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## Chapter 9

## Converging Paths: Girls, Science, and Teachers

By Debra Gann &amp; Jennifer Blue

What could a physics professor have in common with an elementary school teacher? Both of us are now teachers of science, though there are obvious differences. In addition, we have taken different paths towards our interest in science. Debi loved science as a little kid, then got turned off by school science until an enthusiastic teacher she met when doing professional development rekindled her interest in the subject after she had become a teacher herself. Jennifer's interest in science was slower to develop, but once she latched on to physics in high school she never let go. Neither one of us had a stereotypical path towards science, but we found our way towards careers as science teachers. We were each pulled into science by excellent teachers, and now have a professional interest in science teaching.

Our partnership project involved girls, science, and teachers. Our paths to the partnership were different, and our approaches to the task were not always the same, but we have produced some work that we are proud of, and have reaped lasting benefits. In this chapter we discuss our paths to science, our paths to our partnership, and the results of our collaboration.

**Path to Science: Debi**

As a little girl, I was always in the creek behind our house trying to find critters. I was a tomboy by nature and very curious. Curiosity landed me in a lot of time outs, but my spirit of exploration was not dampened. So when I got to school I thought science was going to be my favorite subject. I did not know at

the time, however, that my teacher really did not like science. We did not get to search for critters or do experiments. For a daughter of a chemist mother, it was a rude awakening. Throughout my school years, I would find myself blessed with a teacher who enjoyed science or cursed with one who hated it. Unfortunately, I left my curiosity and enjoyment of science somewhere in that creek that never fast enough with my basic facts to excel in that subject, and although most of its concepts made sense for me, math was difficult. My engineer father had to spend a lot of time helping me with my homework and trying to reassure me that I wasn't stupid in math, I just didn't believe in myself.

When I decided to go to college to become a teacher, I had to choose my field of concentration. I loved to read, and had so many teachers who encouraged that love that language arts seemed to be the right choice for me. Despite that, I did find that I really enjoyed the science classes that I was required to take. When I became a teacher, I decided that I would be the teacher who did not try to hide her lack of content knowledge, but would try to hide her aversion to certain subjects. I would strive to help children find enjoyment in all subjects, even if they still had a favorite. In twenty-three years of teaching, I have taught just about every grade and every subject in elementary school. I have noticed that in the lower grades, science class was usually greeted with equal enthusiasm by boys and girls. I eventually gravitated toward the intermediate grades and discovered that some of my best female students, who had loved science when I taught them in earlier grades, now did not jump for joy when science time came around. I was curious to learn what might have changed their minds. When I questioned them, they did not seem to know why they were not interested in science anymore; they just knew they did not like it.

When given an opportunity to participate in professional development, I began to choose classes that helped to remedy my lack of science content knowledge. I became especially aware of the power of hands-on activities and inquiry-based learning. As my confidence in science teaching increased, so did my passion for teaching science. I also noticed that some of my students, especially some of my female students, became more interested and enthusiastic as well. I believe that the nature of science and scientific inquiry appeals to a female's way of learning. I have encountered plenty of teachers who do not like science, and as a result they don't teach it, or don't teach it well. My thinking leads me to believe that if teachers liked science they might teach it with more enthusiasm. In turn, girls taught by such teachers might begin to like science more, or at least maintain their interest in it.

#### **Path to Science: Jennifer**

My path to science is different. I was not the kind of child who spent a lot of time exploring outdoors or taking things apart. I was content with my books, my dollhouse, and my board games. I knew that my father did science, since he

was the one who provided the wires to my classroom when we learned about electric circuits in fourth grade, but I did not think much about what I would do when I grew up.

When I was in high school, I did not like biology much. I decided that I probably would not like chemistry, either, yet physics sounded interesting. In my junior year I doubled up on my sciences, taking chemistry and physics at the same time so that I would be able to take Advanced Placement Physics my senior year. And I was right – I loved physics! Much of that love for the subject had to do with my physics teacher who had great respect for both the subject matter and his students.

