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Inquiry –Oriented Science in Urban Secondary Schools: Voices of New and Experience Science Teachers On Perception of Preparedness

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Abstract

This study explores urban secondary teachers' perception of how prepared they are to teach science through inquiry-based strategy. It was conducted against the backdrop of recent calls by the National Research Council (NRC) to restructure the way science is taught. Results described in this paper are based on data collected through a Likert scale questionnaire administered to 39 practicing science teachers. The questionnaire provided both quantitative and qualitative data. Analysis of data showed that the majority (78%) of the teachers surveyed believed that they had the knowledge and skill required to teach science through inquiry. Their responses to open ended survey questions indicated something different. Only 13% of the teachers were able to list the elements of inquiry-based science instruction which raised the question about what they actually perceived as knowledge and skills of inquiry-based instruction. These differences are discussed in this paper. Implications for teacher preparation to instruct in an inquiry fashion are also presented.

Keywords: Inquiry, Perception, Preparedness, Professional, Development, Administrative, Instruction, Questionnaire

1. Introduction

One of the greatest challenges facing US public education is tackling the increasing differences in science achievement and educational opportunity between students from high socioeconomic status (SES) backgrounds and students from low SES backgrounds. Students from high SES have continued to score higher on science achievement tests than those from low SES (National Center for Educational Statistics [NCES], 2000; O'Sullevan, Reese, & Mazzeo, 1997). This is supported by the report by the National Assessment of Educational Progress (NAEP) 2000 which shows that 41% of White students, 37% of Asian/Pacific Islander students, 14% of American Indian/Alaskan Native students, 12% of Hispanic students, and 5% of Black students scored at or above proficient in the eighth grade science test. (NCES, NAEP, 1996 & 2000 Science Assessments).

One of the most controversial findings of adolescent science achievement is its association with race and ethnicity (Von Secker, 2004). "Without doubt, teaching and learning science pose many challenges even in the best of circumstances" (Tobin, Roth, & Zimmermann, 2001 p.941). These challenges increase in number and intensity in those urban schools that deal with inadequate funding, teacher shortage, lack of resources, and a high proportion of students from conditions of poverty (Tobin, Seiler, & Walls, 1999).

According to the National Science Education Standards [NSES], science in our schools must be for all students regardless of age, gender, cultural or ethnic background, disabilities, aspirations, or interest and motivation in science. All students should have the opportunity to attain high levels of scientific literacy (NSES, 1996). In an age now driven by the relentless necessity of scientific and technological advancement, the current preparation that students in the United States receive in Mathematics and Science is, in a word, unacceptable (National Commission on Mathematics and Science Teaching for the 21st Century, 2000).

Discussions of the changes in science education that have taken place over the past 20 years often revolve around advances in cognitive science and learning theories, the movement towards teacher professional development, the development of state and national standards, accountability and assessment programs, and on-going call for equity and excellence (Barton & Tobin, 2001). However, the expected change in teacher instructional strategies and student motivation resulting in a significant increase in student achievement has been abysmal as indicated in the Third International Mathematics and Science Study (TIMSS, 2003) and the National Assessment of Educational Progress Report (NAEP, 2000). Heeding the bad news from this report has to involve something more than wringing our hands and raising polite rallying cry for improvement. The issues raised by this report are deeply entrenched and cannot be papered over (National Commission on Mathematics and Science Teaching for the 21st Century, 2000).

Akerson and Hanuscin (2006) explained that portraying science in a way that goes beyond thinking of science as just a body of knowledge requires an understanding of the nature of science itself. Cohen, Raudenbusch, and Ball (2000) as cited in Knapp and Plecki (2001) posited that in some ways, we have come a long way in the past several decades in understanding the nature of high-quality science teaching and conditions that might encourage it in settings such as this. Most of our learning to date has had to do with the fine detail of interactions among teacher, learner, and materials- the "triangle" that lies at the core of instruction in science or any other subject.

Today, educators and researchers understand that most people learn best through personal experience and by connecting new experience to what they already believe and know (National Research Council, 1996; American Association for the Advancement of Science, 1990). According to the National Science Education Standards "learning science is something students do, not something that is done to them…science teaching must involve students in inquiry-oriented investigations as they interact with their teachers and peers" (NRC, 1996, p. 20). The report explains that an inquiry based classroom is more than a "gathering of individual learners brought together for reasons of economy." Inquiry teaching for the purpose of this study includes "diverse ways in which scientists study natural world and propose explanations based on the evidence derived from their work" (NRC, 1996, p.23).

In presenting some clarifications for what an inquiry based classroom represents, the National Research Council explains that some activities provide a basis for observation, data collection, reflection, and analysis of firsthand events and phenomena while other activities encourage the critical analysis of secondary sources-including media, books, and journals in the library (NRC, 1996, p.33). It therefore encourages teachers to use student-centered learning strategies that actively engage students in conversations and activities that will enhance deeper conceptual understanding.

"A number of researchers have shown that in highly resourced settings, inquiry instruction in urban classrooms can be successful, when it includes materials that leverage the culturally relevant knowledge and beliefs held by students from diverse backgrounds. The challenge remains, however, to move these successes from the design environments in which they were created to the wider rough and tumble of neighborhood schools where teachers can enact them successfully and students can benefit from the opportunity" (Marx et al, 2004, p.1064).

