

The Contribution of Science Stories Accompanied by Story Mapping to Students' Images of Biological Science and Scientists

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Abstract

The purpose of this qualitative study was to examine how stories about science and scientists, presented over a 5 week period, influence grade eight students' images of biological science and scientists. The study included 151 students for pretreatment and 121 students for post treatment, with an age range of 14-15 years from an urban area. Data sources included "Draw a Biological Scientists Test" (DABST), "Myself as a Biological Scientist Test" (MABST), and a semi-structured interview. Results indicated that while students' stereotypic images of scientists were not eliminated, students acquired additional images relating to biological science and scientist. The implications and significance of the findings for future research and classroom practice are discussed. The findings will be useful for informing classroom practices in the teaching nature of science, enhancing scientific literacy, and developing suitable instructional materials for school biology curriculum.

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Introduction

Current science education reform urges that every student be frequently and actively involved in exploring the natural world in ways that resemble how scientists work (Luehmann & Markowitz, 2007). Understanding how scientists build, evaluate, and apply scientific knowledge in a scientific inquiry context is a core part of scientific literacy as a science curriculum goal (American Association for the Advancement of the Science [AAAS], 1993; Fensham & Harlen, 1999; Organisation for Economic Cooperation and Development [OECD], 2000). This is shown by its centrality in science education reform and national standards documents in the USA (AAAS 1990, 1993; National Research Council [NRC], 1996), the UK (Millar & Osborne, 1998), Israel (Tomorrow 98, 1992), and Germany (Ertl, 2006), and in international assessments that specify learning goals (Fensham & Harlen, 1999; OECD, 2000). Furthermore, the shifting emphasis of science education debate over the past 30-40 years is clearly reflected in the numerous slogans and rallying calls that have gained prominence, including "Being a Scientist for a Day" (from the early Nuffield science projects in the United Kingdom), "Learning by Doing", "Process, not Product", "Science for All" and "Children Making Sense of the World". From the mid-1990s onwards, much of the debate concerned another slogan - "Scientific Literacy" and how to achieve it (Hodson, 2002).

Students' images of science (Driver, Leach, Millar & Scott, 1996) and their images of scientists are widely accepted as an important aspects of their scientific literacy

(NRC, 1996) and have important implications for how they learn and engage with science in a classroom context (Hofer, 2001). While numerous studies have documented primary students' stereotypic images of scientists as sexist, racist, and asocial, few have examined instructional strategies effective in broadening these views. Studies (Solomon, Duveen, & Scott, 1994; Tao, 2003) involving intermediate and senior students have suggested that science stories can help students develop more authentic views of the nature of science. This article aims to present suitable instructional material for understanding the changes in students' images of biological science and scientists after experiencing science stories accompanied by story mapping in a biology unit, presented over a 5-week period, at the level of grade eight.

Literature Review

Science Stories in Science Education

Bruner (1991) distinguishes between two modes of thought: the paradigmatic and narrative mode. The paradigmatic mode focuses on “good theory, tight analysis, logical proof, sound argument, and empirical discovery guided by reasoned hypothesis”, whereas the narrative mode deals with “the particulars of experience and to locate the experience in time and place” (p. 13). Schank & Berman (2002) describe stories as a “sub-set” of narratives and define them as the “structured, coherent retelling of an experience or a fictional account of an experience” (p. 288). Narratives are constructed out of concern for the human condition (Bruner, 1991) and are, therefore, well suited for the portrayal of the work and lives of scientists (Sharkawy, 2006). Lemke (1990) recommends teachers “emphasize the human side of science: real activities by real human beings, both today and in specific periods of history. Personal characteristics of scientists, with which students can identify, should be emphasized rather than making scientists seem superhuman or alien” (p. 175-6).

As defined by Sharkawy (2006), science stories are “a natural vehicle/venue for placing science within a human context-revealing the relationships between various aspects of the world of science (the nature of scientific inquiry, the tentative nature of scientific knowledge, etc) and human actors”, (p.34). According to Koch (2004), science stories can be used to convey science as a human and social endeavor, and to teach nature of science and scientific work as an effective teaching strategy for the elementary and middle school science classrooms. In this context, the use of stories in science education has been the focus of increasing attention in recent years. Studies on using stories in science education have explored ways to improve students' understanding of some aspects of the nature of science and images of science and scientists (e.g., Gough, 1993; Harrison & Matthews, 1998; Sharkawy, 2006; Solomon et al., 1994; Tao, 2003). The important results from these studies are summarized below. Science stories

1. promote lifelong reading habits relating science and, potentially, a positive attitude towards learning science (Huck, Hepler, Hickman, & Kiefer, 2001; Negrete & Lartigue, 2004),
2. offer a way of amplifying emotions (Lotman, 1990),

3. help students become aware of scientific ideas and skills to investigate and solve scientific problems (Tao, 2003),
4. help students' understanding how scientists work, build, evaluate, and apply scientific knowledge in a scientific inquiry (Tao, 2003),
5. help to create a popular scientific culture that could benefit pupils' understanding of the humanist nature of scientific theory, as well as various controversial concepts (Solomon & Thomas, 1999),
6. help students develop explanations of scientific phenomena that represent important disciplinary understandings (Huck et al., 2001),
7. provide a cross-curricular link with other subjects such as language, social science, thereby drawing on and building on children's knowledge in all areas (Huck et al., 2001),
8. offer a meaningful, supported context for both the introduction and consolidation of science (Negrete & Lartigue, 2004),
9. develop scientific literacy (Gough, 1993, Harrison & Matthews, 1998; Solomon et al., 1994; Tao, 2003),
10. build connections between students' scientific knowledge and their understanding of everyday experiences (Gough, 1993; Harrison & Matthews, 1998; Solomon et al., 1994),
11. can have a strong effect on children's interest (Ellis & Brewster, 2002; Negrete & Lartigue, 2004; Woolnough, 1994), and
12. can motivate students and give them immediate access to the science topic by humanizing the subject matter (Egan, 1997) can broaden students' images of science and scientists (Sharkawy, 2006).

In this context, many authors recommend using stories for science education. For instance, Gough (1993) recommends that lessons should analyze cultural text with scientific content including narratives and historical accounts of scientific work, autobiographies of scientists, scientific journals, and images of science in the arts and in popular media. In a year-long study on students from 6th to 9th grades, Solomon et al. (1994) examined the impact of using stories featuring the activities of scientists, embedded in a historical context, to teach science concepts. Positive outcomes were reported for each of the five classes in terms of students' responses to the question, "Why do you think scientists do experiments?" Students' responses were categorized into three themes: 1) discoveries; 2) explanations; and 3) making helpful things.

Harrison & Matthews (1998) noted positive gains from introducing students to the lives of six scientists from diverse backgrounds. Students completed a reading and an oral presentation on the life of a scientist in small groups. At the end of the study, they found

that students drew more female and ethnically diverse scientists as well as more scientists working together.

Sharkawy (2006) investigated how stories about scientists from diverse socio-cultural backgrounds (i.e., physical ability, gender, and ethnicity) influence grade one students' images of science and scientists. The results of this study indicated that while students' stereotypical images of scientists were not eliminated, students acquired additional images more inclusive of less dominant socio-cultural backgrounds.

Evidence presented through the studies cited indicates that science stories can have a positive impact upon the elementary and secondary students' understanding of nature of science. It would seem, therefore, that science stories can be used at the primary school level, and that such instruction would broaden students' images of science and scientists. This is an important goal for primary school students in science. To fully achieve these goals in science classroom, ways must be found to present, more effective, science stories. Various instructional strategies can be used for this purpose. One such way involves the use of a story mapping approach.

Story Map/Mapping

As mentioned above, one technique that uses story components to foster comprehension of narrative texts is story maps. Story maps capture and organize the semantic content of text graphically, thus contributing to the schema-building process (Reutzel, 1984, 2001). According to schema theory, the correspondence between a reader's underlying knowledge structure (schemata) and the textual material determines the extent of comprehension (Barlett, 1932/1995; Idol & Croll, 1987). Readers use their schematic representations of text (narrative, compare/contrast, cause/effect, etc.) to help them interpret the information in the text. If the relevant schemata have led the reader to make appropriate inferences, the textual material makes sense to the reader and is consequently assimilated (Anderson, Reynolds, Schallert, & Goets, 1977; Idol & Croll, 1987).

Several instructional strategies including story maps logically follow from schema theory. This procedure, mapping stories by identifying important information about the characters and events presented therein, was first developed by Beck & McKeown (1981). Beck and her colleagues (Beck & McKeown, 1981; Beck, McKeown, McCaslin, & Burkes, 1979) characterized narrative text structure as consisting of setting, problem, goal, and resolution and interposed between problem and resolution are significant events that contribute to the goal. Story mapping is defined as a reading comprehension intervention in which the student creates a visual representation of the story by writing the important elements (i.e., character, setting, and problem) on a graphic organizer, in other words, a story map (Swanson & De La Paz, 1998). Davis & McPherson (1989) note that story maps can be created in a variety of forms to meet individual needs of students including (1) *locating-information story maps*, which help the student locate or retrieve literal or factual information from the story; (2) *inferential story maps*, which help the student make inferences and draw conclusions; (3) *cause and effect story maps*, which help the students make connections between character motives, actions, and outcomes;

and (4) *compare or contrast story maps*, which help the student compare or contrast characters' traits, motives, and circumstances, as well as compare or contrast different stories. Story maps can be used (1) *before reading* to assist students in activating prior knowledge and making predictions, (2) *during reading* to chart ongoing events and help the readers stay focused, or (3) *after reading* to help students recall or reconstruct what happened in the story. In this context, story maps may focus on a particular episode within a story or on total structure of the story as a whole (Hoggan & Strong, 1994).

