Exploring Mental Models of Science Teachers using Digital Storytelling

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Abstract

Teachers possess certain beliefs - opinions or perceptions accepted as truth - based on their past experiences which they bring with them to the classroom (Norman, 1983). These beliefs shape their reality and give them the confidence to try new things, ask new questions, or question their existing beliefs (Dervin, 2003). This article discusses the use of drawings, written narratives, and digital stories to examine the beliefs that science teachers have about their teaching of science. There have been previous studies that have examined teachers' beliefs about science teaching using drawings and written narratives. The use of digital stories in this study was piloted as an additional assessment for analyzing teacher beliefs.

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Theoretical Framework

The research for this pilot study is grounded in mental model theory. Mental models consist of beliefs, ideas, images, and verbal descriptions that people form from past experiences and which guide thoughts and actions (Johnson-Laird, 1999). These representations of perceived reality explain cause and effect, give meaning to events, and cause individuals to behave in certain ways (Jarvelin & Wilson, 2003). According to Libarkin, Beilfuss and Kurdziel (2003), "a person's mental model reflects his/her belief system, acquired through observation, instruction, and cultural influences (p. 123). Norman (1983) proposes that 'in interacting with the environment, with others, and with the artifacts of technology, people form internal, mental models of themselves and of the things with which they are interacting. These models provide predictive and explanatory power for understanding the interaction" (p. 7).

Individuals have numerous internal representations, or mental images (Veenema & Gardner, 1996) and many of these representations are difficult to change (Jarvelin & Wilson, 2003). One reason that mental models are so significant is that individuals are reluctant to give them up (Foreman-Wernet, 2003). However, mental models, or the mental images that an

individual has, can be changed through the development of new knowledge or the change in a situation that brings forth an adaptation of an already existing mental model.

According to Nespor (1987), beliefs are drawn from past experiences in an individual's life. Beliefs tend to be strong predictors of behavior and influential in determining how individuals organize and define tasks and problems. Furthermore, Nespor proposes that these mental images from past experiences later impact an individual's teaching practices. Additional research suggests that teachers' belief systems significantly influence the perceptions they have about their teaching (Calderhead, 1988; Clark, 1988; Goodman, 1988; Calderhead & Robson, 1991).

Methodology

We chose to use the case study design for this research to allow greater depth of evaluation of individual participant data (Merriam, 1988). We were interested in investigating the use of digital stories in assessing the mental models of teachers. How does the use of digital stories as a data source provide evidence about the beliefs science teachers have about science teaching?

Participants

Three in-service teachers from low income, high minority school districts in a large urban setting in the south central United States were purposely selected for this study due to their accessibility. They were participating in a university-sponsored professional development program for science teacher mentoring held on the university campus. Their participation in this study was not related to the professional development program nor did the researchers participate in the program. They were instructed about the purpose of the study and gave consent for their participation, agreeing to complete surveys, create a digital story, and participate in follow-up discussions and the sharing of their stories with the researchers.

All three teachers are female and two are of Hispanic and one of Caucasian ethnic backgrounds. Two teachers had been teaching for four years and one had been teaching for nine years. For the purpose of this article, the three cases have been abbreviated in the findings section and pseudonyms are used for each teacher.

Data Collection

The three primary sources of data collected from the three participants consisted of drawings and written narratives derived from the Draw-A-Science-Teacher-Teaching Checklist (DASTT-C), self-reflective scores on the DASTT-C Teaching Styles Continuum, and analysis of individual digital stories. Case studies were then constructed to highlight similarities and differences across the teachers. The researchers collectively created the cases and met regularly to share perspectives drawn from each case. Mental model theory provided the theoretical framework for describing and explaining the teachers' beliefs about their science teaching. The drawings, written narratives, and digital stories were used as sources of evidence for analyzing the mental models.

The three teachers were asked to complete the DASTT-C survey and the DASTT-C Teaching Styles Continuum on the same day. In addition, they were given the digital story assignment, using the same prompt as used for the DASTT-C. They orally presented the digital stories four months after receiving the assignment, followed by a reflective discussion session with the researchers. This session allowed for the teachers to further explain their digital stories and clarify any misconceptions.

Draw-A-Science-Teacher-Test-Checklist (DASTT-C)

This study is an extension of earlier and extensive research in science education using drawings as a methodological tool in examining the beliefs and mental images teachers and students have about scientists and science teachers. The development and conceptual framework of the DASTT-C relates to the Draw-A-Man-Test (Goodenough, 1926), the Draw-A-Scientist Test (DAST) (Chambers, 1983) and the Draw-A-Scientist Test Checklist (DAST-C) (Finson, Beaver, & Crammond, 1995). Based on the research by Goodenough (1926), Chambers (1983) developed the Draw-A-Scientist Test (DAST) to provide information regarding children's perceptions of scientists. Finson et al. (1995) developed the Draw-A-Scientist Test Checklist (DAST-C) to facilitate ease of assessment. The DAST-C was further modified by Thomas, Pederson, and Finson (2001) to include elements judged to be characteristic of science classrooms and science teachers, calling the revised instrument the Draw-A-Science-Teacher Test Checklist (DASTT-C). This test was initially designed to analyze the beliefs of elementary preservice teachers prior to course work in an elementary science methods course.