In the past decade, there have been efforts by science education community to make inquiry-based science a reality in the classrooms through professional development programs, science methods classes, and other reform-based science materials (Abell et al. 2005;Lowden, 2005; Tobin, Roth & Zimmerman, 2001; Barton, 2001; Amaral, Garrison & Klenstshy, 2002; Fraser-Abder, Atwater & Lee, 2006; Supovitz & Turner, 2000). Yet according to Keys and Bryan (2001) "as yet we have little knowledge of teachers' views about the goals and purposes of inquiry, the processes by which they carry it out, or their motivation for undertaking a more complex and often difficult to manage form of instruction" (p. 636). Also, not much is known about whether urban teachers' skill levels and understanding are adequate to actually implement inquiry-based science instruction in urban science classrooms. This study therefore seeks to explore what urban science teachers are saying about implementing inquiry in their classrooms. In doing so, the study hopes to ascertain whether the teachers' have adequate skill levels and understanding to implement inquiry in the classroom.

1.1 Urban Schooling

Understanding the diversity evident in urban school setting, teachers must reflect on a more ethnographic approach to inquiry based pedagogy. Murillo (1997) as cited in Barton (2001) argues the relevance of an ethnographic inquiry in urban classrooms: "ethnographic inquiry is most appropriate when it places events and people in the social, cultural, and political history and contexts in which they are constituted. It can never be innocent or neutral, since it is embedded in a political and moral process." Urban school teachers and administrators must understand that the inquiry based pedagogical reform is a process that requires a clear awareness of the specific goals of science education. Marx et al (2004) in citing different studies that point to the need of urban science reform explains, "over the past decade, systemic reform has been advanced as a comprehensive and systematic approach to school improvement (Fuhrman, 2001; Smith & O'Day, 1991) designed to increase student learning through careful programming and alignment of curriculum and instruction, assessment, and professional development." The study furthermore emphasizes, that systemic reform in science often takes place in large urban systems that present a particular set of challenges for educators and their partners in reform (Blumenfeld, Fishman, Krajcik, Max, Soloway, 2000). Teachers and administrators should not assume that a structured hands-on activity will necessarily have all of the elements of inquiry. This only results in what Moscovici and Nelson (1998) referred to as "activity mania" and does not result in the necessary conceptual understanding needed in science learning. Inquiry as defined in the national science education standards (NSES):

Is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations (p. 23).

According to NRC (2000), "developing the ability to understand and engage in this kind of activity requires direct experience and continued practice with the processes of inquiry. Students do not come to understand inquiry simply by learning words such as "hypothesis" and "inference" or by memorizing procedures such as "the steps of the scientific method." They must experience inquiry directly to gain a deep understanding of its characteristics." (p.12). It is based on this premise that we sought to identify the key perception of new and experienced urban science teachers about inquiry oriented science instruction in urban secondary schools. Identifying teachers' perceptions of inquiry will support professional development opportunities that address the systemic needs in the area of science instruction. Jarrett (1997) explains, "teachers and administrators should look out for certain inquiry specific structures already mentioned above when observing an inquiry rich classroom."

Cultural diversity is another important consideration when discussing the challenges of teaching and learning in urban settings. Based on the U.S. Census report (2000), an estimate of 75% of its inhabitants resides in urban areas while the central urban cities make up 29% of the total population of the U.S. "Educators in the urban area while developing science curriculum must develop urban/science specific instructional strategies that will benefit the students of low SES that are predominant in urban settings.

1.1.2 Teachers' Beliefs about Inquiry

The act of becoming a teacher is a complex process of socialization into a community of practice" (Murrell, 2001; Wenger, 1998). Goodson (1992), Helms (1998) and Zeichner (1983) as cited in Proweller and Mitchener (2004) point out studies of teacher socialization as documenting a long tension between notions of teaching rooted in the personal; that is, the teacher's person or self influences what is taught and the structural constraints of school organization and culture (p.1044).

Cuevas, Lee, Hart, and Deaktor (2005) as cited in Krystyniak and Heikkinen (2007) noted "the difficulty of finding a clear-cut definition of inquiry, and cited separate work regarding inquiry theory, a process, and the relative extent to which it is student – or teacher driven." Creating an inquiry based classroom requires teachers asking students for their suggestions and allowing students to take ownership of the learning process. This puts urban school teachers in a position to share control and effectively guide learners while ensuring a safe classroom environment. A situation that seems to dishearten some urban school educators in pursuing an inquiry based classroom environment. It also takes a courageous teacher to encourage students to offer their own ideas, to make comments, to debate the validity of explanations and solutions, and to take part in the decision making (Borasi, 1992) process. "Teachers hold personal beliefs that inquiry promotes the scientific thinking and learning autonomy that they want for their students; yet, enacting inquiry is mediated by cultural beliefs, such as transmission and efficiency". "These dual belief sets cause tension for teachers who are attempting to use inquiry-based instruction" (Keys & Bryan, 2001, p. 636).

Wallace and Kang (2004) in citing several studies explain the importance of teacher belief in effective inquiry based instruction. In their opinion "teachers' understandings of the nature of science may create barriers to implementing inquiry-based instruction. They suggest that "previous studies have indicated that many teachers have a view of the nature of science as an objective body of knowledge created by a rigid "scientific methods" (Duschl & Wright, 1989; Brickhouse, 1990; Gallagher, 1991). Continuing on this, Wallace and Kang posit that "teachers have no educational background in the history and philosophy of science, nor do they have first hand experience practicing science" (p.940). Thus, they tend to portray science as a collection of facts, principles, and concepts with little or no instructional attention given to the processes by which scientific knowledge is made public and validated (Gallagher, 1991). An implication of the resulting dilemma is that with such shallow understanding of how scientists work, teachers may be inhibited to involve students in inquiry-based science activities that reflect the way scientists work.