When I went to college, I had planned to major in philosophy and then go on to law school. My advisor in college, however, seeing that I wanted to take physics and calculus my first year, advised me against also taking introductory philosophy (another famously hard course), and I never got back on that track. I had to wait a semester to take calculus-based physics in college, since the first semester offered was in the spring, so I took a "physics for poets" class that first fall. This was a physics class for people who did not like science, which included a lot of storytelling and philosophical talk together with the science and math. It turned out that not only did I enjoy all of that, but even more important, I was better at it than many of the college seniors who were taking the class simply to satisfy a science requirement that they had been putting off. By the time I got to the physics that would count towards my major, I was leading study sessions in my dorm. I was the only female physics major in my class at college, which surprised me. If not for the direct encouragement of several of the physics professors, I would have changed majors. I still remember talking to one of the professors about whether I should stick with it, and she said, "We have been talking about it, and think you'll do fine." This direct encouragement nourished me for years. I also made friends with women majoring in math, chemistry, and astronomy, and together we formed a group to talk about issues of women in math and science. Of the seven of us whose participation in the group eventually led to us taking a course on women in science, five of us have become professors of science or mathematics, and one is a veterinarian.

After college, I knew I wanted to teach physics, but I could not decide whether to teach at the high school or college level. I had not earned a teaching license, so I applied to teach at private schools at the same time as I applied to study at graduate schools. When I had to really make my decision, I went back for advice from my high school teacher, who urged me to go on with physics while it was still fresh in my mind. So I went to graduate school in physics, where I discovered that the advanced classes were just okay, working in a laboratory was not as fun, and working as a teaching assistant was exactly what I wanted to do. I took a master's degree in physics and then transferred to the department of Curriculum and Instruction, getting a Ph.D. in science education instead of in physics. I then taught high school physics (and astronomy, and

math) at a private girls' school for several years before taking a job as an assistant professor of physics.

#### **Path to Partnership: Debi**

Due to my renewed interest in science I began taking classes through The GREEN Teacher Institute, a professional development program offered through Miami University and The Hefner Zoology Museum. Upon completion of the institute's level III course, The Natural and Cultural Study of Costa Rica, I was asked to participate in the Hefner Zoology Museum's "Women in Science and Technology Sabbatical Program" for the 2005-2006 school year. My main project while working there was to survey young girls to find out at what grade level they lose interest in science and math. I also wanted to determine how local teachers felt about science and teaching science. This data was later used in the submission of a grant from The National Science Foundation. In order to complete this survey, I needed the help of the local school districts to administer the surveys to young girls and their teachers. I was introduced to Jeff Winslow, the newly appointed Science Instructional Leader for the Talawanda School District. He was instrumental in setting up a time to survey the K-8 teachers and young girls in grades 4-8 in his district. Through our conversations, he discovered that I was still seeing girls shy away from science and that it was happening sooner than I had expected. He then contacted me about a newly hired assistant professor in the Physics department who had taught at an all girls' high school before coming to the university. He saw the connection between us, and our shared concerns about keeping young girls interested in science.

#### **Path to Partnership: Jennifer**

I had been working at Miami University as a visiting professor for two years when the school made the decision to hire science education researchers in the College of Arts & Science. The university does have a good school of education, but often people who approach education research from the science departments have a different take. I was hired to do physics education work, and that same year there were educational researchers hired in botany, chemistry, and math, as well as another science educator in the department of Teacher Education. The five of us quickly became a cohort, a group called on by the university to address different issues.

One of the people who called the cohort together was Tom Petter, one of the editors of this volume. He brought us together with public school teachers to do partnership work, and we jumped at the chance to get involved locally so soon after moving to Ohio. We wanted to work with teachers, and wanted the problems that we studied to come from the teachers; too often we had seen professor/teacher alliances where the power seemed to all be on the professor's side, when it seemed clear that the teacher knew better what issues were impor-

tant to her own school or classroom. Once Jeff Winslow knew that I was interested in gender issues around science education, he introduced me to Debi.

#### **The Survey**

Both partners have done research into gender issues. One interesting finding from the literature is that most girls start kindergarten interested in math and science and leave high school with that interest having vanished, as happened to Debi. Girls and boys enter school in kindergarten with the same measured math abilities. By the time they graduate from high school, girls are behind boys in both math ability and self-esteem (American Association of University Women, 1992). Elizabeth Fennema and her colleagues have found that girls' confidence in math drops in middle school before their achievement in that subject drops (American Association of University Women, 1992; Fennema & Peterson, 1986). Adolescent girls' self-esteem drops, especially as compared to boys' (American Association of University Women, 1992). Follow-up studies have shown that much of the change in self-esteem can be linked to girls' and boys' differential experiences in schools (Orenstein, 1994). At all stages, girls get less attention from teachers than boys do (American Association of University Women, 1992; Jones & Wheatley, 1990; Kahle & Lakes, 1983; Sadker & Sadker, 1994).

