THE IMPACT OF THE 6E MODEL IN A THIRD GRADE SCIENCE CLASSROOM

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A Thesis

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ABSTRACT

Dr. Emilio Duran, Advisor

The purpose of this research thesis was to investigate the impact of modifying a highly effective instructional model to address the needs of all learners in a third grade science classroom. The modification of the 5E model consisted of adding a new phase (Express) after the explanation phase to formally assess the progress of the students in the learning cycle. The results of the express phase were then used to differentiate instruction in the elaboration phase with the ultimate goal of helping all students achieve the learning objectives. This study was comprised of a mixed methods approach where the quantitative instruments of pre and post assessments were used in addition to qualitative instruments of interviews. Also, a quantitative instrument of a t-test of independent samples was used to conclude the significance of the modified 5E model in comparison with the original. This research was conducted at a local elementary school in the Toledo area. A total of 49 students and one classroom teacher participated in the study. The results of the study suggested that grouping the students by ability was an important strategy that appeared to help students improve on their science knowledge. Furthermore, the results seemed to confirm the hypothesis that the modified 5E model effectively addressed the learning needs of all students and confirmed the potential of the model and the need to test it on a much larger scale based on the significance that was found in the t-test of independent samples.
Dedicated to:

My parents Debbie and John Fletcher who

Have made me the strong and successful

Person I am today, I love you.
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CHAPTER I: INTRODUCTION

There have been many reforms in science education, but science teachers are still struggling to meet the needs of all students. Armstrong and Haskins (2010) agree:

The phrase ‘one size fits all’ most certainly does not apply to instruction in today’s diverse classrooms. Each school day a dynamic mix of learners walk into classrooms, students who differ by performance levels, learning styles, gender, ethnicity, race, and socioeconomics. If we take into account variables such as health, disabilities, stressful life incidents, and level of family support for education, the picture becomes even more complex. Yet each of these unique children needs to be educated as a citizen of and contributor to the twenty-first-century world. And it is our job to teach all of them (p. 6).

Science education must fit the needs of each and every individual learner to be effective. One of the most effective and common learning cycles used in science teaching is the 5E model that is comprised of five phases: Engage, explore, explain, elaborate, and evaluate (Bybee et al., 2006). This model is considered beneficial in the classroom to students with the various instructional strategies and steps it provides (Bybee et al, 2006). In addition, the step by step process of going from the prior knowledge of the students to the final phases of elaboration and evaluation is beneficial and logical for the students to follow. Instead of forcing students to memorize facts it allows them to be involved in inquiry based learning science experiences (Chessin & Moore, 2004). Therefore, students will be learning with a purpose rather than to strictly memorize facts. However, the 5E model still has its limitations. These limitations have sparked interest in others to test out various expanded models aimed to enhance student learning.
in the 5E model based on new research or knowledge that has been introduced (Eisenkraft, 2003).

**Statement of the Problem**

Although the 5E model includes various instructional strategies and is inquiry based, there are still limitations within the model, especially when it comes to adapting to each and every student’s individual learning needs. Even though the 5E model contains all components of inquiry based learning and is intended to help each and every individual learner, there is the limitation that there is not enough differentiated opportunities to ensure students are ready to move on to the elaboration phase and ultimately the evaluation phase. For example, it is often that teachers think that if their students participated or enjoyed the exploration phase that they understood the material presented to them and the teachers are then surprised by the results of the post assessment (Duran, Duran, Haney, & Scheuermann, 2011). Sometimes, students still have misconceptions by the end of the learning cycle. And often times, the teachers are not even aware of those misconceptions.

To combat this problem, a new proposed 6E model suggests a pause in the learning cycle to provide teachers with evidence that students are making adequate progress in the learning cycle. This can be done by administering a formative assessment probe that differentiates from the informal evaluation that occurs in other phases of the cycle and instead is used to evaluate teacher effectiveness and student progress in the learning cycle to eventually lead to a three tiered or differentiated elaboration phase (Duran, et al., 2011). Furthermore, the differentiated elaboration phase would place students into three tiers specific to their individual learning needs whether it is Tier I-Novice Learning Level, Tier II-On-Target Learning Level, or Tier III Advanced Learning Level. Therefore, this study attempted to find how to make an already
highly effective learning model even more effective by using tiered instruction to group students by their level of understanding. This allowed students to receive the proper differentiated opportunities to progress adequately through the learning cycle.

**Rationale**

The discussion of this study provided educators with strategies to meet the needs of all learners in the classroom while still using a learning cycle. The current 5E model does not explicitly address tiered activities. Therefore the findings in this study contributed to the complex issue of finding strategies to meet the needs of all learners in the classroom. This study attempted to test out the new 6E model with the added step of express and to see whether or not it could positively affect student learning. Furthermore, this study can help an educator discover whether or not adding the additional phase of express would help students learn more by teaching the content specific to their individual learning needs. More specifically, it could help the teacher see whether or not administering an assessment probe after the explanation phase, would help to determine how to differentiate opportunities for students better so that they would perform well in the elaboration phase as well as the evaluation phase.

**Research Questions**

The primary questions that lie in this research dealt with the beliefs and attitudes of the teachers and students on the effects of the 5E model in comparison with the 6E model. The goal was to figure out whether or not the 6E model would help make the already efficient 5E model more beneficial to students, specifically if the 6E model helped students reach a higher post test score. The following research questions were the foundation of the research that was completed:

1. Is there a difference in science knowledge between students taught using the 6E model and those taught using the 5E model?
2. Are there differences in science knowledge among the different levels of students taught using the 5E and 6E model?

3. What are the students’ perceptions and attitudes about differentiated instruction?

4. What are the teachers’ perceptions and attitudes about differentiated instruction?

**Definition of Terms**

- **Inquiry** - A form of learning that is based on asking questions to arrive at new knowledge. More specifically, it is an instructional method that puts the teacher as more of a guide rather than a leader. The teacher’s job is to guide students with questions to ask themselves to arrive at the end goal or new knowledge that is being taught. Inquiry can also be defined as students obtaining new science knowledge by asking questions, making predications, and participating in experiments to arrive at conclusions or answers to these questions (Straits, 2008).

- **5E model** - A learning cycle that is composed of the phases of engage, explore, explain, elaborate, and evaluate. This learning cycle uses the inquiry form of learning where students ask questions to arrive at answers. It is a hands-on learning model that is widely used in science education. It follows a step by step process to allow students to go from their initial prior knowledge to forming new knowledge or understanding of new concepts. In this particular learning model the teacher obtains the role as more of a guide rather than a leader and uses guided questioning to help the students arrive at new knowledge. The goal of this learning model is to help students become active in their learning and perform hands-on activities to arrive at new knowledge (Appendix A).
• Differentiated Instruction- This is used in terms of finding out ways to instruct students that fit each students’ learning styles or needs so that they are successful and achieve proficiency in what is taught to them.

Limitations

The research study had some limitations. Aside from minor limitations, the main limitation was that since the sample size was so small and only consisted of 49 students, it was impossible to generalize the findings. However, the findings still contributed to making science education more effective. Aside from this major limitation, one of the minor limitations was that since a large portion of the data were collected during the school day, there were students that were absent throughout the 5E model or 6E model lesson in the duration of the week. This can be considered a limitation because if a student came in on the third day of the 5E model or 6E model lesson, it was possible he or she may not perform as well in the evaluation at the end of the lesson.

Another limitation was that not every student got their own set of materials in the lessons as there was only a select amount of the materials that were needed for the lesson. To accommodate to this limitation, students worked in small groups of 4-6 students. In addition to this, in one particular lesson that was taught, the fire drill went off and this definitely affected how the students acted for the rest of the lesson. There were some that could not get their mind off of it in addition to an interruption that caused the time to be shortened for the lesson. One final limitation that was involved in this study occurred when administering the assessment probe to students. Some students would put an answer down that was correct. However, their explanation had nothing to do with the answer they chose. Therefore, the final limitation was possibly that students were looking at other students’ papers or they just were not able to explain
their answer. This posed a problem or limitation because it was hard to place them in a tier when there was not an explanation that was long enough to decipher what the student’s misconceptions were during the pause of the learning cycle for the 6E model.

**Conclusion**

In summary, the focus of this study was to compare and contrast the highly effective 5E model of instruction with the proposed 6E model to study the impact on student learning. The framework of this study was based on differentiating instruction in the 5E learning cycle so that the instruction can be adapted to all students’ needs. The proposed research questions that surround this study dealt with the attitudes and beliefs of classroom teachers on the 5E learning cycle in addition to the discrepancy of performance of students who are taught using the 5E learning cycle versus that of the 6E model.
CHAPTER II: LITERATURE REVIEW

Research for this project was based on the information previously mentioned in the literature on science education and the implementation and effectiveness of the 5E model. The 5E model is comprised of five main phases of which include: engage, explore, explain, elaborate, and evaluate. The first phase, engage, introduces students to the topic they are learning and determines their prior knowledge. The second phase, explore, allows students to partake in hands-on activities that reinforce the new topic that is being taught. Next, for the phase of explain, the teacher typically asks a series of guided questions to help students arrive at conclusions or answers to the topic they are learning about. Then, for the phase of elaborate, the students then take this new information and often conduct an experiment to challenge their thinking. For the last phase, evaluate, students are tested on their knowledge of what they have learned whether it be a test or even an activity (Bybee et al., 2006). This model of instruction has had a positive impact on student learning because it has been proven to motivate students with the fun activities that are often involved in the lessons (Boddy, Watson, Aubusson, 2003; Bybee et al., 2006). This learning cycle has also undergone changes or modifications since its original development. Therefore, it is imperative for future educators to take a look at what modifications have been suggested so that they can educate their students to their fullest capacity and so that students are able to maintain the information learned in science lessons that are taught. The literature found focused on the suggested modifications and how educators could come to meet the needs of all the different learners that are in their classrooms.

History of the 5E Model

The development of this learning model began back in the 1960s. In 1962, a study entitled the Science Curriculum Improvement Study started to develop at the University of
California in Berkeley that aimed to solve the problem of the gap between what scientists know about science and what teachers know about science (Karplus & Their, 1967). Much later after this came into play, a Curriculum Topic Study (CTS) was formed that strived to improve the education classroom teachers had on the science topics they were teaching (Keeley, 2005). This related to the 5E model as some teachers did not fully understand the topics that they were teaching. Therefore, CTS was developed in an effort to close the gap between what scientists know and what teachers know about the science topics that they are teaching. In addition, Keeley (2005) further discussed how science instruction through CTS strives to motivate students to connect topics learned in science to other subject areas in addition to improving student performance from different backgrounds and abilities. From this study arose the Biological Science and Curriculum study that indicated a form of instruction in a series of steps that allowed students to use their prior learning experiences and use these experiences to gain an understanding of a new topic, the 5E model (Ansberry & Morgan, 2007).

The 5E model of instruction allows the students to be engaged by talking about their existing knowledge and eventually leads them to use their prior experiences to construct new knowledge. This is described as the following in regard to the 5E model:

The 5E model provides a planned sequence of instruction that places students at the center of their learning experiences, encouraging them to explore, construct their own understanding of scientific concepts, and relate those understandings to other concepts. (Ansberry & Morgan, 2007, p. 29).

Therefore, the 5E model allows students to gain scientific knowledge taught to them based on their prior experiences and allows them to go through a series of steps to construct new knowledge based on what is in their existing knowledge.
Using Learning Cycles in the Classroom

Learning cycles have been proven by research to improve student learning (Yalcin & Bayrakceken, 2010). For example, in a recent research study, different classrooms were compared using traditional teaching methods versus that of the 5E model learning cycle. The results indicated that the 5E learning cycle was more effective than that of traditional approaches due to more student engagement and student interest in the topic that was being learned that which promoted more learning (Yalcin & Bayrakceken, 2010). In addition, Gunckel (2010) wrote about a learning cycle in science education entitled Experiences Patterns Explanations (EPE). This learning cycle improved student learning because students gained more hands-on experiences versus traditional approaches to teaching with fewer hands on experiences and more explanation. Furthermore, the cycle emphasized the importance of having explanations to go along with experiences so long as there were a plentiful amount of hands on experiences in the science lesson that was taught. Another learning cycle in science education is that of the scientific method where students come up with a hypothesis or guess and go through a step by step learning model to come to a conclusion (Fulton & Sabatino, 2008). A recent study indicated that this learning model was quite effective in getting students to understand the connections between math and science based on a survey given out to students and the students also indicated that they were motivated throughout the lesson in their written responses (Fulton & Sabatino, 2008).