Idol (1987) recommended using questions to frame the story map. These questions are also cues that are used together with a story map. They are simple questions intended to remind students of the basic elements of a story, such as character, setting, event, goal, and outcome, as well as possible ideas associated with the these elements. The questions can be used to guide students in developing their stories (Li, 2000).

Earlier studies show that the use of story maps lead to positive effects on reading comprehension skills of elementary (Baumann & Bergeron, 1993; Davis, 1994; Idol, 1987; Idol & Croll, 1987; Newby, Caldwell, & Recht, 1989) and secondary (Dimino, Gersten, Carnine, & Blake, 1990; Gurney, Gersten, Dimino, & Carnine, 1990) students with and without learning disabilities. The general conclusions from these studies are listed below.

A story map

1. is an effective tool for helping students comprehend stories and recalling story information (Idol & Croll, 1987; Vallecorsa & deBettencourt, 1997),
2. is an effective instructional strategy for promoting first-grade students' ability to identify central narrative elements in authentic children's literature (Baumann & Bergeron, 1993),
3. enables students to visualize the basic structure and story elements (Boulineau, Fore III, Burke, & Burke, 2004; Davis, 1994; Gardill & Jitendra, 1999; Idol, 1987; Idol & Croll, 1987; Vallecorsa & de Bettencourt, 1997),
4. provides students with a bird's eye view of the basic story structure and the relationship between story elements (Maxim, 1997),
5. can be used to promote inferential thinking, a skill necessary for comprehension of higher-level cognitive tasks (Davis & McPherson, 1989),
6. is the visual tool that delineates the most important ideas and reflects the linkage of concepts or facts within a passage (Reutzel, 1985) and help students generate questions about narrative stories (Gardill & Jitendra, 1999),

7. directs students' attention to relevant elements of stories using a specific structure (Boulineau et al., 2004),
8. helps students organize the progression of a story and enhance reading comprehension (Gardill & Jitendra, 1999),
9. and can be used as an instructional strategy across the curriculum to incorporate all four of the language modalities (reading, writing, speaking, listening) encompassing a variety of grade levels and content areas (DeKemel, 2003).

While numerous studies have documented primary school students' (K-8) stereotypic images of scientists, only a few studies have examined instructional strategies effective in broadening these images. Studies (Solomon et al., 1994; Tao, 2002, 2003) involving intermediate and senior students have suggested that science stories can help students develop more authentic views of the nature of science.

This study was designed to determine the effectiveness of the science stories accompanied by story mapping on eighth grade students' images of biological science and scientists. The specific aims of this study were

- a. to investigate whether there would be any differences in students' images of biological science and scientists with respect to the scores of "Draw a Biological Scientist Test" before and after treatment.
- b. to investigate whether there would be any differences in students' perceptions toward themselves as a biological scientist with respect to the scores of "Myself as Biological Scientist Test" before and after treatment.

Method

Research Design

The major aim of this study was to describe and interpret the meaning and significance of changes in students' images of biological science and scientists, after experiencing science stories accompanied by story maps. Hence, it primarily relied on the assumptions and methods of the qualitative research paradigm: it was exploratory, interpretive and particularistic. It did not aim to make generalized claims or attempt to establish cause and effect relationships between the stories presented and the results.

Participant Selection

A sample of five intact science classes selected from a school in an urban area (N=151 including 61 boys and 90 girls for pre-test and N=121 including 59 boys and 72 girls for post-test, with age range 13-15 years) was used. The difference between the numbers of students who participated in the pretest and the posttest resulted from some students' being absent. The same teacher taught all of classes.

Instruments

Three instruments were used to collection data. Students completed the instruments “Draw a Biological Scientists Test (DABST)”, “Myself as a Biological Scientist Test (MABST)”, and an interview protocol.

The Draw a Biological Scientist Test (DABST). Drawing is a very powerful instrument in the analysis of children’s imagery. The most common technique used to assess students’ images of scientists has been the Draw-A-Scientist Test (DAST), developed by Chambers (1983). Chambers identified seven key parts of the stereotypical images which were produced: lab coat, eyeglasses, facial growth of hair (beards, moustaches, sideburns, etc.); symbols of research—e.g. scientific instruments and laboratory equipment; symbols of knowledge—such as books and filing cabinets; technology—‘products’ of science; relevant captions—e.g. formulae, taxonomic classification, and the “Eureka!” syndrome. After Chambers’ study, variations of the DAST have been utilized in many countries in addition to the USA with similar results.

Researchers have expressed concerned about its *reliability* (the consistency with which test scores measure an attribute) and its *validity* (the accuracy of test scores). Chambers (1983) conducted a systematic study of images of scientists People’s Republic of China, finding that the images of scientists drawn by students closely matched those from Western culture. In that same year Schibeci & Sorenson (1983) conducted a study of elementary children in Australia using DAST. The purpose of their study was to examine the potential of the DAST as a quick and reliable means of assessing elementary school students’ images of scientists. Children were asked to draw a picture of a scientist, and then analyzed by two raters. Interrater reliability was determined to be 0.86 ($p < 0.01$). The other researchers have similarly determined inter-rater reliabilities, or correlations among different people doing the coding, of 0.87 (Maoldomhnaigh & Hunt, 1988), 0.97 (Mason, Kahle, & Gardner, 1991).

The validity of the test, however, is another matter. Schibeci & Sorenson (1983) suggest that interviews with students can provide an indication of the validity of DAST. When an Australian researcher interviewed Year 10 students after they drew scientists, in most cases their verbal images matched their visual ones (Tobin, Kahle, & Fraser, 1990). Studies around the world [including Canada (Parsons, 1997), Ireland (Maoldomhnaigh & Hunt, 1988), England (Brosnan, 1999), Korea (Song & Kim, 1999), Taiwan (She, 1998), and Australia (Rennie, 1986; Schibeci, 1986; Schibeci & Sorenson, 1983;)] show that children, teens, and college students hold similar stereotypic images of the scientists. The same stereotypical image of the scientists has been encountered in the past 50 years of research (for a review, see Finson 2002). The results of the studies show that DAST is method for assigning global images of science and scientists and it has since been used with various populations

The instructions Chambers (1983) used in administering the DAST were modified in subsequent studies. Instead of asking students to just "draw a scientist," for example, Huber & Burton (1995) asked students to "draw a scientist at work", Matthews & Davies (1999) asked to students “draw two scientists at work”, and Thomas & Hairston (2003)

asked students to “draw an environmental scientist at work.” The DAST has been used to explore the students’ images of science and scientists in general science perspective.

In the study reported here, the students were asked to describe the image and activity of the biological scientist at work depicted in their drawing and therefore its name was changed by the researcher. The DAST Checklist (DAST-C) developed by Finson, Beaver, & Cramond (1995) was also adapted to become the Draw A Biological Scientists Test-Checklist (DABST-C), modeled Thomas & Hairston’s (2003) study. The DAST-C is a checklist for scoring students’ illustrations and was not suitable for this study for several reasons.

- a. DAST-C is not concerned with the students’ images of biological science and scientists. It was developed to scoring students’ images of science and scientists in general perspective not a specified science perspective.
- b. The DAST-C is a tool that is limited to labeling stereotypic features of drawings.
- c. The DAST-C is not concerned with the activity of the scientist or other important features of the drawing, such as natural setting of work.
- d. The DAST-C can measure changes in students’ perceptions of scientists by identifying a decrease or increase in the stereotypic features from pretest to posttest.

The DABST-C, however, can more effectively measure changes in students’ perceptions of biological science and scientists because it identifies an increase or decrease in specified categories. A pilot study was designed to provide sufficient data from which to select the items to be included in the DABST-C and to evaluate the survey and materials and administrative procedures planned for the final survey, such as contacting respondents, setting, test administration, scoring of responses, and data capture. The pilot study was conducted on 154 ninth grade students who have taken grade eight science courses. In order to better understandings the students’ conceptions of scientists and of what they thought doing biological science involved, focus group interview were conducted after the drawings activity. Interviews with students were suggested by the researchers using DAST (e.g., Schibeci & Sorenson, 1983; Tobin et al., 1990) for the validity (*the accuracy of test scores*) of the test. Similarly, the pilot study found that the interview was essential to more accurately score the DABST and better interpret the students’ images of biological science and scientists. Also, the pilot established the reliability of scoring DABST by assessing the level of agreement between different people who independently code the same student drawings. The inter-rater reliability of 0.96 was found between the researcher and her colleague, a biology professor who did the coding for this study. The similar results were recorded in the previous studies using DAST and DAST-C (Finson, et al., 1995; Mason et al., 1991; Maoldomhnaigh & Hunt, 1988). The seven standard images, including lab coat, eyeglasses, facial growth of hair, symbols of research, symbols of knowledge, technology, and relevant captions, of a scientist identified by Chambers (1983) were used

in the first section of the DABST-C (See Table 3). The second section of the DABST checklist represented the alternative images of a biological scientist. Alternative images are closely related to the mythic stereotypes (Basalla, 1976). Finson et al. (1995) add “age, race and gender” to this alternative images for American sample. Race did not emerge as alternative images indicator in this study. Thus, ethnic background was not included in DABST-C for this sample although this indicator was included in previous study (Finson, et al., 1995; Thomas & Hairston, 2003). These indicators and specific descriptors were added in the DABST-C because they showed up frequently in the drawings of students during the pilot test.

