2014

MICHIGAN TEACHER EXCELLENCE PROGRAM: A LIFE-CHANGING EXPERIENCE

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MICHIGAN TEACHER EXCELLENCE PROGRAM: A LIFE-CHANGING EXPERIENCE

By

Claudia Witt

A REPORT

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE
In Applied Science Education

MICHIGAN TECHNOLOGICAL UNIVERSITY

2014

This report has been approved in partial fulfillment of the requirements for the Degree of MASTER OF SCIENCE in Applied Science Education.

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Abstract: The first chapter consists of an action research report submitted by Rebecca Joyce, Kari Luckett, and Claudia Witt as part of the Action Research class taken through the Michigan Teacher Excellence Program (MiTEP) during the winter of 2013. The research involved the use of stations to address student misconceptions in urban high school chemistry classrooms. Chapter two contains a personal reflection on the MiTEP program and how it has affected teaching strategies/practices, personal confidence, and professional relationships.

Introduction to Station Activities and Misconceptions in the Chemistry Classroom

Research Report:

For students in the Michigan Teacher Excellence Program, Action Research was a required course. It also was needed for the Applied Science Education master's degree. Students of the MiTEP program chose groups and a topic to research and reported out our findings. I chose to work with Rebecca Joyce and Kari Luckett, two fellow Kalamazoo Public School high school teachers. We researched what would happen if we used stations to address common misconceptions in the atomic theory unit of Chemistry A. After asking students what they believed to be true at the beginning of the chapter, we created stations about various topics in the atomic structure chapter to address their misconceptions. As a review activity before their test over the topic, we administered stations containing these misconceptions. We observed what happened when students used these stations as a review activity to address misconceptions again prior to the test.

I had several contributions to this activity. I hosted both Rebecca to make observations in my classroom during the stations activity. Kari and I discussed the similarities and differences in my classes and her classes where she was administering the stations activity. This helped us make observations about Kari's classes at Kalamazoo Central and my classes at Loy Norrix High School. I collected data from my classes prior to our stations activity and again after the activity was completed. Kari, Rebecca, and I all collaborated to write the paper and complete the conclusions of the project.

Chapter 1

Station Activities and Misconceptions in the Chemistry Classroom

Claudia Witt, Kari Luckett, Rebecca Joyce

Kalamazoo Public Schools

Motivation for the study

This action research was conducted by a group of three science teachers who have worked together as part of the Michigan Teacher Excellence Program (MITEP). The MITEP program was designed to develop teacher leaders who are empowered to "...lead their schools and districts through the process of systematically improving science teaching and learning." (Michigan Teacher Excellence) Though we each work in different high schools we have participated in this professional development program together for two years and share an interest in science education that is focused and effective for our students.

Claudia Witt has been teaching chemistry for six years at Loy Norrix High School in Kalamazoo Public Schools (KPS). Kari Luckett has been teaching chemistry at Kalamazoo Central High School in KPS for eight years. Rebecca Joyce works at the Kalamazoo Area Mathematics and Science Center, a county-wide program which supports math and science education.. In the past she has taught high school physical science, earth science and elementary science. She currently works with high school students on college and career preparation.

Kalamazoo Public Schools has two regular high schools and one alternative high school. Loy Norrix High School has 1514 students, 44% of whom are white, 37% African American, and 14% Hispanic. Kalamazoo Central has approximately 1620 students, of whom 48% are African American, 34% are white, and 8% are Hispanic. At Loy Norrix 66% of students qualify for free and reduced lunch and at Kalamazoo Central 63% of students qualify for free and reduced lunch .

Secondary schools in KPS have recently switched from a block schedule to trimesters, so what was once a one semester class of chemistry has been switched to a two trimester Chemistry A and Chemistry B class. A passing grade in Chemistry A is a prerequisite to be enrolled in Chemistry B. In Michigan, students must take either Chemistry or Physics to graduate (for KPS Chemistry A and Chemistry B or Physics A and Physics B). Most students choose to take Chemistry A and Chemistry B as there is a reputation for it being an easier, less math-intensive class. Claudia is part of one of the Sophomore Academy teams at Loy Norrix and most of her students are in 10^{th} grade, although her students range from 10^{th} to 12^{th} grade. Kari is part of a liberal arts and international studies SLC, small learning community. The students in this SLC range from 10^{th} to 12^{th} grade. Based on her schedule, Kari primarily teaches outside of her SLC, having mainly 10th graders from the health and science and engineering small learning communities. There is no reading requirement for Chemistry in KPS, so readers of all abilities and levels can be enrolled. Students must pass both Biology A and B in order to enroll in Chemistry (or Physics). In addition, students must pass a minimum of Algebra in order to be eligible for Chemistry. As Chemistry/Physics is a graduation requirement, students who have previously been unsuccessful are re-enrolled in the class. Generally there are less than five “repeater” students in a given chemistry class. In KPS, we also give students the option of taking Honors Chemistry instead of General Chemistry. Honors Chemistry has a different curriculum, which covers the same content as General Chemistry, in addition to more complicated topics. KPS also offers sections of co-taught Chemistry, where a content teacher and a special education teacher teach together. These classes typically have between five and fifteen special education students in each class period. These students have a range of disabilities and receive services to have content modified and differentiated. At Kalamazoo Central, Kari teaches all of the co-taught chemistry classes.

In chemistry, many of the concepts require consistent and regular practice for students to master the concept. In co-taught classes, students were getting bogged down or overwhelmed by long and numerous worksheets. Also it was hard to see where students were developing misconceptions because the grading of many worksheets was cumbersome on the teacher. We wanted to find a way to practice the concepts in a segmented fashion, where students could address concepts in a small amount of time and with a limited number of questions and teachers could address small groups and look for/address misconceptions that had developed.

In both Claudia and Kari's Chemistry classes, all students are required to take a pretest at the beginning of the course. In addition, Claudia gives a five-question pretest at the beginning of each chapter. The questions chosen on the chapter pretest generally include broad topics to be covered within the chapter. Students are required to complete the pretests, and are given a formal grade on them which do not affect their overall class grade. The pretest grades are calculated with a weight of zero and are hidden in the online grade book so students and parents can not see them. Comparing the class and chapter pretests to post tests in both situations help demonstrate student growth. Through the collaboration of Claudia and Kari, Claudia has started using station activities in her Chemistry classes. The hope is that with additional practice, more students show more success on their post tests (both chapter and final exam). The topic we chose to research dealt with the theory behind atomic structure. We picked this topic because our research was happening during the fall trimester and we had common content with Chemistry A during that time. We wanted to give ourselves enough time to research and analyze our findings, so we determined the theory of atomic structure to be the ideal unit.