An urban teachers' orientation plays a major role in teacher beliefs. Friedrichsen (2002) found in her study of high school chemistry teachers that instructional decisions are generally based on their beliefs and attitude. Wallace and Kang (2004) in the analysis of their study comprising of six secondary science teachers, outline the diverse perspective of science teachers to the relevance of inquiry based instruction based on their perception of student preparedness, academic abilities and state content requirements. Of the teachers studied, two major belief strands emerged. The first belief strand ranged from the curriculum being less rigorous to students being too immature and lazy to appreciate the inquiry process. While the second belief strand ranged from inquiry process creating independent, deep thinking and problem solving skills to inquiry process stimulating creativity in science learning.

1.1.3 Teacher Preparation and Professional Development

Teaching in ways recommended as powerful for student learning, will require most teachers to develop new knowledge and skills in teaching (Borko & Putman, 1996). Professional development lies at the heart of nearly every educational effort to improve student achievement (Supovitz &Turner, 2000). Yet, paradoxically, the development of educators is a much maligned enterprise. In a 1985 national survey, teachers ranked in-service training as their least effective source of learning (Smylie, 1989). Tobin, Roth and Zimmerman (2001) explains that the characteristics of urban schools make likely the necessity of employing a radically different approach from that successfully employed in preparing teachers for schools with students from middle and upper class settings. Such a different course is especially likely to be needed when the majority of students in an urban school are from the working class or from homes in which earnings are below the poverty line. The goal of any professional development effort should be: (a) to aid urban science teachers to possess the tools in dealing with the specificities of urban science teaching in terms of school climate, size, funding, and demographics; and (b) to develop better urban public schools and science teachers who want to stay in urban settings (Fraser-Abder, Atwater, Lee, 2006).

Although professional development has not realized its potential, it is still seen as the best bet for changing teaching practices, because alternative methods, such as policies and programs that regulate teacher behavior, have not fared better (Smylie, 1996). Urban school administrators must plan high quality professional development opportunities that are both systemic and sustainable in nature as they strive for an inquiry based science classroom. Despite historical shortcoming, evolutionary advances in science professional development hold promise as a way of influencing the teaching and learning of science in American public schools (Supovitz & Turner, 2000). The question then is how have these professional development trainings especially those on inquiry-based approach to science instructions changed teachers' perceptions about science and the way it should be taught in the urban classrooms?

1.1.4 Administrative Support

Excellence and equity in science teaching and learning in urban schools are determined by various social, cultural, and linguistic factors by the major players in the arena (Fraser-Abder, Atwater, Lee, 2006). Urban school teachers continue to seek avenues to engage their students in a meaningful way while addressing other external variables that play a significant role in daily classroom behavior. To promote goals established for student learning, reform efforts in science education have focused attention on classrooms and how teachers can improve their instructional practices (Schneider, Krajcik, & Blumenfeld, 2005). Although educators agree that the 1996 National Science Standards has prompted a focus on inquiry based instructional strategies, however, there is a need for urban school administrators to address the issue of teacher preparedness in addressing inquiry-based science instruction (Basista, Tomlin, Pennington, & Pugh, 2001).

Urban School science classrooms often lack appropriate science instructional materials and supplies, a state of affairs often exacerbated by more generalized lack of resources and funding in urban schools serving large numbers of underperforming and underrepresented groups of students (Fraser-Abder, Atwater, Lee, 2006). Administrators have to reflect on this lack of resources and funding as a major cause of the achievement gap and the teacher attrition, as well as student and teacher low moral as they plan and design relevant professional development opportunities for urban science teachers. Basista, Tomlin, Pennington, & Pugh (2001) in their study, emphasized the need for administrators to participate in professional developments focusing on inquiry based instruction.

Professional development for urban administrators to understand and support an inquiry based pedagogical strategy is important in effectively supporting urban teachers in their quest to reform instruction. According to the National Commission on Mathematics and Science Teaching for the 21st Century (2000), administrators need to understand that effective teacher professional development will, (1) deepen their knowledge of the subject; (2) sharpen their teaching skills in the classroom; (3) keep up with developments in their fields, and in education generally; (4) generate and contribute new knowledge to the profession; and (5) increase their ability to monitor students' work, so they can provide constructive feedback to students and appropriately redirect their own teaching.

1.1.5 Purpose of Study

Several studies continue to focus on secondary school teacher perception of inquiry –oriented Science in diverse classrooms (Knapp & Plecki, 2001; Barton & Tobin, 2001; Eick & Reed, 2001; Von Secker, 2004; Bencze & Hodson, 1999; Jarrett, 1997; NWREL, 1997; Max et al, 2004; Supovitz & Turner, 2000; Fuhrman, 2001; Volkman & Zgagacz, 2003; Akerson & Hanuscin, 2006). Krystyniak and Heikkinen (2007) explain, "that a major effort in science education reform has been the implementation of inquiry strategies into k-12 classrooms and laboratories … Since then, the National Science Education Standards (NSES) has included inquiry as both learning and a teaching expectation for k-12 instruction (NRC, 1996). This served as an impetus to explore through the present study what teachers are doing in their classrooms as well as what they are saying about inquiry as an approach to science instruction especially in urban setting. Specifically, the current study was designed to answer the following research questions regarding urban science teachers' perception and preparedness for inquiry based instruction.

1. What are urban science teachers' perceptions of their knowledge base and skills of teaching science through the inquiry approach?
2. Do these perceptions affect their preparedness in implementing inquiry based instruction?
3. How do these perceptions influence their implementation of inquiry-based instruction?

2. Methodology

2.1 Study Participants

The study participants include teachers from four urban school districts in southern California who were either enrolled in our science methods course or were full time science teachers in an urban school setting. These are teachers from urban secondary schools in Los Angeles County, California with about 62 percent of them holding or enrolled in either a master's or doctoral degree program. Out of the 39 secondary teachers who participated in this study, 64 percent have been teaching science for less than 20 years. Fifty nine percent of the participants have less than 6 years experience working in an urban setting. Participants were selected based on their teaching science in an urban secondary school.

