Details

Four circular tables and twenty-four brightly colored chairs occupy much of the space in the Merit Workshop classroom. A recent addition also includes ceiling fans and a window air-conditioner. The room is located in the basement of the mathematics building. Chalkboards are present on three of the four walls. I suppose the students enjoy the newly remodeled classroom. They do spend many hours in this room working on challenging calculus problems.

The students enrolled in the Merit Workshop Program for Emerging Scholars in Mathematics are selected based on several factors. Entering freshmen who have declared either a mathematics, science, or engineering major and are either a minority, female, or student from a small high school are targeted. Then based on high ACT scores (last year it was a score of 27 or higher) and high class rank in their high school graduating class the students are sent applications to be in the program. After the applications are reviewed, interviews are set-up with the director (which is myself) to see if this is the type of learning environment that is best suited for them. The students then enroll in either Math 120, 130 or 242.

A high school student may receive many papers from colleges, so what initially attracted students to this program? I discovered several reasons effecting their decision. One was the additional credit hours they receive if they are in the program. They receive these extra hours since they are spending more time in class, however. Another reason was that a friend had told them to enroll based on their experience in the program. They told me their friends really enjoyed the program and that it helped them in calculus, as well as in making new friends in their major.
When walking by the Merit room you can hear many loud voices. Professors down the hall have asked what is going on in that room. It is too loud. So, before entering the Merit Workshop classroom, one may think that the students are only socializing in these courses. Opening the wooden door with a frosted window and walking onto the newly tiled floor, however, provides an entirely different view than from being in the hallway. The students seem to like it cold in the room: air conditioner and ceiling fans on sometimes with the door open. How many times do I have to ask them to keep the door closed when the air conditioner is running?

Once inside the classroom students are working at the tables in groups of three to five. Some students choose to do work on one of the three slate chalkboards. Debate seems to occur when students are putting their work on the board. Someone may not agree with what is being put on the board and they will openly voice their opinion. The noise level. Students are openly discussing calculus problems and many times they are quite vocal. I have never had a problem with the noise level as long as the students are working, but I imagine some people would.

One Tuesday afternoon I was observing a workshop class and the students did not talk about anything mathematical for the first nine minutes. Various discussions I heard centered on a recent party, the Illinois-Michigan football game, an upcoming physics examination, and spring break in Cancun, Mexico. They were socializing, which seemed to be a normal action for the class. However, after nine minutes it was if something magical happened. Everyone in the class began diligently working on the worksheet prepared by the teaching assistant (TA), Abby. Abby did not even tell the students to begin working on the worksheet.
The class I am focusing on is Math 242 Merit, which is the third semester of calculus at the University of Illinois at Urbana-Champaign (UIUC). They have lecture Monday, Wednesday, and Friday from 10:00-10:50 and workshop on Tuesdays from 1-2:50. Abby is the TA for both lecture and workshop and this is her first semester teaching in the department. The students (16 males and 1 female and all engineering students) seem to interact with her well. During lecture many students asked questions and one student went up to the board to draw a picture of what he was trying to verbally explain. Even though Abby is lecturing to the students, I would not consider it a traditional lecture. There exists an interaction between Abby and the students that seems familiar and comfortable. The students gather around her as though she were a combination of coach, older sister, and parent. During the workshop portion Abby does not lecture at all. In fact, Abby does not answer students’ questions directly. Abby will answer a student’s question with a question. Often she will direct one student who has a question to another student who may be working on the same problem.

An initial frustration given by the Merit students was the fact that the TA will not answer questions. However, all interviewees said reflecting back on their first Merit class, they are glad the TA did make them think more for themselves. By the time the students are in Math 242 Merit they do not ask the TA many questions, especially compared to Math 120. I was the instructor for a majority of these students when they were taking Math 120 and they bombarded me with questions all of the time to see if I would give them a direct answer! While in Math 120 the students say they relied on the TA for answers because this is what they were used to doing in high school. The students did not have an active learning environment in their high school mathematics
courses, but had a lecture led by the teacher. So, which of these instructional methods has helped students learn the best?

As educators we can bestow instructional methods on our students that we believe are most beneficial to them. Also, many of us have various methods we think should be employed in the classroom. However, shouldn’t we also listen to students to see what they believe works best for their learning? I have interviewed three Merit Workshop students. I wanted to interview students that have completed the program or are in their last course of Merit. I also had to consider students that I thought would be reflective and willing to share their experiences. The students I interviewed are all males, which is very representative of the section I observed and are all engineering majors. Two of the students, Roberto and Charles, are currently enrolled in Math 242 Merit. Gil is a student who has completed the Merit Workshop Program and is now enrolled in a non-Merit mathematics course, Math 285 (differential equations). I will briefly discuss Roberto and Charles’s stories and will provide a more in-depth look into Gil’s background. Hopefully, this will provide examples of the types of students in the Merit Workshop Program and their voices will be heard as far as how they view the learning of calculus.
The Students

Roberto

Roberto grew up in Puerto Rico and came to the U of I in August of 1999 to major in computer engineering. His first semester at U of I was a little challenging for him, not due to course work, but due to the fact that he was coming from a different country. The language was somewhat of a barrier, but for him “it was only like an obstacle...but I overcame that.” Roberto’s father is both an architect and a teacher. Roberto looks up to his father and seems to be following closely in his footsteps. He has a very close-knit family. In fact, Roberto’s younger brother is also attending the U of I this year. He told me his brother is very intelligent and may even finish school before him. I could sense that Roberto is quite proud of his brother. I have never seen Roberto in a bad mood. He is always polite, cheerful, and kind. Roberto is very unselfish; he is a caring and giving person, which helps describes why he is currently helping students in Math 120 and 130 Merit.

Roberto has decided to pursue a degree in computer engineering. Besides working on his own course work, he also is an undergraduate teaching assistant for the Merit Workshop Program. As mentioned before he helps Math 120 and 130 students. He spends time in the classroom with the students and the TA and takes on a role similar to the TA. During class Roberto does not answer the student’s questions directly either, rather he makes the students think for themselves. As an undergraduate TA for both courses he says, “when you explain something to someone...I don’t know why...you really learn it.” He also spends time outside of class helping the students. Each week he sets aside time to help the students on their work in the course. Most of the time they meet in lounge in one of the dorms on campus. Observing Roberto with these
students is truly amazing. Teaching seems to come naturally for him. He is patient with
the students, considerate of other people’s opinions, and asks pertinent questions to the
students. On several occasions I have tried to convince him to also pursue a teaching
degree, which he is considering.