The Structure of the 5E Model

The 5E model has been found a successful model of science instruction in the classroom. One of the reasons that it was found to be successful was that it motivated students and maintained their interest in what was being taught (Boddy, Watson, & Aubusson, 2003).
Therefore, students were able to maintain much of the information that was taught to them because they enjoyed it instead of being forced to learn it. This instructional model was also supported by Bransford, Brown, & Cocking (1999), who referenced that student learning needs are best met when, “activities can be structured so that students are able to explore, explain, extend, and evaluate” (p. 127).

As shown in Appendix A, the first step of engage, allows the students and the classroom teacher to focus on the connection between past learning experiences and present ones and participate in short activities that center around the new topic to be learned (Bybee et al., 2006). In the next phase, explore, students often conduct experiments and gather questions from these experiments to set up the framework for what would be learned. The next phase, explain, is teacher-directed and is meant to have the students explain their understanding while the teacher guides them to a different perspective or a deeper understanding of the topic. This can be viewed as an evaluation, as learners are encouraged to explain their understanding of the topic (Bybee, 2006). However, a critical component of this phase is for teachers to guide students toward a deeper understanding of the topic, usually through guided questioning (Bybee, 2006). Closer to the end of the 5E model, is the phase of elaborate or extend. During this phase, students use what they have learned in the lesson to conduct different activities on the subject that enhance their understanding of the topic. The final phase, evaluate, allows the teacher to administer a formal assessment that checks the students’ understanding of what was taught. This is not to say that this is the only place where evaluation takes place, as guided questioning is used throughout to monitor progress of the students. The final evaluation phase is meant to formally evaluate students in a variety of ways whether it is a project, activity, or hand-written test so that students
are able to demonstrate their knowledge on the topic they learned and so teachers can properly assess whether or not the students have met the learning objectives (Bybee, 2006).

**Student Learning and Motivation**

In comparison to learning cycles, there are also more traditional approaches to teaching science such as question and answer methods in the form of direct teaching. Based upon a recent study by Cardak, Dikmenli, & Saritis (2008), using a learning cycle like the 5E model proved to be a better method of student learning because the students were able to partake in activities throughout the 5E model lesson to clarify any misconceptions that the students had within their prior knowledge. With direct instruction, typically students are not given the opportunity to clarify their misconceptions through hands-on activities. In addition to hands-on activities, motivations in science lessons are important because this is what keeps students interested in what they are learning. The research stated how using instructional models can improve students’ attitudes and therefore increase their motivation (Bybee et al., 2006). Therefore, by using the 5E model of instruction, students are likely to gain positive attitudes toward science and will be motivated which will in turn cause an increase in their performance. This student learning and motivation can be defined as eagerness to participate as a result of the hands-on activities that according to research have proven students to gain positive attitudes and enjoyment towards the science topics they are learning (Boddy et al., 2003).

**Benefits versus Limitations of the 5E Model of Science Instruction**

One benefit of the 5E model is that it helps the teacher plan lessons by determining the prior knowledge of the students and using this to establish the best way to construct the new knowledge that they will learn (Keeley, 2005). The 5E model has benefits in the sense that it helps students bridge the concepts they have already learned with the new concepts they are
learning, which will eventually result in the mastery of the content being taught. Another benefit of the 5E model of instruction is that it can be considered a more open-ended approach to instruction where students have the ability to explore and test their understanding versus having direct instruction and being told concepts or terms (Lawson, 2001). In addition to this, another benefit of this learning cycle is clearly stated by Chessin and Moore (2004) when they wrote, “it is a valuable tool that allows us to structure science experiences so students use the processes of scientific inquiry to construct and connect ideas rather than simply memorize seemingly unrelated facts” (p. 47). Therefore, it allows students to find value to what they are learning and remember it rather than memorizing flash cards or doing a simple worksheet.

Although there are several benefits of this learning cycle, the 5E model does have its drawbacks and limitations. One limitation of the 5E model, described by Eisenkraft (2003), suggests “too often the elaboration phase has come to mean an elaboration of the specific concepts” (p. 59). In addition, the research confirmed that too often classroom teachers will not extend or elaborate in a new context and will instead use an extension that is too hard for students. A good elaboration in a lesson, proposed by this research, was if students are learning about friction, a highly effective elaborate phase could be inventing a sport that one could play on the moon. This activity could be useful to students, according to the research, because it would allow the students to apply the new concept of friction to a new context of “sports.” Another limitation of the 5E model is how many educators are using only verbal explanations during the explain phase and there are other ways to do this including that of video, films, and educational courseware (BSCS IBM, 1989). Lastly, the 5E model as described, provides limited opportunities to pause and differentiate instruction on what the students already know.
Proposals of Changes in the 5E Model of Science Instruction

Several modifications have been suggested for this effective model of instruction of the science curriculum. One suggestion that has been made is a 6E model of instruction. The additional step being that of a 5th E entitled “e search” where a technology component was added to each step of the learning cycle to enhance learning (Chessin & Moore, 2004). This addition to the 5E model argues that the “e search” component of the learning cycle does not take the place of hands-on learning. However, it builds on it and allows the students to explore the material covered using technology. Another suggestion has been to add two steps to the 5E model to make it a 7E model (Eisenkraft, 2003). In this proposed 7E model, the additions include that of an elicit phase before the engage and an elaborate before the evaluate phase at the end of the learning cycle (Eisenkraft, 2003). The elicit phase was designed to gather what prior knowledge the students have on the science concept being learned and the elaborate phase had the students raising questions on what they have learned thus far in the lesson before the evaluation takes place (Eisenkraft, 2003). Even though the engage phase is intended to assess prior knowledge, often times teachers do not do this enough in this phase and instead only excite students in the topic to be learned (Eisenkraft, 2003).

Interestingly, and in contrast with the original 5E model of instruction, the 7E model splits the last two phases of the original model into three steps of elaborate, evaluate, and extend. Eisenkraft (2003) described the purpose for this as, “the addition of the extend phase to the elaborate phase is intended to explicitly remind teachers of the importance for students to practice the transfer of learning” (p. 34). Another proposal that has been suggested is that of a 6E model with the 6th E being that of “express” right after the phase of explain in the learning cycle (Duran et al., 2011). The phase of express is meant for students to have access to
“differentiated opportunities” and for teachers to assess the progress of the students mid-way in the cycle. From this phase the teacher plans out a three-tiered elaboration phase which separates the students into the following categories: Novice, On-Target, and Advanced. This then allows the students to receive “differentiated opportunities” in their instruction and will help them master the content by the end of the learning cycle. This is not to say the students will not be challenged, as each tiered activity will enhance each student’s thinking and assist the students in learning what is taught to them.

**Differentiated Instruction and Importance of its Inclusion in the Learning Cycle**

The 6E model with the phase of express supports the need for differentiated learners in the classroom through the use of tiered activities. Tomlinson (1999) discussed the importance of tiered activities when she wrote, “tiered activities are very important when a teacher wants to ensure that students with different learning needs work with the same essential ideas and use the same key skills” (p. 83). By using tiered instruction, differentiation is starting to take place so that all material is appropriate for all students (Armstrong & Haskins, 2010). Therefore, through the use of tiered activities in the three separated groups in the 6E model, each group is receiving differentiated instruction according to their individual needs. Tomlinson (1995) discussed placing students in groups which relates directly to tiered activities. For example, she described how a classroom teacher split her class into two different groups to learn the concept of extinction and one group focused on more concrete activities whereas the other group focused on more abstract activities. She commented on how this is effective at meeting individual learning needs by writing, “the teacher proactively matches the “equalized buttons” of the tasks and materials to each group’s learning needs” (Tomlinson, 1995, p. 47). Therefore, the proposed solution suggested by the literature is that of grouping students according to their needs.
Interestingly and in relation to the 6E model of instruction, Armstrong and Haskins (2010) discussed the process of effectively tiered instruction by first assessing where students are cognitively. Then, the next step is performing tiered instruction by placing students into small groups that point all students to where they should go next. Finally, the last step is selecting the best teaching methods to reach those learning targets specific to each child’s needs. This relates strongly to the 6E model of instruction with the phase of express being a formative assessment probe that a classroom teacher would use after the explanation phase to then differentiate or tier instruction to ultimately select teaching methods to get all students to meet the learning targets specific to their individual needs. More specifically, Armstrong and Haskins (2010) discussed the importance of different factors that must be taken into consideration when grouping students according to their individual learning needs as the following: “the same learning goal is applied, the format of the activity remains the same, tasks are engaging, challenging, and respectful, and complex thinking activities take place in each group (p. 71).” Therefore, to eliminate the argument of students not being challenged when grouped by learning levels, when students are tiered into different groups such as the ones in the 6E model of instruction, the students are being challenged but within reach of their cognitive abilities.

In order to further support the express phase in the 6E model of instruction, Armstrong and Haskins (2010) discussed the significance of authentic assessments in relation to the formative assessment probes that are used in the 6E model of instruction during the express phase when it was stated, “if learning is enhanced when information is authentic, teachers should model this goal through their assessments as well…rarely, if ever, are professionals completing worksheets to show what they know” (p. 104). Therefore, assessments that are given to students to arrive at what the students know and understand should be more than just a simple worksheet
with right and wrong answers. It should go much beyond that and should allow students to express what they truly know through an extended response question that allows the students to explain their thinking and provide the classroom teacher with information where he or she can maintain a variety of ability levels in order to properly differentiate instruction.

Furthermore, the use of technology in science lessons has been said to improve or support differentiate instruction. Colombo and Colombo (2007) discussed using blogging to improve students’ education in science because it provides the classroom teacher with “extra” time to review concepts learned and answer questions that the students may have. These researchers went on to discuss how English Language Learners can also benefit from the technology of vodcasting where the classroom teacher is able to combine PowerPoint presentations with narrations so they can listen to it.

**Summary**

There are different approaches to teaching science with learning cycles. Learning cycles have been known to be an effective teaching strategy for teaching science. One model in particular has caught the attention of many teachers which is the 5E model of instruction. There has been an extensive amount of research done on the 5E model and proposals of modifications to make the model even more effective. These modifications include adding technology, differentiating lessons, and adding more activities to elicit prior knowledge during the engagement phase.

Aside from proposed modifications to this model of instruction, the review of literature also displayed what the 5E model consists of and how it is beneficial to students. One of the largest components in the review of literature was that of differentiated instruction and how it is much needed in this particular learning cycle. It is important according to the review of
literature to group students according to their needs. Therefore the research that was completed in this study, added to the current research found in the literature by testing out the phenomenology of this 5E model by adding the step of “express” to determine if tiered activities would help students meet the goals of the science lessons that were taught to them.
CHAPTER III: METHODS AND PROCEDURES

Introduction

The purpose of this study was to take the already highly effective 5E model, and to see whether or not adding the new phase of express would impact student learning. In addition, the study had the purpose of figuring out what the teacher’s and students’ attitudes were towards both types of instruction, the 5E and the 6E, to see if there was a clear difference in views towards each type of instruction.

To fulfill the purposes of this study, the following research questions were generated:

1. Is there a difference in science knowledge between students taught using the 6E model and those taught using the 5E model?
2. Are there differences in science knowledge among the different levels of students taught using the 5E and 6E model?
3. What are students’ perceptions and attitudes about differentiated instruction?
4. What are teachers’ perceptions and attitudes about differentiated instruction?

Methods

Mixed Methods Research Design

This study was conducted using a mixed methods approach comprised of qualitative and quantitative methods. A mixed methods approach provides a balance of qualitative and quantitative methods in addition to finding a compromised solution between the two viewpoints that bridges theory and practice (Johnson, Onwuegbuzie, & Turner, 2007). This was done by using the qualitative method of an action research approach and the quantitative method of analyzing test scores by having a t-test of independent samples done to determine if students
made significant gains as a result of the 6E and to examine the difference between individual pre and post test scores.