Claudia and Kari use daily warm ups which usually consist of a question for which there is a correct answer. After determining misconceptions (using the pretests), a power point/lecture is done to clear any confusion. Warm ups are used on following days to help students review and explain in their own words corrections to these misconceptions. Warm ups are graded and returned to students on a daily basis. This year, stations have also been introduced to Claudia's classroom through collaboration with Kari, who uses them on a regular basis. During the stations activities, common misconceptions are addressed again and written about by the students. Students are invited to use notes, worksheets, books, warm ups, etc. during the stations activities, however are encouraged to attempt to complete the activity without them to help them gauge their progress in a particular unit. Station activities are typically done the day prior to a test. To determine if the misconceptions were properly addressed and practiced, students were again assessed on their chapter test.

Since Kari and Claudia already have previous experience in using rotating learning stations and have found them worth continuing, we wanted to know more about this method and its effectiveness. We wanted to observe students more closely and gather data on their work in stations. We wanted to see if students stayed on task during station time and were able to complete the assignments at each station independently.

We also wanted to use the stations to address student misconceptions in chemistry. We often hear our students voice misconceptions when we elicit prior knowledge at the beginning of a unit. These conceptions can be difficult to change. We wanted to identify misconceptions students held in this unit, identify which students had these misconceptions, and help them develop their understanding. We hoped that we could more easily identify their misconceptions by observing students during the time they worked at stations and discussed station tasks with their peers. Other science teachers may be interested in the results of our study because the misconceptions we are investigating are common and may impact student understanding of chemistry, physics and biology.

Research question

The research question we chose was "What will happen if we try to use station activities to address student misconceptions in atomic structure?" Initially we planned to study the question "How will the use of station activities affect student misconceptions in the atomic structure unit?" However, when we looked at the data we were able to collect during this unit, we decided to change our question to "What will happen if we try to use station activities to address student misconceptions in atomic structure?" We made this adjustment because we thought to answer the first question thoroughly and conclude that the intervention of station activities affected student misconceptions we would need pre and post tests and a control group. We were not able to do that in this time period but it would be a good second stage for this action research.

Readings about the study

In our readings the terms "misconceptions," "pre-conceptions," and "student alternative conceptions" were used to describe ideas that were not in accord with current science. There is some controversy over these terms but we chose to use the term "misconception," judgmental as it is, because it reflects how these ideas are approached in our teaching practice. In an era of high-stakes standardized testing we are motivated to teach students the "correct" and standard scientific explanations as quickly as possible.

We do however, know that it is important for us to develop as much understanding as possible about what these misconceptions are. As Horton states, "Learning is an active process, and what students do with facts and ideas with which they have been presented depends to a very high degree on what they already think and believe. Being able to recognize and work with these student-held ideas and conceptions is thus a key component of an effective educational strategy." (Horton, 2004)

In some cases, the misconceptions are deeply rooted and make it hard for students to assimilate new information. Mulford and Robinson (2002) also address this problem, stating:

> Alternative conceptions play a larger role in learning chemistry than simply producing inadequate explanations to questions. Students either consciously or subconsciously construct their concepts as explanations for the behavior, properties or theories they experience. They believe most of these explanations are correct because these explanations make sense in terms of their understanding of the behavior of the world around them. Consequently if students encounter new information that contradicts their alternative conceptions it may be difficult for them to accept the new information because it seems wrong...If anomalous new information is presented in a learning situation where the student is rewarded (with grades) for remembering it, the information may be memorized in order to

earn the reward, but it is likely to be quickly forgotten because it does not make sense.

In our reading, we looked for specific misconceptions that our students might hold in the atomic theory or following units. The University of Dallas's Comprehensive Conceptual Curriculum for Physics describes the following misconceptions which students may have in atomic structure:

There is only one correct model of the atom.
Electrons in an atom orbit nuclei like planets orbit the sun.
Electron clouds are pictures of orbits.
Electrons can be in any orbit they wish.
Hydrogen is a typical atom.
The wave function describes the trajectory of a electron.
Electrons are physically larger than protons.
Electrons and protons are the only fundamental particles.
Physicists currently have the "right" model of the atom.
Atoms can disappear (decay) (Olenick)

In addition, a common error that students make is "...the easily avoidable one of not counting the correct number of electrons (equal to the atomic number for a neutral atom). They also fail to take into account the loss or gain of electrons if the subject species is an ion" (Miller). Other common misconceptions we identified in our reading were "Atoms are like cells with a membrane and nucleus,"

"The size of an atom depends on the number of protons it has," and "Hydrogen is a typical atom" (Horton, 2004).

Research plan for the study

This study was conducted at Kalamazoo Central High School and Loy Norrix High School in Kalamazoo, Michigan. The courses investigated were Chemistry and Honors Chemistry with students in grades 10-12. We read articles on the topics of common misconceptions in chemistry and identified common misconceptions about atomic structure. We did not find literature about the use of learning stations in high school science classrooms. The use of learning stations in elementary classrooms appears to be more common.

We designed the learning station activities so that three of the stations would identify students who have these common misconceptions. We assessed whether students have these misconceptions by observing them completing activities and through their writing at stations. We planned to set up somewhere between four and eight stations throughout the classroom. Students would receive a station guide and would have about have about ten minutes at each station to complete the activity. Claudia and Kari designed a short follow-up in their lessons that addressed these misconceptions before the chapter assessment. Generally the concept surrounding the misconception was addressed by the teacher right then and there, however in instances where time was a factor, they may have been addressed the following day. We also collected samples of students' chapter tests including items assessing those specific misconceptions we observed. Examples of these test items can be viewed in the following section.

Analysis and Interpretation

In our reading we identified several common misconceptions that were relevant to our teaching in this unit. Of those common misconceptions in the literature, we noticed some overlap with misconceptions we observed in our classes. The chart below notes student misconceptions we noted in the classes as well as how they were identified and addressed. These misconceptions primarily consist of chapter four content surrounding atomic theory and the scientists who contributed to it.

