it was not. He also noted that if there were one black student in a school, it would be, “easy to take a specific instance and put it through that lens and assume that it was racist or culturally insensitive somehow,” (Tyler interview, 10 September 2008). How “sensitive” someone was to “racial issues” then might depend on the racial diversity of a given school or classroom.

At the end of student teaching, Tyler’s thinking about race and racism had changed appreciably. While his conception of racism still required malice, he seemed less
threatened about the prospect of dealing with issues of race in the context of his subject matter. His response to the Van de Graaff question—fraught as it was with language reflecting personal biases—was nearly a complete about-face, and was notable in the fact that he perceived such a student question as an opportunity for inquiry with the class:

It works a little better with straight hair; it doesn’t matter whether you’re white or black. If it’s nice and straight, beautiful straight strand that very can easily separate from everything else, so you get a more impressive effect. If you have time, and you have a black student, ideally one with a giant Afro, and a girl with nice long hair. You do the guy with the afro, and you see if there’s any sort of difference, see if then you can tie that back to physics and see if you can get them to predict, well why did her hair do that, why did his hair do this? I would say, it works better on straight hair, it’s not the issue of white verse black, it’s…blacker tends to be curlier and be more densely bunched. It doesn’t separate out as easily, that a big difference. If I had time, maybe you know I have a day of wiggle room...You roll with that experiment. You turn any question you can, if they seem genuinely interested, especially if it’s something that you can do right then and there and roll with it. (Tyler interview, 22 January 2009)

When pressed on his comfort level in conducting such a conversation, remnants of the previous sense of feeling threatened by the topic of race still remain. He stated:

You kind of keep an eye on it and make sure it doesn’t go somewhere blatantly racist. It kind of depends on the kids’ view of this. But I have been nothing but impressed with the kids. Such a diverse school. It strikes me as they’re very used to this. Now [if] this is something like the first day and this comes up? That’s going to make me uncomfortable. If I’ve had these kids for a month and I know how they’re going to react, I might push this. (Tyler interview, 22 January 2009)

Toward the end of the study, I raised the issue with Tyler about his use of terms like “nice,” “beautiful,” and “impressive” and his positive phrasing such as “easily separates,” and “better” when describing White hair, compared with his use of terms like “dense,” “giant” and “bunched” and negative phrasing like “doesn’t separate” to describe Black hair. He admitted being unaware of doing this, and was genuinely surprised and accepting that this was evidence of being “primed to use” such terms unconsciously. He spoke about his recent interest in the psychology of the unconscious and concluded by stating, “I was completely unaware of that...that’s interesting.” (Tyler interview, 31 March 2009). This was the first evidence I obtained that suggested Tyler might be coming to view racism as something other than malicious, and appeared less threatened than he might have been earlier if confronted with evidence that conflicted with his view of himself as not racist. The fact that I also identify as a White man may have also made it less threatening for Tyler to discuss these issues with me.
Similarly, in regard to a different hypothetical question in which a student asks, “How are genes for skin color related to other genes?” he responded that his answer to the student would include a specific example of how the gene for sickle-cell anemia is common in African Americans, yet also confers some resistance to malaria. This was not a response Tyler voiced at the beginning of student teaching. He now showed no inclination to shirk from this conversation with students, and it was also clear that a better understanding of his subject matter—to which he attributed having to teach it—influenced his responses in both the Van De Graaff and gene questions. Table 3 illustrates this analysis of Tyler’s conceptual change in notation used in the previous analysis of Paley’s narrative and the genetics classroom example.

Two other conceptions seem more plausible to Tyler at the end of his student teaching than they had at the start. The first concerns Tyler’s initial conception of race as an uncomfortable subject with unpredictable power. Initially, the topic of race was so threatening to him personally, that Tyler was “willing to sacrifice a little content” in order to keep race talk from surfacing in classroom discussions. Tyler’s sense of this threat became more nuanced over the semester, beginning with his early observation that, at least at Central High, “everybody just treats everybody else absolutely equal.” Over time, he began to perceive race as “a non-issue in my school.” This was certainly optimistic unrealism (Ross & Smith, 1992) on Tyler’s part, given the racial disparities in Central High School’s graduation rates between different student groups. In 2008, the high school completion rate at Central High was 89% for white students, compared with 70% for black students and 45% for Hispanic students. He also reported observing an absence of self-segregation in his classes, which he had expected to see, and remarked on the casual
way students deployed race for humor. He described an incident when a quiz buzzer failed to light for an African American student during a test review competition because he had not been the first to press the button to answer. The student asked, “Is it because I’m black?” to the reported amusement of the whole class.