**Action Research Approach**

There are three major components to action research: the teacher or researcher, data collection, and data analysis. According to Bresler (1995) the goal of action research was described as the following:

The objects of action research - the things that action researchers study and aim to improve, are their own educational practices, their understandings of these practices and the institutions in which they operate. Action research involves intervention not only as a main feature during the data collection, but as an explicit goal of the research (p. 16).

For this particular study, I was the teacher and the researcher. In addition, I was responsible for the data collection and analysis to better understand my research questions. Therefore, this study utilized action research to improve educational practices in the field of science education by determining whether the additional step added to the effective 5E model would impact student learning. Saul and Launius (2010) conducted several classes on the action research method and claim that some of the major benefits of this type of research according to their students was that multiple perspectives are provided aside from the researchers themselves, several examples are typically used even if the researcher focused on one classroom, and it is easy to identify with the research being conducted. The action research approach used with this study did all of the above by gathering multiple perspectives aside from the researcher, but also included perspectives of the classroom teacher and the students who participated in the study.
Interpretivist Paradigm

More specifically, this research study followed an interpretivist paradigm primarily so that the experiences of the students could provide an in depth discussion based upon the type of instruction that they received. Glesne (1999) explains the interpretivist paradigm as one that relies on an in depth interaction with research participants. Furthermore, she goes on to describe this specific paradigm when she notes, “the researcher becomes the main research instrument as he or she observes, asks questions, and interacts with research participants” (Glesne, 1999, p. 5). Most of the information that I gathered throughout the time I spent at my research site was based not only upon the work the students completed in class, but it was also largely based upon informal conversations that took place with the students and classroom teacher.

Qualitative Research Validity and Credibility

In this study, these procedures were followed to ensure validity and credibility. The data that were collected, can be considered and labeled as valid or believable based on the prolonged engagement that took place at the school building where data collection took place. For this study, research and data were collected for a total of six and a half weeks where three and a half weeks were spent observing the classroom environment to build rapport and trust amongst the research participants. Prolonged engagement is considered as a proper form of validity and credibility through the extensive time investment at the research site (Driessen, Vleuten, Schuwirth, Tartwijk, & Vermunt, 2005). In addition, the data collected had transferability since they can be found useful to educators to see how to accommodate to all students’ needs, specifically in the field of science education. Lastly, the data can be found to be credible because of the opinions and values of the research that were gathered through the use of a reflexive journal during the extensive amount of time spent at the research site. Reflexive
journals are found to be credible because of the extensive tasks of writing and reading the journal, reflecting on the information in the journal, and deciphering relationships between what is in the journal and the reflections made (Borg, 2001).

**Quantitative Research Validity and Reliability**

In addition, validity and reliability were also maintained in the quantitative component of the study. Reliability was used especially with the t-test of independent samples and was determined by the significance level that was used. The significance level was set at a value of 0.05 to determine if the treatment implemented in the study made an impact on the students. This value is often set at a 0.05 because it shows that there is very little chance, 5 out of 100, that there will not be significance as a result of the treatment (Trochim, 2006).

**Participants**

All of these participants were from a local elementary school in the Toledo area. The classroom teacher who participated in the study had ten years of teaching experience in addition to a significant amount of science education experiences. She also teaches two sections of third grade science. Therefore, the participants were from two different third grade classrooms in the same school building and were selected by the science department at the university in addition to a classroom teacher that was interested in differentiating instruction for her students in the field of science education. Even though this is not typical to switch classes as young third grade, it is proven to be affective according to the building report card from 2009-2010 which indicated that they met all eight state indicators in addition to meeting adequate yearly progress (Ohio Department of Education, 2010). Furthermore, this state report card implied that the science achievement for fifth graders improved from 82% in 2007, to 86.4% in 2009, and 91.7% in 2010 (Ohio Department of Education, 2010). Therefore, it is quite possible that the implementation of
switching classes for the subject area of science as early as third grade has had a positive impact on students. Table 1 displays the research participants that were a part of this study.

Table 1

*Research Participants*

<table>
<thead>
<tr>
<th>Classroom</th>
<th>Number of Students</th>
<th>Males</th>
<th>Females</th>
<th>Ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>24</td>
<td>13</td>
<td>11</td>
<td>10 Caucasian, 1 African American</td>
</tr>
<tr>
<td>B</td>
<td>25</td>
<td>13</td>
<td>12</td>
<td>All Caucasian</td>
</tr>
</tbody>
</table>

Since the students that were research participants in this study were under the age of 18, a parental consent form was required for each student to be a part of the study (Appendix B). In addition, a consent form was given to the classroom teacher and a signed letter of consent was provided by the principal of the school building to give permission that the study take place in the school building where the data were collected (Appendix B). Furthermore, before the research study was conducted and because of different reading abilities, all students were read aloud a student assent form and had to give verbal consent in order to participate in the study.

To better understand the impact of the 5E and 6E models two science units were taught, one on life cycles and one on forces and motion. To make sure that there was always a control; the first week one class was taught the life cycle unit using the 6E model and the other class the life cycle unit using the 5E model. For the following week, a forces and motion unit was taught and the 6E model was used with the class that did not receive it the previous week and the 5E
model for the class that did receive the 6E model the previous week. This was done primarily because this study can be viewed as two individual studies: one for life cycles and one for forces and motion. Furthermore, it was done to maximize resources and research subjects because the purpose of the study was to figure out if the 6E model was an effective way of teaching science. By switching the classes who received the 6E, the number of unique students was effectively maximized because each class had its own unique group of students. Both classes had six students on an Individualized Education Plan (IEP). However, classroom A had 2 students with physical disabilities whereas classroom B had most students with individual learning needs. Therefore, since each class had its own set of unique group of students the research subjects were effectively maximized. Furthermore, throughout my reflexive journal I noted that just because a student was strong in one unit, did not mean they were strong in the next. Therefore by doing different lessons, it helped determine if the 6E made an impact.

**Description and Context of the Life Science 5E and 6E**

The 5E life cycle unit was from a book entitled *More Picture-Perfect Science Lessons* by Ansberry & Morgan (2007). During the engage phase of this lesson students were asked a series of guided questions about life cycles and what this means. After this, for the phase of explore, students were given a small dish with a Mexican Jumping Bean on it. They were then given the opportunity to explore the Mexican Jumping Bean’s behavior with a magnifying glass. In addition, students wrote down in their journals what they observed wondered and learned after hearing other student’s observations. Next, for the explain phase, students read an article as a class about the Mexican Jumping Bean and its origination. Then for the extension phase students participated in an experiment where they saw how light and temperature affected a Mexican
Jumping Bean’s behavior. After this for the evaluation phase, students were given a hand written test on their knowledge of life cycles.

As for the 6E, students were grouped into tiers based upon their answers to an assessment probe that was administered after the explanation phase. The students that received the 5E still took this assessment probe to see if it would have made a difference had they received the 5E. However, the students that were placed in Tier I, Novice Learning Level, made a poster and re-read the article about the Mexican Jumping Bean. The poster was made to emphasis the life cycle of the Mexican Jumping Bean and to eliminate any misconceptions the students still had on this. For Tier II students, On-Target Learning Level, these students continued on life the 5E students and conducted the experiment to test how light and temperature affected a Mexican Jumping Bean. Then for Tier III students, Advanced Learning Level, they selected an experimental question to solve of their choice.

Description of the Forces and Motion 5E and 6E

The 5E forces and motion unit was also from the book *More Picture-Perfect Science Lessons* by Ansberry & Morgan (2007). This lesson started off students in the engage phase by using guided questioning to understand what their prior knowledge was on the concept of gravity. The students were then read a short story about roller coasters and how more force is required to push the roller coaster cart up the hill versus down the hill. Then, for the explore phase, students were put into small groups and they completed roller coaster design challenges. Each small group was given a piece of foam pipe insulation and was asked to complete a series of challenges where the students would have to bend the pipe insulation to complete the challenge. The goal was to complete the challenge by rolling a foosball down the track or foam
pipe insulation without it falling off, and eventually reaching the plastic cup taped at the end of the track.

Some of these challenges asked students to do one hill, two hills, and even a loop. Next, for the phase of explain, guided questioning was then used while the students presented how they were or were not able to complete each challenge. Then, for the elaborate phase, students conducted an experiment where they completed dropping races. The students worked in partners to discover whether dropping two objects from the same height at the same time would affect the order in which the objects fell. The students soon found out that despite an objects mass, all objects are pulled by the force of gravity at the same rate and therefore land at the same time. After this, a book was read to the students about gravity and dropping objects. The book allowed students to understand that although gravity does pull on objects at the same rate, some objects have air resistance and therefore do not land at the same time as other object. Then for the evaluate phase, students were given a hand written test that tested their knowledge on the concepts they had learned about forces and motion.

The 6E students were grouped into their respective tiers according to the assessment probe they were given after the explanation phase. The students that were placed in Tier I, Novice Learning Level, completed more roller coaster design challenges to clarify any misconceptions they had. In addition, they completed some dropping races in order to understand the concept of gravity pulling on all objects at the same rate except objects with air resistance such as a piece of paper or tissue. Tier II students, who were in the On-Target Learning Level, completed the dropping races experiment as explained in the 5E. Tier III students, who were in the Advanced Learning Level, selected an experimental question to solve about the concept of gravity.
**Qualitative Instrumentation**

**Interview rationale.**

Interviews are often used as a qualitative instrument to gather perceptions and attitudes of the research participants in addition to learning about what was not able to be seen while conducting the research (Glesne, 1999). Interviews were conducted with both students and the classroom teacher that was a part of the study. More specifically, three students were interviewed from each type of instruction, the 5E and the 6E for both units on life cycles and forces and motion, with one student being interviewed from each Tier I, Tier II, and Tier III. Therefore, a total of 12 interviews were conducted for the study, 6 all together for each unit. Even though students in the 5E were not separated into the three tiers of instruction, they were still interviewed based on the tier they would have been placed in to decipher whether or not it made a difference if they were in the 5E versus the 6E and if it affected their amount of engagement, attitudes, or feelings about the type of instruction they received.

Again, this action research study can be viewed as two individual studies: one for the life cycle unit and one for the forces and motion unit. During each unit, there was a class that received the 5E and one that received the 6E. In essence, they both received the 6E, but for different units. These interviews were conducted to understand and interpret the experience of the students as they participated in an educational phenomenon and what they thought of it. Interviews are found to be useful to researchers because, “at the root of in-depth interviewing is an interest in understanding the experience of other people and the meaning they make of that experience” (Seidman, 2005, p. 3). Therefore, by conducting these interviews it was helpful in determining the true experiences of both the students and the classroom teacher based on the phenomenon of the newly proposed 6E model of instruction.
**Design of interviews.**

The first set of interviews that were conducted with the students were composed of questions to the students about their feelings on the science activities they participated in and how engaged they felt they were in the lessons to decipher whether or not the science activities made them want to participate. Furthermore, these student interviews were asked to both the students who received the 5E and the 6E for that particular unit and vice versa when they received the different type of instruction the following week. Overall, the goal of the student interviews was to figure out how students felt from varied abilities. See Appendix C for interview questions that were asked to the students and the classroom teacher. In addition to the student interviews, an interview was conducted with the classroom teacher that was a part of this study. This interview was composed of six questions that asked the classroom teacher about the lessons she observed on the topics of the life cycle of a Mexican Jumping Bean and forces and motion. More specifically, the interview questions were asking how effective she felt the 6E model was in addition to how engaged she felt students were while the lessons were being taught.

Most importantly, these questions aimed to see the major challenges she felt were involved with the newly proposed 6E model in addition to benefits she felt it provided. Finally, since I wanted an external opinion, I asked the interview questions that were generated to gain multiple perspectives about the phenomena that were studied in this action research project. This is one of the validating reasons for doing action research and is considered valid through the use of triangulation where more than two sources look at the phenomena and in this case would be me as the teacher, the students from the interviews they participated in, as well as the interview conducted with the classroom teacher (Saul & Launius, 2010).
Administering the interviews.