The DASTT-C instrument (see Appendix A) consists of a sheet of paper with the prompt: *Draw a picture of yourself as a science teacher at work* and a space to write a brief narrative explaining the drawing with the two prompts: *What is the teacher doing? What are the students doing?* The descriptive narrative is used to assist in the scoring of the drawings. The DASTT-C rubric (see Appendix B) is divided into three sections that focus on the teacher, students, and the teaching environment, with a range of possible scores of 0-13 (the higher the score, the more teacher-centered the image). Each section is further divided into subsections where each item in each subscale depicts teacher-centered elements of the teaching and classroom images. The Teacher section is divided into two subsections that focus on what the teacher is doing and his/her location in the classroom while teaching. There are also two subsections in the Student section that focus on what the students are doing and where they are located in relation to the teacher. The Environment section consists of five subsections related to the elements found inside science classrooms, such as the arrangement of desks and the presence of science and laboratory equipment and teaching materials. Internal reliability of the DASTT-C was determined to be Kuder-Richardson 20 = 0.82 and validity of content was determined by a panel review of five individuals (Thomas et al., 2001).

The drawing scores from the DASTT-C rubric were initially organized into two distinct categories: teacher-centered (scores of 6.5-13) and student-centered (scores of 0-6.5) (El-Deghaidy, 2006). Thomas et al. (2001) define teacher-centeredness as a model where "the teacher is the knowledge conduit and the classroom environment is organized to facilitate the teacher as the knowledge conduit. Student input is acknowledged but not expected and the learning curriculum is focused on specific outcomes" (p. 293). In contrast, Thomas et al. (2001) define student-centeredness when "the classroom environment is open and encourages student

inquiry and exploration. Students manage their own learning and generally set the direction in which lessons proceed" (p. 298). Finson, Thomas, and Pedersen (2006) later refined the analysis of the scoring of the drawings, grouping the scores into three ranges on a continuum with scores of 0-4 classified as Exploratory or inquiry/constructivist in teaching style; scores of 5-9 considered Conceptual but not truly constructivist in their teaching style; and scores of 10-13 as Explicit or expository/didactic.

DASTT-C Teaching Styles Continuum

In this study, as modeled in a study by Finson et al. (2006), the teachers also self-reflected about their primary teaching style using the DASTT-C Teaching Styles Continuum (see Appendix C), derived from Simmons et al. (1999). As defined by Finson et al. (2006), exploratory teaching is represented by student-centered images in which students are actively engaged and the teacher is facilitating instruction. Conceptual teaching is represented in the drawings by images with students at the center, but containing more images of the teacher directing conceptual understandings and showing students engaged in investigations with some materials. Explicit or didactic teaching is represented by images where the teacher is the central image, giving out information, while students are passive.

Digital Stories

Our study sought to investigate the mental models of the three teachers beyond the data collected from drawings and narratives as done in previous studies. Thus, after completion of the drawings, written narratives, and self-reflections, we asked the teachers to construct a three to five minute multimedia digital story composed of a mix of images, video, music and/or text using a modified prompt from the DASTT-C: *Develop a digital story of yourself as a science teacher at work.* The teachers then attended a workshop in the computer lab on how to develop digital stories and use them as an instructional tool in the classroom. Four months later, the teachers orally presented their digital stories to the researchers, followed by a reflective discussion session.

The Collins English Dictionary (n.d.) defines a **narrative** (or **story**) as any account that presents connected events and experiences to an audience. A narrative will consist of a set of events (the story) told in some form or process of narration (or discourse) in which the events are arranged in a particular order (the plot). Narrative inquiry uses stories, autobiographies, journals, field notes, letters, conversations, interviews, photos, and videos to research and understand the way people create meaning in their lives as narratives (Riessman, 1993). According to Heo (2004), "narrative inquiry is a way of understanding, organizing and communicating experience as stories, lived and told" (pg. 230). Pedersen (1995) describes storytelling, a form of narrative inquiry, as one of the first instructional strategies in teaching. Storytelling allows an individual to make sense of the external world through the expression and creation of stories (Bruner, 1990).

Digital storytelling is an adaptation of storytelling and utilizes multimedia tools to engage individuals in "authentic learning experiences that provide real world relevance and personal value within a situated context" (Walters, Green, Wang, & Walters, 2010, p. 42). Digital storytelling uses computer-based tools to tell stories (Yuskel, Robin, & McNeil, 2011) and is described as merging "a personal story with video, still-frame imagery, music, and voice to create a personal multimedia story" (Jakes, 2005, p. 1). Digital stories combine still images and

sound (Jenkins & Lonsdale, 2007) and has the capability of integrating technology with content, facilitating an emotional connection to that content, and allowing for the sharing of that content with others (Kieler, 2010). The Digital Storytelling Association further defines digital storytelling as

> The modern expression of the ancient art of storytelling. Throughout history, storytelling has been used to share knowledge, wisdom, and values. Stories have taken many different forms. Stories have been adapted to each successive medium that has emerged, from the circle of the campfire to the silver screen, and now the computer screen (Matthews-DeNatale, 2008, p. 2).

Moon's Map of Learning

The DASTT-C was developed and validated to analyze teachers' mental models using still images or drawings. Our initial methodology of using the DASTT-C for further analysis of the digital stories indicated its limitations towards their assessment. Because the intent of the use of digital stories in this study was to encourage teacher reflection about their teaching of science, we then analyzed the digital stories using Moon's Map of Learning (1999), developed as a means of "analyzing the events of learning in order to locate reflection" (Moon, 1999, p. 152). This five stage model demonstrates the stages in the reflective learning process as: 1) Noticing (memorized representation); 2) Making Sense (reproduction of ideas, ideas not well linked); 3) Making Meaning (meaningful, well integrated, ideas linked); 4) Working with Meaning (meaningful, reflective, well structured); and, 5) Transformative Learning (meaningful, reflective, restructured by learner, creative).