A third category, Additional Images of a Biological Scientist, contained four indicators. These were, type of scientist, emotions of a biological scientist, natural setting(s) of work, and nature of scientific work.

All the additional images, except for types of scientists, indicators were taken from Draw an Environmental Scientist Checklist, developed by Thomas & Hairston (2003). As a result of the pilot study, the indicator, “Types of scientists”, was added. The researcher decided type of scientists according to the results of the students’ drawings and answers to open ended questions at the bottom of the drawing test.

Semi-structured interviews with students. In this study, interviews were used for following two goals (1) to find out about their views on the science stories and the scientists presented in science stories and (2) to support analysis and interpretation of the students’ drawings and match their visual images for validity. Only the students who received parental / guardian consent were audio – taped for later decoding. Semi-structured interviews have a suggested set of interview questions, but the specific questions are flexible and can evolve with each interview if students bring up topics that are pertinent to the research question. This allows more freedom to explore an area without limiting the participants’ responses to questions which the researcher thinks is important.

Myself as a Biological Scientist Test (MABST). This test aimed to expose student ideas about biological science and scientist. It is originally a subtest, named *Myself as a Scientist*, of Relevance of Science Education (ROSE) Test. The original subtest is not only aimed to determine student ideas about biological science and scientists, but it also aims to expose student ideas’ about technology, chemistry, physics, psychology, social and economic sciences. For this study, open ended questions were not asked to students in general format as in the original version.

Data Collection

Data collection was completed at each classroom on the same day. The instruments including DABST and MABST were handed out to the students by the researcher and teachers during classes. All conditions were the same for both the pretest and posttest.

DABST

DABST was administered to students in all classes. Instructions were given as seen in Appendix A. This descriptive narrative assists in scoring the drawing. Students were also asked to put down date of drawing, their class level, age and sex—but not their names—on the paper. The teachers who administered the instruments were asked not to give any further directions to students and no time limit was set for drawing the pictures and writing the answers of the questions.

MABST

As can be seen in Appendix B, MABST was given to the students with DABST. MABST includes an open ended question. The students directly wrote their answers to this question on the sheet. The students completed the DABST and MABST independently, with supervising teacher instructed to respond only to students' queries about procedure. The teachers reported that students completed the task in 30 minutes or less. The same instructions and instruments were administered to all students in the pre- and post testing sessions.

Semi-structured interviews with students

The interview was administered under the school conditions. Students from each class and each achievement level (very good, mediocre, and weak) were chosen to be interviewed. The interviews were conducted in a semi-structured format with thirty students. Only the names of these students were written on the survey by the teacher after their drawing activities in order to find their survey easily for interview process. After their drawing activities, these students were invited to participate in an interview about their drawings (See Appendix C). Interviews took approximately 10 to 15 minutes long. All interviews were conducted to deepen an understanding of the research results and to allow the children to interpret the pictures

Data Analysis

The “DABST” and the “MABST” were analyzed using coding process (Miles & Huberman, 1994) which began with identification of important categories highlighted by the research on students' images of scientists and interests towards science (Chambers, 1983; Driver et al, 1996; Finson et al, 1995; Sjøberg & Schreiner, 2002).

The researcher compared the drawings, the DABST-Checklist scores and the transcribed interviews based on pretest and posttest in science stories accompanied by story mapping activities. The DABST-Checklist results were also compared to results

from the Pretest and Posttest of Finson et al. (1995) in order to determine if any trends emerged.

For MABST, as recommended by the ROSE project organizers on the website (<http://www.ils.uio.no/forskning/rose>), students' responses were coded into predetermined categories by the organizers. The first part which students answers were coded as to sub-scientific field in biology (genetic, anatomy, molecular biology, zoology, botany, biochemistry), and students' opinions about why they study these fields were coded in five groups: (1) curiosity, interests, seems fun, want to, exciting, (2) related to the profession I want to, (3) important in general or for society/humanity, help (people, animals, etc.), (4) get rich, popular, famous, and (5) others. Student answers that included professions not related to science and reasons were coded "other" group.

After all data for DABST and MABST were coded, frequencies, percent and chi-square values were calculated for each item. The analysis was carried out at a significance level of $p = 0.05$. As mentioned above, the excerpts of interviews were used to develop better understanding about research results. The interviews were transcribed in full. From the transcripts summaries of per interview were written. The transcripts of the interviews and the summaries were read by the researcher. They were first analyzed using a provisional list of categories that emerged naturally from the research questions and the interview guide (Miles & Huberman, 1994, p.58). The results of the interviews are presented in the findings section.

The Design Process, Context, and Setting

This study was conducted over a 5 - week period. The classroom instruction for all groups was given by the same teacher. At the beginning of the unit, DABST and MABST were administered as the pre-tests by the science teacher for all groups. All students were exposed to the same content for the same duration. Duration of lessons was 15X 40-minute periods in eighth grade, in the unit of Genetics. There were five main subjects in this unit: (1) cell (2) DNA; (3) heredity; (4) biotechnology, and (5) new information and developments about genetics and heredity. During the five week period, each group received an equal amount of instruction and was provided with the same materials and assignments as well as the science stories accompanied story map teaching strategy.

The story themes were selected from the Turkish Primary Science Curriculum (Ministry of National Education, 2000) as a part of regular classroom science instruction. The classroom instruction for all groups had three 40 - minute sessions per week. In general, students were given equal opportunities to perform the activities in each group. The teacher was instructed in the procedure for science stories as described in a researcher-developed teacher training manual. The teacher was specifically instructed not to read the science stories during any part of the weekly allotted science time. Rather, she was instructed to find time within the regular school day in which to read the science stories aloud to the students (e.g., reading time). She also collaborated with the Turkish (language arts teacher) teacher for this study, as referred to in the national science curriculum. The language teacher integrated and used science stories accompanied by

story maps as a part of her regular lesson during reading time. In this way, students also developed their reading comprehension, listening, speaking, and writing skills as a requirement of the Turkish lesson and learned about biological science and scientists presented in the stories.

The science teacher with the support of the Turkish teacher led a discussion about improving reading comprehension, listening, speaking and writing skills. She used an overhead transparency of the story map to show students how to organize information. The map contained seven main areas for recording a narrative story: (a) setting, (b) time, (c) characters, (d) problem, (e) goal, (f) events, and (g) solution/theme. She reviewed story map elements using a pre-printed response card activity in which students identified story elements. The teacher modeled story map completions using an explicit think-aloud procedure.

The stories and story maps were presented over ten 30-40 minute sessions. The stories were presented in three stages: 1) introduction, 2) the story reading or telling, and 3) follow-up activities including story mapping (Figures 1 and 2). Introductions to the stories usually took approximately 5 to 10 minutes. In this section, the instruction consisted of discussing relevant vocabulary and prior knowledge about the topic before reading.

Story reading/telling lasted approximately 10 to 15 minutes. During the story reading/telling, students were invited to share comments or ask questions. From time to time, the story was stopped in order to ask questions or highlight points to focus students' attention on characteristics of the scientists and aspects of their scientific work (Appendix D and E). To invite students to articulate some of their ideas about science and scientists, story maps were used after story reading/telling. As can be seen Figure 1 and 2, story maps were also used to focus attention on a particular aspect of the story such as the personal characteristics of scientists, the nature and/or purpose of their work, and where and how they work.