Source Chapter	**Misconceptions**	**How it was identified**	**Teacher follow up to address misconception**	**How students were assessed**
Chapter 2	Dissolve is a Chemical Change	Noticed during an activity	Immediate feedback during stations PowerPoint slide with correct definition in lecture John Collins writing prompt	Question and % of Students Correct
Chapter 4	"JJ Thomson's contribution was the Plum Pudding Model"	Warm Up – John Collins Type 2 writing	Discussed in following classes and next day in first class	Essay question on Chapter 4 Test
Chapter 4 (10/3/13)	"Atomic Mass" as a part of the chart	Overheard students discussing it	Announced to class that there is no such thing as "atomic mass" at this point. It's atomic number and mass number	Chapter 4 Test – Chart on first page
Chapter 4 (10/8/13)	Rutherford's contribution was the gold-foil experiment and he discovered the nucleus… (missing the HOW part, need more information)	Warm Up – John Collins type 2 writing	Discussed in following class and next day in first class	Essay question on Chapter 4 Test
Chapter 4	Rutherford *only* discovered the nucleus	Warm Up - John Collins type 2 writing	Discussed in following class and next day in first class	Test
Chapter 4	Neutrons make atoms electrically neutral	Practice worksheet	Discuss in notes, warm ups, on quiz, on essay question on test	Quiz and test essay question
Chapter 4	There is only one model of an atom (usually Bohr model)	Observation, during lecture	PowerPoint to address more current models of the atom	Warm Up

We focused on two particular misconceptions through the methods listed in the chart. Multiple students in both schools held misconceptions about the contributions of Ernest Rutherford and J.J. Thomson to atomic structure. We wanted students to understand on a basic level the relationship between these scientists' investigations and their conclusions about the atom: that Rutherford concluded that the atom contained a positively charged nucleus and was mostly empty space and that Thomson discovered the electron using the cathode ray tube and developed the plum pudding model of the atom. We first examined students' prior knowledge with the pretest prompts "Explain J.J. Thomson's model of the atom" and "Explain Rutherford's model of the atom". Below is a sampling of student responses.

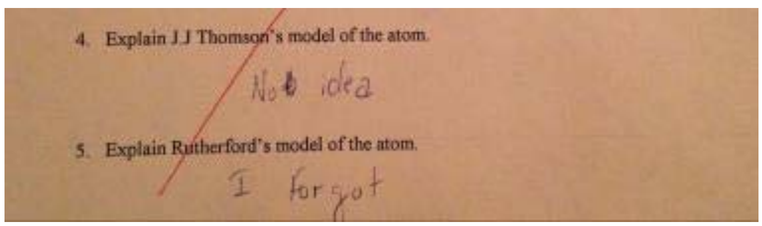


Image 1 - student pretest: student did not know any of the answers.

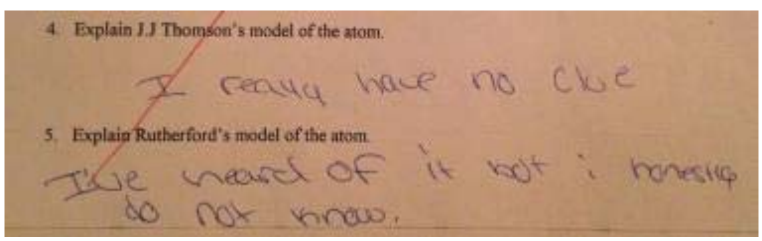


Image 2 - student pretest: student did not know any of the answers but said they have heard of Rutherford's model.

After the pretest, the scientists' contributions to the corresponding atomic models were taught through direct instruction with PowerPoint slide images, student notes taken from the textbook, small group research summarized in a poster, and peer presentations of the posters. After these activities, students were given a warm up question on a subsequent day using the same prompts from the pretests to determine their understanding.

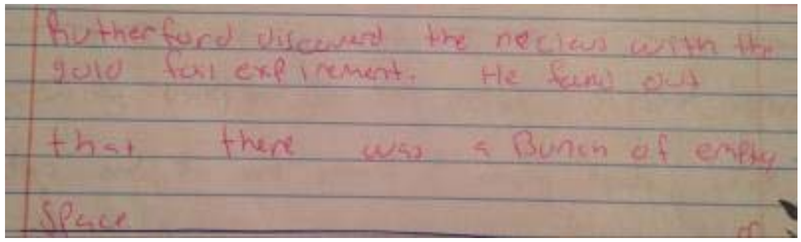


Image 3 - student warm up: This student was missing the “how” part of Rutherford’s contribution. He/she also didn’t describe the experiment.

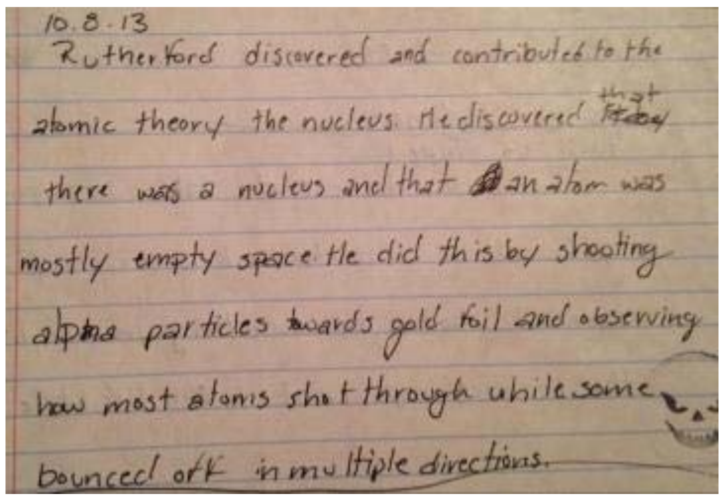


Image 4 - student warm up: This student had a great grasp of Rutherford’s contribution to the atomic theory and included all of the components we were looking for in this prompt.

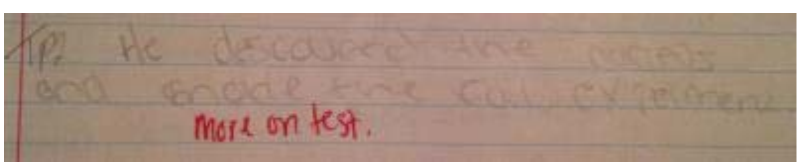
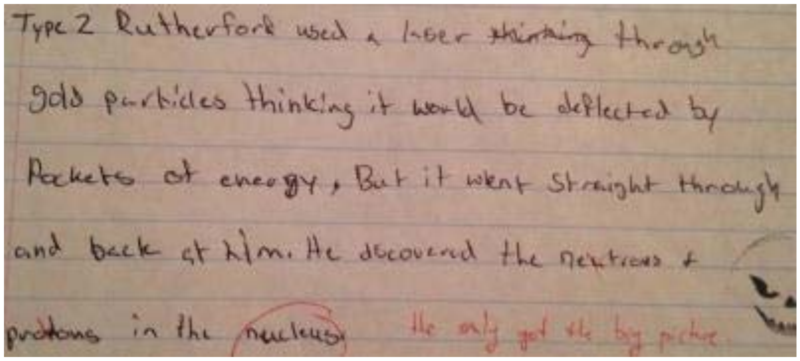
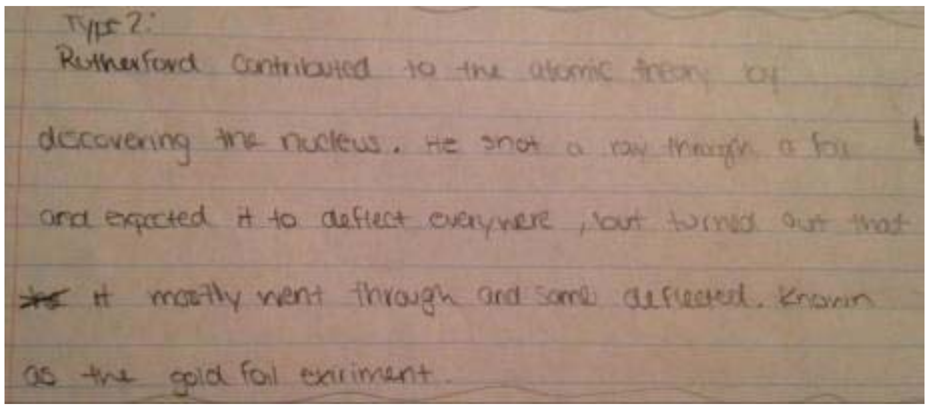