Over her many years in teaching elementary school, Debi has noticed that the age at which girls start to dislike math and science has gotten younger. It seems that while girls in grades 1-3 like math and science, they become disinterested in math and science sometime during grades 4-8.

Furthermore, many K-8 teachers have mixed feelings about teaching science. While science is interesting for their students, a significant number of teachers lack confidence in their own knowledge of science content. Experts on science teaching believe that inquiry is the best way for students to learn (NRC 1996; Ohana 2006). The inquiry activities that constitute the best science teaching can be great fun for students but quite logistically difficult for teachers. We have worked with organizations that provide professional development in inquiry-based science to teachers (GREEN Teachers Institute and SOSI), and wanted to know what sort of help teachers needed to in order succeed in teaching inquiry-based science.

This research was started while Debi was on sabbatical from Hamilton City Schools. Debi contacted superintendents of the schools surrounding Miami University. The request was made to survey teachers who taught Kindergarten to grade 8 and girls in grades 4-8. As stated above, Debi had seen an increase in the number of girls who did not like science, and it appeared that this increase was happening at an earlier age. Debi was looking for data to reinforce her own belief that some teachers would teach science with more enthusiasm if they themselves were more confident with science concepts. Also, she was looking for a way to identify the age in which girls seemed to drift away from their earlier interest in science.

Debi's original request was to personally administer the surveys, but it became readily apparent that this was not a realistic expectation. One local school district did provide an opportunity for Debi to speak with the teachers and survey them personally. All other teacher and student surveys were completed without Debi present. In one local district, there were several elementary buildings that declined to participate in the survey without a reason being provided. One school that declined to participate was predominately African American. Debi was disappointed that this school did not participate, in that the data collected might have offered a small window into the feelings of minority girls in that district. Nevertheless, in those schools that did participate, for the most part teachers and principals worked together to administer the surveys and the return rate was very high. A total of 1,997 girls from the grades 4-8 and 320 teachers from grades K-8 completed the surveys. The survey form used appears in the Appendix.

#### Survey Results: Students

Once Debi and student workers in the Hefner Zoology Museum had entered all the survey data, Debi and Jennifer got together to decide which questions were the most interesting to study. Originally, much of the reason that the staff of the Hefner Zoology Museum supported Debi by allowing her to use her time on the survey was that they were interested in looking for a need for teacher professional development. However, Jennifer was more interested in the girls' responses on the survey, so those are what we studied first.

We approached the data from the student survey with three central questions: (1) Do girls stop liking math? If so, at which grade? (2) Do girls stop liking science? If so, at which grade? and (3) Do girls like science and math less than they like language arts and social studies? We thought that girls would like science and math less than other subjects, and that they would stop liking science and math by the time they got to middle school.

To answer these questions, we first looked at the modes, the number between one, for "strongly dislike," and five, for "really like," chosen most by the girls from each grade. These results are shown in Table 1. Girls in fourth grade chose five most often for both math and science. As this was the most positive choice available to them, we conclude that fourth grade girls like both math and science. The mode for both math and science was also a five in both fifth and sixth grade. The first time that the mode drops for either math or science is in seventh grade. The mode of the seventh grade girls' responses was a three for both math and science. Since three is in the middle of the scale, three reflects a neutral feeling, halfway between the options of one and five. The mode of the responses about science increased to four (halfway between neutral and "really like") in eighth grade, while the mode of the responses about math remained a three (neutral).

Table 1: Student Survey Responses – Modes

Grade	Language Arts	Social Studies	Science	Math
4 <sup>th</sup>	5	4	5	5
5 <sup>th</sup>	4	3	5	5
6 <sup>th</sup>	3	3	5	5
7 <sup>th</sup>	3	4	3	3
8 <sup>th</sup>	3	2	4	3

From looking only at the modes, we might conclude that girls stop liking math and science in seventh grade. In order to take a closer look at the data to confirm this conclusion or call it into question, we also looked at means. The means of the girls' responses are in Table 2. The means get lower each year from fourth to seventh grade, and then rise in the eighth grade (though not to the fourth-grade levels).