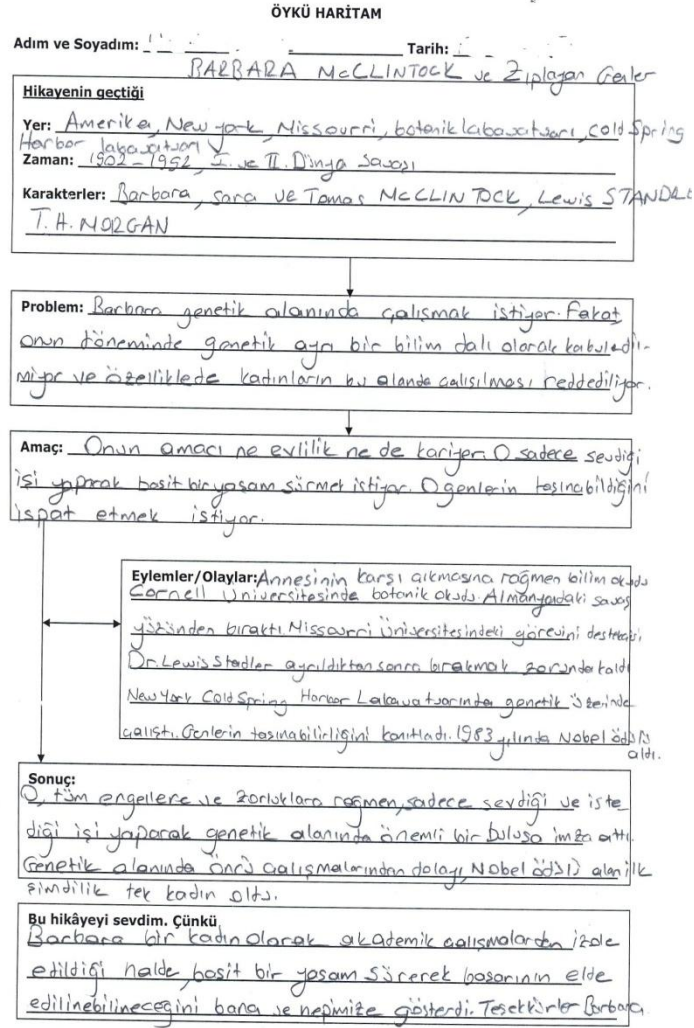


Figure 1. An example of a student's story map

My Story Map

My name is: _____ Date: _____

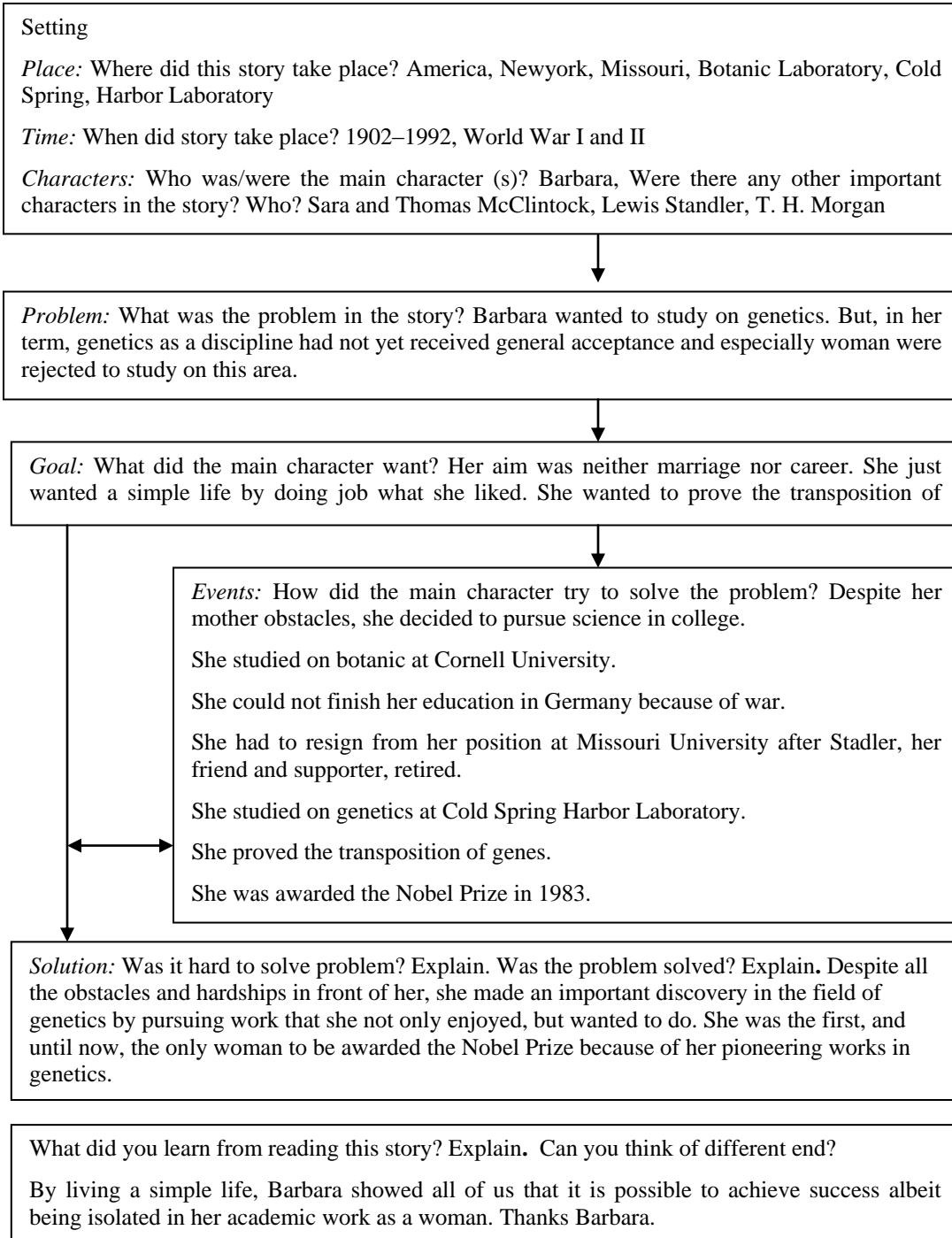


Figure 2. English translation of the Figure 1.

(Note: The students' responses on the story map were translated in English exactly unchanged.)

Story mapping activities often took place immediately after the story reading/telling and took approximately 10-15 minutes. Individually, the students completed a blank story map after reading their stories during each session. Students were guided in completing a story map and help to 'see' the relationship between specific features about the scientists and their work.

After the story map was completed, the student was given 5 minutes to review the story map independently. The teacher asked students to respond to story map items (e.g., Who are the main characters?) by writing answers on individual dry-erase boards. The teacher then led discussion of students' responses (Figure 2). She asked students to place pre-printed sentence strips corresponding to the story on a large story map or a transparency of the story map and discussed with students their selections and reviewed students' story map. The teacher provided feedback on students' understanding of story map using a checklist developed by **Boulineau** et al (2004). The checklist consisted of procedural items that the teacher performed during each instructional session, including (a) providing students with a purpose for using story maps, (b) presenting students with the appropriate passage, (c) prompting students to read with expression while attending to relevant features, (d) randomly calling on students to read once per session, (e) providing verbal feedback after reading (praise), (f) correcting errors (pronouncing words correctly), (g) using a transparency of the story map or a large story map to record answers during baseline, (h) referring to each element at least once during each session, (i) beginning a new passage once criterion was met, and (j) administering the story map. As each element was addressed, the teacher checked it off. This checklist was not used for grading students' story maps.

Stories were created using books written about science and scientists (for story 4, 5 and 8) and internet sources (story 1, 2, 3, 6, 7, 8, and 9) on the subject matter studied by the scientists and scientists' biography (Table 1 and 2). Nine science stories were used in this study. All of the science stories used in this study included the following six basic characteristics, as well as covered in the National Science Curriculum content standards: (1) contained a simplified story about scientists and their work that extended beyond facts, dates, or time-lines of scientists' lives, (2) demonstrated a non-stereotypical portrayal of scientists, (3) contained accurate information, (4) used age-appropriate language, (5) displayed a common theme of the struggles these scientists faced and their perseverance, and (6) contained colorful illustrations and easy text. This ensured that the history of science was accurate, the pedagogy was appropriate, and the science content was accurate and aligned to course objectives.

The researcher developed and published seven of these stories because of the limited availability of appropriate science story books that specifically included the previously discussed six characteristics. The following science stories were designed to elicit and foster students' images of science and scientists were selected for this study.

Also, the researcher invited the students to participate in interview to share their thoughts about science and scientist contained in science stories (see Appendix F).

Table 1
Science Stories, Science Topics and Resources

Number of story	Science Stories	Science Topic	Resources
Story 1	Invention of the Microscope and the story of Anton van Leeuwenhoek	Cell	Adapted and translated by the researcher: http://www.ucmp.berkeley.edu/history/leeuwenhoek.html
Story 2	The story of Genetic in History (Principal Leaders of Genetic: Pythagoras, Empedocles, Aristotle)	Principal studies about Reproduction and genetic	Adapted and translated by the researcher: http://tr.wikipedia.org/wiki/Genetik
Story 3	The story of Lamarck	Natural selection	Adapted and translated by the researcher: http://www.ucmp.berkeley.edu/history/lamarck.html
Story 4	The Story of Darwin	Natural selection and Evolution	The Leaders of Science by Cemal Yildirim (2001), TUBITAK Publications Ankara.
Story 5	The story of Mendel	Genetic	The Leaders of Science by Cemal Yildirim (2001) TUBITAK Publications Ankara
Story 6	The story of Rosalind Elsie Franklin	Structure of DNA	Adapted and translated by the researcher: http://www.sdsc.edu/ScienceWomen/franklin.html http://tr.wikipedia.org/wiki/Rosalind_Franklin
Story 7	James Watson, Maurice Wilkins and Francis Crick: Discovery of the Structure of DNA	Structure of DNA	Adapted and translated by the researcher: http://nobelprize.org/nobel_prizes/medicine/laureates/1962/crick-bio.html http://nobelprize.org/nobel_prizes/medicine/laureates/1962/watson-bio.html
Story 8	The story of Barbara McClintock and jumping DNA	Genomes, human genome, genetic disorders and human evolution	Adapted and translated by the researcher: http://www.mbl.edu/html/WOMEN/mcclintock.html http://curie.che.virginia.edu/scientist/mcclintock.html http://www.nalusda.gov/pgdic/Probe/v3n1_2/mcclinto.html Gardner, A.L. (1997). "Barbara McClintock, Geneticist, 1902-1992," in Matyas, M.L. & Haley-Oliphant, A.E. (Editors). (1997). <i>Women Life Scientists: Past, Present, and Future – Connecting Role Models to the Classroom Curriculum</i> . Bethesda, MD: American Physiological Society, p. 307-324.
Story 9	Dr Ian Wilmut and Dolly's birth	Biotechnology, molecular biology, genetic copy/cloning	Adapted and translated by the researcher: http://tr.wikipedia.org/wiki/Ian_Wilmut