Image 5 - student warm up: This student understood the basics of Rutherford’s model (“He discovered the nucleus”), however was missing the key components of the “how” and the concept of empty space.



Type 2 Rutherford used a laser through
gold particles thinking it would be deflected by
Pockets of energy, But it went straight through
and back at him. He discovered the neutrons &
protons in the nucleus. He only got the big picture.

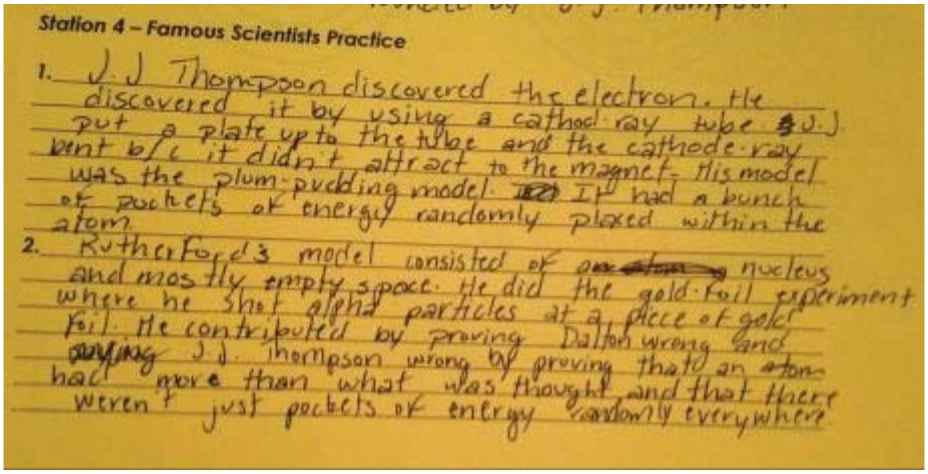
Image 6 - student warm up: Student was missing some details about empty space and added some incorrect information about Rutherford's discovery.



Type 2:
Rutherford contributed to the atomic theory by
discovering the nucleus. He shot a ray through a foil
and expected it to deflect everywhere, but turned out that
it mostly went through and some deflected. Known
as the gold foil exiriment.

Image 7 - student warm up: Student was missing the idea that Rutherford contributed to the idea that atoms are mostly empty space.

As a final review before the unit assessment, students performed the stations activity. We wanted to see if the interventions and practice we had provided changed or strengthened students' understanding of atomic models. For consistency, the questions were phrased the same way: "Explain J.J. Thomson's model of the atom" and "Explain Rutherford's model of the atom".

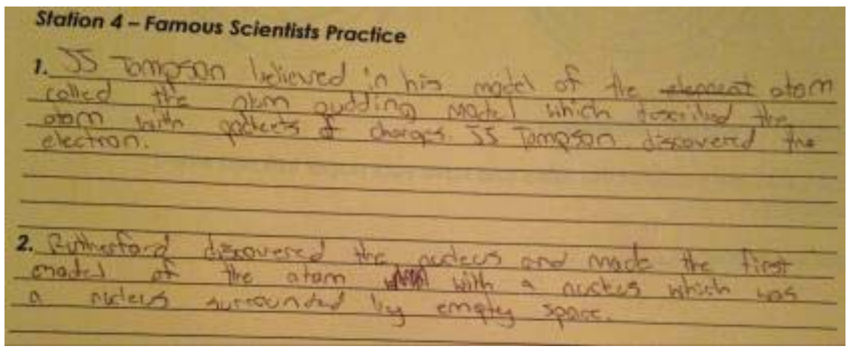


Station 4 – Famous Scientists Practice

1. J.J Thompson discovered the electron. He discovered it by using a cathod ray tube. J.J. put a plate up to the tube and the cathode ray bent b/c it didn't attract to the magnet. His model was the plum pudding model. It had a bunch of pockets of energy randomly placed within the atom.

2. Rutherford's model consisted of a nucleus and mostly empty space. He did the gold foil experiment where he shot alpha particles at a piece of gold foil. He contributed by proving Dalton wrong and J.J. thompson wrong by proving that an atom had more than what was thought and that there weren't just pockets of energy randomly everywhere

Image 8 - student station guide: thorough answers made for both questions by student.

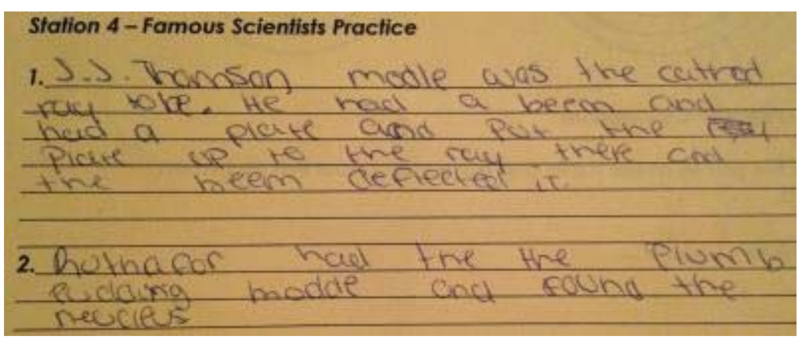


Station 4 – Famous Scientists Practice

1. JJ Tompson believed in his model of the atom called the plum pudding model which described the atom with pockets of charges. JJ Tompson discovered the electron.