2.1.1 Data Collection

A brief questionnaire (part Likert and part open ended) was used to obtain data from participating teachers. For the purpose of this study, the questionnaire was structured to provide both quantitative and qualitative data (Tashakkori & Creswell, In Scott et al. 2007). The questionnaire consisted of demographic information and twenty eight questions focusing on perceptions of inquiry instruction while also identifying professional development focus areas that can enhance teacher efficacy in inquiry based instruction. This study relied on teacher self-reports of pedagogical activities. The current focus on teacher perception included open and close ended questions regarding three areas: (1) Knowledge and skill of teaching science inquiry; (2) teacher perception of inquiry; (3) teacher understanding of inquiry reflected in assessment and classroom resource selection. Mayer(1999) as cited in Smith et al (2007) points out, "research has shown that survey measures of teaching, especially composite measures such as those we used in this study, can be effective in describing and distinguishing among different types of teaching practices." Other topics include open ended responses to the questions: List all the elements that you will see in a classroom where science inquiry is employed. What system have your school established to support your teaching of science? What sources of professional development have been very useful for your teaching of science? What issues if any have arisen for you in providing adequate and appropriate science education experience to different groups of students, and how have you resolved these? What are three major challenges you face in implementing the science curriculum? Item response format used a 4 structured Likert scale for some of the questions while the rest were yes or no responses

2.1.2 Reliability and Validity

The survey used in this study was a three page questionnaire developed by researchers and an evaluation team. The survey was validated by a summative committee comprised of science teacher leaders, administrators who are aware of science practices and science methods professors. This team reviewed the construct validity of the open ended question to ascertain the fidelity with which the responses from this category were coded. Construct validity is an indicator of the logical, conceptual connection between a test and what it is designed to measure. Reliability analysis of the items resulted in an alpha coefficient of .92, indicating a strong internal consistency of items. This format ensured both reliability and validity of the instrument. The final questionnaire for the teachers contained 27 questions.

2.1.3 Procedure

Administered surveys were collected over a two month time period. Despite hand delivering the tools, emphasis on anonymity, and several follow-up phone calls, some of the teachers did not complete the questionnaire. A total of 78 percent (n= 39) of the teachers responded. Some of the limitations to the study include possible non-response bias of the respondents who did not answer all questions on the instrument and lack of information on non respondents.

2.1.4 Data Analysis

The presentation of our quantitative and qualitative data analysis is organized around our three research questions. Data analysis procedures for the survey included descriptive statistics such as percentages used to collate and tabulate the patterns of responses. For the open ended questions (eg. List all the elements that you will see in a classroom where science inquiry is employed?), a three step process was used for coding responses. First, the term inquiry was defined based on the National Science Education Standards (NRC, 2000)'s essential features of inquiry to include all activities in the classroom that enabled the learner to: (1) engage in scientifically oriented questions, (2) give priority to evidence in responding to questions, (3) formulate explanations from evidence, (4) connect explanations to scientific knowledge, and (5) communicate and justify explanations. Based on this, we proposed that student inquiry application in the class room should include all minds-on, hands-on activities in which students are guided in the practice of making observation, collecting data, reflecting, and analyzing firsthand events and phenomena and suggesting possible explanations based on scientific evidence (NRC, 1996). Second, we discussed each teacher's response and the appropriateness in relation to the above mentioned characteristics of inquiry. Third, the responses are coded as inquiry or no inquiry. Those responses that fall into the definition will be coded as inquiry while those responses that do not reflect the characteristics in the definition will be coded as no inquiry. In addition, we randomly selected six (three from those who listed the correct elements of inquiry and three of those that did not list the correct elements) teachers' free responses to the open ended survey questions for in-depth analysis. For easy understanding of our presentation and because we are going to quote the teachers' exact responses, we decided to use the pseudonyms: Andrew, Johnson Kate, AnnMaria, Keisha, and Annette to represent these six teachers.

3. Results

To organize the data analyses of this study in clear and coherent manner, the result of the study is presented under two sub-titles: Quantitative analysis and Qualitative analysis.

3.1 Quantitative Analysis

(Place Table 1 about here)

In order to answer research question one, we obtained information about teachers' perception of their level of understanding of what inquiry is as well as the skill of using this approach in science instruction by analyzing the teachers' responses to the knowledge and skills question cluster. This revealed that 78 percent of the teachers who participated in the study thought they were either proficient or accomplished in their level of understanding of what science inquiry means while 62 percent indicated that they were either proficient or accomplished in the use of science inquiry. Based on this, we assumed that these groups of teachers had clear (or at least a working) understanding of the inquiry approach and may likely use this approach in their classrooms.

3.1.1 Qualitative Analysis

However, when asked to list all the elements that need to be found in an inquiry-based instruction, about 39 percent of the teachers surveyed listed attributes such as hands-on, students centered, scientific methods, questioning, open-ended, active participation, discovery, student communication, teacher modeling, lab. before lecture, use of note books, performance based, interactive, collecting and interpreting data, predicting, student ownership of experience, engagement, discussion, explanation, higher order, evaluative and analytical thinking, constructivism, prior knowledge, construction of logical framework, making connections, cooperative groups, problem-solving, and exploring ideas. Also, we found that only 33 percent of this group listed the elements that point to the five essential features of inquiry as prescribed by NRC, (1996) such as:

Students are actively participating in learning. Students are interacting w/each other. Students are conducting investigations. Students are communicating using a variety of methods. Teacher is seen modeling & supporting learning, using a variety of methods. Hands-on activities, cooperative learning interactive science notebooks, labs before lecture, performance-based assessment. Questioning, experimentation, observation. Collecting and interpreting data, the one development, evaluation of ideas, predicting outcomes of experiments. Engagement, student ownership of experience, group discussion, questioning, pursuing explanation of a certain phenomenon. Student engagement open-ended questioning constructivism, higher-order evaluative and analytical thinking, observations, connections to prior knowledge, the construction of logical framework, etc.