Data Analysis

Using the constant comparative method of grounded theory (Strauss & Corbin, 1990), the research team began data analysis after the oral presentations of the digital stories and continued throughout the study. The researchers' goals in analyzing the data and constructing the cases were to understand the participants' mental models as derived from several sources. Analysis was ongoing and continually informed the data collection process. As recommended by Merriam (1988), internal validity was established through triangulation with multiple researchers, sources of data, and methods to confirm the findings. The teachers were informed about how their stories and drawings were to be used as a pilot research study and agreed to participate. Unfortunately, over a year occurred from the time the teachers presented the stories to data analysis. Due to this unexpected delay and subsequent non-responses from the teachers in follow-up communication, the researchers were not able to share their analysis and conclusions back with the teachers as participant check.

This study attempted to uncover more information regarding the mental models of the teachers that was initially drawn from the drawings and narratives. The DASTT-C scores of each drawing were compared to the self-reflective scores on the DASTT-C Teaching Styles Continuum. Then the digital stories were initially analyzed using the continuum and the DASTT-C rubric and those findings were compared to the drawings and narratives.

Findings

Susan

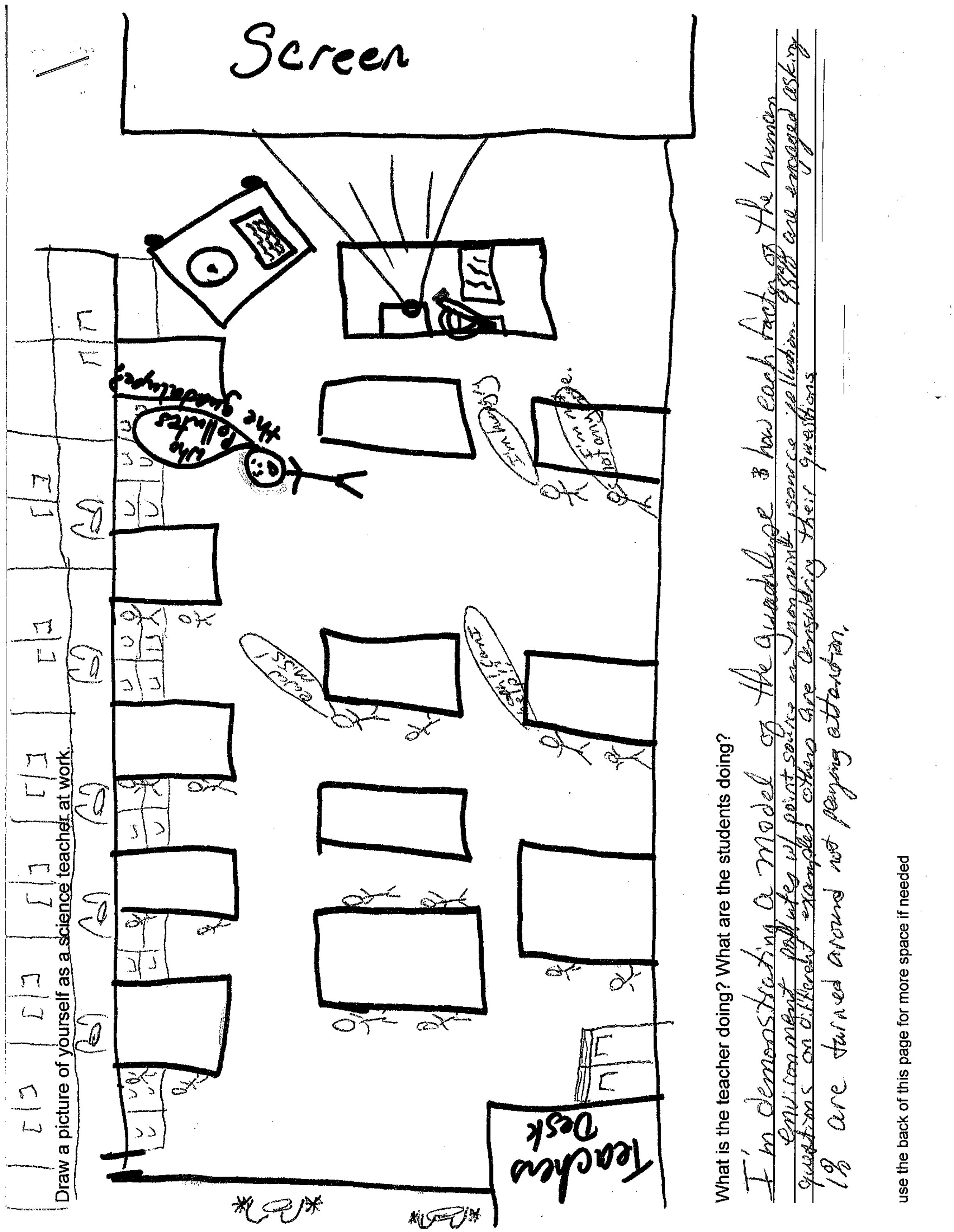
Susan is a white female who has been teaching for four years. She received her Bachelor of Science degree in Multidisciplinary Sciences with teacher certification in General Science (grades 8-12). At the time of the study she was teaching 6th – 8th grade science at a middle school in an urban, inner city school district with a high Hispanic student population (over 90%).