2. Rutherford discovered the nucleus and made the first model of the atom with a nucleus which was a nucleus surrounded by empty space.

Image 9 - student station guide: student did not describe how both J.J. Thomson and Rutherford made their discoveries.



Station 4 – Famous Scientists Practice

1. J.J. Thomson modle was the cathod ray tobe. He had a beem and had a plate and put the plate up to the ray there and the beem deflected it.

2. Ruthafor had the the Plumb pudding modde and found the neuclus

Image 10 - student station guide: student described Thomson's experiment, but failed to mention what he actually discovered. Student stated that Rutherford had the plum pudding model and lacked details about Rutherford's experiment or model.

Another persistent misconception, we noticed, was not addressed in the stations activity, but was taught using other strategies. This misconception is that an atom is electrically neutral because of neutrons (arising because the words are similar). This concept was taught first in a lecture. The students learned that in a neutral atom the number of electrons is equal to the number of protons, therefore the negative charges cancel out the positive charges. The concept was revisited several times in an inquiry activity, an atoms practice sheet, and a quiz before the students took the unit assessment. Below are samples of student work which show a range of answers on the atoms practice sheet and the atoms quiz.

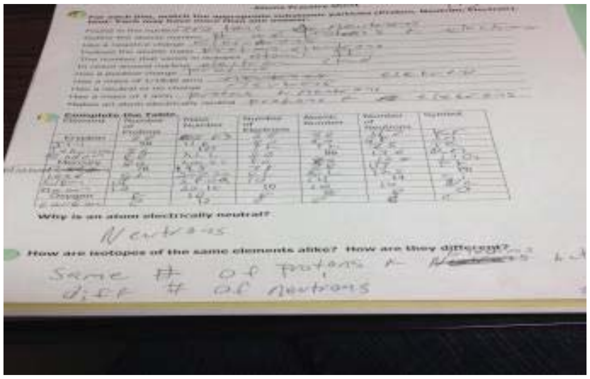


Image 11: student incorrectly answered the question “Why is an atom electrically neutral?” with “Neutrons” on the atoms practice sheet.

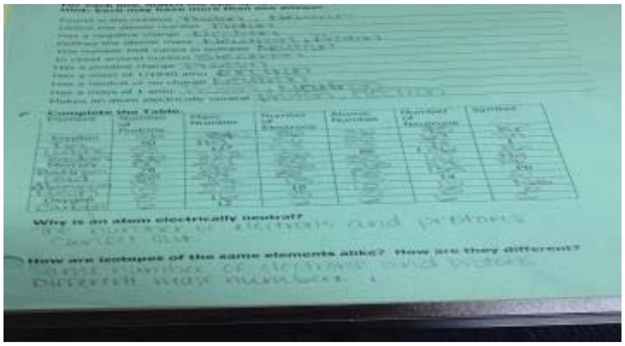


Image 12: student correctly identified question “Why is an atom electrically neutral?” on the practice sheet with “The number of electrons and protons cancel out.”

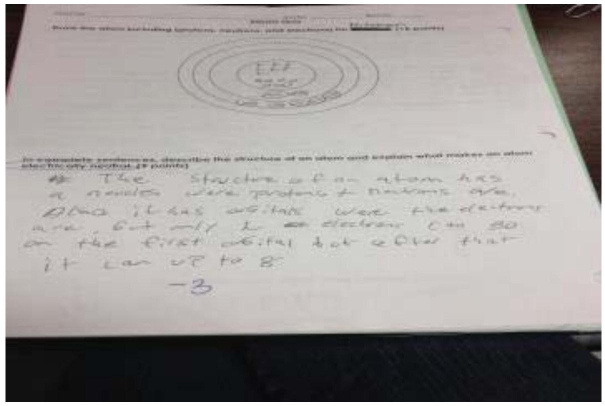


Image 13: for the quiz question “Describe the structure of an atom and explain why an atom is electrically neutral” student only describes the structure and omits describing why it is electrically neutral.

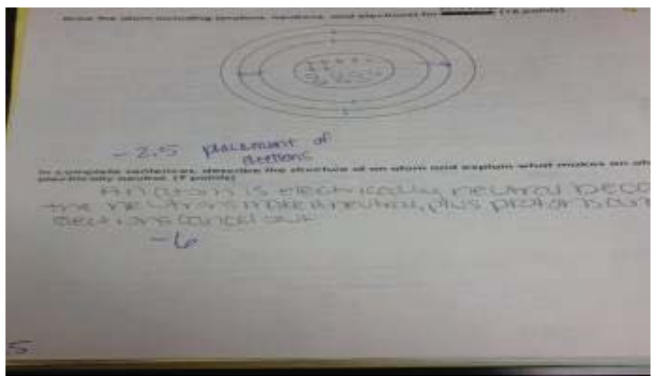


Image 14: student incorrectly answers “An atom is electrically neutral because the neutrons make it neutral, plus protons and electrons cancel out” on the quiz.

Discussion

Elementary classrooms often use stations, or centers, as an effective learning strategy and we were also able to see success with this strategy in our secondary classrooms. We observed that stations provided an opportunity to meet diverse student needs in several ways. For one, they provided all students an opportunity to get more individualized support because the teachers circulated among the stations. One teacher was able to listen to, discuss, and reteach a group of three to four students on a chunk of content that was previously taught. We observed more student discussion because students were standing together at the same station instead of at their individual desks. Also, the stations provided a visual and often hands-on activity to help strengthen understanding. Additionally, the activity provided an alternative to a worksheet, where the student's focus was on practicing one key concept, with fewer questions and lots of teacher support. In the stations format we were able to check-in with our special education students without singling them out in a whole-group setting.

Kari and Claudia have often used stations to go beyond the initial lecture and practice, in order to further the students' understanding and review for assessments. They have used matching models, Venn diagrams, computer animations, and other manipulatives in particular stations. Kari found that matching models allowed students to quickly categorize content. This type of station allowed her to quickly assess student understanding and what needed to be retaught. Also, these stations forced students to get their work checked and initialed by the teacher, providing an opportunity for Kari to collect informal data and reteach on the spot. Claudia found that the use of stations as a review activity has increased time on task for her students. Kids who usually would wait to do a worksheet or other review work at home or choose not to complete it at all, were required to get the work done in class. This allowed Claudia to make observations and determine which topics needed more time and practice in the future. Additionally, students who would normally have incomplete or missing work were completing the work in class. Claudia was also able to address students' misconceptions or incorrect answers immediately to steer them in the right direction for the future assessment. For teachers it provided a quick informal check on student understanding. While we might not be able to tell if the student conceptions have changed because of that station activity, we can see if they are learning or strengthening their understanding.