The second conception with increased plausibility is that of race as a category with explanatory power for teaching and learning. In his teaching, he reported finding that his African American students had much higher analogical reasoning skills in classroom discussions than their White counterparts. His also reported that his African American students tended to have slightly poorer writing skills, and that their written work often required greater scrutiny for meaning on his part in order to assign a grade that accurately reflected his students’ knowledge. He often struggled to find the language to express these observations in a way that did not resort to stereotyping.

**Looking across the two cases at teacher learning for diversity**

In the two cases discussed above, both individuals underwent conceptual change regarding the relationship between race and teaching. Clearly, changes regarding these issues neither proceed in a straightforward manner nor affect large domains of an individual’s conceptual ecologies at once. For example, Paley is limited in terms of her thinking about race until she can lower the status of her ideas concerning the fact that students are all treated the same at her school. Tyler’s thinking about race is linked strongly to notions of conflict avoidance, and once he realizes that race talk among students does not in itself produce conflict, his earlier conception of race as a dangerous
topic becomes less plausible. Despite this change however, his conceptions regarding
racism remained quite static.

Using the conceptual change model to analyze the text of a written narrative has
the advantage of using the built-in structure created by the author that clearly points to
significant events and issues. In Paley’s account, she has carefully considered and
described the causes of her intellectual development, and the chronological nature of her
text paints a reasonably clear picture of its occurrence. Such detail is much more difficult
to come by in Tyler’s interview data, even when supplemented with observations of his
student teaching. Paley has also crafted the story she wants to tell and the image of
herself as a learner that she wants to convey. As such, we see that her narrative neatly
converges towards what might be termed an appropriate conception of diversity. A
different author offering an account of coming to terms with the meaning of Newton’s
laws of motion might construct a narrative in a similar fashion: I used to think this, but
then something happened and so now I think that, which is much more correct.

In stark contrast, Tyler’s conceptual change shows a much messier picture.
Though it could be argued that he drifts in the direction of his teacher education
program’s vision of an appropriate orientation to student diversity, Tyler has simply not
had the opportunity to shape his narrative in the same manner as Paley, and has only
limited hindsight in this regard. One benefit to the analysis of Tyler’s case however is
that it offers clear evidence that certain conceptions have not changed, such as in the
example of his limited understanding of the nature of racism. If fact, one can even make
the claim that some of his conceptions, such as the one evidenced by the statement,
“some kids…just don’t care, and you can’t make them care,” (Tyler interview, 22
January 2009) change in a manner that run counter to the goals of his teacher education program. This is reminiscent of other studies that show that field experiences can sometimes reinforce negative stereotypes (Haberman & Post, 1992; Hollins & Guzman, 2005). He has however, started to see that an individual orientation towards student difference does not quite explain his observations concerning his African American students’ proficiency in analogical thinking and finds it more plausible now that a relationship may exist between racial identity and this particular aspect of teaching and learning. Seeing this as a cultural resource to be drawn upon in the future may allow Tyler to proceed further in understanding other pedagogical implications of student diversity.

**Implications for teacher education**

I conclude the paper with a discussion on the conceptual change model as a theoretical framework with explanatory power, and outline the implications such a view has for teacher education efforts. In this paper, I have argued that efforts to prepare teachers for student diversity have been largely atheoretical in regard to the way that individuals change their ideas about the pedagogical implications of student diversity. I have also presented conceptual change theory as a candidate for understanding and analyzing teacher learning in a broad sense, and demonstrated its potential as a tool for better drawing what Grant and Secada (1990) termed the “maps of how teacher cognitions, beliefs and skills with respect to the teaching of diverse student populations actually develop” (p. 419). Two cases of learning the pedagogical implications of student
diversity from teaching were depicted and analyzed to demonstrate the explanatory power of the conceptual change model of learning.

In the context of a discussion about the length of time it takes to prepare teachers for diverse populations, teacher educator Mary Louise Gomez (1996) posed the question, “Why are the perspectives of prospective teachers so difficult and so slow to change?” The conceptual change model of learning offers a possible answer to this question. If the prior conceptions that prospective teachers hold about students, schools, learning, society, and perhaps most importantly, about themselves continue to enjoy high status within their conceptual ecologies, then it seems likely that these concepts will be quite resistant to change. To the prospective teacher, they may simply remain too plausible to be rejected.