Table 2
The Critical Aspects covered Science Stories

Science stories	The critical aspects refer to science and scientists presented in the science stories: Images of science and scientists connection
Story 5 and 7	Scientists usually work in collaboration and one scientist's work is often followed up by other scientists (Tao, 2002).
Story 5, 6, 7, 8, and 9	Scientists carry out experiments to test their ideas, hypotheses and theories (Tao, 2002).
All of stories	Men and women have made a variety of contributions throughout the history of science and technology.
Story 1 and 5	Careful and systematic study is not enough, scientists need to be creative (Tao, 2002).
Story 4	Scientific theories are constructed by scientists to explain and predict phenomena; they do not necessarily represent reality (Tao, 2003).
Story 1 and 2	Scientific knowledge, while durable, has a tentative character (Tao, 2002).
Story 1 and 2	Science and technology have been practiced by people for a long time.
All of stories	Many people choose science as a career and devote their entire lives to studying it. Many people derive great pleasure from doing science.
All of stories	Science will never be finished. Although men and women using scientific inquiry have learned much about the objects, events, and phenomena in nature, much more remains to be understood.
Story 5	A scientist can be anyone.
Story 4	Science and its methods cannot give answers to all questions (Tao, 2003).
Story 1, 2, 3, 4, 5	Scientific discoveries are for understanding nature; inventions are for solving problem and changing people's way of life (Tao, 2003).
Story 5, 6, 7, 8, and 9	Scientists require accurate record keeping, peer review, and replicability (McComas, Clough, & Almazroa, 1998)
All of stories	People from all cultures do contribute to science. (McComas, Clough, & Almazroa, 1998)
Story 1	Science and technology impact each other. (McComas et al., 1998)
All of stories	There is no one way to do science (therefore, there is no universal step-by-step scientific method). (McComas et al., 1998)

Findings

The findings are presented in two sections. The first section is the image of biological scientists represented in the DABST. This section includes three sub sections: the standard images, alternative images, and additional images. In the second section, the students' perceptions toward themselves as a biological scientist are presented. Students' interviews are presented to support and interpret quantitative results of the research.

The Images of Biological Scientists

The standard Image of a Biological Scientist. All seven indicators of the standard images of a scientist (Chambers, 1983) were present in the students' drawings of a biological scientist. Chamber's list was used for comparison in this study. Indicators 4- 7 were taken from Chamber's list, and were expanded to accommodate the specific characteristics shown in the drawings of the subjects. Table 3 shows the frequencies, percentages, and chi-square results of indicators of a standard image of a biological scientist drawn by the subjects.

At the beginning of the study, the students had similar images of scientists to those revealed in previous studies (Chambers, 1983; Finson et al., 1995; Fort & Varney, 1989; Huber & Burton, 1995). Generally, as shown Table 3 and 5, the students perceived scientists as being males who work indoors including laboratory and combination of laboratory and outside of laboratory with chemicals and notably test tubes and flasks. After the treatment, several changes were noted in the drawings.

Table 3
The Pretest and Posttest Frequencies, Percentages, and Chi-Square for DABST

Images of a scientist (from Chambers, 1983)		Pretest	Posttest	df	X ²	p	Level of Significance
		(n=151) f (%)	(n=121) f (%)				
1. Lab coat		60(39.7)	37(30.6)	1	2.455	.117	NS
2. Eyeglasses		64 (42.4)	46(38)	1	.532	.466	NS
3. Facial growth of hair		68(45)	43(35.5)	1	2.508	.113	NS
4. Symbols of research	Test tubes	86(57)	40(33.1)	1	15.426	.000	*
	Flasks	104(68.9)	31(25.6)	1	50.273	.000	*
	Magnifying glass	66(43.7)	69(57)	1	4.767	.029	*
	Microscope	33(21.9)	53(43.8)	1	14.965	.000	*
	Bunsen burner	25(16.6)	10(8.3)	1	4.020	.045	*
	Experimental animals	38(25.2)	66(54.5)	1	24.552	.000	*
	Experimental plants	38(25.2)	76(62.8)	1	39.099	.000	*
	Binoculars	4(2.6)	62(51.2)	1	86.303	.000	*
5. Symbols of knowledge	Books	102(67.5)	74(61.2)	1	1.202	.273	NS
	Filling cabinets	65(43)	57(47.1)	1	.448	.503	NS
6. Technology	Computer	33(21.9)	45(37.2)	1	7.724	.005	*
	Machines	6(4)	39(32.2)	1	38.848	.000	*
7. Relevant Captions	Formulae	10(6.6)	45(37.2)	1	38.907	.000	*
	Taxonomic classification	9(6)	40(33.1)	1	33.396	.000	*
	Eureka syndrome	50(33.1)	56(46.3)	1	4.898	.027	*

*p≤.05

As seen Table 3, while many of the students who participated in this study still drew pictures of scientists working alone, wearing a lab coat, using eye glasses, and with facial hair, the number of scientific and technological instruments (Figure 3 S1b) decreased, and laboratory- tested plants, laboratory-tested animals (Figure 3 S4b), binoculars, microscope, magnifying glasses (Figure 3 S2b) , machines, and computers replaced smoking test tubes in many of the drawings. The other significant increase from the pretest to the post test was in the attribute of the scientists using relevant captions.

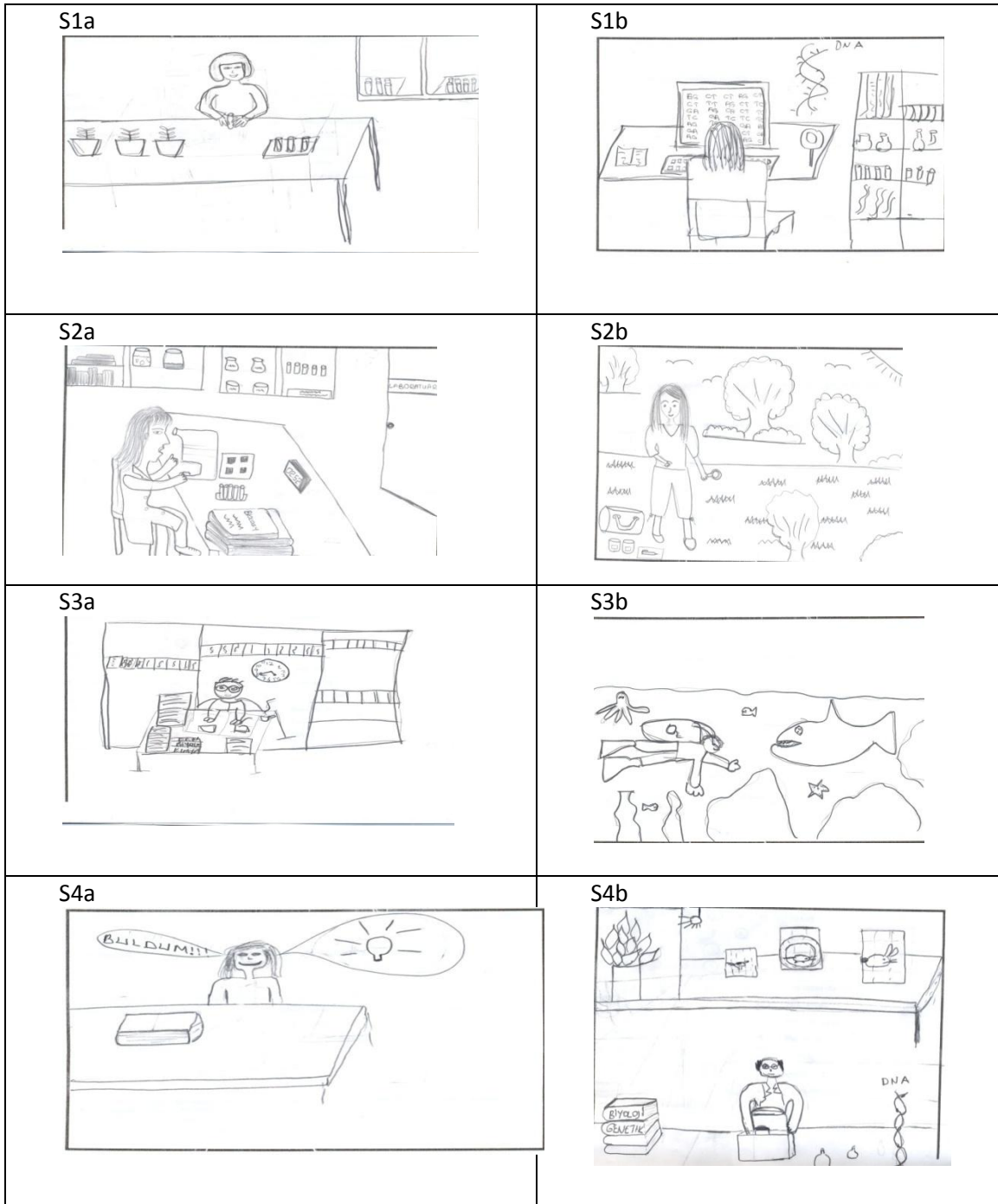


Figure 3. Examples of four students' (S1–S4) drawings of biological scientists before and after the treatment.

The Alternative Images of a Biological Scientist

Analysis revealed the subjects drew many alternative images of a scientist that helped define their perceptions of a biological scientist. Table 4 shows the frequencies, percentages, and chi-square results of indicators on the alternative images of a biological scientist drawn by subjects.