Roberto was initially attracted to the Merit Workshop Program because he read
that students would be working in small groups on challenging problems. He enjoyed
working with others in high school and mentioned that he especially enjoys challenging
problems. Roberto began in Math 120 Merit where I was his TA. Our workshop session
met from 9-11am on Monday, Wednesday, and Friday. This was a little tough for
Roberto. He is not a morning person. I can remember days when he would come to
class and would look tired. Some days he was late. He worked hard in class though
and stayed on task the entire time. Roberto says that, “it (Math 120) was like the best
thing that could ever happen.” However, he did not feel this way while taking Math
120. He says it was a lot of work, time, and effort. At first, he wanted answers to the
worksheets and the only place for answers during workshop was to turn to the other
students in the class. Roberto mentions the “network” of people that was created in his
Math 120 Merit course.

Roberto decided to take Math 130 in a traditional setting; therefore, he did not
take Math 130 Merit. I spoke with Roberto on occasion during this time and he seemed
to be doing well in the course, but I sensed that he wished he had stayed in the Merit
Program. Roberto came to me after Math 130 and asked if he could enroll in Math 242
Merit; I immediately said yes. He says he loves Math 242 Merit mostly because he can
see a connection to the real world and the three-dimensional aspect of many of the
problems discussed in class. Another positive attribute Roberto likes about Math 242 is
that he is glad to be with friends that he had made in Math 120 Merit. When observing
Roberto in the Math 242 workshop I noticed each time that he is one of the students
who uses the chalkboard quite often. He goes to the board many times to work with
others on problems that have been posed by the TA. I have seen him teaching a
solution to others in the class, as well as listening to others teach him solutions to
problems.

We discussed the TA's role in general and did not focus on specific TA's in the
Merit Program; however, Roberto did have me as his Math 120 TA. Then we talked
about how he views my role as the director of the program. Roberto feels the TA's role
in Merit is to motivate students, think beyond the problems being presented, force you
to think on your own, and present you with problems you are likely to encounter in the
"real world." Here is the thoughtful response Roberto gave to what my role is as the
director of the program:

As a director? Well, that's kinda funny. It's like...I don't know...I think your role
is like to be...to have everything under control. You make sure the TA's know
the rules and actually motivate the students to get together and get to know
each other. They help them create a network of people that you can trust and
work together. So, just like math. It's a subject you cannot learn just by lookin'
at something. You've gotta practice and practice and practice. That's the only
way you're gonna learn math. So, I think your role is like being sure TA's
motivate people like making the worksheets, be sure the worksheets are
challenging enough, and to keep them going to make sure they really
understand their field. I also think you have a close and personal relationship
with the students.

When asked about an active learning environment, Roberto says this type of
learning environment is “my kind of flight.” This type of environment is where he is
most comfortable and seems to learn best. When I asked Roberto about the
questioning involved with this type of learning, he questioned me back asking me what I
knew about it! The questioning forces him to think on your own “cause in the real world
you are not gonna be able to prove that something you think of is true...you’ve gotta think and rethink, and rethink again ‘til you get it right...and you’ve gotta trust your feelings.”

The worksheets were a source of frustration for Roberto while in Math 120. While taking Math 120 he thought he should have been given the answers to the worksheets. In retrospect he is glad the answers to the worksheets were not given to him. They take a lot of time to do, but you get used to it. Also, you don't get answers to the worksheets, which also seemed to frustrate Roberto somewhat. At first, he did not know if he was able to validate his answer or not since the TA did not give a solution to him. However, he realizes there will not always be a teacher there to tell him the answers.

Roberto will take differential equations next semester in a traditional class setting. A class where the main instructional method will be a lecture. Roberto believes the Merit TA’s he has had in class are really committed to teaching and says the following about taking differential equations next semester, “I’m scared at the thought of having like a bad teacher or like someone that doesn’t like really teach...someone that knows this material, but doesn’t know how to get the message to the students.” I was recently discussing the approaching differential equations class with Roberto and was telling him some trouble my brother is having in the course. I really was not trying to scare him, but after I told him about the trouble I felt bad. I felt as though I was scaring him about the course. However, he responding quite cheerfully saying he is not scared about taking the course and believes he will do well in the course, which I am sure he will!
Roberto is someone I could sit and talk to for hours. I think his ability to carry on a conversation and interest in learning about various points of view is something that carries into the classroom setting. I am confident in saying that Roberto will make an excellent engineer and teacher even if he is not in academics. Roberto and Charles, who is discussed next, are both students that I have always been able to rely on for assistance both in and out of the classroom. They make my job a lot easier and more enjoyable.

Charles

The first time I met Charles I thought he was a basketball player. In fact, I believe he resembles one of the players on the current University of Illinois basketball team. I vaguely remember asking him if he played basketball in high school. Yes, he did. I was Charles's TA for Math 120 Merit. He was one of the best students in the class. Even though he seemed to know most of the material quite well, he worked hard in the course. He would always be willing to help others in the course that were struggling with the material. I could count on Charles to help any of the students in the course.

Charles began to like math in the fourth grade. “This is when I just fell in love with math.” He thought he had failed a test because he had not studied the night before. While taking the test he decided to use reason to work his way through the problems. The test was returned and he received a 100%. “Ever since then I was like math is my subject.” He continued to do well in math throughout middle school and high school. Charles carried this ability to do well in math to the college level. He is the first in his family to attend college and hopes that by attending college he has “started something and it will help them [brothers and sisters] go to college and see what it’s
Charles's father initially wanted him to focus on playing basketball at the college level, but has since gained respect for all of the hard work Charles has given to academics. On the otherhand, his mother tended to focus more on his success in academics. After hearing Charles speak about his mother, I truly want to talk with her sometime. She sounds like a wonderful lady that is very giving and supportive of those around her.

Charles is majoring in mechanical engineering and says he decided on that particular major the summer before attending U of I. He signed up for the engineering program not knowing if he wanted to be an engineer or not. He just signed up because “it seemed like the right thing to do.” He told his high school counselor that he wanted to do something that involved problem solving, trouble shooting, and physical work. During the summer before his first days of college Charles had some work experience as an engineer, which helped him decide that this is what he wants to do for the rest of his life. So, why mechanical engineering? The internship consisted of mostly industrial and mechanical engineers. However, he went in as a mechanical engineer and worked with the mechanical engineers. He did speak frequently with an industrial engineer about typical job activities of an industrial engineer and decided he was more on the mechanical side of engineering.