Both sets of interviews were administered in a particular way to ensure validity. Due to requests from the building principal and parents, the interviews were not able to be digitally recorded. However, when conducting the interviews both the students and classroom teacher were asked to speak slowly so that their answers could be written down verbatim to what they were saying. As stated earlier, 12 students were interviewed total consisting of one that was interviewed from each of the three tiers or levels of understanding for both the 5E and 6E for both units. Therefore, six students were interviewed for both the life cycle and forces and motion unit where one student was interviewed in Tier I (Novice Learning Level), one in Tier II (On-Target Learning Level), and one in Tier III (Advanced Learning Level) which totals to 12 interviews since it was done for the 5E and 6E students for both units. To clarify, these tiers or levels of understanding were determined based upon the student answers to an assessment probe that was administered. See Appendix D for the assessment probe that was used for the life cycle unit. The forces and motion assessment probe was not included due to copyright issues, however, it is briefly explained later in this chapter.

Since two of the primary research questions within this study were understanding differences in science knowledge among the different levels of students taught using the 5E and 6E model, and interpreting what students’ perceptions and attitudes were about differentiated instruction, asking students from all three tiers was extremely important. Of the 50 students involved in this research study, only 12 were chosen to interview. These students were chosen by using a random internet generator that selected a student name from the excel chart on a computer. To protect the privacy of all of the students, the computer files were kept locked with a password. In the end, three students were interviewed from each class after each unit. Three
were interviewed that received the 5E instructional model for that week and three were interviewed that received the 6E instructional model for that week, all of which were from each learning level. More specifically, one student from Tier I, one student from Tier II, and one student from Tier III were interviewed in each class to arrive at conclusions from students at multiple levels. As stated earlier, only one classroom teacher was interviewed and this interview was conducted after school on the last day of the research study so that she had the ability to answer all of the questions based upon everything that she had observed while the research study was being conducted. Interviews provided useful data to the study because of the in-depth format that was used to conduct these interviews. Siedman (1998) describes this by writing, “the interview allowed me to get closer to understanding this student teacher’s experience than I would have been able to do by other methods such as questionnaires or observation” (p. 19). Therefore based upon the rapport that was built from the extensive amount of time that was spent with the research participants, it allowed the participants to feel comfortable enough to provide in-depth answers. Furthermore, since this was not a questionnaire or mere observation, it was more useful since the opportunity was given to re-ask questions or re-word it in a way that they could understand.

**Analyzing interviews.**

The interviews were analyzed based upon the attitudes and perceptions of the students and teachers on differentiated instruction which relates directly to the research questions. A table is displayed in Appendix E that correlates each research question with each interview question. More specifically, it separates each interview question into the perceptions of the students and classroom teacher as well as the attitudes of the students and classroom teacher.
The interviews were also coded according to the themes that arose from the answers the research participants provided.

**Quantitative Instrumentation**

In addition to the interviews, pre and post assessments were used. The pre and post assessments were used as a tool so that it could be discussed whether or not students improved from their pre to post test score if they received the 5E model versus the 6E model. More specifically, they were used as a research instrument to determine if the 6E model truly adapted to every student’s needs as it intends to. To make these determinations, a statistical analysis was conducted through the use of a t-test of independent samples to examine the gains a student made from pre to post as a result of the model of instruction they received.

**Design of pre and post assessments.**

The overall goal of the pre and post assessment was to obtain results that indicated a variety of ability levels. Based on this, it could be determined whether students still needed to cover the topics that were tested, in addition to fulfilling the goals of this research which can be summed up as finding an instructional model in the field of science education that fits the needs of all learners. Furthermore, it is important to know that the pre and post assessment were the exact same questions so that it could be determined whether or not students improved more if they received the 5E model of instruction versus that of the 6E model of instruction. The same pre and post assessment questions were used so that the control group for each unit would be treated the exact same and so a direct statistical comparison could be made from the pre to post assessments for both units.

In addition, for the first pre assessment on the topic of the life cycle of a Mexican Jumping Bean, there were four multiple choice questions on basic vocabulary and facts about the
Mexican Jumping Bean. There were additional questions on the changes the Mexican Jumping Beans go through during the life cycle and two short answer questions that asked students to describe some things that might make the larvae inside jump or move around. These questions covered content that was going to be discussed later in the lesson through the form of an experiment. The last short answer question, asked students to describe in great detail the life cycle stages in order from first to last of the Mexican Jumping Bean. The same test was given to the students after the unit took place to decide whether or not the students who received the 6E performed better than the students who received the 5E model of instruction and so that a statistical analysis could be made comparing the scores from the 5E versus the 6E. In retrospect, a t-test of independent samples was conducted for each unit that tested the significance of both models at a 0.05 level where below a 0.05 would indicate that there was significance. Furthermore, the mean difference between the pre and post test score was examined to see which model of instruction had more of a gain in scores.

In addition, pre and post assessments were designed for the unit on forces and motion. Similarly, this pre and post assessment contained both multiple choice questions and a short answer question to obtain the mix of ability levels within the students. There were six multiple choice questions that asked students basic facts about gravity, the mass of objects, and how the mass of an object affects the rate at which it falls. In addition, there was one short answer question that provided the students with a scenario they could relate to their real lives and asked them to describe what would happen if they dropped a piece of paper and a shoe at the same time from the same height. Furthermore, it asked students to explain which object would hit the ground first and why. The goal was to get students to understand that although gravity pulls on all objects at the same rate, objects such as a piece of paper or a tissue will hit later because of
the air fighting against the gravity. All of these questions except the short answer question for the forces and motion pre and post assessment were designed around lessons that were created by Ansberry & Morgan (2007).

The pre and post assessment for the life cycle unit was written entirely by me. All of the questions came from what the students would be learning throughout the unit. In contrast, for the forces and motion unit, all of the multiple choice questions came from a lesson developed by Ansberry & Morgan (2007), however, the short answer question was written by me. To ensure validity, all pre and post assessments were reviewed by two scientists at Bowling Green State University for review.

**Administering the pre and post assessments.**

Both the pre assessment for the life cycle unit and for the forces and motion unit were given to students one week prior to receiving the instruction for the unit. This was done so that students did not memorize the questions and so that there was enough time to decide exactly how much knowledge the students already had on the topics that were taught to them. It is important to always pre-assess students before the lesson takes place and to use the same questions to make comparisons between the pre and post assessments. This is important so teachers can visualize the end results of the unit and use a backward design to obtain clarity on what students are going to learn and how it will be assessed, and this ultimately leaves little room for shock in the students when they are taking the post assessment (Armstrong & Haskins, 2010). The post assessments, were given on the last day of the unit. To accommodate the students’ IEP needs, questions were read aloud as well as the answer options for the multiple choice questions, and directions to each question, so that students understood what the question was asking them. It is important to note that no hints were given to students and this was done to strictly follow the IEP
of each student that had one in the classroom. Even if the students did not have an IEP, it was important that they each understood what each question was asking them to eliminate the issue of the students not reading the question or interpreting the question wrong. Furthermore, it was done so that the students answered the questions to the best of their ability so that it could be decided if the students had prior knowledge on the topic that was going to be taught.

Pre and post assessment analysis.

A t-test of independent samples was conducted for both the life cycle and forces and motion unit. First, the difference between the pre and post test score had to be calculated for the students to see if they made a gain from the pre to post test score as a result of the instruction they received. Then, a statistical computer program was used to conduct the t-test of independent samples using each student’s gained score. The goal was to determine whether or not the 5E or 6E caused students to have higher gains from the pre to post test score. The purpose of a t-test of independent samples is to make a comparison of the average scores of two different groups on a given variable (Archambault, 2000). For this specific t-test of independent samples that was conducted for this study, the variable was the type of instruction the students received and the comparison was based on the average gained score from the pre to post assessment.

In order to analyze the pre and post assessments for both units, a point value was given to each question. For each multiple choice question, one point was given to the student if they got it correct and four points were given to the students if they answered each extended response question correctly in addition to if they answered all parts of the question. For example, if a student answered all components of the question in addition to providing enough detail for why he or she answered the question the way he or she did, then that student would receive full credit.
However, if students answered the question correctly but did not provide an explanation as to why they chose that answer, then they would lose a point or two depending on the amount of detail they wrote down. Extended response questions were also graded in accordance to what was taught in the unit. For example, in the extended response question for the forces and motion unit, students were asked to describe what would happen if a piece of paper and a shoe were dropped at the same time from the same height. More specifically, which object would hit the ground first? In the unit, students were read a book and conducted a hands-on activity where they dropped a series of objects at the same time from the same height to discover that all objects hit the ground at the same time despite their mass. The goal was for students to explain air resistance and why some objects may not hit at the same time.

For validity and reliability, a rubric was created to evaluate students equally. This rubric was used for both units on life cycles and forces and motion. The rubric describes the point values to each question and what the general analysis was for each short answer question that was asked. The rubric also breaks down each assessment by question and provides information on what a student had to put to receive full credit. Since all multiple choice questions had only one correct answer, each student was given either 1 point or 0 points. As for the short answer questions the rubric was used to differentiate point values amongst the students and why they might have received a specific point value. Keep in mind that the point values varied for the short answer questions depending on whether the students were learning about life cycles or forces and motion. This rubric can be found in Appendix F.

**Assessment probe rationale.**

In addition to interviews and pre and post assessments, an assessment probe was administered after the explain phase for both the 5E and the 6E instructional model. The goal for
the 6E model was to use this assessment probe to make a thoughtful instructional decision to place students into three separate tiers (i.e.: Novice, On-Target, and Advanced) before moving onto the elaborate phase and to correct any misconceptions the students had at that point in the learning cycle. Although the students who received the 5E model were not separated into these groups in the elaborate phase, they still took the assessment probe to see whether or not it may have made a difference if they received the 6E model of instruction and to get a range of student views in the interviews that were conducted. The assessment probes for both the life cycle and forces and motion unit were given to students to decipher what misconceptions, if any, the students still had on the topic they were learning. The assessment probes were then graded to decipher what tier the students would be placed in. Furthermore, for the students who received the 6E model, students were separated into their respective tiers in hopes of having a higher number of gains from their pre to post test score in comparison to the students who received the 5E model and did not get grouped into tiers for the elaboration phase.

**Design of the assessment probe.**

The life cycle assessment probe was designed to incorporate the components of the unit that was taught at that point. The students were given a scenario that had three children describing what they felt would be the perfect habitat for a Mexican Jumping Bean. Upon reading all of these, the students were to choose which habitat would best fulfill the needs of the Mexican Jumping Bean and so that it would remain active or jumping. Also, the students had to explain that if the Mexican Jumping Bean survived in the habitat they chose, they then had to explain what life cycle stages the Mexican Jumping Bean would go through. This was done so students could be evaluated on both the life cycle stages of a Mexican Jumping Bean and certain things that would cause the Mexican Jumping Bean to move or stay active, all of which were
included in the unit that was taught. For the forces and motion unit, an assessment probe was administered where the students had to explain how gravity affected the fall of an object and which object would hit the ground first. Students were provided with three different balls that each had a different mass and the goal was for students to explain that they all would hit the ground at the same time despite their weight because gravity pulls on objects at the same rate.

**Administering the assessment probe.**

To clarify, an assessment probe was administered to students for both units on the life cycle of a Mexican Jumping Bean and forces and motion. Each assessment probe was administered after the explain phase and fulfilled the purposes of the express phase in the 6E model of instruction in order to separate students into the three separate tiers of Novice, On-Target, and Advanced Learning Levels. The results of the assessment probes were then interpreted to decipher which tier each student would be placed in. It is also important to know that the assessment probes were given in a similar format to the pre and post assessments where the students were asked to take it in complete silence and to look at their own paper to eliminate the students from copying one another. Furthermore, the assessment probes were administered the day before the elaborate phase was taught.