In student evaluations, we found the students sometimes disliked the idea of stations (primarily because we force them to get up and move around) but also stated that stations were instrumental in developing understandings in each unit of study. Students report that they like the student-to-teacher ratio during stations, where the teacher is circulating and readily available to provide support.

Kalamazoo Public Schools requires the use of common growth assessments as part of annual teacher evaluations. By using several different learning strategies and formative assessments, including stations, we were able to use the observational data we collected as part of our evaluation. In our opinion, data from district level assessments alone was not reflective of what occurred in our classrooms. As teachers, we are allowed to provide additional evidence of student learning, when or if the district data is not reflective of the required student improvement. The data we collected helped support our teaching methodologies and effectiveness.

Through this study we made many observations about the utility of stations as a strategy in our classrooms, but did not determine whether the stations led to conceptual change for students who came into the unit with incorrect preconceptions or developed misconceptions during the unit. As we collected data we did not link it to individual students so we did not know which students had misconceptions and if they were corrected through the use of stations, through the use of other strategies, or not corrected.

Conclusion

In this study we learned about student misconceptions in atomic theory and structure in the literature and in our classes. Our list of misconceptions in this unit was different from the ones present in the literature because we focused only on atomic structure and asked specifically about theorists and their contributions. Our students shared a misconception identified in our readings as common: “there is only one correct model of the atom.”

We also determined that more research needs to be done to conclusively determine if the misconceptions were corrected during stations activities. The pretest format we used could work well, but specific questions would need to be modified in order to make the connection between the pre and post test data. Many students know that the pretest is not connected with a grade, therefore do not take them seriously. Most students put their name on it and turn it in completely blank or randomly answer questions. This could skew our results greatly.

The structure of the stations allowed us to easily assess the students’ understanding, but because of the teacher to student ratio (both Kari and Claudia had over 25 students in each class), we couldn’t assess and address every student at every station. Other teachers might find it useful to integrate stations into their classrooms because it is a great alternative to worksheets. It addresses the kinesthetic learning style and encourages student movement and discussion during class. It allows teachers to circulate so students can have one on one interaction when possible. It is especially beneficial in co-taught classes where there is more than one adult in the room. It reduces the number of questions that a student needs to complete and gives them a concrete time frame for each station. The ability to move on after a given time frame regardless of station completion is acceptable as long as the student is engaged at each station. For teachers, this is an easy way to modify and differentiate the activity for learners with different ability levels.

All teachers could also benefit from being aware of their students' common misconceptions. Knowing these misconceptions give teachers the opportunity to address them multiple times in the classroom in different ways. Misconceptions are commonplace in the science classroom and often times remain misconceptions forever if not addressed properly.

Initially we planned to study the question "How will the use of station activities affect student misconceptions in the atomic structure unit?" However, when we looked at the data we were able to collect during this unit, we decided to change our question to "What will happen if we try to use station activities to address student misconceptions in atomic structure?" We made this adjustment because we thought to answer the first question thoroughly and conclude that the intervention of station activities affected student misconceptions we would need pre and post tests and a control group. We were not able to do that in this time period but it would be a possible second stage for this action research.

Future Study

We found this project to be a good initial investigation that could lead to future research into misconceptions in high school chemistry. If we continued with this second stage, we could develop longer, more detailed, pre-tests for each class based on the ones given by Claudia in this unit. This would require us to motivate the students to take the pretest more seriously and to answer the pretest items more completely. Then, we would give the same or very similar items as a post test and compare student scores. The disadvantage of this design would be that it is difficult to determine the misconceptions that cause students to answer pre or post test items incorrectly.

Another possibility we considered would be to try two different interventions to address student misconceptions. For example, one class could use the station activities we used this time. Another class could complete a worksheet or book questions addressing the same topic. This would allow us to have a control group and to compare these two interventions to see whether the station activity was more effective. The disadvantage in this case is that we think all of the strategies we use currently such as stations, labs, warm-ups, worksheets and manipulatives are beneficial to students and we don't want to omit these for any group of our students.

Instead of using the control group design we would prioritize an investigation design that could be more easily integrated with our teaching practice. We would like to continue our investigation of misconceptions by taking a closer look at the type of misconceptions our students have. We would not focus only on station activities but instead look at the impact of all of our teaching strategies during a unit. We would also like to track the conceptual development of individual students. In this investigation we observed that some of the students have misconceptions that they have developed prior to the class and some misconceptions are developed during the class. In other cases, the student does not have a misconception, but rather an incomplete recall of a topic. We could categorize these errors and develop a checklist that we would use with students as we observe them and assess their work. This would help us understand which misconceptions are most prevalent and to more rigorously track which students have these misconceptions. Kari would like to try a keeping a chart of all of her students with common errors listed. When she observes a common error, she would check this box by the student's name. For example, she has observed that students think that neutrons make atoms electrically neutral. So, any time she hears or observes a student making this error she will note it in her chart. With this data, she would be able to see which students corrected this misconception by the end of the unit as shown on the unit exam. We would also like to increase our focus in our readings and study design on which strategies are most helpful for changing students' particular misconceptions.

Contributions to the Action Research Project

Claudia Witt - administered stations, collected data, analyzed misconceptions, collaborated on writing paper

Rebecca Joyce - researched readings, summarized readings, observed stations in Claudia's class, collaborated on writing paper

Kari Luckett - administered stations, collected data, analyzed misconceptions, collaborated on writing paper

Chapter 2

Michigan Teacher Excellence Program Experiences

The science departments at both Loy Norrix High School and its sister school, Kalamazoo Central High School, in Kalamazoo, MI have benefited greatly from the Michigan Teacher Excellence Program (MiTEP). As a science teacher at Loy Norrix High School, I have grown significantly in my teaching practices and ability to form professional relationships with colleagues both in and out of the district due specifically to the MiTEP program.

Upon hearing about MiTEP through fellow Loy Norrix science department members that had already gone through the first year of the program, I jumped on the opportunity to apply. To be truthful, I had been looking for a master's program to start and was most excited with the prospect of not having to pay for it. In the long run, this was a significant draw and I may not have even applied had this not been the case. I have never been all that interested in Earth Science (I think my last Earth Science class was in middle school) and I was nervous about the thought of my Master's degree being focused specifically on Earth Science. I was hesitant to apply for the program because I am not certified to teach Earth Science (nor had I intended to get the certification). I was assured that MiTEP classes were more focused on science misconceptions and inquiry-based learning and that, in the grand scheme of things, it wouldn't be a big deal if Earth Science was not my true love.