This represented about 13 percent of all the teachers surveyed and so raised doubts about the 78 percent that had indicated that they had clear understanding of inquiry based instruction.

(Place Table 2 about here)

To answer research questions two and three, we resorted to an in-depth analysis of the open ended survey questions since they assumed that the teachers' responses to these questions will give them a clearer understanding of the teachers' perceptions and their actual level of understanding. Three of these survey questions which adequately served this purpose will be analyzed. The first question had to do with whether the teachers implement inquiry in their classrooms. To this question, 46 percent of the teachers responded that they use inquiry- based science instruction in their classrooms while 29 percent said they use inquiry sometimes. Five percent of the teachers responded that they rarely use inquiry in their science classrooms.

The second question had to do with the ease with which the teachers implemented inquiry-based instruction. Analysis of teachers' responses to this survey question showed that 59 percent of the teachers responded that it was either very easy or easy while 41 percent responded that it was either difficult of very difficult. The third survey question asked teachers to list all the elements that they will see in a classroom where science inquiry is employed. This question was specifically designed to be open ended to give teachers the opportunity to actually verbalize what their understanding of science inquiry is. Analysis of this question which was coded to highlight the various elements of inquiry evident in teachers' responses showed very clear divergence in what the teachers perceived and applied as science inquiry (Strauss & Corbin, 1990).

For the purpose of this analysis, we decided to randomly select six teachers to represent the participants who responded to these questions from the sample of 39 percent of teachers who correctly identified some elements of inquiry and 61 percent who did not identify elements of science inquiry for a descriptive analysis. Because we were going to quote the teachers' exact responses, we decided to use the pseudonyms Andrew, Johnson, Kate, AnnMaria, Keisha, and Annette to represent these six teachers.

These teachers were asked to respond to the third of the three survey questions. The first three randomly selected teachers' responses identified some of the elements outlined in the NRC (1996) as evidence of an inquiry- based science classroom. Specifically, Kate's response to that question was "controlled chaos – students moving, talking (loudly even), questioning, and discovering." Johnson's response was "measuring, observing, creating, classifying, graphing, experimenting, hypothesizing, and sequencing (all process spills)." Finally, Johnson's response to the question was "collecting and interpreting data, development and evaluation of ideas, and predicting outcomes of experiments."

While the first group of teachers appeared to have fairly good understanding of the elements of inquiry -based science instruction in the classroom, the second sample group seemed not to understand the elements of an inquiry- based science instruction as outlined by the National Research Council (1996) or at least did not list them. These three teachers, AnnMaria, Keisha, and Annettes' responses are as follows: AnnMaria: "unique work product/different curriculum." Keisha: "reading assessments and labs." Annette: "standards, wall, and students work." A cross-analysis of their responses point out the divergence in their understanding within this subgroup as it relates to science inquiry. For instance, Annette understood science inquiry as following state content standards for the grade level and exhibiting student finished work as evidence of inquiry while Keisha points to reading and laboratory exercise as examples of inquiry- based science instruction (Maxwell, 1996).

3.1.2 Discussion

The purpose of this study was to explore urban science teachers' perception of what their understanding and skill levels are about inquiry-based science instruction and to ascertain whether these perceptions influence their implementing inquiry in their classrooms. To do this, we resorted to the use of qualitative and quantitative data sources. Analysis of the quantitative data revealed that a majority of teachers surveyed perceived themselves as being knowledgeable and skillful about inquiry. To find out how their perception influenced their implementation of inquiry-based instruction in their classrooms, we analyzed the open-ended question that asked them to list all the elements that reflects an inquiry-based instructional strategy. Data showed that their responses to this open ended survey question contradicted this belief. This finding appears to contradict the study by Tobin, Tippins, and Gallard (1994) which found a strong influence between teachers' beliefs about teaching and learning and how they taught science. This disconnection between the teachers' beliefs and what they do in the classroom may be attributed to their lack of understanding of what inquiry-based instruction actually means. Their perception of inquiry may have been wrong at best or may not have reflected the actual meaning of inquiry as described by the National Science Education Standards.

It is important to note at this time that although 46 percent of the study teachers agreed that they use inquiry-based instruction often, evidence from their responses to the open ended survey questions did not support their claims or true understanding of inquiry and its elements as related in their instructional description. In addition, the fact that 59 percent of these teachers responded that they found it easy to use inquiry, even though they were not able to identify the key elements of inquiry as outlined by the National Science Education Standards (NRC, 2000) raises an interesting question about what these teachers refer to as inquiry. This finding supports the findings of Cuevas, Lee, Hart, and Deaktor (2005) which points to the difficulty of finding a clear-cut definition of inquiry. Also as Smith et al (2007) reiterates "although inquiry-oriented approaches to education have been advocated since Dewey, early in the last century (Dewey, 1910, as cited in National Research Council, 2000), what constitutes inquiry in science instruction varies widely across the literature (Anderson, 2002). Evidence based on collected data analysis is consistent with the notion that these teachers are either not as knowledgeable as they claim or are still confused about what inquiry-based instruction actually is. We assumed that they may have heard that there is a push for the use of inquiry-based instruction and decided to agree that they use it. The inquiry strategy has been promoted in a lot of science professional development in the Los Angeles area at the time of this study and it is possible that some of the participating teachers have either participated in these professional developments or have heard about inquiry from other colleagues that may have participated in these trainings.