**Assessment probe analysis.**

The assessment probe fulfilled the phase of express after the explanation phase in the 6E model of instruction to identify any misconceptions the students had on the topic they were learning and the ultimate goal was to correct those misconceptions before getting to the evaluation phase. For the life cycle assessment probe, students again were given a choice of three habitats to choose from that would best fit the needs of a Mexican Jumping Bean and the students were asked to describe the life cycle of the Mexican Jumping Bean. Students were
placed in Tier I, Novice Learning Level, primarily if they chose Susie’s habitat which was a habitat that was dark and would not allow the Mexican Jumping Bean to be active or jumping. Students were also placed in Tier I if they just selected a habitat but did not provide an explanation. Also, students were placed in this tier if their explanation did not match the habitat they chose. Furthermore, most students in this tier did not write down the life cycle or their steps were not easily understood. Tier II students, On-Target Learning Level, were placed in this tier mainly if they chose Bobby’s habitat. Although this habitat would allow the Mexican Jumping Bean to be active, since it is near the sun it might harm the Mexican Jumping Bean. Although most students in this tier provided several stages of the life cycle, some were reversed and were not in the correct order. Finally, students were placed in Tier III, Advanced Learning Level, mainly if they chose Freddy’s habitat which was the best of both worlds and allowed the Mexican Jumping Bean to stay active without becoming too warm in temperature. Furthermore, students in this tier typically were quite detailed in their life cycle explanation and put the stages in the correct order.

As for the forces and motion assessment probe, again students were given a scenario where three balls with three different masses that were dropped from the same height at the same time and they had to predict the order in which they would fall. Students were placed in tiers primarily according to the explanation they provided and its strength. Students were placed in Tier I if their explanation did not match the prediction they made or if they did not attempt to answer the question. Students were placed in Tier II if they provided 1 to 2 quality reasons as to why they chose the prediction they selected. Finally, students were placed in Tier III if they predicted that they would all land at the same time and provided 2 to 3 quality reasons as to the
reasoning for this. The main reason was that despite an object’s mass, gravity pulls on objects at the same rate and therefore they would all land at the same time.

To clarify, not all students who chose Susie, Bobby, or Freddy were grouped in the respective tiers as described above. Primarily, it depended on what the student wrote as his or her explanation to choose which tier would be best for that student. For instance, if a student put Bobby, but was able to explain that it may get too hot underneath the sun for the Mexican Jumping Bean to survive that student might be placed in Tier III since he or she would have been able to provide a valid argument for reasons the habitat would not work. In contrast, if a student put Freddy, but was not able to provide a valid argument for why the habitat would work that student might be placed in Tier I or Tier II depending on the strength of the argument that he or she provided. As for the forces and motion assessment probe, most elementary students will reason that the heaviest ball or object would hit the ground first (Keeley, Eberle, and Dorsey, 2008). Therefore, these students were mainly placed in Tier II. However, if a student again was not able to provide a valid argument or just simply put the heaviest one, that student would be placed in Tier I since an explanation was not given. Furthermore, a student was placed in Tier III if he or she was able to reason that gravity pulls on all objects at the same rate and therefore all three balls would hit at the same time. Since this was found to be out of the ordinary for an elementary student, the students who were able to provide a reason such as this were placed in Tier III (Keeley et al., 2008). Overall, the goal for the assessment probes was to catch any misconceptions the student’s had at that point in the learning cycle. Lastly, it is important to note that just because a student was in Tier I for the life cycle unit did not mean they were in Tier I for the forces and motion unit. Therefore, it is possible that students change tiers depending on the topics that they are learning.
Summary

Overall, a mixed methods approach was used to collect and analyze the data for this study because quantitative methods were used in order to grade student assessments and qualitative methods were used to interview both the students and the classroom teacher. The research participants were mainly of Caucasian descent and were from a local elementary school in the Toledo area. There were a total of 49 students that were a part of the study in addition to one classroom teacher. Furthermore, all students were at the third grade level. Also, the data that were collected are considered credible since a method of prolonged engagement was used to build quality rapport with the students and classroom teacher that were the research participants in the study. In addition, a reflexive journal was used to share opinions and values of the research. Furthermore, the data that were collected are considered truthful since it can be found useful to the entire educator population to fit the needs of all learners.
CHAPTER IV: RESULTS

Purpose of Study and Research Questions

The purpose of this study was to test the effectiveness of the 6E model of instruction in comparison with the 5E model of instruction. More specifically, the study was designed to test the impact of tiered instruction as a means to address the needs of all learners. First, an express phase was added after the explanation phase in the learning cycle to identify any misconceptions the students had on the topic they were learning. Then, students were grouped according to their levels of cognitive ability so that each and every individual student was challenged at their level to ultimately perform better on the post assessment that was given at the end of the learning cycle. The essential research questions for this particular study were:

1. Is there a difference in science knowledge between students taught using the 6E model and those taught using the 5E model?
2. Are there differences in science knowledge among the different levels of students taught using the 5E and 6E model?
3. What are the students’ perceptions and attitudes about differentiated instruction?
4. What are the teacher’s perceptions and attitudes about differentiated instruction?

Findings by Method and Research Question

For clarity, the findings and results from this study were organized by the qualitative and quantitative measures that were used in addition to how they relate to each research question. Since this study can be viewed as two individual studies, the first classroom or control group, classroom A, received the 5E learning model for the life cycle unit on Mexican Jumping Beans and the second classroom, classroom B, received the 6E learning model of who were the experimental group. For the second unit, classroom A was the experimental group and received
the 6E model for the unit on forces and motion and classroom B was the control group and received the 5E model. Again, these were switched to maximize resources and because both classrooms had a different makeup. For example, classroom A had 6 students on an IEP, 2 of which had a disability that required a classroom aide. Although classroom B had 6 students on an IEP as well, none of those students had a physical disability. Furthermore the classes differed as a result of classroom B having one more student than classroom A.

Research Question One: Is there a difference in science knowledge between students taught using the 6E model and those taught using the 5E model?

Quantitative results.

The results for the first research question were based on the scores of the students on the pre and post assessment for each unit. The scores were analyzed and averaged to measure the impact of the 6E model on increased science knowledge versus that of the students who received the 5E model of instruction. In addition, a statistical analysis was done through the use of a t-test of independent samples to see the gains students made from their pre to post assessments for both units. Table 2 displays the difference from the pre to post assessment. More specifically, it shows the number of students in each classroom who received full credit on each question for the life cycle unit. As seen in Table 2, classroom B who received the 6E model had more students who received full credit for each question on the post test, and in addition to this that they had higher gains as result of the 6E model of instruction. The students in classroom A did have gains in their test scores however these gains were not as high as the students in classroom B who received the 6E model. Table 3 displays the results of the same gains for the forces and motion unit. In contrast to the life cycle unit, the students in classroom A who received the 6E model for this unit had more students who received full credit on three questions, however, there were three
questions where the students in classroom B had a lower amount of students receive full credit from the pre to post assessment in addition to one question where students from classroom A and B had an equal amount of students receive full credit. However, from a statistical point of view and looking at individual pre to post test score gains in a t-test of independent samples, there was a mean average of higher gains from students who received the 6E model versus the 5E model. This t-test can be found in Table 4. Next, Figures 1 and 2 display the average test scores from pre to post for both the life cycle and forces and motion unit of which a higher average was found for students who received the 6E model of instruction. Lastly, Tables 4 and 5 display the t-test of independent samples that show the difference in student gains as a result of the type of instruction that they received.

Table 2

*Full Credit Given to Students for Life Cycle Test*

<table>
<thead>
<tr>
<th>Question</th>
<th>Classroom A 5E (n=24)</th>
<th>Classroom B 6E (n=25)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>1</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>22</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>12</td>
</tr>
</tbody>
</table>
Table 1 displays the number of students in each class that received full credit for each question for the pre versus post assessment. It is important to note that classroom A that received the 5E model, had 24 students and classroom B who received the 6E model had 25 students. It is clear from this table that the students in classroom B had more students who received full credit for each question on the post assessment which indicates that they gained more knowledge. In particular classroom B had 3 more students receive full credit for question 1, 7 more students for question 2, 3 more students for questions 3 and 4, 7 more students for question 5, and 5 more students for question 6. To clarify, questions 1 through 4 were all multiple choice questions and asked students about Mexican Jumping Beans and the changes they go through during their life cycle. Questions 5 and 6 were extended response questions and asked students to write two things that would cause a Mexican Jumping Bean to be active or jumping and to describe the life cycle of a Mexican Jumping Bean. Lastly, it is important to note that both classrooms regardless of the type of instruction they received performed higher on the pre test rather than the post test.

Table 3 documents that both groups of students regardless of the type of instruction they received, performed higher on the post assessment versus the pre assessment. This table displays similar results like Table 2 and shows that overall classroom B who received the 6E model, had more students who were awarded full credit for 3 out of the 7 questions. Specifically, classroom B had more students receive full credit on questions 2, 4, and 5 of that were all multiple choice questions. Question 2 asked students which object would hit the ground the hardest and their options were a paper clip, a bowling ball, or both would hit just as hard. Question 4 provided students with a picture where two objects were being held by a rubber band. The students had to look at the picture and circle which object was heavier or if they were equally heavy. Then for
question 5, it asked what gravity means and the options were pulling things, pushing things, and lifting things.

Table 3

*Full Credit Given to Students for Forces and Motion Test*

<table>
<thead>
<tr>
<th>Question</th>
<th>Classroom A 6E (n=24)</th>
<th>Classroom B 5E (n=25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pre: 9 Post: 20</td>
<td>Pre: 3 Post: 18</td>
</tr>
<tr>
<td>2</td>
<td>Pre: 23 Post: 24</td>
<td>Pre: 25 Post: 25</td>
</tr>
<tr>
<td>3</td>
<td>Pre: 17 Post: 24</td>
<td>Pre: 21 Post: 24</td>
</tr>
<tr>
<td>4</td>
<td>Pre: 20 Post: 20</td>
<td>Pre: 23 Post: 25</td>
</tr>
<tr>
<td>5</td>
<td>Pre: 8 Post: 20</td>
<td>Pre: 10 Post: 23</td>
</tr>
<tr>
<td>6</td>
<td>Pre: 11 Post: 24</td>
<td>Pre: 18 Post: 23</td>
</tr>
<tr>
<td>7</td>
<td>Pre: 0 Post: 12</td>
<td>Pre: 0 Post: 7</td>
</tr>
</tbody>
</table>

In contrast to the life cycle unit, classroom A of whom received the 5E model of instruction had more students receive full credit on questions 1, 6, and 7. Question 1 provided students with a picture of a paper clip and a bowling ball and asked students which object would hit the ground first or if they would land at the same time. The goal for this question was to get students to understand that gravity pulls on all objects at the same rate except those with air resistance. Question 6 provided students with a picture of a roller coaster and they had to circle at what point on the roller coaster they would be going the fastest. Question 7 was an extended response question and asked students if a piece of paper and a shoe were dropped at the same
time from the same height, which object would hit the ground first? The goal for this question was for them to again understand air resistance and that the shoe would hit first as a result of this. Lastly, it is important to note that for question 3 both groups had an equal amount of students who received full credit which asked students to identify what force causes an object to fall, which was gravity.

Figure 1

_Difference between Pre and Post Assessment for Life Cycle Unit_

This graph displays the difference between the pre and post assessment scores for the life cycle unit. In particular, it displays the average pre and post assessment scores for both classroom A and classroom B. To clarify, the average pre test score for classroom A that received the 5E model was 17.5% whereas the average post test score for classroom B who received the 6E model was 18%. This displays that they had approximately the same amount of prior knowledge. Furthermore, the average post test score for classroom A was 76.7% and for classroom B was 91.2%. Therefore, the students in classroom B who received the 6E model performed higher overall with the average post test score of a 91.2%.
This graph shows the same results as the graph shown in Figure 1, however, it displays the
difference in science knowledge based upon the model of instruction given from pre to post test
scores for the forces and motion unit. More specifically, this graph displays that classroom A
who received the 6E model for this unit had an average pre test score of 57.9% whereas
classroom B who received the 5E model had an average pre test score of 63.2%. Furthermore,
classroom A had an average post test score of 89.2% whereas classroom B had an average post
test score of 86.4%. Therefore, even though classroom A had a lower average pre test score they
still surpassed classroom B that started with a higher average pre test score of 63.2%.