The conceptual change model has important implications for the goals of teacher education for diversity. This view of teacher learning promises a potentially fruitful theoretical framework for explaining those elements of teacher education for diversity that have already demonstrated their power, such as racial autobiographies, cross-cultural tutoring experiences, and various approaches to reflection that are commonly employed in teacher education programs. By bringing the lens of conceptual change theory to examine these practices, we can understand more clearly why they appear to work in some cases and not in others. Theories about teacher learning rooted solely in notions of cognitive dissonance are not powerful enough to explain why some teachers fail to learn from these experiences. Some teacher educators may even resort to deficit perspectives or notions of innate ability to describe prospective teachers’ failure to learn in these cases (e.g. Haberman & Post, 1998). The conceptual change model of learning however, suggests that dissatisfaction with one’s current conceptions alone may be insufficient for
learning. While such dissatisfaction or cognitive dissonance is a necessary precondition for change, it simply lowers the status of the existing conception. If an alternate conception is available, it must be at least as intelligible, plausible, and/or fruitful than the concept it is meant to replace or modify.

Perhaps more importantly, the conceptual change model holds promise beyond that of just as an analytical tool; it offers strategies for making conceptual change more likely in preservice teachers. In educating teachers for student diversity, teacher educators must be able to present ideas for consideration to preservice teachers that have the potential to be evaluated and given higher status. The task for teacher educators is to identify and draw upon a sound research base for these ideas. In a wide-ranging review of the literature on effective teaching of students in a culturally diverse society, Zeichner (1996) compiles a list of findings that might usefully serve to characterize this knowledge base. A comparison of a statement from this list to a science concept illustrates the analogous nature of their two respective knowledge bases. In the statements, “Teachers have a clear sense of their own ethnic and cultural identities,” (Zeichner, 1996) and “Organisms have tens of thousands of genes that determine individual traits,” (Biggs et al., 2000) there is little different in the characterization of their subjects. Each of these ideas could be offered to students as an idea for consideration, and each is backed by empirical research in their respective disciplines.

One pragmatic implication from this research that may be of immediate use in teacher education programs concerns a seemingly minor stage in the analysis of the data, that of summarizing each conception of interest into what I shall term here a conception statement. Each conception statement was a phrase or single sentence that represented a
précis or “theme statement” of the conception as a whole in the mind of the person holding it (Hewson & Hewson, 1989; Hewson et al., 1995). In this paper, I have used such conceptual statements as a way to represent the organizing ideas of the teachers under consideration. In the case of Tyler, I also used them as a way to communicate my findings with him and ascertain their validity. Some of these “member-check” conversations entailed substantial metacognition on Tyler’s part, and the act of finding the right statement through slight changes of wording was certainly a valuable exercise in refining his thinking.

Arriving at such conceptual statements can be an arduous task for researchers, given the amount of data it may take to identify them, but they ought to be much easier for individuals to construct for themselves. Teachers throughout the professional continuum commonly engage in reflection about their practice, and the present research suggests that the process of articulating and examining conception statements—particularly in the light of potential rival conceptions—may represent a powerful tool for professional growth.

Conceptual change theory may have explanatory power in the area of teacher education for diversity, but further research is needed to ascertain whether the theory also has predictive power. Such work is possible because the conceptual change model suggests a number of specific strategies for the design of learning tasks for prospective teachers. These include the need to make space for the articulation of prior conceptions, the provision of alternate ideas for consideration, and a willingness to foster the explicit consideration of the status of competing ideas affected by the connectedness of conceptions within an individual’s conceptual ecology. Prospective teachers’ ideas about
students, society, school, and self all must be made explicit, and in the spirit of
Hennessey’s elementary science classroom (Beeth & Hewson, 1999) may have a place at
the center of the teacher education curriculum. If teacher educators take up the task of
teaching for conceptual change in teacher education, it is possible that prospective
teachers might undergo conceptual change more readily, strengthening teacher education
as an intervention. This framework might also help guide other promising practices in
teacher education, such as authoring case studies of one’s own practice (Shulman, 1996),
conducting action research as part of teacher preparation (Tabachnick & Zeichner, 1999),
or the use of teaching portfolios for teacher learning (Delandshere & Petrosky, 2010).