An analysis of Susan's drawing and written narrative (see Figure 1) indicated a total score of 12 (out of 13) on the DASTT-C rubric, which falls in the category of Explicit (scores 10-13) or teacher-centeredness. She drew the teacher standing as the head of the class, lecturing with one visual aid (overhead projector), which indicated teacher-centeredness. The balloon drawn from her mouth indicated she is asking a question about the lecture. The students are seated at lab tables arranged in rows, again indicating teacher-centeredness. Around the room is counter space drawn with multiple sinks. One balloon drawn from a student's mouth indicated disengagement: "I'm hungry." Two other students are shown with balloons indicating interest and seeking attention: "Eww Miss!" and "Oh! Can I help!?" A total of 20 students were drawn sitting at empty lab tables with no signs of verbal or physical interaction. The only science equipment drawn, a single microscope is on the teacher's desk along with an overhead projector and a text. The students' desks are drawn empty of any equipment, materials, textbooks, and even paper. Susan's written narrative, as cited below, also mirrors the didactic teaching style of her drawing:

> I'm demonstrating a model of the Guadalupe River and how each fact of the human environment pollutes with point source or nonpoint source pollution. 98% of students are engaged asking questions on different examples; others are answering their questions. 1% are turned around not paying attention."

In comparing Susan's drawing to her self-reflective analysis of her teaching style on the DASTT-C Teaching Styles Continuum, she reports herself also as being teacher-centered and considers herself to be Explicit or didactic in some areas and Conceptual in others. She indicated on the continuum that "students need themed, conceptual learning experiences" and that "tests check for understanding of important concepts." Both of these beliefs indicate more of a Conceptual teaching style rather than Explicit. However, she also indicated that "curriculum is focused on specific outcomes, that the teacher is the knowledge conduit (telling is teaching), the teacher initiates activities, and student input is acknowledged but not expected" – all elements identified as Explicit or didactic teaching style on the DASTT-C Teaching Styles Continuum.

Figure 1


Screen
Teacher Desk
Draw a picture of yourself as a science teacher at work.
What is the teacher doing? What are the students doing?
use the back of this page for more space if needed

Susan's digital story at first viewing appeared to be in direct contrast to her drawing, narrative, and self-reflection of her teaching style. The DASTT-C Score Sheet used for the drawing was used initially to score the digital story, with a total score of 5 (out of 13). This score indicates more student-centeredness. The digital story contained many images of her classroom environment with multiple science equipment (microscopes, beakers, balance beams, pH meters) and some symbols of teaching (computers, chalkboard) shown on her lab desk and on counter space in the room. Students in a few images are shown seated but not directly involved in an activity. She is not in any of the pictures and there is no narration to the story that would indicate her involvement in the teaching process. Thus, because of the absence of images of her teaching, the DASTT-C score for the digital story indicates no elements of teacher-centeredness related to her teaching in her digital story.

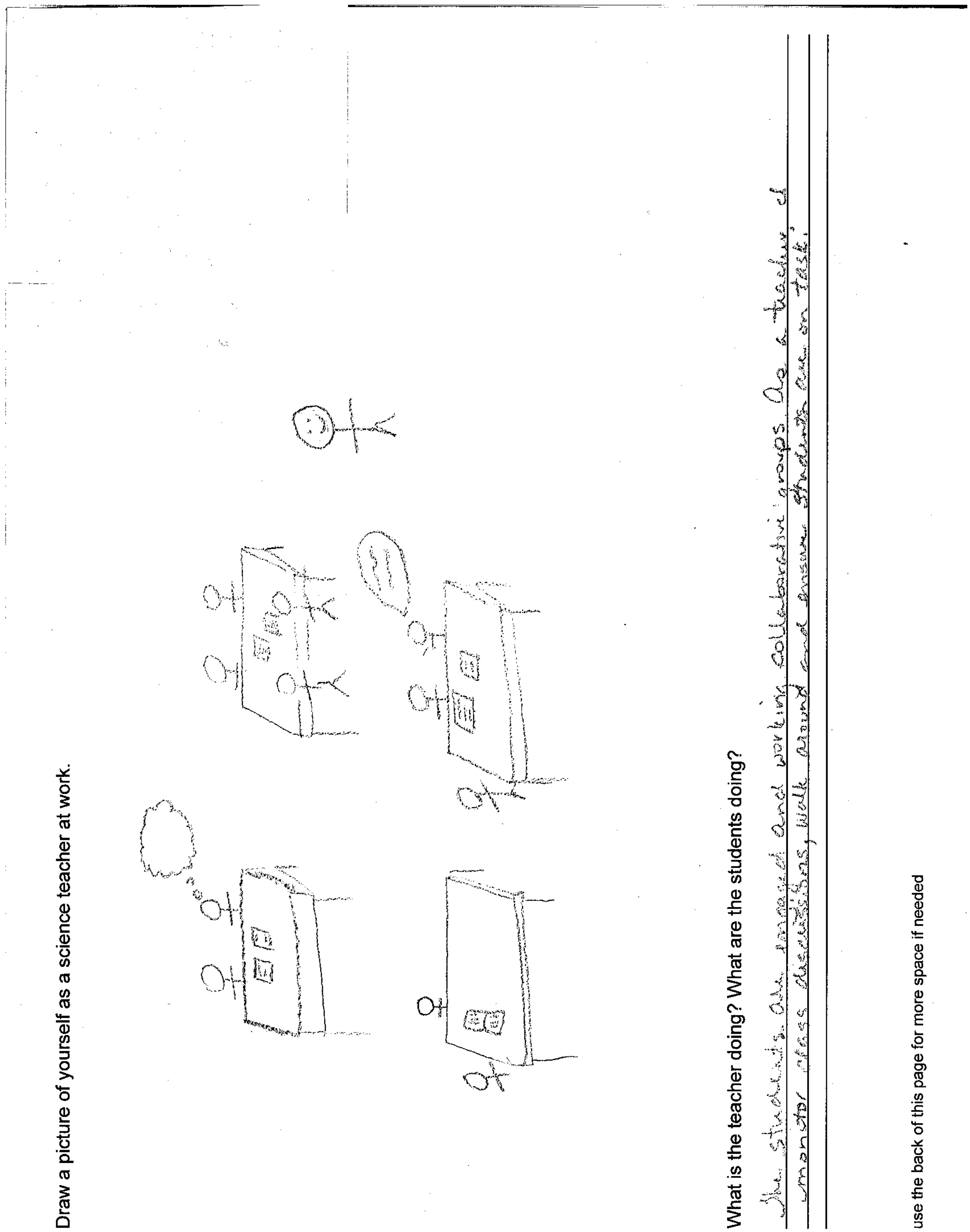
However, in a more in-depth review of the digital story, it was determined that her digital story did support her teacher-centeredness as demonstrated in her drawing and narrative, but in a different way not measurable by the DASTT-C rubric. A caption at the beginning of her story stated "Welcome to the World of Ms. Susan," reflecting the teacher-centeredness of the story. Half of the digital story showed images of her with family and friends on extended trips, highlighting topics in her travels that informed her teaching. Because she as a teacher was not in the images, the Teacher subsection as identified by the DASTT-C rubric could not be scored, causing a low total score that reflects more student-centeredness. However, her digital story was more about her and less about the students which supported her drawing and written narrative as a teaching style of teacher-centeredness.