Charles initially joined the Merit Workshop Program due to the extra credit hours he would be receiving. He came into college knowing he could begin in Math 130, but decided to start in 120. “I just wanted to come in like the average student. I wanted to get a high grade point average my freshman year.” He figured he would be working on calculus many hours a week anyway, so why not work with others and also receive additional credit at the same time. Working with others is something Charles did not
experience much in high school. Most of his classes were lecture. If he needed help understanding something, he would just ask the teacher. To this day Charles attends his instructor's office hours on a regular basis. During Math 120 he went to the professor's office hours quite regularly. In fact, she and I had several discussions regarding Charles and his dedication to learning.

A main point Charles makes about Math 120 Merit is that it helped him to learn calculus better from others than it did from the lecture. The students would meet outside of class on average of three times a week. They would work in one of the dorm room lounges doing their homework and studying for quizzes and exams. The students had to work problems out together, especially since I would not give them direct answers in class. He told me as a TA I pulled everyone together and helped establish the “little family thing we got going now.” When I asked Charles to tell me about Math 120 and his experience with not receiving direct answers, he replied:

I think at first if was kind of difficult because you are used to getting your questions answered. If you ask a question in this situation the TA wasn't allowed to answer your question. So, it forced me and others to try and work with each other and work it out. It's kind of weird because sometimes we wouldn't know if we had the right answer or not, be we were pretty confident in knowing that maybe two other groups had the same answer. So, it forced us to think a lot.

Charles also mentions that some of the students did not work as much as the others and saw class as more of a social environment. However, he says this could vary on a daily basis and some of the people that were socializing before would “step up and start asking questions of other students.” He believes everyone in the class benefited from an active learning approach. However, those who did not receive as much benefit from the style of learning had themselves to blame because they did not want to get involved.
The main difference for Charles in the transition from Math 120 to Math 130 Merit came outside of the classroom. The TA in Math 130 was “good, very good, useful, and helpful.” Charles did not study with the others outside of class as much as he did in Math 120. The study sessions became more of a social gathering and he did not feel like much work was getting done at these sessions. However, Charles did spend much time in office hours with the TA. The TA in Math 130 was the only instructor for the course. I asked Charles how can you learn calculus if you do not have a lecture, which he did not in Math 130. I received a lovely response:

How would you learn the material without a lecture? My answer would be first of all you have to be a student who’s willing to read on your own, which you should be doing anyway. Even for those students who don’t do a lot of reading on their own, they will learn from the other students. I mean when you go to class-there’s been days where I didn’t read ahead and I went to class and then did the worksheet. You’ve got five or six people doing the same thing that you’re doing and if you don’t understand a particular part, then they’ll explain it to you. To me it’s better than lecture. You don’t have to sit there and wait to get a certain part. I mean assuming you read ahead, you don’t have to wait to get to a certain part. You can say, hey, I don’t understand this. Did you understand this when you read it last night? They can jump straight into that part and say, ‘oh yeah, I understood that and this is why it is.’

Many of the students that are in Math 242 with Charles have been in Math 120, Math 130, or both with him. Charles seems to think of this as both beneficial and hindering. First, Charles believes students feel very comfortable in class to ask questions, if they do not understand a particular topic. If someone does not understand something, then they don’t understand it. No big deal. They should just ask the question because nobody is going to think differently of them. On the other hand, he feels as though sometimes the questioning by students can take away from the current lesson. Not all of the material may be presented due to student questioning. Charles seems to be bothered by a lot of questioning because he felt “we would miss out on the
material.” Charles believes his Math 242 TA is a very good TA. She tries to keep the students on the subject and makes sure they get the subjects covered in a day or so.

So how will Charles’s Merit experience impact him in his future endeavors? Mostly, he feels his leadership skills have developed as a result of the program, as well as those of the other students in the class. He feels much more comfortable in forming study groups, which is something he did not do before attending college. In future non-Merit courses the previous Merit students will be the “go-getters” in their courses.

When I asked Charles to talk about one thing that has helped him learn calculus the most here is the wonderful response he first wanted to ask me a question about that question! He wanted to know if I meant learning calculus with respect to his experience here at U of I or his whole life experience. Of course, I was interested in hearing about both.

Ok, well (laughs) you just made the question tougher. I say in my whole life, I guess as a whole, what helped me learn calculus better is just trying to understand the reason. I always have a question of why is it this way. I mean even in the early part of my math days or whatever. I know how to do the problems just from seeing the teacher do it or somebody else do it. I can remember the correct route to get the answer, but then I start asking the question, “well, why is it that?” because you get higher up there [in mathematics] and there are theories and things like that. Those are the basics and you need to know those. One thing that’s helped me overall to learn calculus better is to know why-why the answer is what it is instead of just how to get it. At U of I what helped me learn calculus better...Merit played a part in it. I’m not just saying that just to say it for this tape or whatever, but Merit did play a part in it because of the interaction we got in class. It’s easier to ask someone sitting right next to you about a problem instead of trying to go to a professor’s office hours. It’s easier if this person, someone next to you, or someone in the room is really good in a particular area and they can sit down and explain it to you right there on the spot. There’s just something about that that helps...in that sense I think Merit played a big part in helping me to learn better in calculus. Or should I say the students in Merit.

When I observed during the lecture portion of the class I noted that Charles chose to sit in the front of the room. He answered most of the questions posed by the TA during
the class. I also noticed that he asked for verification several times about various points throughout the lecture. When I observed the workshop portion of the class I saw just what I had expected to see from Charles. He was consistently working with others and stayed on task the duration of the time I was in class. I never particularly noticed that he was one of the more verbal students in the class. He seemed to mainly work at the table where he was sitting. However, several students did seek Charles out when they needed help on a problem or wanted to compare answers.