Upon getting accepted into the program, I prepared myself for the first summer up north. I was in the process of becoming an AP Chemistry teacher at my school, so I had to attend a summer institute in Lapeer, MI the week prior to our week in the Upper Peninsula. I left from Lapeer on the Friday night prior to the program and drove to Marquette to stay in a hotel for a couple of nights before needing to be in Houghton, MI on Sunday to start our first class. In hindsight, I am disappointed that I didn't drive up with the rest of the group, as I think I missed out on some bonding time and pertinent picture taking opportunities. Many of the positive points that I took from the MiTEP program were in the professional relationships I have formed, most specifically in the past year. Being involved in the MiTEP program has given me the opportunity to get to know teachers throughout the district and I am so fortunate to have had that chance. There is definitely an irreplaceable sense of community that we experience when we go to district-wide meetings and see each other. I know that I can lean on any of them and ask for help if it ever is necessary.

The first week in Houghton was a fantastic learning experience. I had never had a class "in field" like that and it was something I looked forward to on a daily basis. Throughout the program, I have viewed it as "glorified sightseeing" and it has made the information being taught much more interesting. Being surrounded by the topics we were studying made the experience unlike any other I had as an undergraduate. The days were long and the assignments were tedious, but I learned a lot. Some of my favorite learning experiences the first week in Houghton included observing and measuring potholes, finding stromatolites at Copper Harbor, creating an Earth Cache for others to find and learn from, learning about paleomagnetism, and visiting the various sites related to mining, most specifically, the stamp sands. I think that I am most interested in human impact, how we have negatively affected the environment, and how we plan to remediate it (or are in the process of remediation).

I found that even though the downstate week in Jackson was supposed to help us apply some of what we learned to our more proximate surroundings, I didn't get as much from it as the week in the Upper Peninsula. The place/activity I enjoyed most and found the most likely to be transferred into my classroom was the trip to Woods Lake to do water quality testing. I thought the various water quality tests that we practiced were a great way to incorporate real-life experiences into the curriculum. The problem with this was that most of the curriculum I teach does not relate specifically to water quality. I could relate some of the water quality testing to chemistry or environmental science, however a field trip to Woods Lake, and the materials necessary for a lesson similar to the one I experienced was out of the question. I did incorporate a water quality testing unit into AP Chemistry last year in a river across the street from Loy Norrix, and used some of the information I learned in the MiTEP program. I found that the students appreciated the relationship to their real life and the proximity of the river to our high school. Students performed tests on nitrates, phosphates, dissolved oxygen, flow rate, temperature, and turbidity. Students also had the opportunity to present their findings to the rest of the class, acting as members of the community/city council. The students were able to relate the levels of various pollutants to their perceived "healthiness" of the river. They also compared the pollutant levels to other large rivers in the United States and gave outcomes and various solutions to hypothetical catastrophes to our river. Examples of catastrophes given to groups included oil spills, pollutants being introduced into the river, invasive species overwhelming the river, and fertilizer being used more frequently around the river. The students were required to give the negative result of the catastrophe (what would happen to the river) and a potential remediation for their catastrophe. This is a project that I think my students enjoyed and I probably would not have tried without my experiences in the MiTEP program.

Several online classes were required for the program and have not really had much of an impact on my teaching. These were classes that we had to take for the degree, rather that in the MiTEP program, itself. I am not denying that I learned in the process of taking them, however most of the information is not applicable because I do not teach Earth Science. I am not certified to teach Earth Science, nor do I have any intention on becoming certified in the subject area, so the information I learned was not something I see myself using as a teacher. One example of this includes learning about storm systems and weather patterns.

One class that was required for the MiTEP program that was very helpful in my teaching experience was the Lesson Study class that I worked through with Kari Luckett in the spring of 2013. We studied how integrating manipulatives into teaching and practicing balancing chemical reactions helped our students. Our studying of this concept allowed me to begin integrating more manipulatives into my teaching practices. In one manipulative, we had students use bingo chips to practice balancing chemical equations. The idea was that each color chip should have the same quantity on each side. We practiced and I found that many of my students who had previously had trouble with balancing had a much better idea of how it worked with the use of this activity. Another manipulative we used for our lesson study was in creating ionic compounds. Students used laminated cards with sizes corresponding to the amount of charge that various ions carry. They would pair the appropriate number of cation (positive) cards up with anion (negative) cards. This allowed students to see how many of each ion were required to neutralize the ionic compound. Again, students who had struggled with the idea of balancing charges were given an alternative way to look at how ionic compounds formed. I have noticed that using manipulatives has begun to affect my students in a positive way. I have found that students understand better with the use of manipulatives, especially during review for assessments.

The second summer we spent in the program was similar to the first summer in that we spent one week in the Upper Peninsula and one week downstate, this time, however, the downstate week was mostly in Kalamazoo, MI. The trip to and from Michigan Tech this time was much more relaxing because I did not have to drive myself. I found a real sense of camaraderie in being able to make the trip to and from our destinations with other teachers in the program. Being able to discuss our teaching practices and our take on various programs in the district was fantastic and appreciated by most on our journey. I believe that if the program had only been for one summer, some of the deeply-rooted bonds that were solidified during the second summer would not have been as fruitful. I enjoyed the second summer more than the first, mostly because of the bonds we had formed throughout year one. Since we knew each other already, there was no awkward “getting to know you” time required during the beginning of the second summer.

The most memorable activities during the second summer’s week at Michigan Tech included mining at the Caledonia Mine, collecting banded iron formation (BIF), and seeing the water treatment plant. I loved the chance to go see the mine and actually participate in our own mining activities. It was a once-in-a-lifetime opportunity for me to be able to wear a helmet and break rocks while looking for copper. Learning about how the bands of copper form in the rocks was interesting and can relate to some of the mineral work we discuss in chemistry. I thought that seeing the banded iron formations was also pretty interesting. Again, without a lot of background in Earth Science, seeing rocks like this in real life and being able to collect samples to take home was a fantastic experience for me. I was glad to have gotten the opportunity to learn about Earth's history and how various rocks came to be.

That summer (summer of 2013), the most useful parts of the downstate week included creating plaster molds of fossils, visiting the Environmental Protection Agency's superfund site in downtown Kalamazoo along with the oil spill site along the Kalamazoo River, and visiting both the water treatment plant and the coal power plant in Jackson, MI. I found that a lot of the material we covered in this part of the course related to Environmental Science, a class I was teaching at the time. It was great to have material (and pictures) that I could use in the future when I teach the class. I loved how so much of what we were doing related to what our students would see as "real life." Unfortunately, I have been removed from teaching Environmental Science recently, so I haven't really ever had the chance to try to integrate some of the information into a class I've actually taught.