Table 4

Pretest and Posttest Frequencies, Percentages, and Chi-Square for DABST

Alternative images of a scientist (adapted from Finson et. al., 1995)		Pretest (n=151) f (%)	Posttest (n=121) f (%)	df	χ^2	p	Level of Significance
8. Gender	Male	76(50.3)	31(25.6)	1	17.189	.000	*
	Female	42(27.8)	62(51.2)	1	15.608	.000	*
	Gender-neutral	33(21.9)	31(25.6)	1	.592	.467	NS
9. Age	Young aged	12(7.9)	61(50.4)	1	61.694	.000	*
	Middle aged	40(26.5)	46(38)	1	4.128	.042	*
	Elderly scientist	99(65.6)	14(11.6)	1	80.635	.000	*
10. Indications of danger		25(16.6)	21(17.4)	1	.31	.861	NS
11. Presence of light bulbs		65(43)	57(47.1)	1	.448	.503	NS
12. Mythic images		27(17.9)	19(15.7)	1	.227	.634	NS
13. Indicators of secrecy		34(22.5)	6(21.5)	1	.041	.839	NS

* $p \leq .05$

Six indicators assessed in this category are (1) gender, (2) age, (3) indications of danger, (4) presence of light bulbs, (5) mythic images, and (6) indicators of secrecy. Indicator 8 “gender” was expanded to “male”, “female”, and “gender-neutral”. Indicator 9, “age of scientist” three choices are included, “young aged”, “middle aged”, and “elderly” to accommodate the subjects’ perceptions. Table 4 summarizes the responses to the indicators on the alternative images on a biological scientist.

The drawings were 50.3% male ($n=76$), 27.8% female ($n=42$) and 21.9% gender neutral ($n=33$) at the beginning of the study. Gender neutral drawings such as stick people, a drawing with members of both gender, a drawing of a cartoon animal, and brain were observed. In the post-test, the percentage of gender-identifiable figures was increased in favor of female figures $\chi^2(1, N = 151_{for\ pretest}, 121_{for\ posttest}) = 0.00, p < .05$.

Here are two samples of responses from female students:

Interviewer: what did you learn from the story about Barbara McClintock? Was that an interesting story for you?

Students A. Barbara McClintock is my hero because she shows determination and that if you keep at your goal you will get what you want. Until I came across a story about her, I did not know anything about her and her studies. I believe that she was a very distinctive woman for her day. She never put up with dresses or long hair unless it was for a special reason. She had no taste for luxury or fame so when she won the Nobel Prize she hardly cared at all. She first recognized jumping DNA. According to her, some stretches of DNA are unstable and "transposable and they can move around—on and between chromosomes. She received a Nobel Prize in 1983 for her discovery—making her one of only two women ever to receive an unshared Nobel Prize in science. The other was Marie Curie. She taught me there is a certain appearance for a biological scientist. A biological scientist can be anyone, a man or woman..... (Girl, 14)

Interviewer: what did you learn from the story Rosalind Franklin? Was that an interesting story for you?

Students B. I first learned about Rosalind Franklin from “The story of Rosalind Franklin”. For me, it was very interesting and dramatic biography. To achieve all she did during her short lifetime shows she was courageous, insightful and intellectual. Rosalind Franklin was one of the first women geneticists *whose research and discovery work in the 1950s led to the comprehension of the structure of DNA. In 1962, four years after Franklin's death at the age of 37 because of cancer, three other scientists, James Watson, Francis Crick, and Maurice Wilkins received a Nobel Prize for the double helix model of DNA.* She was not awarded since she had died and Nobel prizes can only be rewarded to live people. Even though the Nobel Prize did not recognize Franklin for her outstanding discoveries, I hope I have made her name a little more known so she can be remembered in history as the women who first determined the structure of DNA. She taught her life story to me if I want I can be a scientist as a female. After that, I believe that science is not peculiar to men. *Men and women have made a variety of contributions to universal science development. (Girl, 14)*

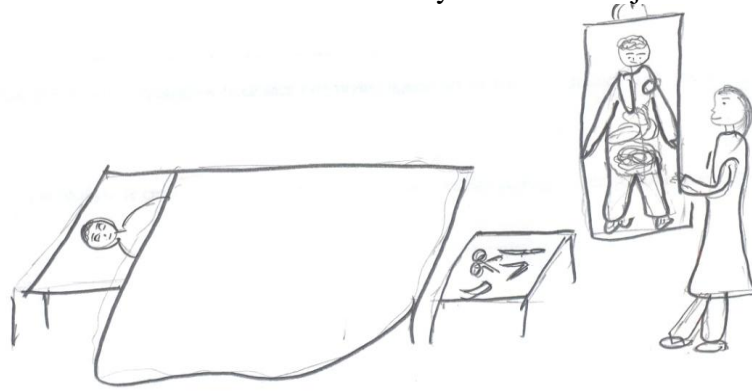
Additional Images of a Biological Scientist

The additional images specific to a biological scientist was depicted in 1-4 indicators of the DABST-C. These indicators were: (14) types of biological scientist, (15) emotions depicted, (16) natural setting (s) of work, and (17) nature of scientific work. Indicator 14 defines the type of biological scientist such as microbiologists, botanist, aquatic scientists, anatomist, geneticist, paleontologist, zoologists, and wildlife biologists. Indicator 15, the emotions of biological scientist, was expanded to include joy, hope, and

sadness. Indicator 16, the settings of work, was expanded to include common environments in which biological scientists perform their work. Finally, indicator 17 serves to record the nature of scientific work including science process skills drawn and described by subjects. Table 5 summarizes the additional images of a biological scientist analyzed from the drawings of the subjects.

At the beginning of the study, the type of scientist drawn was generally “Zoologists and wildlife biologists”, “Botanist”, “Microbiologists”, and “Generic”, however, a small percentage of the pictures drawn depicted “Paleontologist”, “Anatomist”, “Geneticist”, and “Aquatic scientists”. The reasons for these drawings may be due to their previous class biology curriculum content and association and immediacy of experience with persons in biological science related occupation.

At the end of the study, there were significant increases in students’ perception towards type of scientists. The majority (26.4 %) of students’ drawings in post tests were depicted as geneticists (see Figure 3 S1b and S4b). The other changes were as follows: paleontologist (14.2 %), aquatic scientists (see Figure 3 S3b) (9.8%), anatomist (see Figure 4) (5.6%). There is a value to the type of the scientists chosen as an indicator. The results show that students can see what different study areas and subjects of the biology



areas.

Figure 4. A student’s post drawing. “The scientist is an anatomical scientist, so she is working with a cadaver.”

Two excerpts from students' interviews were given below. These excerpts were used to develop better understanding about the type of biological scientists depicted in the students' drawings.

Interviewer: What did scientist in your drawing do?

Students E...*She collected dinosaurs’ bones and examines fossil.*
(Paleontologist)

Students F. ... *He investigated fishes and plants in the sea.* (Aquatic scientists)

The primary students may not recognize the type of the scientists as named. They learn biology in a holistic context. The fields of the biology as a special course were not taught to them in their primary and secondary school years. However, basic concepts and principles of these areas were presented in the context of the science courses. Thus, the researcher determined the type of the scientists based on the students' drawings, descriptions and interviews.

Table 5
Pretest and Posttest Frequencies, Percentages, and Chi-Square for DABST

Additional Images of a Biological Scientist (adapted from Thomas & Hairston; 2003)		Pretest (n=151) f (%)	Posttest (n=121) f (%)	df	X ²	p	Level of Significance
14. Types of biological scientist	Microbiologists	19(12.6)	10(8.3)	1	1.315	.251	NS
	Paleontologist	6(4)	22(18.2)	1	14.685	.000	*
	Anatomist	9(6)	12(11.6)	1	1.476	.224	NS
	Geneticist	1(7)	31(26.4)	1	40.306	.000	*
	Zoologists and wildlife biologists	38(25.2)	19(15.7)	1	3.631	.057	NS
	Aquatic scientists	4(2.6)	15(12.4)	1	9.823	.002	*
	Botanist	60(39.7)	8(6.6)	1	39.307	.000	*
	Generic drawing	14(9.3)	4(3.3)	1	3.869	.049	*
15. Emotions depicted	Emotions of joy/hope	22(14.6)	83(68.6)	1	82.722	.000	*
	Emotions of sadness	75(49.7)	20(16.5)	1	32.459	.000	*
	No emotion depicted	54(35.8)	18(14.9)	1	15.054	.000	*
16. Natural Setting(s) of work	Laboratory	24(16)	27(22.3)	1	1.748	.186	NS
	Combination of Laboratory & Outside	39(25.8)	30(24.8)	1	.038	.846	NS
	Water environments	5(3.3)	17(14)	1	10.419	.001	*
	Mountains	10(6.6)	4(3.3)	1	1.514	.219	NS
	Trees/forest	26(17.2)	3(2.5)	1	15.321	.000	*
	Soil/dirt	21(13.9)	3 (2.5)	1	10.904	.001	*
	Wildlife	17(11.3)	47(38.8)	1	28.407	.000	*
	Urban city	7(4.6)	0(0)	1	5.757	.016	NS
17. Nature of scientific work	Observing	25(16.6)	39(32.2)	1	9.713	.002	*
	Measuring	37(24.5)	21(17.4)	1	2.046	.153	NS
	Testing samples with scientific instruments	101(66.9)	31(25.6)	1	45.798	.000	*
	Collecting data	33(21.9)	45(37.2)	1	7.724	.005	*
	Experimenting	60(39.7)	37(30.6)	1	2.455	.117	NS
	Reporting	64(42.4)	50(41.3)	1	.031	.860	NS
	Working cooperatively	5(3.3)	17(14)	1	10.419	.001	*

*p≤.05

The indicator for emotions helps to assess the expressions depicted in the drawings. While 68.6% of students' drawings at the end of the study were depicted as emotions of scientists as joy and hope, 49.7% of students' drawings at the beginning of the study were interpreted as biological scientists with sadness. It may be an indication of changing students' perceptions of science and scientists during this study. Students may see science as an amusing and creative activity and or a sort of adventure, and scientists as happy and joyful people or adventurers with the effect of the aspects refer to science and scientists presented in the science stories.