Anna

Anna is a Hispanic woman who has been teaching science for 11 years. She has a Master of Arts in Education degree and at the time of the study was teaching 6th - 11th grade science at an interdisciplinary science and arts magnet school. The school serves a low socioeconomic Hispanic (98%) student population.

Anna's drawing (see Figure 2) scored a 5 (out of 13) on the DASTT-C rubric, indicating a conceptual style of teaching (scores 5-9), yet leaning toward exploratory (scores 0-4) or student-centeredness style of teaching. Anna drew students working in groups, an example of student-centeredness, and noted in her written narrative that her role was to "monitor class discussions, walk around and ensure students are on task." One student was drawn with an empty bubble indicating talking while another student had a thought cloud drawn overhead. There were papers or books on the student desks but no science equipment. Anna indicated in the reflective discussion session after the oral presentation of her digital story that her teaching placement had a prescribed curriculum in science with some freedom for implementation.

Figure 2


Draw a picture of yourself as a science teacher at work.
What is the teacher doing? What are the students doing?
The students are engaged and working collaborative groups. As a teacher I monitor class discussions, walk around and ensure students are on task.
use the back of this page for more space if needed

Anna's conceptual style is further supported by her self-reflective analysis on the DASTT-C Teaching Styles Continuum. She identified heavily with conceptual statements noting she "believes students need themed, conceptual learning experience," and content should be "exploratory, organized around key concepts." Anna's tendency towards an exploratory style is exemplified by her perception of the role of the teacher is to "lead and guide student activities/investigations."

An analysis of Anna's digital story supports her drawing and written narrative as conceptual, leaning towards a more exploratory approach with much of the story representing cross-disciplinary content. Digital images of a variety of school activities were shown with story text indicating how science concepts are integrated with other subjects. An image of a choral concert was correlated to characteristics of sound waves. Text is used to point out a symphony concert as an example of the laws governing motion. A photo of students standing in front of a large mirror in a dance studio is related to how bodies grow.