Some caution is warranted, however. Teacher education research has shown that
prospective teachers generally drift towards their preparation program’s vision of good
teaching, which may or may not explicitly attend in productive ways to issues of diversity
or social justice (Zeichner & Conklin, 2008). Further, teacher educators must be prepared
to offer alternate conceptions for consideration that are consistent with the research base
of teacher preparation for student diversity, a task that has been called into question by
those who note the demographic homogeneity of teacher educators (Irvine, 2003;
Ladson-Billings, 2005).

One of the greatest challenges for teacher educators however, may be to resist the
temptation to revert to transmissionist practices in the drive to ensure that prospective
teachers leave their teacher preparation courses “with the right answers,” about topics
concerning diversity. This strategy commonly produces resentment and resistance,
particularly among White prospective teachers (Clift & Brady, 2005). If my argument is
correct that the conceptual change model is as applicable in teacher education as it is in
science education, then the model predicts such a “right answers” approach will be ineffective in developing deep and lasting understandings about the pedagogical implications of student diversity. It would be no more effective than a lesson in which a physics teacher has students simply memorize a definition of Newton’s second law in order to substitute the values of variables into an existing equation. To be effective, the teaching for conceptual change approach requires careful attention to the existing ideas of the learner (including affective considerations), instruction based upon these ideas, and adequate time for students’ explicit consideration of competing ideas.

To some, such an approach may seem an insufficient solution to the demanding and raw inequities of our schools and the larger society. From the perspective of critical race theory (Ladson-Billings & Tate, 1995) one can identify a parallel between the slow pace of change in addressing racism within legal frameworks (Crenshaw, 1988) and the slow pace of change in teacher preparation for student diversity (Ladson-Billings, 1999). While critical race theorists often critique “incrementalism” in liberalism’s vision of social progress, by appropriating the conceptual change model here I am arguing here for a different kind of incrementalism—at the level of the individual—in understanding how people learn to teach in diverse classrooms. If we wish to work for a more equitable world, then our responsibilities as teacher educators entail using the theoretical tools available to us—and I submit here that the theory of conceptual change is only one of many possible—to prepare teachers for this task.
References


Table 1. Status analysis categories (adapted from Hewson & Lemberger, 2000; Thorley 1990).

<table>
<thead>
<tr>
<th>Status analysis category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligibility: representational modes</td>
<td></td>
</tr>
<tr>
<td>IMAGE</td>
<td>Use of pictures or diagrams to represent conception</td>
</tr>
<tr>
<td>EXEMPLAR</td>
<td>Real world exemplar of conception</td>
</tr>
<tr>
<td>LANGUAGE</td>
<td>Linguistic or symbolic representation of conception</td>
</tr>
<tr>
<td>Plausibility: consistency and casual factors</td>
<td></td>
</tr>
<tr>
<td>OTHER KNOWLEDGE</td>
<td>Reasoned consistency with other high status knowledge</td>
</tr>
<tr>
<td>CLASSROOM EXPERIENCE</td>
<td>Consistency with observations in the classroom</td>
</tr>
<tr>
<td>PAST EXPERIENCE</td>
<td>Particular events consistent with conception</td>
</tr>
<tr>
<td>EPISTEMOLOGY</td>
<td>Consistency with epistemological commitments</td>
</tr>
<tr>
<td>REAL MECHANISM</td>
<td>Causal mechanism invoked</td>
</tr>
<tr>
<td>Fruitfulness:</td>
<td></td>
</tr>
<tr>
<td>POWER</td>
<td>Conception has wide applicability</td>
</tr>
<tr>
<td>PROMISE</td>
<td>Looking forward to what new conception might do.</td>
</tr>
</tbody>
</table>
Table 2. Summary of episodes, tentative conceptions, targets of conceptions, and status elements within Paley’s (1989) account of learning to teach a culturally diverse class of students