Overall, Charles is a truly dedicated student and goes the extra mile to make sure he understands whatever material is being covered. This may mean Charles will seek help from other students, form study groups, meet with the professor or TA outside of class, or do extra reading on the topic. I believe Charles may be one of the top students I have seen in the Merit program during the past three years I have been involved with the program. I say this due to his integrity, compassion, and dedication. Hopefully, his brothers and sisters will follow in his footsteps and be successful in whatever it is they choose to pursue in life. This would be a nice tribute to Charles and all of his hard work.
Gil

Gil is currently a junior at the University of Illinois majoring in Civil Engineering. He has completed the Merit Workshop Program and is currently taking differential equations. Talking with Gil is always a pleasure, especially since he is reflective and appreciates the research I am doing. I was Gil’s TA for Math 120 and have kept in contact with him since then. Gil and I started interviewing this past summer and continued to meet periodically. His story is captivating.

Gil’s family has always been supportive of him in his endeavors. His parents came from Mexico to work at a young age; therefore, they do not have much formal education. However, they love school. They think it is great. Gil never felt any pressure from his parents to pursue a particular field of study. Even though they could not help much on Gil’s homework, they would always offer to help. They would ask him daily if he had completed his homework. They wanted him to stay on task. If Gil would get a “C” in a class, they did not get angry with him. Instead they would tell him to try harder the next time. Gil believes his parents, “have all of the confidence in the world in me.” Gil’s father is interested in math and was actually a college freshman in Mexico majoring in engineering before he had to leave for the states. Gil’s parents have helped instill a confidence level in Gil that is truly amazing.

I have this confidence. Even if I don’t go to college and I’m just doing this because I have the opportunity…I don’t want to let anyone down. I know I can do it, but I can do anything and I know it will turn out to be OK. Some people go to math class or school and they get good grades and don’t understand the meaning behind it. My main goal is to understand the techniques.

Gil is highly confident that he can do anything he sets his mind to and gives all his effort. Reasons supporting this confidence include continued family support and not yet failing at anything he has tried.
Gil has been interested in sports as long as he can remember. In the fifth grade he was a member of the basketball team. He may not have been the tallest person or the skinniest on the team, but he was one of the good players. Even if others could run faster or jump higher than him, Gil would still be able to score. He contributed to the team, which worked well together to win many games. This is where Gil began to realize the value of teamwork.

In high school Gil had varied experiences with his math teachers and courses. As a freshman he took Algebra I, which to this day he would like to take again to prove to himself and the teacher he can do well with the material. He had the same teacher, which he really liked, for Geometry and Algebra II. The teacher for these courses involved the students in group work, talked about math with intensity, explained things well, and made connections to real-world ideas. During Gil’s senior year he had pre-calculus with a “tough teacher.” Gil said the teacher was dry, which made him slack off of his work. However, he did go in before school on occasion to get help. Gil admits in high school he really did not care too much about academics. He would just do the work and not really think about what he was doing. He would sit in the back of the class and know the answer to a question, but would not offer the solution.

During the summer between Gil’s senior year in high school and freshman year at the University of Illinois he had an internship with a construction company. This experience is central in learning about where Gil is at now in his life. This is when Gil first thought he might want to major in engineering. Gil was a digger at the construction job. Gil said the first day of work, which began at 4:30am, was “the worst day of my life.” The work demanded much physical activity. He could not move the next day, but he liked the work he was doing. At this job he could actually see things
being done and could actually be a part of something. Listen to what Gil says about this experience:

I was like, ‘Wow.’ I wonder who actually thinks of the stuff behind it. ‘Cause I was just doin’ the labor work. Anybody can do that, but the ideas behind it. There’s a lot of thought that goes into it.

Gil seems fascinated at both the design and management of the construction site. While Gil was down in a ditch trying to put sewers under the street, he began thinking about the design of the entire project. He wanted to know who thought about how far you have to go down below the street. What testing on the soil they had to do before they knew where to put the drill. He says the reason he initially started thinking of many questions about the construction site was because he wanted to get his mind off the work. One of Gil’s thoughts was what it would be like to actually own a company.

That’s what started it. That was my first initial thought. You know if I wanted to own it I would have to know every aspect about it. So, I started thinking about everything. Person by person. I’m like somebody’s gotta do that. Somebody’s gotta design it…dig a hole.

Gil goes on to describe many of the thought he had while at the construction site. He discusses how the job was a lot of work and a lot of digging! Gil’s thought process during this entire experience helped develop his decision to pursue engineering. So, why did Gil choose Civil Engineering? According to Gil, “You know I went into civil because it has a lot to do with construction. It has a lot of branches to it. Just the thought process of it…it’s all tied together.” Gil also believes civil engineering is the toughest of all engineering and this is one of the reasons he chose to pursue it. He likes the challenge. However, Gil is still waiting to see how what he is learning at U of I will connect to his job at the construction site.
After the summer Gil then came to U of I where he would continue to question how various things work. He says when he got to U of I he changed. He doesn't know what changed him, but gave Merit as a possibility. Gil decided to start his mathematical venture at U of I in Math 116. He says he could have started in Math 120, but he chose Math 116 because he was not absolutely sure he wanted to pursue engineering at this time. Business would be another area Gil was interested in pursuing. He wanted to see how he could perform compared to other students in engineering before he would declare a major. Math 120 Merit is the course that paved Gil's way into civil engineering.

Gil was extremely frustrated with the Merit Program at first. He felt as though he was not getting any help from the TA (which was myself) and did not see the purpose of the program. The worksheets were making him mad. Later he says he realizes this is “mad in a good way. It's mad that you have to think.” Gil did not come to this realization at first though. After the first quiz he was trying to decide if he should drop the course or not. However, something told him to stay with the program. It took about four weeks before Gil started seeing the point of Merit. Even though he says it took a lot of time, it was worth it to him at this point and, at the same time his grade started to slowly increase. So, why did he stay with the program?

I guess I’d heard a lot of good things about it. I wasn’t seeing it for a while. I wish I knew what is was that convinced me. I think maybe I sat with Natalia or Chad and we just clicked. Doing it together and it finally started…I was like, ‘wow.’ I know how to do it. Sitting in lecture I didn’t learn anything about calculus. Like your (talking about me in 120)explanations were good. People around me...hearing it from people my age really helped. They don’t use the same terms. They don’t use math lingo. You feel more comfortable. Period.

Even though Gil’s grade started slowly increasing, he was still disappointed in his grade. He felt he really understood the material, but just could not show it. Even
though his grades aren't as good as many others in his field, understanding the material is much more satisfying to him. This gives him the confidence and courage to continue in spite of lack of recognition from the system. However, understanding the material in Math 120 was almost not enough to give him the confidence to continue in engineering.