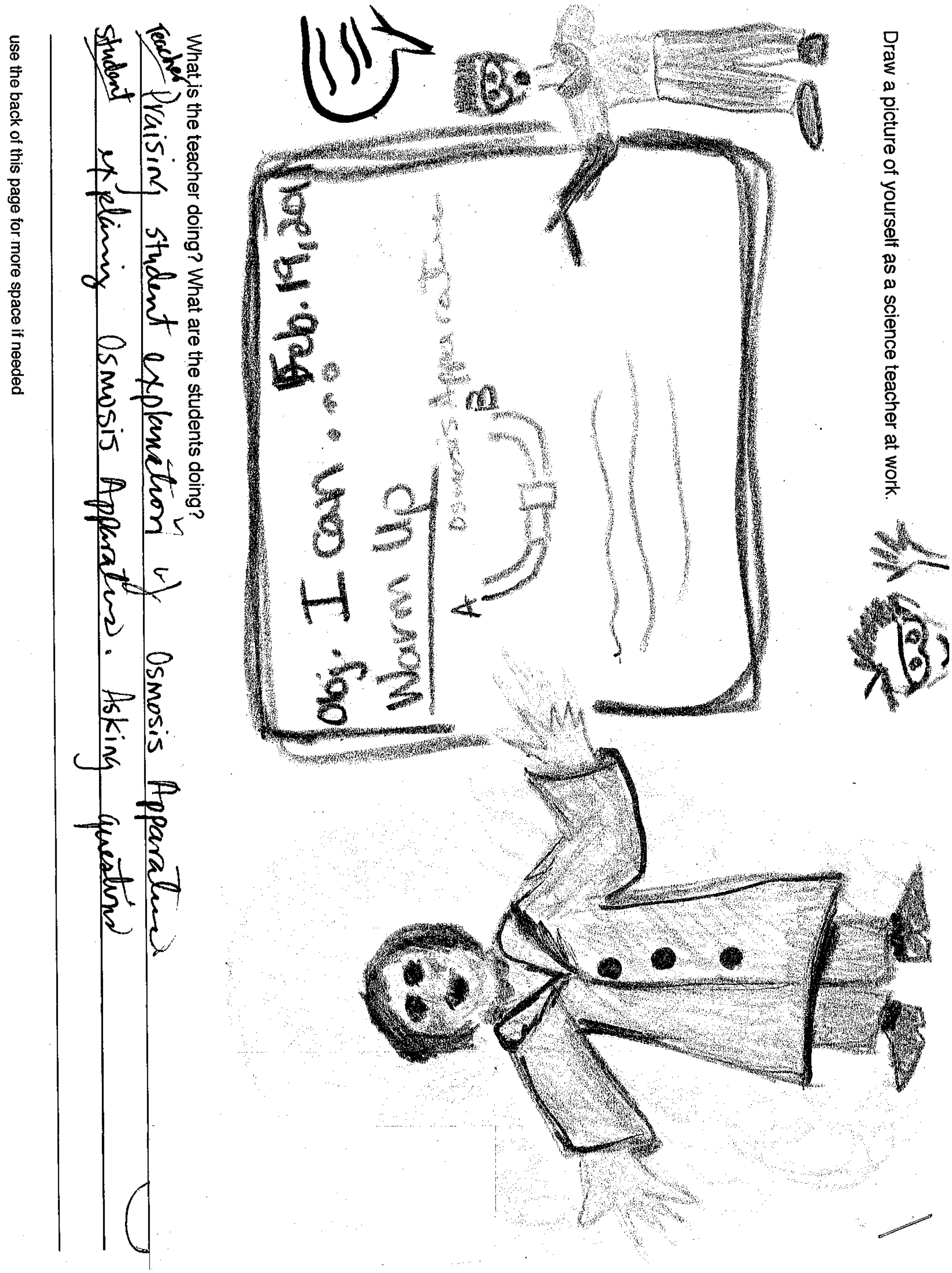
In addition, her digital story was reflective of both a personal and professional relationship with her school. Through narration, she indicated she grew up in the school neighborhood, currently lives there, and has interactions with students outside of school. Anna narrates in her story that: "There are advantages and disadvantages to living where I work. I can no longer just stop and shop at local grocery stores." Following this text, she displays a humorous cartoon image of a woman in her house robe and hair curlers standing in the milk aisle of the grocery store. Although she alluded to potential challenges of intertwining her personal and professional lives, Anna's digital story showed her pride in her school district and the teaching profession. The final image is evidence of Anna's pride in her career choice as she ends her story with the quotation, "Teaching is the profession that teaches the other professions."

Christina

Christina is a Hispanic female who has been teaching for four years. At the time of the study she was teaching 9th-10th grade Integrated Physics and Chemistry (IPC) and Biology at a high-need urban school with over 92% Hispanic student population. Christina received her Bachelor of Science and Master of Arts in Education degrees and holds a teaching certification in General Science (grades 8-12).

An analysis of Christina's drawing and written narrative (see Figure 3) indicated a total score of 6 (out of 13) on the DASTT-C rubric, which falls in the category of conceptual (scores 5-9) or teacher-centered. Christina drew a science teacher in a lab coat demonstrating osmosis using a visual aid (chalkboard) and lecturing. There are only two students in the picture; one is asking a question (hand raised) and one is answering a question (balloon with lines for text). Both students are wearing goggles (science equipment) and one student is seated while the other student is pictured standing. Christina has drawn no desks in the picture, including no teacher's desk. Christina drew a picture of a chalkboard (symbol of teaching) on which were listed objectives for the day. Her written narrative contained two sentences "Teacher - praising student's explanation of osmosis apparatus" and "Student - explaining osmosis apparatus. Asking questions."

Figure 3


Draw a picture of yourself as a science teacher at work.
What is the teacher doing? What are the students doing?
Teacher: Praising student explanation w/ Osmosis Apparatus
Student: explaining Osmosis Apparatus. Asking questions
use the back of this page for more space if needed

In comparing Christina's drawing to the teaching style she chose on the DASTT-C Teaching Style Continuum, she reported herself as being more exploratory (student-centered) and somewhat conceptual. She indicated on the teaching style continuum that "students are capable of managing their own learning" and that "teachers lead and guide activity." Christina's self-reported beliefs are more student-centered on the continuum than her drawing score indicated.

Christina's digital story was initially analyzed using the DASTT-C rubric and scored a 5 (out of 13). This score indicates a teaching style as conceptual (scores 5-9) but leaning more toward the Exploratory (student- centered). Her digital story focused on a lab activity where her students in small groups are sitting at lab tables looking at flowers. Christina narrates the video as if teaching a lesson, using direct instruction in identifying the parts of the flower for them. The digital story never shows any images of Christina teaching. Her digital story score using the DASTT-C rubric was consistent with her self-reflected score on the continuum, both as student-centered. However, Christina's involvement in the teaching process is indicated only through narration but no images of her teaching appear in the story, thus leading to the lower score on the DASTT-C rubric. After additional analysis, it was determined that her digital story is more reflective of teacher-centeredness as was her drawing, with her using direct instruction where students are passive during the lesson.