Table 2: Student Survey Responses - Means

Grade	Language Arts	Social Studies	Science	Math
4 <sup>th</sup>	3.50	3.49	4.11	3.85
5 <sup>th</sup>	3.54	3.17	3.85	3.77
6 <sup>th</sup>	3.37	3.13	3.55	3.56
7 <sup>th</sup>	3.25	3.13	3.11	2.87
8 <sup>th</sup>	3.05	2.91	3.29	2.96

One pleasing result is that all the means in girls' rating of science were higher than three, which means more positive than neutral. This was also true of the means in girls' rating of math until grade seven, when the means dropped slightly below three for both seventh and eighth grade. The girls' ratings of math and science did drop significantly after fourth grade, however.

The result that surprised us was that girls do not like math and science less than they like other subjects. Looking first at the modes (Table 1), we noted that fourth, fifth, and sixth grade girls did not seem to like any subject better than they liked science and math. Their most common response to the question "How do you feel about" the subjects science and math was five ("really like"). The only other subject with a mode of five in those three grades was fifth grade language arts. In both seventh and eighth grade, there were no longer any subjects whose mode was a five. In fact, only one subject in each grade had a mode of four (halfway between "neutral" and "really like"). In seventh grade, that subject was not science or math, but social studies. In eighth grade, the one subject with a mode of four was science.

Looking at the means (Table 2) gives very similar results. Fourth, fifth, and sixth grade girls had higher means for science and math than they did for language arts or for social studies. In seventh grade, the highest mean was in social

studies, and in eighth grade, the highest mean was in science. One sobering result is that the means for nearly all subjects get lower, indicating less favorable ratings, every year. The one notable exception is the previously noticed increase in the mean of girls' rating of science from seventh to eighth grade.

#### Survey Results: Teachers

One of the reasons for surveying teachers was to find out their professional development needs. Debi attempted to measure these needs with teacher questions 6-9, and we do not address teacher responses to those questions here. Instead, we concentrated our analysis on the responses to the first few questions that asked what their favorite and least favorite subjects are, and why they like or dislike teaching science.

312 teachers answered the question about which was their favorite subject. Of those, 50 (16%) said science. The most common answer was English, including reading and language arts, which was chosen by 128 (41%) of respondents. In addition, 277 teachers answered the question about which was their least favorite subject to teach. Of those, 59 (21%) said science. Again, the most common answer was English, including writing and language arts, which was chosen by 73 (26%) of respondents.

305 teachers rated their feelings about teaching science from 1 (strongly dislike) to 5 (really like). The number of teachers who gave each rating is presented in Table 3. The average rating was 3.6, and only 13% gave a negative rating of 1 or 2. We were happy to see this result.

Table 3: Ratings of teachers' feelings about teaching science

Rating	Number	Percent
1 (strongly dislike)	17	5.6%
2	35	11.5%
3	88	28.8%
4	75	24.6%
5 (really like)	90	29.5%
Total	305	100%

The next question was, "Why do you like or dislike teaching science?" Of the 286 who responded to this question, 168 (59%) gave reasons that they like teaching science and 144 (50%) gave reasons that they did not like teaching science. (26 teachers gave reasons for both, which is why the percentages add to more than 100%.) We grouped the reasons given into broad categories, and present them in Table 4.

Table 4: Reasons teachers like and dislike teaching science

Why teachers like teaching science	Why teachers dislike teaching science
168 teachers responded	144 teachers responded (2 gave 2 answers)
Methods	Logistics
93 (55%)	76 (52%)
Students like science	Lack of confidence
32 (19%)	41 (28%)
Teacher likes science	Teacher does not like science
31 (19%)	18 (12%)
Integrated to other subjects	Curriculum inappropriate
12 (7%)	11 (8%)

The first thing we noticed was the similarity between the reasons many teachers like teaching science and the reasons many teachers dislike it. The biggest category of reasons given for enjoying the teaching of science was about the methods of teaching science, mostly the hands-on and inquiry-based activities. At the same time, the biggest category of reasons teachers gave for not enjoying teaching of science was the logistics of those same activities. We conclude that the hands-on, laboratory nature of school science is both its blessing and its curse.