Table 4

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Change</th>
<th>T-score</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom A 5E</td>
<td>59.1667</td>
<td>-2.273</td>
<td>.028</td>
</tr>
<tr>
<td>(n=24)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom B 6E</td>
<td>73.2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n=25)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This table displays a t-test of independent samples for the life cycle unit of which was conducted to discover whether the students that received the 5E, classroom A, or the students who received the 6E, classroom B, had more gains from the pre to post test score. In addition, this table displays that classroom A had a mean change from their pre to post test scores of a 59.2% and classroom B had a mean change of 73.2%. Therefore, students in classroom B who received the 6E model had more gains from their pre to post test score versus the students in classroom A that received the 5E model. Even though classroom A did not have as many gains from the pre to post assessment, there were still a lot of gains made as can be seen by the mean change of 59.2%. In addition to this, there was a significance level of .028 and a t score of negative 2.273.

To clarify, the t score stands for the statistical difference between the groups (Barron’s Educational Series Inc., 2005). In addition, if the t-value is less than negative 2 or higher than positive 2 it indicates a greater confidence in the coefficients as a predictor (Barron’s Educational Series Inc., 2005). Therefore, since the t-value with this test was less than negative 2 it shows a high level of confidence. Furthermore, the confidence level in this t-test indicates that if a gained score was pulled randomly from a student who received the 5E and 6E, it would be a safe assumption that the student who received the 6E had a higher gained score. Also, the significance level of .028 indicates that there was significance as a result of the instruction that was implemented since this was tested at the .05 level. For clarification, if the significance level is found to be lower than the level it was tested at this determines that there was significance as a result of the treatment that was implemented.
Table 5

*T-test of Independent Samples for the Forces and Motion Unit*

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Change</th>
<th>T score</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom A 6E</td>
<td>31.2500</td>
<td>2.186</td>
<td>.034</td>
</tr>
<tr>
<td>(n=24)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom B 5E</td>
<td>23.2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n=25)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This table displays that classroom A who had the 6E model had a higher percentage of gains at 31.3% whereas classroom B who had the 5E model had an average gain over 23.2%. The t-score of 2.186 indicated that there was a greater confidence in the coefficients as a predictor since it is above a positive 2. Therefore, the same assumption could be made for this unit as the life cycle unit. More specifically, if a random sample of one student was taken from each class, it would be likely that the student who received the 6E model would have a higher gained score from the pre to post assessment.

**Research Question 2: Are there differences in science knowledge among the different levels of students taught using the 5E and 6E model?**

**Quantitative results.**

The results were determined by the increase in scores from pre to post assessment for both units for each tier in relation to the 6E model of instruction. Again, even though the students who received the 5E model of instruction did not get grouped into their tiers for the elaboration phase of the learning cycle, they still were administered the assessment probe to tier them to see if it may have made a difference had they received the 6E model of instruction.
Tables 6 and 7 display each tier of students and what gains they made from the pre to post test based on the type of instruction they received. More specifically, these tables show the average test score of students in each tier on the pre and post assessment. Keep in mind questions 1 through 4 were all multiple choice that asked students about Mexican Jumping Beans as well as certain changes they go through. In addition to this, questions 5 and 6 were extended response questions and they asked students to list two things that make Mexican Jumping Beans active and moving. In addition, they were asked to describe the life cycle stages in order and in detail for the Mexican Jumping Bean.

Table 6

*Effects of Tiers in Life Cycle Unit*

<table>
<thead>
<tr>
<th>Classroom</th>
<th>Classroom</th>
<th>Classroom</th>
<th>Classroom</th>
<th>Classroom</th>
<th>Classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier I (n=7)</td>
<td>Tier I (n=4)</td>
<td>Tier II (n=13)</td>
<td>Tier II (n=14)</td>
<td>Tier III (n=4)</td>
<td>Tier III (n=7)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pre</th>
<th>Post</th>
<th>Pre</th>
<th>Post</th>
<th>Pre</th>
<th>Post</th>
<th>Pre</th>
<th>Post</th>
<th>Pre</th>
<th>Post</th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>14%</td>
<td>79%</td>
<td>15%</td>
<td>95%</td>
<td>20%</td>
<td>75%</td>
<td>16%</td>
<td>91%</td>
<td>15%</td>
<td>90%</td>
<td>24%</td>
<td>94%</td>
</tr>
</tbody>
</table>

As displayed in Table 6, the students regardless of tier or type of instruction improved from the pre to post test. Keep in mind, that questions 1 through 4 were multiple choice and were 1 point each and questions 5 and 6 were extended response questions and were 3 points each.
Also note that the students in classroom A that received the 5E model did not separate into these tiers, but were assigned a learning level or tier after they took the assessment probe to see if it would have made a difference had they received the 6E model of instruction.

Since classroom B received the 6E model, they actually were separated into these tiers. For Tier I students, the Novice Learning Level, they re-read an article about Mexican Jumping beans and made a poster about the life cycle. This was done to reinforce the concepts they still had misconceptions on. In addition to this, Tier II students, the On-Target Learning Level, proceeded with the lesson as normal and did an extension activity where they conducted an experiment to test how light and temperature affect a Mexican Jumping Bean. Finally, for Tier III students who were the Advanced Learning Level received a series of experimental questions to solve about Mexican Jumping Beans and as a group they selected one experimental question to solve. The question they chose to solve was how light affected a Mexican Jumping Bean. Overall, one can see in the table above that the students who were grouped into their respective tiers, classroom B, made higher gains as a result of receiving the tiered instruction.

More specifically the students in Tier I and in classroom B, had an average pre test score of 15% and an average post test score of 95% whereas the students that would have been grouped in Tier I that were in classroom A had an average pre test score of 14% and an average post test score of 79%. Therefore, the Tier I students in classroom B showed a more significant gain than the students that would have been in Tier I in classroom A. As for Tier II, the students in classroom B had an average pre test score of 16% and an average post test score of 91% whereas the students in classroom A had an average pre test score of 20% and an average post test score of 75%. Therefore, Tier II students in classroom B benefitted from their respective tier. Lastly for Tier III, the students in classroom B had an average pre test score of 24% and an
average post test score of 94% whereas the students in classroom A had an average pre test score of 15% and an average post test score of 90%. Overall, it was found that all students in classroom B who received the 6E model benefitted greatly from the tiers and learning levels they were placed into.

As a result, tiered instruction was found to be successful and based upon these averages it displays the strength of the 6E model and how to take an already highly effective model and make it even better so it fits all students and their individual learning needs. In essence, it was found that by grouping students into their respective tiers, they ultimately benefitted from it and made higher gains from the pre to post assessment.

Table 7

<table>
<thead>
<tr>
<th>Classroom</th>
<th>Classroom</th>
<th>Classroom</th>
<th>Classroom</th>
<th>Classroom</th>
<th>Classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 6E</td>
<td>B 5E</td>
<td>A 6E</td>
<td>B 5E</td>
<td>A 6E</td>
<td>B 5E</td>
</tr>
<tr>
<td>(n=24)</td>
<td>(n=25)</td>
<td>(n=24)</td>
<td>(n=25)</td>
<td>(n=24)</td>
<td>(n=25)</td>
</tr>
<tr>
<td>Tier I</td>
<td>Tier I</td>
<td>Tier II</td>
<td>Tier II</td>
<td>Tier III</td>
<td>Tier III</td>
</tr>
<tr>
<td>(n=5)</td>
<td>(n=10)</td>
<td>(n=15)</td>
<td>(n=9)</td>
<td>(n=4)</td>
<td>(n=6)</td>
</tr>
<tr>
<td>Pre Test</td>
<td>Pre Test</td>
<td>Pre Test</td>
<td>Pre Test</td>
<td>Pre Test</td>
<td>Pre Test</td>
</tr>
<tr>
<td>Score</td>
<td>Score</td>
<td>Score</td>
<td>Score</td>
<td>Score</td>
<td>Score</td>
</tr>
<tr>
<td>48%</td>
<td>61%</td>
<td>59%</td>
<td>62%</td>
<td>68%</td>
<td>98%</td>
</tr>
<tr>
<td>88%</td>
<td>83%</td>
<td>87%</td>
<td>84%</td>
<td>68%</td>
<td>68%</td>
</tr>
</tbody>
</table>

Table 7 displays the difference in the average of test scores for the different tiers of students to see whether or not the 6E model of instruction for the forces and motion unit in comparison to the 5E model of instruction. Although this graph does not display as significant
of a gap between pre and post test results, there still was more of an increase in scores for the students who received the 6E versus the 5E model. For instance, the students in classroom A that were in Tier I improved by 40% from pre to post test scores whereas the students in classroom B improved by 23%. As for Tier II students, the students in classroom A improved by 28% and the students in classroom B improved by 22%. Finally, for Tier III students, the students in classroom A improved by 30% and the students in classroom B improved by 24%. Even though the percentages were close, the students in classroom A still improved slightly more and it may have made a difference had the students been grouped into those tiers during the elaboration phase.

The students in Tier I, Novice Learning Level, completed roller coaster design challenges again to clarify the misconceptions they had on the concept of gravity. After this, they completed dropping races where they dropped two objects from the same height at the same time and learned that even though the mass of the objects may be different, they still land at the same time. Tier II students, On-Target Learning Level, completed the elaboration phase as planned and conducted the dropping races activity. Lastly for Tier III, Advance Learning Level, the students selected an experimental question to solve the answer to based on the concept of gravity. Specifically, this group in classroom A that received the 6E model, chose to find which surface in the classroom a ball would roll the fastest. Since the students in classroom B received the 5E model, they did not get grouped into these tiers. However, as seen in the table above they may have benefitted from their assigned tiers.
Research Question 3: What are the students’ perceptions and attitudes about differentiated instruction?

Qualitative results and interviews.

Interviews were conducted with different students from both classroom A and classroom B. There were three students from each tier that were interviewed which totaled to be six interviews for each unit that was taught, for a total of 12 interviews were conducted. Briefly, the classroom context that I was in was vibrant with color and resources. For classroom A, there were 24 students all of which were Caucasian except one who was African American. This class also had 13 boys and 11 girls as well as 6 students who were on an IEP. In addition, there were two students with physical disabilities who also had a full time aide in the classroom. Classroom B was quite similar in that all of the students were Caucasian and had 13 boys and 12 girls. This class also had 6 students on an IEP. However, none of them had a physical disability. Since this particular school had students rotate classes in third grade for the areas of social studies and science I worked with two classes, but with one science teacher. Therefore, the lessons were taught in the same classroom.

In my reflective log I noted that the classroom was set up where the desks were positioned in rows with students facing one another which resulted in the students’ frequent collaboration (March 7, 2011). However, it was sometimes difficult for students to pay attention since they had to turn to face the board. This is something I considered when teaching my lessons where I had the students come to the carpet so they could face me and see me. During one lesson that I observed, the classroom teacher that I worked with had students do an activity entitled three corners. The students were asked a series of questions on measurement and had to go to the corner of what they thought the answer was to the question they were asked. In my
reflective log, I noted that this activity related to the assessment probes in the 6E model because it helps a teacher check for understanding or misconceptions (March 9, 2011).

When conducting the interviews, the students were selected by a random internet generator. Students were asked a series of questions on their perceptions and attitudes about the type of instruction they received. One theme that arose from the 5E interviews that were conducted on the life cycle unit was that the students did not feel engaged and often felt that the activities in the lesson were not at their level. For example, one student that I interviewed that would have been placed in Tier I, Ryan, said “I always yawned during the lessons but I always want to learn new things.” This implied that he was not engaged as a result of him commenting on yawning. In addition, his comment on his eagerness to learn new things implied that he wanted to learn something, but was not able to. In addition to this interview, the student who I interviewed that would have been placed in Tier II, Sarah, said “the activities were not too hard, but they were kind of tricky and the quiz short answer questions were too hard.” Again, an implication could be made that she was not engaged because she felt the activities were too hard. Furthermore, it definitely shows that she did not feel the activities in the lesson were at her level. Lastly, the student who I interviewed who would have been in Tier III, Justin, said “I think the activities were too easy.” This also implies that he did not feel engaged as the activities were not challenging enough for him. In addition, this displays that he would have benefitted from the 6E model since he would have been placed in Tier III with a higher learning level activity where he might have been more engaged.