After that class I was like no more math for me. I’m going to go business. I’m going to take Math 125 and that’s it. I’m through with it. I was upset with my performance. The thing was I didn’t totally grasp calculus, but it does interest me. It was a whole new language. I had the option to quit. It was a huge challenge. The hardest class I’d ever taken. Before that my classes were pretty simple. I’d never challenged myself (in high school), which I regret later on because I’m paying for it. That class (Math 120) showed me even though I did bad (grade wise), I could compete with the people in there. I was like, ‘I might not get the same grade, but I understood.’ I saw that math could go higher and higher and that’s the tools that people need - like an engineer. Math is his tool.

One reason Gil may have stayed in Math 120 could be contributed to a fellow classmate, Shenyka. Gil worked a lot with Shenyka on calculus in and outside the classroom. He thought of her as someone who was not that different than himself. “We’re not the smartest people in the class, but we can do it also. We can totally do it. It’s all about hard work.” Gil thought Shenyka’s work ethic was unbelievable. He really seemed to like the fact that Shenyka would sit down to work on a problem and would begin at the very beginning and go through every single step. I asked Gil if Shenyka would check his work.

She would when we would work together. I would be like, ‘Shenyka this is what I understand, but I get stuck here.’ She would be like all right, look, tell me what you know. I would tell her and she would say that’s great. Now think about this. I would think about it and she would start me going.... Every time someone was lost on something I would be like, ‘what do you know.’ They’d tell me the little bit that they knew and then I would ask them another question. We also know this. How do they relate? Because this is what Shenyka could do with me or somebody else. She just stuck out. She would ask me questions and little by little it would click.

When solving problems he now used the “what do you know” approach that was
taught to him by Shenyka. This approach pays attention to the specific details of a
problem, which Gil displayed at the construction site. He gives much attention to details
of a situation, whether it is the organization at the construction site or the planning of a
solution to a Merit Workshop problem.

Shenyka is not the only person Gil worked with while in the Merit Program; many
other students aided in his understanding of the material, which was mainly presented
on the worksheets. To Gil a worksheet in Merit is like a puzzle that you have to put
together. “One person might find one piece and be like, oh it goes here. Another
person is holding another piece and oh, it goes in this spot. Everybody slowly adds their
piece and it comes together.” Gil’s frustration would come when he felt as though he
did not have a piece to contribute to the puzzle. However, if he did not have something
to contribute at a particular moment, he knew there would be a time when he would be
the one holding an important piece to the puzzle. Gil also believed the TA was not
going to contribute much at all to the puzzle.

“They’re not going to give us the answers, but there’s someone in here (Merit class)
who’s tried it and were able to get it and would then relate it to others. The best
way to learn something is to teach it. So once I taught something - or even better
than that - there were problems where all of us put in stuff. Since each of you
knew that piece really well and somebody else knew another piece, you could put it
all together and figure it out.”

The results of active learning are satisfying and rewarding to him. For example, he liked
being part of the finished product at the construction site and a contributor to the
“puzzle” in Merit.

As mentioned previously, Gil was ready to switch to business after taking Math
120. However, after returning for his sophomore year at U of I he decided to stick with
engineering. This meant he would now be enrolled in Math 130 Merit with Tony as his
TA. Later Gil would say that Tony is one of the best teachers he has ever had. Gil gives a nice description of Tony and his teaching style:

“They teach children, some high school. Some could do both, but Tony can teach anybody. He could teach from kindergarten to someone who has never gone to school. That’s the style – he found the right profession for himself.”

Tony may have contributed to Gil’s success in Math 130 and then Math 242. “Actually, 130 is what changed it for me.” Math 130 had no lecture, so Gil felt as though “this was all on us”, which scared him. He wanted to know how they were going to learn the material without a lecture. This is interesting since he previously said the lecture portion of Math 120 did not really help him much in learning calculus. However, Gil said that somehow somebody always knew where to start on a problem and once it got started then they were able to continue. Also, he said the person who would know how to start the problem would generally be someone different and that he felt good when it was he. Gil met outside of class with Tony every week. They would work on many calculus problems. Tony would not answer questions, but would relate the material to things Gil already knew.

The class size for Math 130 was smaller than Math 120 and Gil believes this helped the overall course.

“We were a smaller group and we were tighter. Everybody knew each other perfectly. There were a few new people, but the backbone was there from Math 120 and that helped tremendously. When you go into a new class, you’re shy. This time we were ready to work from day one. 130 changed it for me. I had more confidence. I liked it, especially the way Tony came in.

Gil continued in the program and took Math 242, where he had Tony again as his TA. This time Tony would lecture to the students three days a week and then would hold a workshop session once a week. At the beginning of the course Gil remembers telling Tony that he does not like doing volume problems (recalls related rated problems
from Math 120). Tony tells him that is what Math 242 is mostly going to be about. Gil then decided this was going to be a chance for him to redeem himself from Math 120. When Gil talked about Math 242 it was as if he had finally reached a mathematics course where he really felt comfortable, which he contributes in part to Tony. I told Gil I think Tony is a great teacher and he replied; “I can't even describe how good he was.”

Almost everyone would go to Tony’s office hours, which were held at the Courtyard Café in the Illini Union. The students would break off into groups and start working with each other, because Gil says they were “so used to working together.” Tony was there in case they needed the extra boost to help them on their homework or to answer any questions they had. For example, Gil once asked Tony why calculus invented. Gil remembers Tony laughing at him, especially since Gil told Tony he could put a “bunch of rules together and invent his own (calculus), too.”

After completing Math 242 Gil seems to be fairly confident that he will be able to successfully complete a degree in civil engineering. He will at least give it his best shot. He is fascinated by engineering and hopes that he “thinks like an engineer.” One characteristic Gil has displayed in several situations is his ability to think about everything, every little thing. For example, when I was interviewing him he told me he looks at many things and wonders. “Like this tape recorder…I’d like to mess with it. Open it up and whatever.” However, Gil does realize that he has much more to learn about engineering. It is hard for him because it takes a lot of practice. Not because he cannot do it. It may take Gil longer than others because he thinks; “some of those people (other engineering students) just do it and don’t think about it. Maybe I spend more time thinking about how it is actually done.” Some of the people at the university
blow Gil’s mind. He thinks many of them are quick and smart, but he also know that however long it takes him, he will get to their level also.