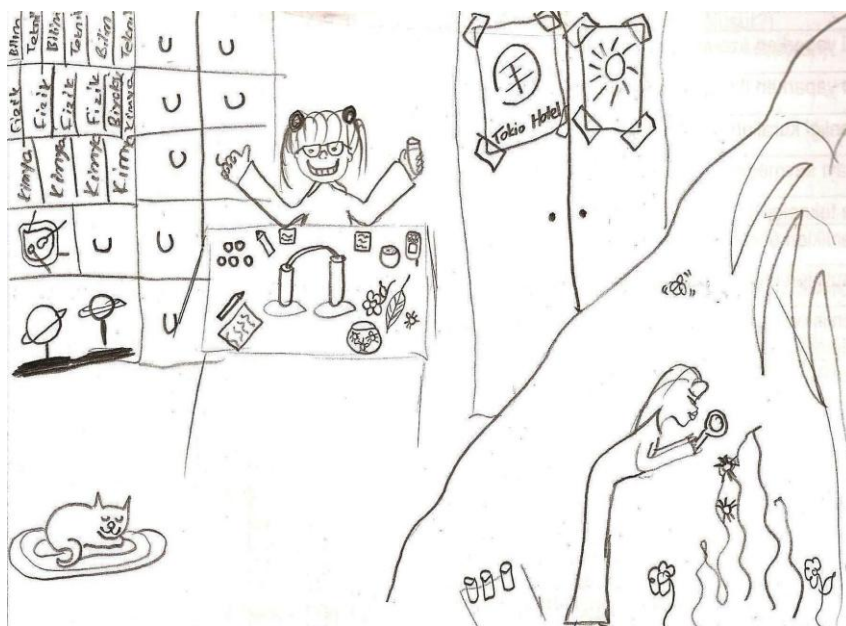


Figure 5. A Student's post drawing: "The scientist is working both inside and outside, doing an experiment inside and observation outside using biological tools. She is very happy and joyful. She love her job."

The three most popular setting of work drawn by the subjects at the beginning of the study were as follows: combination of laboratory and outside (25.8%), trees/forest (17.2%), and laboratory (16%).

At the beginning of the study, a student's interview excerpt was given below.

Interviewer: Where do scientists in your drawing work?

Student H: *In a lab.* "

Interviewer: Is that the only place?

Student H: *"No, she also works in nature. She collects samples from nature and then she brings them to her laboratory for her research."*

At the end of the study, statistically significant ($p < 0.05$) changes were observed in favor of wildlife ($\chi^2 (1, N = 151_{\text{for pretest}}, 121_{\text{for posttest}}) = 0.00, p < .05$) and water environments ($\chi^2 (1, N = 151_{\text{for pretest}}, 121_{\text{for posttest}}) = 0.01, p < .05$) (see Figure 6).

At the end of the study, a student's interview excerpt was given below.

Interviewer: Where do scientists in your drawing work?

Student H. *She works in the desert, rain forest, plains and other areas for finding new animal and plant species.*

Other significant changes between pre-test and post-test including soil/dirt ($\chi^2 (1, N = 151_{\text{for pretest}}, 121_{\text{for posttest}}) = 0.01, p < .05$), and trees/forest ($\chi^2 (1, N = 151_{\text{for pretest}}, 121_{\text{for posttest}}) = 0.00, p < .05$) were indicated a decreasing in frequency and percentage. The results show that science stories have a significant role in helping students understand what are images and elements about nature of scientific work and natural setting(s) work and changing them.



Figure 6. A student's post drawing. "My scientist is a middle aged male. He is observing the behaviour of both land and water animals using binoculars".

The most common perceptions about nature of scientific work by a biological scientist drawn and expressed by the eighth grade students on the pre-test were testing samples with scientific instruments (66.9%), reporting (42.4%), and experimenting (see Figure 6) (39.7%). On the post-test, the top three activities drawn depicted including working cooperatively (see Figure 7) $\chi^2 (1, N = 151_{\text{for pretest}}, 121_{\text{for posttest}}) = 0.01, p < .05$), collecting data $\chi^2 (1, N = 151_{\text{for pretest}}, 121_{\text{for posttest}}) = 0.05, p < .05$), and observing (See Figure 5- 7) $\chi^2 (1, N = 151_{\text{for pretest}}, 121_{\text{for posttest}}) = 0.02, p < .05$) were observed more than others at significant $p \leq .05$ level.

Further information about how the students see nature of scientific work was gathered from the interviews. Students' explicit responses indicate their awareness that some biological scientists work together, collect data and are observer.

Interviewer: What are biological scientists?

Student A : *Ordinary people men, women, young and old. A man, much younger than a scientist, working with tools...*

Interviewer: Like what kinds of things?

Student A: *usually working with microscope, binoculars magnify glasses, the Internet and computers.*

Interviewer: What does he do, using these tools?

Student A: *He examines microscopic germs and living cells with microscope, observes nature and living things in nature with binoculars, writes his research report with computers and publish his report on the Internet.*

Interviewer: What are biological scientists?

Student B: It sounds like an observer to me, so I think of a nature observer, without lab coat”; “Works with other scientists and collects data from nature.

Interviewer: What do scientists in your drawing do as scientists?

Students C: The scientists in my drawing are working as a group including female scientist and male scientist. They are doing an experiment in a cooperation project



Figure 7. A Student's post drawing: "The scientists are working as a group including female scientist and male scientist. They are doing an experiment in a cooperation project.

Perceptions toward themselves as a biological scientist

Student' answers to the questions on second subtest of instrument to the students "If you were a biological scientist, in which field would you like to work? Why?" are shown on Table 6.

Table 6

Pretest and Posttest Frequencies, Percentages, and Chi-Square for DABST

Myself as a scientist	Pretest (n=151) f (%)	Posttest (n=121) f (%)	df	X ²	p	Level of Significance
what						
Biology: human, body	18(11.9)	6(5)	1	4.047	.044	*
Biology: deceases, medicine, cure	33(21.9)	7(5.8)	1	13.828	.000	*
Biology: microbiology, gene technology	18(11.9)	42(34.7)	1	20.293	.000	*
Biology: animals, plants, nature	17(11.3)	46(38)	1	27.025	.000	*
Invent things	49(32.7)	10(8.3)	1	23.416	.000	*
Do experiments, work on laboratory	3(2)	4(3.3)	1	.466	.495	NS
Do not want to do research	12(7.9)	3(2.5)	1	3.854	.050	
Biology: other	0(0)	1(.8)	1	1.253	.263	NS
Why						
Curiosity, interests, seems fun, want to, exciting	40(26.5)	13(10.7)	1	10.616	.001	*
Related to the profession I want	24(15.9)	11(9.1)	1	2.773	.096	NS
Important in general or for society/humanity	12(7.9)	51(42.1)	1	44.151	.000	*
Help (people, animals, etc.)	10(6.6)	35(28.9)	1	24.200	.000	*
Get rich, popular, famous	51(33.8)	9(7.4)	1	27.100	.000	*
Other	14(9.3)	2(1.7)	1	7.042	.008	*

*p≤.05

The results of student-reported interests in biological science (see Table 6) showed that students reported significantly ($p < .05$) more interest about two fields of biological science topics including (1) microbiology and gene technology ($X^2 (1, N = 151_{for\ pretest}, 121_{for\ posttest}) = 0.00, p < .05$), and (2) animals, plants, nature ($X^2 (1, N = 151_{for\ pretest}, 121_{for\ posttest}) = 0.00, p < .05$) at the end of the study. The second part in this subtest measured students' reasons or motivation for their choices. The students at the end of the study stated that those show more interested in biological science for helping people, animal (28.9%) and its important in general or for society / humanity (42.1%).

Conclusion

This study investigated the contribution of science stories accompanied by story mapping to students' images of biological science and scientists. Science stories accompanied by story mapping instruction led to improved images of biological science and scientists in the eighth graders as shown in Table 3-6. In this study, students broadened their images about the type of biological scientist. While students at the beginning of the process generally knew botany, zoology and microbiology under biology as a fundamental science; they recognized much more sub disciplines including genetics and anatomy at the end of the process as shown on their drawings.

Students' images relating to gender and age of the scientists changed in this study. While students mostly perceived a biological scientist as an elderly scientist and male at the beginning of the study, at the end of the study more students perceived a biological scientist as young and female.

Students' images of the work environment of a biological scientist were broadened outside of laboratory. At the end of the study, students perceived that a biological scientist can work anywhere such as water, forest, laboratory, soil, and/or mountain.

Changes were observed between beginning of the study and the end of the study relating to students perceptions about how a biological scientist works and how a biological scientist builds, evaluates, and applies scientific knowledge in a scientific inquiry context. Students broadened their views to include two aspects of the nature of scientific work. Their posttest drawings showed an increase in a biological scientist works collaboratively with one another and a biological scientist uses of scientific process skills especially observation and data collection.

Additionally this study investigated how students saw themselves as a biological scientist. At the beginning of the study, students wanted to invent things and work on curing diseases, medicine, and students at the end of the study wanted to study on "microbiology, gene technology" and "animals, plants, and nature". There were microbiology, gene technology, nature, animals, and plants as a theme in the science stories presented to the students. Students read and understood these themes as a part of biological scientists' studies. This result suggests that using science stories can be changed students' perceptions themselves as a biological scientist.