Discussion

Drawings and written narratives were used in this study initially to investigate the mental images or beliefs that three science teachers had about their teaching styles. As Weber and Mitchell (1996) state, drawings can be used for the evaluation of personal identities, influenced by past experiences, and sometimes are in contrast to actual practice. However, as cautioned by Markic and Eilks (2008), the use of drawings to identify conceptions about science teaching is just a 'snap-reading method of observation,' capturing a specific moment, or in this case specific mental images, in time. Thus, digital stories were added to this study to further investigate the teachers' mental models. The digital stories allowed for more teacher reflection in their development because of the ability of the teachers to reflect on and then choose what images best demonstrated their beliefs. According to Jenkins and Lonsdale (2007), "the choice of images and their association with the audio is important to the impact of the story" (p. 443) and assists in the reflective process. The teachers selected and sequenced images that meaningfully supported the content of their stories. The teachers were given four months to create their digital stories, in contrast to the thirty minute time period for their drawings. This expanded time period allowed for more time for reflection and revision in the production of the digital stories.

The authors agree with Thomas and Pedersen (2003) that the DASTT-C is an effective instrument in assisting teachers in identifying their own beliefs about how to teach science and to build a biographical understanding of self. According to Lortie (1975), an understanding of one's self may be a critical factor in learning how to teach, as teachers learn by the many teaching methods they themselves are exposed to as learners in the classroom. We also see that the use of digital stories along with the DASTT-C adds an opportunity for teachers to personally reflect on how their learning experiences have impacted their personal teaching beliefs. Sadik

(2008) concluded from the analysis of digital stories produced by high school students that "students were encouraged to think more deeply about the meaning of the topic or story and personalize their experience and also clarify what they knew about the topic before and during the process of developing and communicating their stories" (p. 502). We think the same was true for the three teachers in this study.

The digital stories were further analyzed using Moon's Map of Learning. Based on this model, the three digital stories examined in this study indicated varying stages of self-reflection. Upon analysis, Susan's story was classified as Level 3-Making Meaning, as she linked how her personal travels informed her teaching. Anna's story scored the highest level of reflection of the three cases, Level 4-Working with Meaning. Her story was reflective about her personal and professional relationships to her school and her teaching. In contrast, Christina's story scored a Level 2-Making Sense, where her story revolved around her teaching one specific lab activity, but not linked directly to her teaching style. Despite the variance in reflection levels among the three cases, the use of digital stories could be seen as a viable resource to encourage reflection and deep learning and a potential source of data regarding the level of that reflection.

We initially chose to use the DASTT-C rubric to score the digital stories. The rubric evaluates definite items in three distinct categories of teaching styles - the role of the teacher, the role of the student, and the environment in which the two interact. Our study concluded that the DASTT-C as written is not an appropriate assessment tool to analyze the digital stories. It was designed to analyze only one image drawn at one given time. In contrast, the digital stories consisted of multiple images drawn over time as in the compilation of a book of drawings that depicts the teachers' personal stories about how they perceived themselves as teachers. For the DASTT-C to be used to assess digital stories, the rubric needs to be modified to more adequately score the digital stories or the prompt for the digital stories needs to be more explicit. The three teachers in this study had the same prompt for the digital stories as the drawings, yet none of them included images or videos of themselves in the digital stories as teaching. They told their stories through the use of narrations and captions. Thus, this left incongruences between the rubric and the actual items in the videos. Did the teachers think that their role as a teacher was reflected in the narrations or captions they used in the digital stories rather than in videotaping their actual teaching? Thus, we recommend that the directions for the digital stories should include more specific guidelines on what should be included in the videos to ensure closer alignment with the DASTT-C assessment.

We believe that the true potential of the use of digital stories in the investigation of teacher beliefs lies in the connection of how their personal lives relate to their teaching. It was from the digital stories that we gained more insight into how the teachers valued that connection. Information about the teachers' personal lives could not be drawn from the drawings or the written narratives. In contrast, the digital stories included images and captions from personal travel, professional development workshops, surrounding neighborhoods, and interactions with colleagues. As an example, Anna expressed a personal value by using the caption that states: "As teachers we carry our children and teach them how to soar with the future." This personal value would not have been derived from just her drawing of herself teaching science. Digital stories as reflection artifacts can provide information "for researchers seeking insight beyond

participant self-reports to identify ways in which reflective processes can be evidenced (Walters et al., 2011, p. 49).

Conclusion

Narrative inquiry is the process of gathering information for the purpose of research through storytelling. According to Coulter, Michael and Poynor (2007), "narrative inquiry is widely recognized as a viable approach to conducting qualitative research" (p. 103). Narrative inquiry can be used in research because "humans are storytelling organisms who, individually and socially, lead storied lives. The study of narrative, therefore, is the study of the ways humans experience the world" (Heo, 2004, p. 2). Storytelling as a recognized form of narrative inquiry is a way for teachers to explore their professional identities (Hay & White, 2005) and to clarify their own thinking (Heo, 2004). Digital storytelling is an extension of narrative inquiry integrating modern technology (Walters et al., 2011).

According to Dogan and Robin (2009), "there are few research studies that show how digital storytelling can be used as an effective tool in the classroom, what effects can be observed on student learning, and what kind of problems can arise in the implementation process" (p. 2). Field notes, interviews, journals, letters, autobiographies, and orally told stories are all recognized methods of narrative inquiry. Because digital storytelling is the telling of stories using digital cameras, authoring tools, and computers to create short multimedia stories (Meadows, 2003), we propose that digital storytelling has potential as another data source when conducting narrative inquiry research. The digital stories of the teachers were accounts about their personal teaching styles, using events (the story) narrated through voice and/or captions (discourse) and arranged in a particular order (the plot). The teachers used digital tools to tell their 'story' about themselves as a teacher at work, focusing on the specific topic of describing themselves as teachers from their particular point of view.