Another class that was especially effective in my teaching practices was the action research class taken in the fall of 2013. I had never done research of that caliber before, but it was a fresh perspective on what worked and what did not work in the classroom. I did my research with Kari Luckett and Rebecca Joyce, both fellow science teachers for Kalamazoo Public Schools. Learning how to research the "right way," along with being able to improve my classroom through newly learned skills has helped me become a better teacher. This class also allowed me to continue to improve my students' test review activities through the integration of review stations. I have since created station review activities for all of the chapters in the curriculum for Chemistry A. I have found that students are more likely to remember various concepts we have covered if they have the additional chance to review them in a stations activity prior to the test. The stations activities have given students an opportunity to work amongst their peers to practice, relearn, relate, or teach others content they should have gained during the particular chapter.

Pedagogy days were another way that MiTEP helped create a more lasting professional learning community and friendship from the time we students were required to spend together. I looked forward to these days, especially in the wintertime when the day-to-day routine became a little monotonous. I enjoyed catching up with my colleagues and sharing teaching practices, inquiry activities, and watching others present on the integration of inquiry-style teaching in their classrooms. The pedagogy days allowed for us to often travel with fellow teachers (our now friends) to and from our classroom in Jackson while discussing our careers together.

I have had the fortune of getting to present at not only the Michigan Science Teacher's Association conference, but also the National Science Teachers Association conference this year. If you would have told me a couple years ago that I would be presenting at a science teacher's conference, I would have said that there was no way. Specifically because of the MiTEP program, I have had positive experiences doing group presentations at both venues mentioned above and would gladly do them again. I have found that in attending these types of conferences (again because of the MiTEP program), I know what types of presentations will benefit me the most. I appreciate the types of presentations that allow me to take away something that can be (relatively) easily implemented in my classroom.

One topic that the MiTEP program focused heavily on was addressing student misconceptions. I think that learning about Earth Science misconceptions has opened my eyes to how I deal with student misconceptions in my chemistry classroom. I never really thought about the way that I question my students nor how I specifically address their misconceptions on a regular basis. Now I am able to notice that I address what I find to be common misconceptions as I teach and review them in my classroom rather than after I've taught them or have assessed on them. My questioning techniques have changed as well. I am now in my seventh year of teaching, so some of the things I have changed are due to experience, however I also attribute a change in how I ask questions to what I have learned throughout MiTEP. I find myself asking probing questions rather than direct questions. I try to work the answer out of my students through the way I ask questions rather than giving them the answer so we can move on. I believe that if students can be asked the right questions to determine the answer themselves they will be more likely to problem solve in the future without my help.

Perhaps the best experiences I have had as a direct result of the MiTEP program occurred during the summer of 2014. Knowing that we had two distance classes to take that were each three weeks long, the anticipation of this past summer was nerve wracking, to say the least. My camping background was beginner at best, and I was not nearly prepared for the level of intensity that the Geology of Utah's National Parks class was going to require. I had heard about the National Parks Internship, and was looking forward to my internship at Pictured Rocks as more of a vacation than a class.

Utah was a once in a lifetime opportunity that I would take again if I had the chance. Most of the places we visited I can not imagine myself going to again, nor ever going to on my own. Being able to visit the sights and bond with fellow Kalamazoo Public School and MiTEP teachers was excellent, to say the least. Of all the places we went, I loved seeing the dinosaur footprints and measuring how fast they were moving based on their pace length. I also enjoyed calculating the size of various rocks that could be moved by slow or fast currents. The beautiful sights were unforgettable and will not likely be matched any time soon. I did not find a lot of applications to teaching chemistry, however bonds were formed with the other students that were in Utah with me. I found excitement in being able to return with new friendships and a continuation and deepening of a professional learning community that had been started with the beginning of the MiTEP program. The lesson plan that was a class requirement was good because it required me to relate the content of the class to my teaching practices, however I cannot see it being used in the future. Unfortunately, the curriculum and pacing guide that I am required to use to guide my teaching do not leave a lot of wiggle room to integrate a lesson like the one I wrote for the class. I met and got to know more Kalamazoo Public School science teachers throughout the Geology of Utah's National Parks class and continued to foster a fantastic professional learning community because of the experiences I had in Utah. Throughout the past year, I have been meeting with Jennifer Finta and Kari Luckett, two other members of cohort four of the MiTEP program to work on class work, collaborate on lesson plans, and discuss best practices in our classrooms. This has been an irreplaceable opportunity that I probably would not have explored if I were not a part of the MiTEP program.

Heading into the second class of the summer of 2014, I was excited, but worried about how fast my summer was already flying by. I had heard from previous cohorts that the summer internship was a fun, relaxing experience. I was most anticipating being able to work closer with Kari Luckett and Jennifer Finta, both women I had formed a professional learning community with over the past year working on our online classes through Michigan Tech. I had been in close contact with Kari Luckett throughout the entire program because she is the AP Chemistry teacher at Kalamazoo Central. At Pictured Rocks I also had the opportunity to work with Jim Wright, a Biology teacher at Kalamazoo Central. The already-formed relationships with Jenny and Kari naturally led to an ever-widening friendship when we spent so much time together at Pictured Rocks. Being able to explore on our own schedule allowed us to see most of what there was to see at Pictured Rocks. Our time spent together gave us more opportunities to collaborate on lesson planning as well as Earth Caches and our project, putting together an Earth Cache tour of existing Pictured Rocks Earth Caches. We had the chance to see rock formations and make connections to our teaching roles throughout the trip and were fortunate enough to enjoy each other's company in the process.

Another part of my teaching experience that has been influenced by the MiTEP program is my involvement in leadership positions at my school. Since starting with the MiTEP program, I have become a team leader for one of our Sophomore Academies, joined the School Improvement Team, been a mentor teacher for a teaching fellow from Western Michigan University for the second time, and found myself speaking up more at meetings. This year, we have begun integrating a common vocabulary word of the week in all of the science classes at my high school because of something I suggested during a department meeting at the end of last year. We have not had very good science ACT scores in our school and are trying to see if having a word of the week might help students understand the vocabulary typically understood to be “background knowledge” for high school students.

Looking forward, I am saddened by the camaraderie that will be greatly missed with the lack of pedagogy days, meetings, and master’s classes this year. I am excited in anticipation of what my future holds and how I can become even better, and more conscious of integrating inquiry more fully into my classroom. I am anxious to see how I can incorporate more inquiry and professional learning community work into my teaching career. I have been forever grateful that I stumbled upon the MiTEP program and will treasure the knowledge and personal bonds I have made as a result of my experiences over the past two and a half years.

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