Gil believes group work (specifically mentions Merit Workshop) is what enabled him to successfully complete Math 120, 130, and 242. He says he will try to initiate or form groups in his non-merit courses. If he gets stuck in a class where no one wants to work together, then he will try his best to get them to work in groups as he did in Merit. “I’ve done everything with group so far. Why would I stop now? It’s working.”

Gil was a true delight to work with on this project. Learning more about him and his background fascinated me in several ways. I especially believe I learned a significant amount of information about the Merit Workshop Program. Gil was honest and told me his frustrations with the program along with the benefits and I am thankful for that. I definitely want to keep in contact with Gil as he continues his education. I am sure he will be extremely successful in whatever he decides to pursue. During one point he told me he would like to have his own construction company. I would say to him to go for it; no goal is too high for him to reach. He has the confidence and dedication to be a huge success.
Discussion: One big family

The interviews and observations I conducted for this research study not only helped me learn more about the program, but also helped me learn more about the students enrolled in the program. I have noticed common themes throughout the study, as well as some unique instances of differences. If time would have permitted, I would have interviewed and talked to every student in the class. However, doing this certainly was not feasible. Therefore, I will try to summarize the overall themes I noticed and hopefully in the future will be able to contribute portraits of more students in the program.

A family. Many of the students in the program view the Merit Workshop Program as a family in their course of study. They spend much time with others in the program, so they are able to feel comfortable in asking questions of each other. Interestingly in this unique family, students would take on roles of parent, child, or distant relative! The role would change depending on the day I observed. The student who acted like a parent would make sure each person at his or her table (or in the room) understood the material. They would not proceed on to the next problem until everyone understood the current problem. The child in this scenario was constantly asking questions. Why did you do that? How did you know that? The distant relative did not fall into any of the previous categories. This person seemed to just be there. I could not tell if he was understanding the material and was just quiet, or if there was complete confusion with the material. The TA served as the nosy neighbor of the family. You know—she is always asking questions and wants to know just what is going on inside that house. Even though Abby was a part of the class, she could never be a part of their family. She has not been with them throughout their entire
experience; however, she does have a great impact on their current experiences. I would view myself as the mom of this family. I am constantly talking with students and helping them keep on track. I have laughed and cried with students and feel a responsibility for helping them with their education.

**The work.** By the time the students take Math 242 Merit they seem to be used to the general idea of the worksheets in Merit. The questions will be difficult. You will hardly ever finish a worksheet. You are not expected to know all of the answers to the questions on the worksheet. In this class I did not notice students asking Abby many questions about the worksheet. The participants told me they are now used to the TA saying they will not give answers. Therefore, they first turn to others in the class for help. These are the same students I had in Math 120 Merit that questioned me until no end when I had them in class. They constantly tried to get me to answer their questions. They do not do this anymore. They rely on their knowledge, as well as other students’ knowledge.

The lecture portion of this course is different from other lectures I have observed. Lectures where the students have not been through a program such as Merit. The students are very active in class. They answer questions posed by the TA almost immediately, which eliminates the acquired pause I have noticed in some lecture courses. The students also are quite comfortable raising their hands to ask questions about the material. I am sure many factors contribute to their comfort level in class that are beyond their actual experiences in Merit. For example, the TA’s interaction with the students makes a difference as to how comfortable the students are at asking questions. However, the students in other sections of Merit I have observed in the past also have this level of comfort in class.
Overtime. Students in the Merit Program spend much more time in class compared to those students in traditional sections. Why do they want to do this? I found varying reasons for some possible answers to this question. As previously mentioned, possibilities may initially include extra credit or a recommendation from a friend. But, what is it that retains a student in this type of environment? I found many students feel the extra time spent in the class is very worthwhile. As one student told me, “I don't know what I would have done without Merit. Even though I spend more hours in class, I feel as though I am actually understanding the material.” Merit to many students is a place where they can be challenged, yet have fun learning calculus. Yes, learning calculus in this environment is fun to students. The participants of the study all agreed they would not have been challenged to the same level, if they had taken a traditional section of calculus. In fact, Gil discussed how he thought several of the problems on the worksheet were meant to be too challenging for the students, but that trying them was a good exercise.

Vacation. When I was a TA for the Math 120 Merit course that Gil was taking, I made a suggestion for students regarding Spring Break. I really did not anticipate the acceptance of my idea from the students. Most of the students in Gil’s class were from Chicago or the surrounding area. Why not get together at some central location in Chicago and study for the upcoming examination. I was astounded. Immediately the students began exchanging telephone numbers and suggesting places where they could meet. They knew I would be out of the country during Spring Break, but wanted to know when my flights were so that I, too, could participate in their study efforts. I could not make the gathering. However, over half the class met at the Chicago Public Library over their Spring Break to work on homework and to study for
their upcoming examination. I had never seen anything like this before. They were excited and anticipated the get together they would have in Chicago. The students were freshmen at the time.

**Social activities.** Not all of the students in the class meet with each other for activities outside of calculus. However, some of the students told me they do get together on occasion for dinner, movies, or just to “hang out.” Students in Charles and Roberto’s class have had pizza parties and bowling outings. Students, TA’s, and myself all attended these social gatherings. Roberto believes these are very important for the students and they “actually help because they make you feel more loose. You know…you don’t feel that much stress of school.”

**Goodbye, for now**

As the director of the Merit Workshop Program I meet many wonderful students such as the ones discussed in this paper. Conducting this research has been very meaningful and educational to me. I imagine my next step in learning more about the program will be research on the TA in the Merit Program. The TA seems to play a key role in the Merit classroom.

I would like to thank everyone who helped me with this research project. The students gave me several hours of their time throughout the semester for which I am very appreciative. The TA also allowed me to observe her class multiple times and many times on short notice, which I also appreciate. Hopefully, this research will help more people understand what goes on in the Merit Program and what types of students are enrolled in the program, as well as how students view their learning of calculus as the college level.
Methodology

I. Axioms

In 1998 I came to the University of Illinois as a graduate student in the Mathematics Department where I completed a degree in the Teaching of Mathematics. During my second semester I was a teaching assistant (TA) for The Merit Workshop Program for Emerging Scholars in Mathematics, a program within the mathematics department. I was a TA for a Math 120 Calculus I course. I graduated that May and was offered the job as the director of the Merit Program. I delightfully accepted the position and have been the director since Fall of 1999. During the Fall of 1999 I also was an instructor for one of the sections Math 120 Merit.