Another focus of this study is to identify if teachers' perception of inquiry knowledge and skill affects their preparedness to implement inquiry -based strategies in their classroom. Evidence from the data analysis show that teachers' perceptions of inquiry- based instruction affected their ability to clearly identify the elements of inquiry based instruction as outlined in the National Science Education Standards (NRC, 2000) , consequently reflecting their curricular and pedagogical focus in science. We suggest this from comparing data from the skill and knowledge section of the survey instrument and teachers' responses to key elements of implementing inquiry-based instruction in their classrooms. The research findings present a concern in relation to the major push by science education reformers to implement inquiry-based instruction in K-12 classrooms and laboratory. Alsoscience teachers in their identifying, planning, and monitoring professional developments will have to overcome the difficulties created by perception of teacher knowledge and skills as it relates to inquiry- based science instruction.

Science Educators, Lead teachers, and Administrators in supervising these classrooms must intentionally identify strategies for creating awareness as to the key components of an inquiry- based science classroom and laboratory. For example, they may use inquiry-based instruction matrix during and after classroom observations to point out to teachers what inquiry based strategy should look like. Furthermore, science teachers in urban secondary schools will enhance their ability to use inquiry-based strategies in the classroom if they understand the strong influence between teachers' belief about teaching and learning and how they teach science (Eick and Reed, 2001). Indeed, 62 percent of surveyed teachers agree that they have attended professional development sessions focused specifically on inquiry-based science strategies. This percentage when compared to the 39 percent of teachers who identified the key elements of an inquiry-based science instruction leads us to conclude that there is a clear difference between perceptions of professional development and implementation of inquiry- based instruction. From the foregoing, we assume that the attendance of PDs focusing on inquiry-based instruction has not enhanced the teachers' understanding and implementation of inquiry in their classrooms. That raises the question about the effectiveness of the PDs. Administrators and teacher leaders should reflect on these findings and develop ongoing PDs that allow teachers to implement the skills learned from these trainings while presenting an opportunity for reflection and feedback using a monitoring matrix based on the NRC identified components for inquiry.

Science educators and school administrators in planning for the future National Assessment of Education Framework (2009) will have to present learning opportunities that challenge the gap between their teachers' perception of knowledge and skill of inquiry -based instruction and the reality of instruction in the science classroom. This framework founded in conceptual understanding, science investigation, and practical investigation outlined four science practices to be assessed: (1) identifying science principles, (2) using science principles, (3) using science inquiry, and (4) using technological design (U.S. Department of Education, 2007). Wright and Wright (1998) as cited in Smith et al. (2007) "pointed out the gap between science education as it was taught at the time and as it was described in the National Science Education Standards, suggesting that it would take considerable effort for teachers and students to enact the vision of inquiry put forth in the guideline in their classroom."

Focusing on content and analysis rather than the process of inquiry aligned to the key components of the NSES (NRC, 2001) continues to hinder the preparedness of science teachers in urban secondary schools (Fraser-Abder, Atwater, & Lee, 2006). As science education reformers continue to ensure equity in science, it becomes imperative that urban school systems must create a path to bridge the gap between perception and reality. Numerous research on inquiry-oriented science instruction as outlined in this paper support the need for all science educators to develop the ability to understand and engage in the kind of activity that will re-enforce the understanding and continued practice of the skills necessary to foster inquiry-based instruction. Focusing on the science academic needs of urban school districts as exemplified in the State standardized test scores has not yielded the intended result for science education reformers. However, the data from these standardized test scores supports the need for more research on inquiry- based science instruction in urban secondary schools. Studies of learning from inquiry-based approaches in secondary classroom are necessary in light of the difficulties conducting inquiry in the more constraining high school environment (Keys & Bryan, 2001) in urban settings.

3.1.3 Conclusion

Urban science teachers' perception of what their knowledge, understanding, and skill levels are regarding inquiry-based science instruction, and its influence on their implementing these strategies show a gap based on the data analysis from the study survey instrument. Flick (1995) as cited in the McReL Report (1997) point out that teacher skill is crucial to inquiry. These findings support studies that show that teacher skills and knowledge, deep cultural understanding for framing pedagogy, administrative support, collaborative monitoring, and continuous targeted professional development is an integral approach to sustaining two decades of science reform (Fraser-Abder, Atwater, & Lee, 2006; Eick & Reed, 2001; Smith et al, 2007; Luft, 2001;NRC, 2000; Akerson & Hanuscin, 2006). Furthermore, we found that urban science teachers who participated in this study had a different opinion of what inquiry- oriented instructional strategies exemplified in the urban classroom. Methodological frameworks for the study include quantitative and qualitative approaches to address the three research questions proposed for this study. The study data supports the assertion that there is a gap between teacher perception of inquiry -oriented instructional abilities and its actual implementation in the classroom. "How best to reform science instruction has been debated by scientists and science educators for decades, although how science is taught is likely to garner wider public policy interest as science achievement becomes part of the formula for calculating where schools and districts are making adequate yearly report" (Smith et al, 2007).

The voices of these urban school science teachers show that there is a need for district and school site administrators to support teachers through the planning of a structured, continuous inquiry -based professional development topics. Perhaps, preparing these teachers to effectively identify the key elements of an inquiry- oriented classroom and modeling these elements in professional developments will not only improve their daily science pedagogy but will also support the academic growth of urban students as measured in the state standardized test score.