<table>
<thead>
<tr>
<th>Page</th>
<th>Episode</th>
<th>Tentative Conceptions</th>
<th>Target of Conception</th>
<th>Status Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>xiv</td>
<td>Meeting with six African-American parents</td>
<td>Black children are discriminated against in multiple ways in her school.</td>
<td>teachers, school</td>
<td>Intelligibility↑ (LANGUAGE)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All children are treated the same in her school.</td>
<td>teachers, school</td>
<td>Fruitfulness↓ (POWER)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self as enlightened around issues of race.</td>
<td>self</td>
<td>Plausibility↓ (CLASSROOM)</td>
</tr>
<tr>
<td>xiv</td>
<td>Reflection following meeting, and gathering classroom data</td>
<td>“I ignore anything about a child that is different.”</td>
<td>self</td>
<td>Plausibility↑ (CLASSROOM)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All children are treated the same in her class.</td>
<td>self</td>
<td>Plausibility↓ (CLASSROOM)</td>
</tr>
<tr>
<td>9</td>
<td>Keeping lists of troubling incidents</td>
<td>“It was clear to me that I was unable to mention color in the classroom.”</td>
<td>self</td>
<td>Intelligibility↑ (EXEMPLAR)</td>
</tr>
<tr>
<td>12</td>
<td>Meeting with another mother who stated, “Color ought to be recognized, and seen as a positive and interesting difference.”</td>
<td>Color ought to be recognized and seen as a positive and interesting difference.</td>
<td>self teachers school society</td>
<td>Plausibility↑ (OTHER KNOWLEDGE)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Color should not be acknowledged in the classroom.</td>
<td>self teachers school</td>
<td>Fruitfulness↑ (PROMISE)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Plausibility↓ (CLASSROOM)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fruitfulness↓ (POWER)</td>
</tr>
<tr>
<td>26</td>
<td>Reflection about how she might have treated Steven if he were white.</td>
<td>Problematic that “my level of expectations as a group was obviously higher than for blacks.”</td>
<td>self</td>
<td>Intelligibility↑ (EXEMPLAR)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Plausibility↑ (CLASSROOM)</td>
</tr>
</tbody>
</table>
Using the Conceptual Change Model to Research Teacher Preparation for Diversity

All children are treated the same in her class.  

<table>
<thead>
<tr>
<th>Evidence from interview data</th>
<th>Tentative Conception</th>
<th>Target of Conception</th>
<th>Plausibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation of his African American students use of race talk in humorous situations.</td>
<td>Students at my diverse school are comfortable with race talk.</td>
<td>Students School</td>
<td>Plausibility↑ (CLASSROOM)</td>
</tr>
<tr>
<td>“Everybody treats everybody else equal in my diverse school. Race is a non-issue.”</td>
<td>Race is a non-issue in my school</td>
<td>School</td>
<td>Plausibility↑ (CLASSROOM)</td>
</tr>
<tr>
<td>Increased comfort level with his own students; might not be true with new class.</td>
<td>Race is an uncomfortable subject with unpredictable power.</td>
<td>Society</td>
<td>Plausibility↓ (CLASSROOM)</td>
</tr>
<tr>
<td>Race deployed in the context of science topics was safe.</td>
<td>With certain conditions, race talk is acceptable in the science classroom</td>
<td>Students School Subject matter</td>
<td>Plausibility↑ (PAST)</td>
</tr>
<tr>
<td>Ongoing observations that African American students were better with analogies but had more difficulty writing.</td>
<td>Students of a given race were more likely to exhibit certain academic differences.</td>
<td>Students</td>
<td>Plausibility↑ (CLASSROOM)</td>
</tr>
<tr>
<td>Academic differences between students are individual, not categorical in terms of race</td>
<td>Students</td>
<td>Plausibility↓ (CLASSROOM) (OTHER)</td>
<td></td>
</tr>
<tr>
<td>“Odds are stereotypes have come about for a reason, so be aware of them...Know that they’re there and be aware...use it as something to look for.”</td>
<td>Race can help inform pedagogical choices when employed probabilistically.</td>
<td>Students Teaching</td>
<td>Intelligibility Plausibility↑ (EXEMPLAR) (OTHER)</td>
</tr>
<tr>
<td>Selection of the example of the relationship between the sickle-cell gene and malaria resistance in order to illustrate genetics concepts in diverse class because of relevance to African Americans.</td>
<td>The racial or ethnic composition of a class influences the choosing of relevant examples.</td>
<td>Students Subject Matter</td>
<td>Intelligibility Plausibility↑ (EXEMPLAR) (CLASSROOM)</td>
</tr>
</tbody>
</table>
After repeated attempts to teach particular students, view that, “some kids...just don’t care, and you can’t make them care.”

Not all students can be taught science students self

Plausibility $\uparrow$

(CLASSROOM)

Above statement could not have been said, “in one of my education courses without failing the course.”

Some realistic points of view must be concealed in education courses.

teacher education

Plausibility $\uparrow$

(PAST)