We were somewhat surprised by these results. We had expected that the most common reason that some teachers like teaching science would be that the students themselves like science and find it interesting. Instead, that was the second most common reason stated. Also, we had expected that the biggest reason some teachers dislike teaching science would be their own lack of confidence, but it was not. It is possible that the lack of confidence is larger than reported; our experience indicates that sometimes a reported dislike of science sometimes actually reflects lack of confidence. Even if the "lack of confidence" and "teacher does not like science" responses were combined, however, they would still be only the second largest category.

And what do teachers say about the use of laboratory activities in science class? A couple of the teachers said they liked the collaborative and cooperative work that students do when they are doing science, and a few more said they liked the higher-level thinking and creativity that students get to use when doing science. A large group of teachers cited the laboratory nature of science as the reason they enjoy teaching. The words teachers frequently used in such responses were activities, exploring, experiments, discovery, hands-on, inquiry, and laboratories. Some of these teachers said: "I love to watch children explore and learn from observations," "I like for kids to make discoveries and get excited about learning," and "The inquiry approach taught in science carries over to other subjects."

At the same time, many teachers dislike teaching science because of these same hands-on activities. Some teachers said they did not have enough space or adequate materials to teach science, and several teachers noted that they had to buy classroom materials themselves. A few teachers said that it was harder to manage classroom behavior when students are active. A large group of teachers said that science activities just take too much time. They take lots of preparation time and cleanup time, and a good inquiry activity can take more class time than teachers are supposed to spend on science in any given day. Some of these teachers said, "The experiments are too time consuming for the idea that is being covered," "It can be chaotic," and "I've spent a lot of my own money purchasing materials."

If our goal is to keep children interested in science, we need their teachers to teach science and to enjoy doing it. Enthusiasm can be contagious, and so can the lack thereof. Teachers need support from their administrators, and from each other, so that they can have the time and materials needed to set up, conduct, and clean up science activities for their students. Both teachers and students tend to enjoy these activities, fostering an environment conducive to learning science.

#### **Partnership Revisited: Debi and Jennifer Together**

We have gotten a lot done while working together on this project, but it has not been without frustrations and false starts. This is a partnership between people who, while having a great deal in common, really do have very different jobs and very different lives.

We do have a lot in common. We both teach, we both like science, and we are both interested in helping people learn and teach science better. But the contexts in which we teach are quite different: Debi teaches in an elementary school and Jennifer teaches at a university. Although Jennifer used to teach at a high school, since becoming a college professor, she has forgotten that college professors and P-12 teachers don't enjoy equal amounts of autonomy.

Another thing we have in common is that we are both married to men named Rick. But besides that, our family lives are quite different: Jennifer's Rick is a professor, and they have no children. Debi's Rick owns his own business, and they have two sons in school. Debi has more complicated family obligations and, again, less control over how she spends her time.

When we first met, Debi was on sabbatical from her teaching job and was on campus at Miami. She stressed to Jennifer that when summer came, she would be home with her children and then going back to teaching in the fall. The best time to work on the paper, therefore, was before the sabbatical was over. This turned out to be true, although Jennifer did not act as though she believed it. Jennifer procrastinated on the data analysis she was doing, and Debi's sabbatical ended before we were really ready to write.

It turns out that we also have different approaches to writing. Jennifer is in a tenure-track position, which means that she needs to publish in order to keep her

job. She has co-written papers for publication before, and will continue to do so. Debi does not have to publish to keep her job, and has not written a paper since her master's project. We both strongly wanted to fulfill our obligations and complete this chapter, and Jennifer also wanted to take parts of the data and publish them in other peer-reviewed venues.

We do each have a problem with procrastination, which is another thing we have in common. Our self-imposed deadline of the end of Debi's sabbatical passed, the original deadline for turning in the chapter passed, and we had not written very much. Jennifer had made a presentation about part of the survey in the fall after Debi's sabbatical, and made a start at a paper, but that was it. During the school year, we met about five times to talk about paper writing and have dinner. These were fun meetings! We made great plans to write, and then went to dinner and just talked. We have grown a great friendship through those dinners, but the progress on our partnership work was slow. Eventually, we were given another external deadline, which happily was after each of our school years ended. We have had several long meetings in a three-week period where we have time for talking, eating meals together, and, finally, writing. We have encouraged each other and have actually enjoyed ourselves.