For the students who were interviewed who had the 6E, the first student that was in Tier I, Amanda, said “I was not bored during the activities and my favorite activity was the experiment we did and the poster we made to see the life cycle of the Mexican Jumping Bean.”
This student displayed that she was thoroughly engaged based upon her detailed explanation of her favorite activity. In addition, it shows that the activity was at her level as she was not bored. Next, for the Tier II student that received the 6E, Heather, commented on the lessons when she said “I saw you doing different things with other groups but I was not bored and the activities I did were fun and if you weren’t there then we worked on it on our own.” This student, who was in the On-Target Learning Level, indicated that she was engaged even though other students were doing different activities. Also, she implied that the activities were at her level since she completed all the activities even though I was not there to help her all of the time as she stated. Lastly, the student who I interviewed for Tier III, Ethan, said “my favorite day was when we got to go into groups and my group got to pick out an experiment to do and we got to learn how light affected the Mexican Jumping Bean.” This student indicated they were fully engaged by describing their favorite activity in addition to implying that it was at his level and was his favorite activity.

For the forces and motion interviews, the main theme that came about was that both groups of students felt engaged, however, the students that received the 6E model discussed specific concepts they learned in addition to overcoming challenges. The student that was interviewed for Tier I that received the 5E model, Ashton, explained he was engaged by saying “I think the activities were just right but my favorite activity was designing our own roller coaster because it wasn’t too hard.” Although this student was engaged, he did not describe specific concepts he learned. The Tier II student for the 5E, Jessica, said “I liked the activity with the ball and the cup because we got to do different challenges and see what was going on and how the ball moved faster and stuff.” Again, she did comment on being engaged by her description of her favorite activity, but did not comment on how she learned about the concept of
gravity. The Tier III student that received the 5E, Heather, claimed “I liked all of the activities because they were all about gravity and we were always active and doing stuff.” She definitely claimed that she was engaged by her excitement during all of the activities. However, no discussion of gravity was made.

In addition, the Tier I student that received the 6E model, Danielle, said “I think the activities were just right because they weren’t too easy and I liked learning about gravity and doing the experiment with the ball and it was really fun.” This student not only claimed she was engaged, but she also commented on the concept she was learning about, gravity. The Tier II student who received the 6E, Blake, indicated that “sometimes the activities were hard but when I sat down and did the activity and thought about it I got it.” He not only claimed he was engaged, but also indicated that he was able to overcome the challenges provided to them in the activity. Lastly, for the student interviewed in Tier III that received the 6E model, Ashley, said “I noticed you doing different activities with other people but I liked what I was doing.” She commented on how she was engaged and even though others were doing different activities, she still enjoyed what she was doing.

**Research Question 4: What are the teacher’s perceptions and attitudes about differentiated instruction?**

**Qualitative results.**

This research question was approached in the same way as the third research question except for the number of research participants that were interviewed. Since the particular school building that the research was conducted at had the two third grade classrooms rotate for the subject areas of science and social studies, only one classroom teacher was interviewed, Miss
Bradley. This interview was conducted casually to see her views and perceptions on the 6E model and differentiated instruction.

Miss Bradley had a positive outlook on the lessons that were taught from both types of learning models. She herself uses the 5E model of instruction and enjoyed observing the hands-on activities involved with each unit. In private conversations with her, she indicated that she loved the first day of the life cycle unit where the students each got to hold a Mexican Jumping Bean and observe it using magnifying glasses. This she said allowed the students to come up with their own ideas about the Mexican Jumping Bean before given facts about it. In addition, she really liked the roller coaster design challenges in the forces and motion unit where the students had to bend a piece of foam pipe insulation according to the challenge and get the foosball to get in the cup at the end without falling off. She claimed that this activity was hands-on and challenged students to think outside the box. Overall, she liked how the activities were hands-on and thoroughly engaging as well as how enthusiastic the students were when completing the activities in the lessons. As for my reaction, I really felt the students were engaged, but felt it was challenging to balance my time with all the students when they were grouped into tiers during the express phase. If I were to teach these lessons again, I would definitely consider a collaboration method to resolve this issue. I might consult with the guidance counselor, intervention specialist, principal, classroom aide, and even the parents to help with the challenge of balancing time.

Overall, for the interview that was conducted with Miss Bradley, there were two themes that arose. One was that the students benefitted from being separated into their levels of understanding and the other was that it was challenging to balance time with all tiers for the 6E model. For the first theme, she commented on students benefitting from being grouped by tiers
when she said “I think the 6E was effective at differentiating instruction because of grouping students into ability levels and whether or not they were understanding the concept and correcting any misconceptions they may have had.” Based upon this, it implied that she agreed with the tiered instruction during the elaboration phase and that student’s learning needs were met because of it. In addition, she also commented on the benefits of the levels of understanding when she stated “I think some of the major benefits are not moving on and making sure every child got it in addition to grouping the students according to their ability levels.” Therefore, the different tiers she felt were beneficial to the students because it allowed them to meet the learning goals of the lesson.

In addition, there was another theme as mentioned earlier about there being a challenge with the 6E model and balancing time as a teacher with all of the students in the different tiers. She commented on this when she said “I think the biggest challenge was one teacher or one person being expected to circulate around the classroom and attend to all of the groups, especially when it comes to helping all of the children with disabilities.” Therefore, she confirmed my challenge I felt as a teacher to balance time as an instructor with all of the students in addition to making sure they are doing what they are supposed to and getting what they need.

**Summary**

The results section displayed the findings by each research question. In addition, this chapter focused on what the data present as the answers to the research questions. To answer these questions, pre and post assessments, assessment probes, and interviews were conducted. More specifically, the results displayed that the students who received the 6E model greatly benefitted from the being separated into their respective tiers to meet their individual learning needs. It was also found that as a result of the difference found from the pre to post assessment
scores, that the students who received the 6E had more gains. In essence, they had a higher
difference or improvement from the pre to post test score. In addition to this, it was found that
the students who were interviewed for the 5E were not as engaged and were also not able to
provide as much of a description of what they learned. In contrast, the students who received the
6E were able to provide a much more extensive description of what they learned in addition to
commenting on their enjoyment of the activities they participated. Finally, for the teacher
interview conducted with Miss Bradley, she claimed that the tiers did help accommodate to each
of the individual learning needs, however, it was hard for the person teaching the lessons to
balance time with all groups or tiers.
CHAPTER V: CONCLUSIONS

Summary of the Study

This research study took place to test out the newly proposed 6E model of instruction and its effectiveness at differentiated instruction to fit the needs of each learner. The goal of this addition to the 5E model is to tier students according to ability levels so that they can ultimately achieve the learning objectives for the lesson. Furthermore, this study took an already highly effective science learning model and added a step to test its impact on student learning. By adding the phase of express after the explanation phase, it helps to decipher what students still have misconceptions on the topic they are learning in addition to students who may need more of a challenge.

To conduct this study, a mixed methods approach was used so that instruments that were both quantitative and qualitative could be used. In this particular study, pre and post assessments were used to determine the prior knowledge of the students and what knowledge the students gained after the type of instruction that they received. These scores were used to compare the differences in knowledge of the students depending on the type of instruction that they received. Also, the research instrument of assessment probes was used to determine what tier the students were in. In addition, a qualitative instrument of interviews was used to determine how both the students and classroom teacher felt about both types of instruction and in particular the effectiveness of the 6E model and how it differentiated instruction.
Discussion of Findings by Research Question

Research Question One: Is there a difference in science knowledge between students taught using the 6E model and those taught using the 5E model?

Based upon the findings presented, there was definitely an increase from pre to post test scores for students who received the 6E model of instruction. However, the students who received the 5E model of instruction also improved. More specifically, the post test results for the life cycle unit confirmed that the students who received the 6E model of instruction had 3 more students receive full credit for question 1, 7 more students for question 2, 3 more students for questions 3 and 4, 7 more students for question 5, and 5 more students for question 6. Therefore, more students received full points for each question if they received the 6E model.

In particular, questions 2 and 5 show a significantly higher number of students who received full credit in comparison to the students who received the 5E model of instruction. Question 2 asked students what a tiny caterpillar is called and question 5 asked students what two things cause a Mexican Jumping Bean to be active. More specifically, questions 2 and 5 asked students what was inside of a Mexican Jumping Bean and what makes them move the most. These were two primary foundations of the unit and in particular focused on the investigation of what makes Mexican Jumping Beans jump. It is important to note that question 2 was multiple choice and question 5 was an extended response question. Question 2 had 23 students in classroom B that received full credit and 16 students in classroom A that received full credit. Therefore, the students who received the 6E model of instruction had more students who reached these foundations based upon their post assessment scores.

In the forces and motion unit, the same results were found as the life cycle unit. Although the students who received the 5E model of instruction scored well on the post
assessment and increased their scores from the pre assessment, the students who received the 6E model of instruction had more students who received full credit for each question. Questions 1 and 7 in particular had a significantly higher number of students who received full credit that had the 6E model of instruction, classroom A. In this class there were 20 out of 24 students who received full credit for question 1 whereas there were 18 out of 25 students in classroom B that received the 5E model of instruction that received full credit. Keep in mind there was still a high number of students who received full credit for question 1 that had the 5E model of instruction as it is an effective learning model, however, the students in classroom A had a higher number of students who received full credit which displays that the 6E model of instruction strengthens these amount of students who receive full credit. As for question 7, there were 12 students in classroom A that received full credit whereas there were 7 students in classroom B who received full credit. The goal for questions 1 and 7 were for students to understand the concepts of how gravity affects the fall of an object. This was the objective for the majority of the unit as dropping races were conducted and roller coasters were built to see how an object such as a foosball builds enough speed to fight gravity and go through a loop without dropping.

Overall, classroom A received the 6E model of instruction and scored better than the students in classroom B who received the 5E model of instruction. Although it is not a significant increase, there was still an increase in scores since question 7 was worth 4 points and 12 students in classroom A received full credit for this question whereas only 7 students in classroom B received full credit. This affected the overall scores of the post assessment as this question was a significant portion out of the 10 total points that it was worth.

In addition to comparing post assessment results by each individual question, a difference between pre and post scores were examined to see how each model of instruction affected the
growth in science knowledge for each student. Overall, for the life cycle unit both sets of students improved greatly between their pre and post test scores. However, the students in classroom B who received the 6E model of instruction improved slightly more. For example, after the pre assessment was conducted in classroom A and classroom B, students in classroom A had the average test score of 17.5% and students in classroom B had the average score of 18%. Therefore, both groups of students started out with about the same amount of knowledge on the topic of life cycles in regard to a Mexican Jumping Bean. It is clear that the students who received the 6E model of instruction, classroom B, scored significantly higher than the students who received the 5E model of instruction without the added phase of express.

To clarify, the average post assessment score for classroom B that received the 6E model of instruction had the average score of 91.2% whereas the average post assessment score for classroom A that received the 5E model of instruction was only 76.7%. Furthermore, it displays that there was more of an increase in science knowledge of students who received the 6E model of instruction versus the 5E model of instruction. As for the forces and motion unit, similar gains were made with the students who received the 6E model of instruction. On this particular pre and post assessment, classroom A was slightly behind classroom B on their knowledge of forces and motion. However, after classroom A received the 6E model of instruction, they surpassed classroom B with their knowledge level on the topic of forces and motion after receiving the treatment of the 6E model on instruction.

Classroom B still showed an increase in improvement, but they did not perform higher on the post test than the students who received the 6E model of instruction. This confirms the literature found on the 6E model of instruction where a classroom teacher who received training on the 6E model revised her teaching strategies as a result to fit the learning needs of all her
students (Duran et al., 2011). The findings here add to the literature because it provides educators and others with two specific units on life cycles and forces and motion that students gained more knowledge in as a result of the 6E model.