In this study, the analysis of the digital stories informed us as researchers about the reflective process in which the teachers were engaged in the construction of their stories and gave us some insight into their mental models and beliefs about their teaching of science. Further research is recommended to determine the effectiveness of digital stories in teacher development as well as assessment of mental models. Digital stories as a refection artifact "can provide a window into the process of individual change, yielding important information for researchers seeking insight beyond participant self-reports to identify ways in which reflective processes can be evidenced" (Walters et al., 2011, p. 49). As expressed by Heilbrun (1988):

> What matters is that lives do not serve as models; only stories do that. And it is a hard thing to make up stories to live by. We can only retell and live by the stories we have read or heard. We live our lives through texts. They may be read, or changed, or experienced electronically, or come to us, like the murmurings of our mothers, telling us what conventions demand. Whatever their form or medium, these stories have formed us all; they are what we must use to make new fictions, new narratives. (p. 37)

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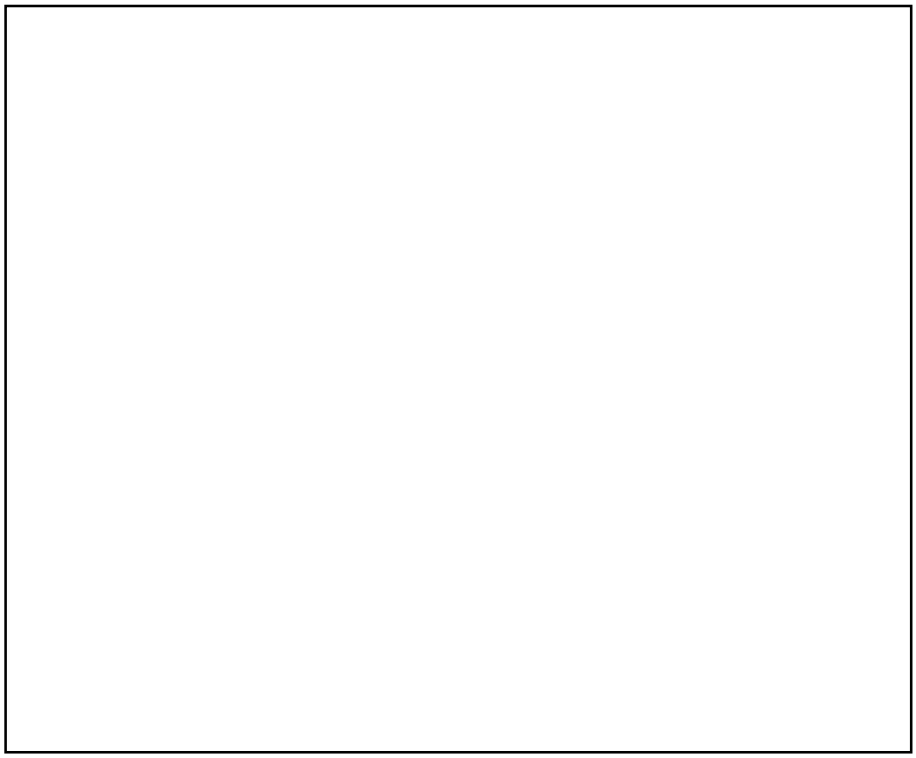
Appendix A:
DASTT-C Instrument

Location:_____

Preservice ( ) or In-service ( )

Draw a picture of yourself as a science teacher at work.



What is the teacher doing? What are the students doing?

Appendix B
DASTT-C Score Sheet

I. TEACHER
Activity
Demonstrating
Experiment/Activity
Lecturing/Giving Directions (teacher talking)
Using Visual Aids (chalkboard, overhead, and charts)
Position
Centrally located (head of class) Erect Posture (not sitting or bending down)

II. STUDENTS Activity
Watching and Listening (or so suggested by teacher behavior)
Responding to Teacher/Text Questions
Position
Seated (or so suggested by classroom furniture)

II. ENVIRONMENT
Inside
Desks are arranged in rows (more than one row)
Teacher desk/table is located at the front of the room
Laboratory organization (equipment on teacher desk or table)
Symbols of Teaching (ABC's, chalkboard, bulletin boards, etc.)
Symbols of Science Knowledge (science equipment, lab instruments, wall charts, etc.)

TOTAL SCORE (PARTS I + II + III) = _____

Appendix C

DASTT-C Teaching Styles Continuum

Exploratory (0-4)	Conceptual (5-9)	Explicit (10-13)
1. Teacher believes students are capable of managing their own learning.	1. Teacher believes students need themed, conceptual learning experiences.	1. Teacher believes students lack knowledge and need assistance in learning.
2. Curriculum is open to student interests.	2. Content is exploratory, organized around key concepts.	2. The curriculum is focused on specific outcomes.
3. Teacher leads and guides student activities/ investigations.	3. Teacher organizes the connections of content and processes of science.	3. Teacher is the knowledge conduit (telling is teaching).
4. Teacher focuses on student questions as an instructional goal.	4. Teacher-centered lessons include hands-on activities, group work, and	4. Teacher initiates activities. Student input is acknowledged but

Directions

1. Read across each row. Check the column that best describes your beliefs.

2. Add the check marks in each column.

3. Compare your column totals. How does your teaching style choice align with your DASTT-C score?