Our friendship is not the only lasting benefit that we take from this partnership work. Jennifer has continued contact with Jeff Winslow, the science instructional leader who introduced the two of us, and through him has done service work with local teachers and students. Debi has been able to stay in touch with her colleagues at the Hefner Zoology Museum, and is going to pursue a community grant with them. We also plan to continue our own professional relationship; Debi can benefit from the professional development opportunities Jennifer hears about at the university, and Jennifer can continue to have contact with elementary school teachers and students.

We came to science from different directions, but we both appreciate the art of teaching. It does not matter if we are teaching elementary school, high school, or college: our students, especially our female students, need our encouragement. Despite each having parents who were scientists, it took active encouragement from our own teachers to set us on our own paths to science! We also came to this partnership project from different directions and even with different goals. Debi was more interested in professional development of teachers, and Jennifer was more interested in the academic study of girls and their interest in science. After some initial difficulties, we achieved our goals, gained new insights into each other's professional lives, and forged a friendship that we plan to sustain within and beyond future collaborative efforts.

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## Appendix: Survey

Student Survey

Grade \_\_\_\_\_

Please take your time and answer the questions to the best of your ability and please be honest. This will not be graded and will be kept secret.

## 1. How do you feel about school in general?

1 \_\_\_\_\_ 2 \_\_\_\_\_ 3 \_\_\_\_\_ 4 \_\_\_\_\_ 5 \_\_\_\_\_  
 strongly dislike \_\_\_\_\_ really like

## 2. How do you feel about the following subjects in school?

*Language Arts*  
 1 \_\_\_\_\_ 2 \_\_\_\_\_ 3 \_\_\_\_\_ 4 \_\_\_\_\_ 5 \_\_\_\_\_  
 strongly dislike \_\_\_\_\_ really like

*Social Studies*  
 1 \_\_\_\_\_ 2 \_\_\_\_\_ 3 \_\_\_\_\_ 4 \_\_\_\_\_ 5 \_\_\_\_\_  
 strongly dislike \_\_\_\_\_ really like

*Science*  
 1 \_\_\_\_\_ 2 \_\_\_\_\_ 3 \_\_\_\_\_ 4 \_\_\_\_\_ 5 \_\_\_\_\_  
 strongly dislike \_\_\_\_\_ really like

*Math*  
 1 \_\_\_\_\_ 2 \_\_\_\_\_ 3 \_\_\_\_\_ 4 \_\_\_\_\_ 5 \_\_\_\_\_  
 strongly dislike \_\_\_\_\_ really like

## 3. Please check all the ways of learning that apply to you!

I like to learn things by:

- \_\_\_\_\_ listening to the teacher talk  
 \_\_\_\_\_ listening to a video or DVD  
 \_\_\_\_\_ discovering for myself through personal research  
 \_\_\_\_\_ working in a group to discover or solve a problem  
 \_\_\_\_\_ working alone to discover or solve a problem
- Circle the one that is your favorite way to learn.

4. What kind of career or work have you thought about pursuing?
5. Why do you think that you are attracted to that career or work?
6. Is there anything else about yourself that you would like to share?

*Thank you so much for all your time and honesty!*

Teacher Survey          Female/Male  
(Optional)

Position: \_\_\_\_\_

District and Building \_\_\_\_\_

1. What subject(s) do you teach?
2. What is your favorite subject to teach?
3. What is your least favorite subject?
4. How do you feel about teaching science?  

1	2	3	4	5
strongly dislike	-----			really like
5. Why do you like or dislike teaching science?
6. Do you use an inquiry approach as a teaching strategy for science or any other subject?  

Yes	No	I'm not sure
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7. Do you use cooperative groups for work in science or any other subject?  

Yes	No
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8. If we were to offer teacher workshops in science with environmental themes at little or no cost to you, would you be interested in participating?  

Yes	No
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9. If you responded, NO, would you explain why?

*Thank you for your time!* Please feel free to add any other comments or questions.