I interview all prospective students for the Merit Program the semester or summer before they are entering the program. I fortunately am able to choose the TA’s for the Merit Program and I meet with those TA’s once a week to discuss issues in the classroom. I also periodically visit the classrooms and talk with the students. My office is located next to the Merit room, so I am able to see many of the students quite frequently. I try to establish a personal relationship with as many of the students as possible. If a TA is having an attendance problem, for example, with a student then I am able to contact the student and speak with them about what is causing them to miss class. Overall, I have mostly had extremely positive instances with the students in the program. Many times students from the program will stop by my office to sit and talk with me. This hopefully means the students feel comfortable talking to me about certain issues, which is exactly what I would like to happen as the director of the Merit Workshop Program.

Since my involvement in the Merit Program I have been interested in learning more about how the students view the program. Many of the studies I have read
regarding active learning environments focus on the teacher’s perspective of the classroom. I want to know more about the student’s perspective. How do they view the TA? What do they see is my role in the program? Do they think an active learning approach to learning is beneficial? What are some frustrations of the program? What initially attracted them to the program? I want to know their thoughts to these questions and more; therefore, I decided to talk to students specifically about their backgrounds and how they got to this point of their life in the Merit Workshop Program.

At first I did not know if this research was going to work. Am I too much of an insider that I cannot separate myself as a researcher? I believe the students I spoke with opened up more than they might with an outsider simply because they do know me on a more personal level. I explained to each of them my purpose and that I am really interested in learning more about them. Each of the students were quite respectful and helpful in aiding in my research. I was able to meet with them only a day or so after I had contacted them to ask for an interview. I would also be interested in seeing what an outsider of the program would get from the students and program itself. I am sure I would see common threads, as well as completely different observations.

During the interviews with the students I tried as much as possible to position myself as the learner. I wanted to learn about them and their backgrounds. The only time I felt like a connoisseur was when I discussed technicalities of the program (i.e. admission requirements) or answered their questions about the program (i.e. Charles asked me why we incorporate Mathematica in Math 130 Merit? Being a proponent of questioning, I first asked him why he thought Mathematica is included in the course).

I am somewhat bias toward the program because I believe it really helps most students understand calculus better than the traditional method. To help with this bias I
specifically wanted Roberto to be a participant in the study. He took Math 120 Merit, Math 130 traditional, and Math 242 Merit. Learning more about his experience might help the bias I have for the active learning approach. However, he likes an active learning environment much better than a traditional lecture environment. I also choose students I previously had in class. I conscientiously made that decision and hope it did not create a bias toward the participants. I thought making this decision would allow me to expand further on each student, especially given the short time I had to do the study.

II. Research Design, Methods, and Trustworthy Criteria

Population

I chose to study students that are currently enrolled in Math 242 Merit Workshop at UIUC or have completed the program in Spring of 2000. Two sections of Math 242 Merit are currently taught this semester and I have chosen to look at one of those sections. I decided to choose the section that will allow me to spend the most time in the classroom observing. I have selected 2 students (Roberto and Charles) from that section to learn about in more detail. The third student (Gil) has completed the Merit Program and is now in Math 285. As mentioned early I have previously had all three of these students in class. I had interviewed another student, Natalia, but our schedules would not allow for us to continue with the interviewing process.

I began working with Gil this past summer and have been conducting interviews since then. I worked with Professor Klaus Witz from UIUC while interviewing Gil. He helped me formulate questions, analyze data, and notice emerging themes with Gil’s interviews. In fact, Professor Witz, Gil, and myself met a few weeks ago and had a group interview, which was quite helpful. Since I have been meeting with Gil over a
longer period of time and have had the fortunate opportunity to have several interviews, I was able to discuss his background in much more detail than Roberto and Charles.

Roberto and Charles were both students I would consider at the top of their class in the Merit Program. They both are hard-working, respectful, and reflective. Talking with them is easy. They both are willing to express their feelings and views. If I were to do this study over, I would maybe choose to interview someone that was not one of the top students. One concern would be that I would not be able to receive as much reflective insight from them. I also realized after the study that I did not interview a female student; however, I originally going to interview Natalia. I would try to include a female, if I did the study again. My main reason for this would be that women are few in mathematics and we should hear their perspectives about their background in mathematics to try to understand how their mathematical sense developed.

For this research study I have chosen to do qualitative study using portraits of the students I interviewed and observed. Since I want to know how students view active learning, I believe portraits along with common emerging themes were quite beneficial to my study. I needed to hear in-depth from students their experiences in learning mathematics (specifically calculus) and observe them working in their natural setting.

Data Sources

Observations

I have observed the lecture portion of this course, as well as, the Merit Workshop portion of the course. Many of the students know me quite well, but I do not believe my presence in the classroom changed the dynamics too much. I observed this entire academic semester, which is approximately sixteen weeks. Other observations
included the TA’s office hours, student-initiated study groups, and peer tutoring. I believe by observing students in their natural settings, I was able to get a better idea of the types of approaches they use to learn calculus. I was able to look at behaviors seen in lecture as compared to those seen in a more active learning environment. A major reason for doing observations was to see the relationship between the TA and the students and their interactions with each other.

**Interviews**

As previously mentioned I am focusing on 2 students from the course and 1 who has completed the program. I completed 2-3 hour-long interviews with each student. The interviews were either conducted in my office or in the Merit room. I would try to be casually dressed for the interviews. Hopefully, this helped eliminate any of the authoritative views the students may have coming into the interview. The number and length of interviews varied for each participant, but were approximately one-hour interviews. In order to get a more wholistic view of the classroom; I may talked with the TA specifically about this research several times throughout the semester. The discussions with the TA focused more on the lecturing and learning of calculus in the Merit Workshop Program. The interviews were semi-structured, face-to-face, and audiotaped. Each interview conducted was transcribed and analyzed. I had several areas to focus on for each interview, but adapted accordingly to the comments given by the interviewee. The interviews allowed me to go in-depth with students about their background in mathematics, about the Merit Workshop Program, views of the TA, and experiences in learning calculus. The interviews for each student were approximately two weeks from one interview until the next. This allowed time for transcription, analysis, and reflection before the following interview.
My ultimate goal from conducting interviews, making observations, and collecting journal entries was to look at the developing emergent themes present in the study. Several emergent themes I noticed derived from the purpose of the study, which is to learn more about why the students were initially interested in the program, how the students view this active learning approach, and what factors they feel have helped them (or not helped them) the most in learning calculus. However, I noticed other emergent themes after talking with the students that I decided look at in more detail. An example would be the frustration that students have in Math 120. Each student reflected that this was a benefit of the program, even though they did not think that at the time of the frustration.