Urban school districts must encourage science teachers and site administrators to incorporate the inquiry framework outlined in the U.S. Department of Education report (2007) in their curriculum development and pedagogy. Although the correlation between professional development and teachers' use of inquiry cannot be ascertained by the survey instrument used for this study, it is evident from the assessment measures that students improved academic growth in science is based on an understanding and continued implementation of inquiry -based strategies. Furthermore, science instruction and science teacher professional development is an area ripe for both experimental and quasi-experimental design methodologies to support the replication of best practices in urban science classrooms.

References

Abell, S., Ehlert, M., Lannin, J., Marra, R., Cole, J., Rogers, M. P. et al. (2005). Profiles of mathematics and science teacher professional development programs: Theoretical basis, activities, and effectiveness. Paper presented at the annual meeting of the American Educational Research Association, Montreal, Quebec.

Akerson, V. L., & Hanuscin, D. L. (2006). Teaching nature of science through inquiry: Results of a 3 year professional development program. *Journal of Research in Science Teaching,* 1-27

American Association for the Advancement of Science (1990). *Science for all Americans*: Project 2061. New York, NY: Oxford University Press.

Anderson, R.D. (2002). Reforming science teaching; What research says about inquiry. *Journal of Science Teacher Education,* 13 (1), 1-12.

Basista, B., Tomlin, J., Pennington, K., & Pugh, D. (2001). Inquiry-based integrated science and mathematics professional development program. *Education,* 121(3), 615-625.

Barton, A. C. (1998). Reforming "science for all" through the politics of poverty. *Educational Policy,* 12, 525-541.

Bencze, L. & Hodson, D. (1999). Changing practice by changing practice: Toward more authentic science and science curriculum development. Journal of Research in Science Teaching. 36 (5), 521-539.

Blumenfeld, P., Fishman, B., Krajcik, J. S., Marx, R.W., & Soloway, E. (2000). Creating usable innovations in systemic reform: Scaling-up technology-embedded project-based science in urban schools. Educational Psychologist, 35, 149-164.

Borasi, R. (1992). *Learning mathematics through inquiry.* Portsmouth, NH: Heinmann.

Borko, H., & Putnam, R. (1996). *Learning to teach.* In R. Calfee & D. Berliner (Eds.), Handbook of educational psychology (pp. 673-708). New York: Macmillan.

Brickhouse, N. (1990). Teachers' beliefs about the nature of science and their relationship to classroom practice. *Journal of Teacher Education,* 41, 53–62.

Cuevas, P., Lee, O., Hart, J., Deaktor, R. (2005). Improving science inquiry with elementary students of diverse backgrounds. *Journal of Research in Science Teaching,* 42(3), 337–357.

Duschl, R.A., & Wright, E. (1989). A case study of high school teachers' decision making models for planning and teaching science. *Journal of Research in Science Teaching*, 26, 467–501.

Eick, C. J. & Reed, C. J. (2001). What makes an inquiry-oriented science teacher? The influence of learning histories on student teacher role identity and practice. *Science Teacher Education,* 402-416.

Flick, L. (1995, April). Complex instruction in complex classrooms: A synthesis of research on inquiry teaching methods and explicit teaching strategies. Paper presented at the meeting of the National Association for Research in Science Teaching, San Francisco, CA.

Fraser-Abder, P., Atwater, M., & Lee, O. (2006). Research in urban science education: An essential journey. *Journal of Research in Science Teaching,* 43(7), 599-606.

Friedrichsen, P. J. (2002). A substantive-level theory of highly-regarded secondary biology teachers' science teaching orientations. Unpublished doctoral dissertation, Pennsylvania State University.

Fuhrman, S. (2001). The policy influence of education R&D centers. Testimony to The U.S. House Committee on Education and the Workforce. 107th Cong., 1st Sess.

Gallagher, J. J. (1991). Interpretative research in science education. NARST Monograph number four, Manhattan, KS: Kansas State University.

Goodson, I. (1992). *Studying teachers' lives*. New York: Teachers College Press.

Helms, J. (1998). Science- and me: Subject matter and identity in secondary school science teachers. *Journal of Research in Science Teaching,* 35, 811-834.

Jarrett, D. (1997). *Inquiry strategies for science and mathematics learning, It's just good teaching*. Northwest Educational Laboratory, Portland, Oregon.

Keys, C.W., & Bryan, L.N. (2001). Co-Constructing inquiry-based science with Teachers: Essential research for lasting reform. *Journal of Research in Science Teaching,* 38 (6), 631-645.

Knapp, S.A., & Plecki, M.L. (2001). Investing in the renewal of urban science teaching. Journal of Research in Science Teaching, 38 (10), 1089-1100.

Krystyniak, R.A., & Heikkinen, H.W.(2007). Analysis of verbal interactions during an Extended, open-inquiry general chemistry laboratory investigation. *Journal of Research in Science Teaching, 44,* (8), 1160-1186.

Lowden, C. (2005). Evaluating the impact of professional development. *The Journal of Research in Professional Learning,* 1-22.

Luft, J. (2001). Changing inquiry practices and beliefs: The impact of inquiry-based Professional development program on beginning and experienced secondary Science teachers. The effects of professional development on science. *International Journal of Science Education,* 23 (5), 517-534.

Marx, R. W., Blumenfeld, P. C. Krajcik, J. S., Fishman, B., Soloway, E., Geier, R., & Tal, R. T. (2004). Inquiry-based science in the middle grades: Assessment of learning in urban systemic reform. *Journal of Research in Science Teaching,* 41 (10), 1063-1080.

Maxwell, J.A. (1996). *Qualitative research design: An interactive approach.* London: Sage.

Mid-continent Research for Education and Learning (1997). Delivering research and practical guidance to educators. Retrieved December, 20, 2007, from: http://www.mcrel.org/standards-benchmarks/docs/purpose.asp

Moscovici, H. & Nelson, T. H. (1998). Shifting from activity-mania into inquiry. *Science and Children* 35(4), 14-17.