Students' reasons or motivation for their choices changed from pre-test to post-test. At the beginning of the study, more students expressed that they want to do science for "curiosity, interest, fun, exciting" related to the profession they want, and getting rich, popular, and famous. At the end of the study, the students' perceptions were changed, they mostly expressed that they want to do science for helping people, animals, etc., and important in general or for society and humanity.

Educational Implications

This study has implications for biology teachers interested in integrating stories as instructional strategies to enrich students' views of who can be a scientist, reflect some of the possible cognitive, social, and affective dimensions of scientists' work, and stimulate their interest in biological science. Although the primary aim of this study was not to explore the cognitive and affective components of students' images, the results of the study may give important clues. As indicated by Brandes (1996), students' images of science are reflections of both their cognitive and affective components. Cognitive aspects include a student's beliefs about which topics are part of science, what activities scientists undertake, and the nature of scientific enterprise. Important affective aspects include the student's feelings about science the interest, dislike, indifference, and excitement they experience in relation to science. In addition, this affective dimension includes science-related self-esteem, which is reflected in statements such as "I want to be a scientist" and "I'm not good at science." The cognitive and affective elements within an image of science are inextricably interconnected.

This study has implications for the methods used to present stories. An implication related to the design of the stories involves the use of story maps. As they were reading, students in this study learned to identify the setting, problem, goal, action, and outcome of stories. Story mapping is an effective way to build structural schemata. Students more easily comprehend events and aspects of nature of science in presented stories through story maps.

The results of this study support the position of schema theorists (e.g., Anderson et al., 1977; Anderson, 1984; Spiro, 1980) that when readers' already existing knowledge is provided with meaningful yet challenging reading material, they become able to draw a relationship between those schemata and the reading material. As a result, most of the students at the end of the study reflect critical aspects referring to science and scientists presented in the science stories in their drawings and responses.

As noted previously, stories are value-laden and carry assumptions about many aspects of biological science (who can be a biological scientist, the nature and purpose of scientific work in biology, and so on). The potential of science stories in this context was also noted by Farland (2006) who found that historical nonfiction trade books helped elementary students broaden their views of the appearance of scientists, the activities they do, and where they work. These assumptions can influence students' thinking, images and shape their views about biological science and scientists. Hence, it is very important for science teachers to be mindful of the values and assumptions that stories about scientists communicate to students, on both an explicit and implicit level.

The results of this study indicate that science stories accompanied by story maps mapping instruction are used not only for making students' stereotypical images of biological science and scientist broadened, but also for enhancing their perceptions towards themselves as a biological scientist. In this context, an additional challenge of using stories about science and scientists in science classes to broaden students' ideas about science and scientists involves the recognition that assumptions/ideas about the

critical aspects of scientific work embedded in stories about science and scientists can influence student interest in science and/or their interest in future work as scientist. Therefore, it is important that biology and science teachers are aware of the potential affective responses of students, which may be positive or negative. Teachers' awareness of this potential impact of stories can lead to their exploration of creative strategies for helping students interpret critical ideas embedded in stories in a way that helps them develop a positive or comfortable view of science.

This study also provides support for the integration of language arts based on activities in science education. Previous research suggest that elementary school teachers find the integration of language arts based approaches to teaching science motivating and empowering (Bencze & Upton, 2006; Lederman & Lederman, 2004). This study should need co-operation between the teachers in language arts and biology or science education. In this context, the results of this study provide a valuable contribution to the curriculum developers who studied on integrated curricula and strategies to improve student learning and motivation in science. Moreover, the data will be valuable for science textbook authors, who have a lot of freedom in choosing different approaches for the nature of science. The science textbook authors may use science stories accompanied by story maps for improving students' conceptions of the nature of science.

Stories in school science have tended to emphasize the importance of objects of science over both the processes of science and the involvement of scientists in the construction of scientific knowledge (Milne, 1998). Hence, using stories in school science has met with a strongly positive response from many educators. As there are only a few studies on the application of science stories accompanied by story mapping instruction into the curriculum, there is a need to conduct more studies on this issue. This present study may give insights for teachers, policy makers, and curriculum specialists about integrating science stories accompanied by story mapping instruction into the curriculum. Science stories can also help direct practitioners and researchers recognize ways in which students' inquiry experiences can be improved.

Researchers should probe more deeply into students' perceptions of scientists in different science areas such as astronomical scientists, chemical scientists, and environmental scientists in future research. Students should be asked to draw a scientist several times and consistencies and changes between these drawings may help researchers understand their perceptions more clearly. Similarly, other interventions, like videos (DVDs) should be designed to determine whether they produce similar results as the science stories on the text in this study. Researchers should continue to examine whether holding a nonstereotypic perception of a scientist influences a student's success in school science education and its implications.

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Appendix A

Draw a biological scientist at work who you think is typical. If you like, you may draw two or more. And please give relevant information in the blanks at the bottom.

<p>Sex: male () female () female and male ()</p> <p>Age: 10s () 20s () 30s () 40s () 50s () 60s ()</p> <p>Features of appearance: _____</p> <p>What is he/she doing? _____</p> <p>Where's the background of the drawing? _____</p>

Appendix B

MABST

Assume that you are grown up and work as a biological scientist. You are free to do research in that you find important and interesting. Write some sentences about what you would like to do as a researcher and why.

I would like to

Because

Appendix C

The following interview procedure was incorporated the DABST-C. All student interviews began with the following questions:

1. I want to ask you a couple of questions about the drawing that you did and I want to learn your views about biological scientists. Is that OK?
2. What is/are a biological scientist (s)?

3. Who can become a biological scientist? (After students answer) Please give me information about his/her characteristics including gender, his/her emotions, age, physical appearance, dress, etc.
4. Where do (es) biological scientist (s) work in your drawing?
5. And what did he/she/ they do?

Appendix D

The Story of Barbara McClintock

A brief description of the story McClintock used in the study follows:

As noted in the introduction, one of the goals of the stories presented was to help students appreciate that people from diverse socio-cultural backgrounds (i.e., physical ability, gender, class, and ethnicity) can be scientists. In this context, the Barbara McClintock's story begins with an emphasis on early years –her family life, her school years, her struggle to do well in school, her parent contribution to her educational development, her personal characteristics -such as her resolution, industriousness, learning ability, motivation-, her growing interest in learning and working with science.

Also additional goal of the study was to encourage students to broaden their image of the nature of scientists' work (i.e. where they work, the kinds of things they do/study and social nature of their work). To achieve this goal, the present story describes McClintock's learning to collect data on maize, (e.g., doing experiments, taking a long time observations,) and nature of scientific work (e.g., scientific knowledge relies on observation and experimental evidence).

In addition, this story included events based on her inventions and answered these questions: How do we use Barbara McClintock's inventions today? Has Barbara McClintock's inventions changed our life? How did the Barbara McClintock's discoveries help today's science? What are Barbara McClintock's key contributions in the fields of science, especially genetics and medical science?

Two important events in her life are highlighted in the story: (1) a simple life, (2) a very distinctive personality. She was a very distinctive woman for her day. When she was young women stayed home and took care of children. She never put up with dresses or long hair unless it was for a special reason. She had no taste for luxury or fame so when she won the Nobel Prize she hardly cared at all. She cared only about her ideas, saying that ideas were like a puzzle that no one else got until she explained to them how they worked.

This aspect of Barbara McClintock's life and work shows us that Woman can do science as well as man and her discoveries opened a universe of new scientific experimentation and her career has served as a powerful model for women scientists in genetics.

As a result, Barbara McClintock discovered transposition and used it to show how genes are responsible for turning physical characteristics on or off. She developed theories to explain the repression or expression of genetic information from one generation of maize plants to the next. She won Nobel Prizes, as second female professor after Marie Curie, in the Physiology and Medicine categories. She has been the first and only woman to receive an unshared Nobel Prize in that field.

These themes highlight the importance of collaboration in a scientific research, evidence on scientific experimentation, sharing scientific inventions with humanity, and being motivated to study and work.

Appendix E

Reading and Questioning Strategy

The following questions were posed by the teacher in order to stimulate discussion were (a) to develop background prior to reading the story, (b) to create interest in reading the story, and (c) to establish purposes to guide active listening, reading and comprehension .

Name:

Date:

1. What do you think this story is about?
2. Why do you think so?
3. When did this story take place?
4. Where did this story take places?
5. Who were the main characters in the story?
6. Were there any other important characters in the story? Who?
7. How did _____try to solve problem?
8. Was it had to solve problem? Explain.
9. Was the problem solved? Explain.
10. What did you learn from reading this story? Explain.
11. What did you learn about scientist qualifications from reading this story? Explain.
12. What did you learn about a scientific research features from reading this story? Explain.
13. Can you think of a different ending?

Appendix F
SAMPLE INTERVIEW QUESTIONS

The following interview procedure was administered after the science stories accompanied by story mapping program.

1. Tell me about your science background
2. Tell me about your genetics background
3. How did you enjoy the stories you heard about scientists?
4. Which stories and activities did you enjoy most? Why?
5. Which stories and activities did you enjoy the least? Why?
6. Which story did you find most interesting? What was it about?
7. When you read this story;
 - a. What did you learn about qualifications of a scientist (physical, emotional, social, and personal, etc)?
 - b. What did you learn from the story about (For example, Barbara McClintock)? Was that an interesting story for you?
 - c. What did you learn about features of a scientific research?
 - d. What did you learn about historical development of genetics?
8. Would you like your teacher next year to use stories like them for you and another student?
9. What did you learn from the story about... (for example Barbara McClintock)? Was that an interesting story for you?