I kept the students involved in my research during the entire semester. I would periodically send them an e-mail to let them know where I currently was in the research process. I really did not know if this was something they were interested in until I started getting responses from them. They seemed to also be interested in this research probably since they are a part of the research. I gave each student a copy of their short portrait. I had them read it and make comments about what I had written. I asked them to correct anything they viewed as being incorrectly portrayed in the write-up. I also asked them to add anything they thought was left out in the write-up. I then met with each of them to discuss what I had written and any general comments they had about the write-up. After making corrections to each of the sections, I then gave each student a copy of the entire paper. Each of them seemed enthusiastic and interested in reading the paper in its entirety.

I decided to not have the TA of the current Math 242 course (the course that Roberto and Charles are taking) read the paper until the semester was over. I did not
want her to be persuaded in any way what the students have expressed to me that I have written about in the paper. I do not feel this would be fair to anyone involved in the study. However, I do plan on giving her a copy of the paper, which she also seems enthusiastic about reading.

Overall, my research design did not change too much from my initial design. I had planned on interviewing at least one more student and had planned on spending more time in the classroom. However, I just did not have enough time to so. When I first started interviewing Gil this past summer I realized a few important aspects about interviews. First, it seems important to let the interviewee do most of the talking. When they are talking it is important to really listen so that you can formulate questions based on responses you are receiving on the current question. Also, each interview should be based on previous interviews, as well as new ideas that could be explored. I do not think these ideas changed my initial research design, but possibly my initial thoughts about conducting interviews. I thought they would be more structured, but am very glad they were not.

III. Analysis and Writing

When analyzing the data I tried to use several ideas to formulate hypotheses and themes for the research paper. I found writing contact sheets was extremely useful in the writing stage of my research. There would be instances when I would need to look back at something said in an interview or something I observed in class. Having the contact sheets available saved me time when I was writing. I also noticed with the contact sheets I was able to code the data much more easily. I could look at the main points I had pulled from the interviews or observations and see what was emerging
from all sources. Having questions on my contact sheet to use in further interviews helped me when I was ready to conduct the next interview.

When coding the data I discovered that much of what I had found related to the some of my initial research thought and some were issues that I had never really considered. An issue I had never really considered was group work the students had done in high school. I had thought most of the students would have told me they had experience of working in groups before coming to college. I thought this of these particular students I interviewed because they were the leaders of the group. However, I discovered this was not the case. None of the students I interviewed had much experience of working in groups in high school. Merit was their first experience, which I thought was very relevant for this study and for my future training for TA's. Also, I realized I needed to probe students more in their interviews for the program about their high school experiences.

As previously mentioned themes were both emergent and pre-determined. An example of a pre-determined theme would be a frustration students have with the Merit Program. From experience I know many students are frustrated with many of the questions on the worksheets. They are difficult and the students do not receive much input form the TA, which frustrates them. I previously thought students overcame this frustration after Math 120, but had not supported this claim with any evidence. However, each of the students in this study did express that the worksheets were frustrating, but they overcame that frustration after Math 120 even though at times they still had difficulty on a worksheet. Along with this same idea of worksheets emerged a theme that I had not anticipated. This theme was the reflection the students had about their Math 120 experience. They discussed that this frustration was “a good thing” and
that they are “glad to have experienced the frustration.” I did not initially think students would recognize the benefits of frustration and verbalize this thought to me.

I did not have peer debriefing with someone in our class; however, I did have a couple people read my paper and offer comments. This served me well. I am open to comments and suggestions about anything I write. Even if I do not agree with the comments, at least it makes me think again about what I have written. In several instances the comments made me be more specific about physical characteristics of either a student or a place I was describing. One person told me to tell the story as if I was telling it to someone who had no idea of the surroundings. This helped a lot. A comment I had some trouble with was that I should have included more information about the TA (Math 242) in the paper. I had conflicting ideas about doing this. First, my purpose of this paper was to talk about the students’ views of learning calculus. On the other hand, the TA is part of their current learning environment and does affect their views of learning calculus. I decided to not include more information other than what is given due to the time constraint. I felt as though I would not be able to provide an overall picture of the TA if I rushed to get information from her.

For this paper I decided to briefly describe the Merit Program, the classroom, and the students. Then I gave short portraits of the three students I interviewed. After the portraits I discussed themes I noticed from all of the interviews and observations. The organization of the paper seemed natural to me. I tried to make the students come alive in the paper. I want a reader to know what types of students are in the program. However, I realize three students cannot represent the entire program. This is why I followed with the themes I found for the entire research study.
From this study I learned how important it is to take a few minutes to listen to what the students have to say about their learning. In class we often do not discuss how the students feel about their own learning; we are too busy focusing on the content. This study has made me more aware of the need to incorporate meta-cognitive exercises in the classroom. I was a little frustrated by the time constraints. I wish I would have had more time to spend observing in the classroom. I also wish I could have interviewed more students. I became almost addicted to learning more about the students I was talking with in this study. I wanted to know more about their lives, wanted to meet the people they talked about, and wanted to see them in a non-school environment (to see how if they acted differently). Methodologically I have learned qualitative research takes a lot of time and energy. However, I also really enjoyed writing the paper for this study. I am hoping my paper will at the least influence the participants to write about some of their experiences. I am also hoping to share the paper with some of my TA's so they can get a better picture of the Merit Program. I do not think I could have expressed many of themes as creatively in a more quantitative paper.

In the future I would like to spend a longer period of time observing and interviewing students. I think it would be beneficial to begin talking with a student when they first enter the program and continue meeting with them at least until they are enrolled in their first mathematics course after the Merit Program. I would also like to audio tape group discussions that occur in class over the semester. Group dynamics are fascinating to me and I believe we can learn a lot from listening to the dialogue in groups.
Overall, this was a great experience that I would gladly do again. I feel as though I have been able to connect with three of my previous students in an important way. Hopefully, they can see that someone is interested in them, their past, and their future. As an undergraduate this is sometimes missing. You feel lost at times and feel as though no one is acknowledging all of your hard work. I have tried to give brief stories of these students to show their wonderful progress in education and life.