Murrell, P. (2001). *The community teacher: A new framework for effective urban teaching.* New York: Teachers College Press.

National Assessment of Educational progress. (2007). Science Framework for the 2009 National Assessment of Educational Progress. Retrieved December, 20, 2007, from: http://www.nagb.org/frameworks/naep_science_framework_2009_re.doc

National Center for Education Statistics, Science Highlights: The Nation's Report Card (2000). Washington DC: U.S. Department of Education, Office of Educational Research and Improvement.

National Commission on the Mathematics and Science Teaching for the 21st Century (2000). Before It's Too Late. Retrieved February 23, 2007 from *http://www.ed.gov/inits/Mathematics /glenn/report.pdf. 47.*

National Research Council (1996). *National science education science standards.* Washington, DC: National Academy of Science.

National Research Council. (2000). Inquiry and the national standards: A guide for teaching and learning. Washington, DC: National Academy Press.

National assessment of educational progress (1996). Report card for the nation and states CY O'Sullivan, CM Reese, J Mazzeo - 1997 - Washington, DC: National Center for Educational Statistics.

Proweller, A., & Mitchener, C. P. (2004). Building teacher identity with urban youth: voices of beginning middle school science teachers in alternative certification program. Journal of Research in Science Teaching, 41 (10), 1044-1062.

Schneider, R.M., Krajcik, J., & Blumenfeld, P. (2005). Enacting reform-based materials: The range of teacher enactments in reform classrooms, Journal of Research in Science Teaching, 42(3), 283-312.

Scott, S. B., Bergeman, C. S., Verney, A., Longenbaker, S., Markey, M. A., & Bisconti, T. L. (2007). Social support in widowhood: A mixed methods study. Journal of Mixed Methods Research 1 (3) 242-266.

Supovitz, J.A., & Turner, H.M. (2000). The effects of professional development on science teaching practices and classroom culture. Journal of Research in Science Teaching, 37, 963-980.

Smith, T.M., Desimone, L.M., Zeidner, T.L., Dunn, A.C., Bhatt, M., & Rumyantseva,

N.L. (2007). Inquiry-oriented instruction in science: who teaches that way? Educational Evaluation and Policy Analysis, 29 (3), 169-199.

Smith, M.S., & O'Day, J. (1991). Systemic school reform. In S. H. Fuhrman, & B. Malen (Eds.), The politics of curriculum and testing (Politics of Education Association Yearbook, 1990) (pp. 233-267). London: Taylor & Francis.

Smylie, M.A. (1989). Teachers' views of the effectiveness of learning to teach. The Elementary School Journal, 89 (5), 543-558.

Smylie, M.A. (1996).From bureaucratic control to building human capital: The importance of teacher learning in education reform. *Educational Researcher*, 25 (9) 9-11

Strauss, A. & Corbin, J. (1990). Basics of qualitative research: Grounded theory procedures and techniques. Newbury Park: Sage.

Tobin, K., Roth, W.H., & Zimmermann, A. (2001). Learning to teach science in urban schools. Journal of Research in Science Teaching, 38, 941-964.

Tobin, K., Seiler, G., & Walls, E. (1999). Reproduction of social class in the teaching and learning of science in urban high schools. Research in Science Education, 29, 171-187.

Tobin, K., Tippins, D. J., & Gallard, A. J. (1994). Research on instructional strategies for teaching science. In D. L. Gabel (Ed.), Handbook on research on science teaching and learning (pp. 45-93). New York: Macmillan.

U.S. Census Bureau. (2000). Metropolitan area population estimates for July 1, 1990

Retrieved December, 20, 2007, from: www.census.gov/population/www/estimates/metropop.html.

U.S. Department of Education. (2007). Science framework for the 2009 national Assessment of educational progress. Washington, DC: U.S. Government Printing Office.

Volkman, M. J. & Zgagacz, M. (2004). Learning to teach physics through inquiry: The lived experience of a graduate teaching assistant. Journal of Research in Science Teaching, 41 (6), 584-602.

Von Secker, C. (2004). Science achievement in social context: Analysis from National Assessment of Educational Progress. Retrieved March 27, 2007, from: www.reorbit.com/news/display/?id=101784

Wallace, S. W. & Kang, N. (2004). An investigation of experience secondary science teachers' beliefs about inquiry: An examination of competing belief sets. Science Education, 41 (9), 936-960.

Wenger, E. (1998). Communities of practice: Learning, meaning, and identity. Cambridge University Press, New York.

Zeicher, K. (1993). Individual and institutional factors related to the socialization of beginning teachers. In Griffin & H. Hukill (Eds.), First years of teaching: What are the pertinent issues? (1-59). Austin: University of Texas, Research & Development Center for Teacher Education.

Table 1. Teacher Perception of Inquiry

Item	1-Rudimentary	2-Developing	3-Proficient	4-Accomplished
Please indicate your skill level in teaching science	0%	18%	43%	36%
Please indicate your level of understanding of what science inquiry means	3%	18%	39%	39%
Indicate your skill level in using inquiry to teach science	0%	36%	41%	21%
Indicate your skill level in using open ended questioning in teaching	0%	23%	44%	31%

Note: Knowledge and skills of teaching science as inquiry

Table 2. Resource Use

Item	1-Never	2-Rarely	3-Sometimes	4-Often
Textbooks	0%	21%	28%	44%
Laboratory	3%	10%	49%	31%
Commercial Kits	28%	13%	39%	13%
Technology	0%	10%	23%	59%
Internet	13%	18%	26%	33%
Commercial Software	13%	18%	26%	33%
Community	26%	46%	15%	3%

Note: Indicate how often you use the following resources