In addition to the difference between pre and post test scores, the findings for the first research question were also found by conducting a t-test of independent samples. This was done so there could be a focus on each and every individual score of the students who received the treatment of the 6E model of instruction to see if it caused significance. These results confirmed that the 6E model of instruction does in fact cause students to make significant gains in their science knowledge since the significance level was less than the tested level of .05.

**Research Question 2: Are there differences in science knowledge among the different levels of students taught using the 5E and 6E model?**

The findings for this research question were found by comparing the different tiers of the students to see if the students that received the 6E model of instruction improved as a result of being grouped according to their ability levels of need. Furthermore, this was done so that the students who received the 5E could be looked at by the tiers they were placed in to see if the 6E may have made an impact on them to be grouped by their level of needs. These results confirmed that it definitely would have made a difference if these students received the 6E model of instruction. Although most of them improved, it possibly could have made an impact on them and increased their science knowledge even more had they received the 6E model of instruction as the students who did obtained more of an improvement from pre to post test scores. For the life cycle unit, the students in classroom A that received the 5E learning model did not improve as much from pre to post test scores as did classroom B who received the 6E learning model. More specifically, the students in classroom A that were Tier I went from an average pre test
score of 14% to a post test score of 79% whereas the students that were Tier I for classroom B
that received the 6E model of instruction went from an average pre test score of 15% to 95%. Therefore, the students who were grouped according to their tiers improved significantly in
comparison to the students who were not grouped by their tiers in the 5E model of instruction. As for Tier II, students in classroom A went from an average pre test score of 20% to an average
post test score of 75% whereas the students in classroom B went from an average pre test score of 16% to an average post test score of 91%. Lastly, for Tier III students in classroom A, their
average pre test score was 15% and there average post test score was 90% whereas the students
in Tier III for classroom B went from an average pre test score of 24% to an average post test
score of 94%. The students in classroom B who received the 6E model of instruction improved
more in their pre and post test scores than that of students in classroom A that received the 5E
model of instruction. Therefore, students in classroom A improved slightly more than the
students in classroom B.

For the forces and motion unit, the students in Tier I for classroom A went from an
average pre test score of 48% to an average post test score of 88%, whereas the students in
classroom B went from an average pre test score of 61% to a post test score of 84%. As for Tier
II students, the students in classroom A went from an average pre test score of 58.67% to an
average post test score of 87.33% where as the students in classroom B went from an average pre
test score of 62.22% to an average post test score of 83.33%. Lastly, for Tier III students, the
students in classroom A went from an average pre test score of 67.50% to an average post test
score of 97.5% whereas the students in classroom B went from an average pre test score of
68.33% to an average post test score of 95%. Therefore, the students who received the 6E model
of instruction greatly benefitted by being separated into the different tiers which ultimately
helped them receive a higher post test score. These findings add to the literature because “when you tier instruction, you acknowledge that the content is appropriate for all students” (Armstrong & Haskins, 2010, p. 8). Therefore the findings that the students who received tiered instruction did indicate that tiered instruction does in fact help the students meet the learning goals for the lesson and adapt to their individual needs.

**Research Question 3: What are the students’ perceptions and attitudes about differentiated instruction?**

This research question was investigated by conducting interviews with the students in each classroom for both units. More specifically, three students were interviewed from each class for each unit. In particular, one student from each tier was interviewed per class to get results on a variety of levels of science knowledge. Based upon these findings, the majority of students that received the 6E model of instruction enjoyed the activities they did and were able to give specifics on not only the activity that they enjoyed the best, but they were also able to provide specific concepts or objectives from the lesson that they mastered. One particular student, Blake, commented on the 6E model of instruction he received for the forces and motion unit. He was in Tier II and he claimed the following after reflecting upon the different activities that he participated in when he said, “sometimes the activities were hard but when I sat down and did the activity and thought about it I got it.” Based upon this response it can be concluded that as a result of the 6E model of instruction and being tiered according to his specific needs, he was able to overcome the challenges included in his tiered specific elaboration phase. In contrast, another student, Justin, commented on his feelings on the 5E model of instruction he received during the life cycle unit when he claimed, “I think the activities were too easy.” This student in particular was in Tier III which leans towards the conclusion that had this student been tiered
according to his needs and received the 6E model instead of the 5E model he may have not felt that the activities were too easy.

Furthermore, a student who was interviewed from Tier I for the life cycle unit, Ryan, said the following about the activities he had received in the form of the 5E model when he said, “I always yawned during the lessons but I always want to learn new things.” This provokes the conclusion that he wanted to learn new concepts, however, was not able to fully as a result of them being too challenging. This can be claimed as a result of his comment on yawning and the lack of interest he had throughout the elaboration or extension phase. Overall, most students who received the 6E model of instruction gave a more detailed description of the activities that they participated in as well as specific objectives for the lesson. However, the students who received the 5E model of instruction were able to provide an activity, but sometimes not a specific objective to fit that activity in addition to occasionally commenting on their frustration of the activities whether it was that they felt the activities were too hard or too easy. This too adds to the literature because it shows an impact in student confidence and motivation of which was discussed in the literature as a result of the tiered instruction the students received in the 6E model.

In addition to this, my notes from my reflexive journal indicate that for the life cycle unit, the students in classroom A that received the 5E model seemed quite engaged. However, there were some of them that seemed to be frustrated in the elaboration phase as some of them struggled with the temperature component of the experiment and how it affected the Mexican Jumping Bean. This confirms the interview results that indicated all three of them struggled with the elaboration phase and they had frustration as a result of this.
Research Questions 4: What are the teacher’s perceptions and attitudes about differentiated instruction?

The findings for this research question were found as a result of the interview that was conducted with the classroom teacher that was a part of this research study, Miss Bradley. These findings suggested that she felt there were major benefits of the 6E model of instruction. However, there are some drawbacks that could be tweaked with to make it a more effective learning model. For instance, when asking her about the benefits of the 6E model she claimed the following, “I think some of the major benefits are not moving on and making sure every child got it in addition to grouping the students according to their ability levels.” Based on this claim, she commented on the primary purpose of the 6E model which is to make an already highly effective model even more effective by using the separate tiers to fulfill the needs of each and every individual learner.

In contrast with the benefits she mentioned, she also discussed some challenges of the newly proposed learning model when she said, “I think the biggest challenge was one teacher or one person being expected to circulate around the classroom and attend to all of the groups, especially when it comes to helping all of the children with disabilities.” According to this statement, a challenge of the 6E is that it is hard for one classroom teacher to divide up his or her time equally amongst all three tiered groups to ensure that they are in fact progressing adequately through the tiered elaboration phase. Overall though, the classroom teacher felt that the 6E model of instruction helped meet the individual needs of all of the students by grouping them according to their abilities so that misconceptions could be cleared up and challenges were low enough to not frustrate the students, but also high enough in that the students would learn something new and ultimately be challenged. This relates to what was found in the literature
about differentiated instruction. Even though it may feel discomforting or overwhelming, it is necessary to understand each individual learner so the end goals can be reached (Armstrong & Haskins, 2010).

**Implications for Classroom Teachers**

In summary, classroom teachers could take from this study the importance of meeting the needs of every student. More specifically, classroom teachers in the field of science education could take an already highly effective model and add in the new step of express to differentiate the elaboration phase according to each and every student’s needs. Moreover, the express phase can be an opportunity for the classroom teacher to evaluate their own effectiveness as a teacher in addition to making sure all students are progressing adequately through the learning cycle (Duran, et al., 2011).

After teaching the 5E and 6E for two different units, I found the 6E to be a highly successful model. However, I did experience the challenges of balancing my time with all tiers and accommodating to all their needs, especially when there were several students with disabilities or an IEP. If I were to teach the 6E model again in a science unit, I would definitely try to accommodate to this challenge by using collaboration with the classroom aide, intervention specialist, parents, and possibly even the guidance counselor. This way the student’s learning needs would be met from a variety of people that know the students well enough to make a quality instructional decision.

**Recommendations for Future Research**

This particular research study implicated findings that the added phase of express helps the 5E model become even more effective. Specifically, it allows classroom teachers to use a highly respected model, but expanded to meet the needs of each and every individual learner by
using tiered instruction from the assessment probe that is administered to the students. To make this research even more valid and effective, possible additions to this research study could be conducted. For instance, a wider study sample could be used in addition to a variety of grade levels to see the effect of the 6E model across the education spectrum. In addition, it would be especially useful to use the qualitative instrument of interviews to see the variety of student perceptions and attitudes towards differentiated instruction across grade levels. It would also be useful to get a variety of perceptions and attitudes from a large amount of classroom teachers so that classroom teachers and others could get a variety of perspectives on how to accommodate to the needs of every individual student in science instruction. Lastly, it would be interesting to see this study done using other subjects instead of science to see if the same results would occur in a variety of subject areas.

Summary

Due to the diverse society, there is no cookie-cutter classroom. In other words, a variety of students with a variety of different needs enter classroom daily. Therefore, as an educator, it is important to consider these differences and accommodate to them so that all students are successful. In science education, the already effective learning model, the 5E, could be modified to the 6E by adding in the step of express after the explanation phase. This phase asks the teacher to administer a formative assessment probe to decipher what misconceptions the students have mid-way in the learning cycle. Then according to how the students do on the assessment probe, they are then grouped into three different tiers, Novice, On-Target, and Advanced Learning Levels. These tiers allow students to receive a differentiated elaboration phase that fits their individual needs.
Furthermore, it was found in this study that the students who received the 6E and were grouped into these tiers mentioned, made higher gains from the pre to post assessments. In addition the interviews conducted with the students indicated their feelings and perceptions of being fully engaged and confident when receiving the 6E model. Also, the perceptions and attitudes of the classroom teacher from this study indicated that using the tiers in the 6E effectively accommodates to individual learning needs of the students. However, this can make it difficult as a teacher to balance time with all students. Even though this can be considered a challenge with the 6E, this can easily be accommodated by using collaboration efforts with parents, intervention specialists, and guidance counselors. Overall, the 6E model was found to be effective and could make the 5E model even more effective.
References


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APPENDIX A
<table>
<thead>
<tr>
<th>Phase</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engage</td>
<td>The students start off with a short activity to gain their interest and assess their prior knowledge on the topic they are learning.</td>
</tr>
<tr>
<td>Explore</td>
<td>The students then complete a hands on activity exploring the concept they will be learning. The teacher is more of a guide during this phase and uses guided questioning to help students arrive at conclusions.</td>
</tr>
<tr>
<td>Explain</td>
<td>The teacher then becomes more of a leader and uses guided questioning to discuss concepts students explored during the previous phase.</td>
</tr>
<tr>
<td>Elaboration</td>
<td>The teacher then extends the lesson by completing a hands on activity to challenge students’ thinking.</td>
</tr>
<tr>
<td>Evaluate</td>
<td>The teacher then evaluates students on the topics they learned either through a project, activity, or hand-written test to assess whether or not the students met the learning goals for the lesson.</td>
</tr>
</tbody>
</table>
Dear Elementary Science Teacher,

You are invited to participate in an educational research study that will investigate the effectiveness of a differentiated model of science instruction. Previous educational research has demonstrated that teachers typically do not proactively modify their instruction in response to the diverse academic needs of their students. Since students all learn at different rates (some slower, some faster), it is doubtful that all students will maximally benefit from a one-size-fits-all instructional model. However, when teachers differentiate their instruction, students are engaged in instructional activities that match the students' academic needs, making meaningful learning more likely. If our differentiated model of instruction is found to be effective at improving student learning, it will be widely disseminated to provide teachers with a practical way to differentiate science instruction in their classroom. You will directly benefit from this study by having first hand experience with differentiated instruction and your students will be provided with instruction that is closely aligned to their academic needs.

The study will be conducted in your science class during two units about motion and the life cycles of animals, which will each last for about one week. Your class will receive regular hands-on instruction during one of the units, and differentiated instruction during the other unit. Stephanie Fletcher, an education graduate student at Bowling Green State University (BGSU), will teach both of the units on motion and the life cycles of animals.

After the units are taught, we will ask you to be interviewed about your perceptions of the differentiated instruction model, and how your students responded and learned during the unit. If you give us your consent, we will interview you and your interview responses will be used for the purposes of the research study. The length of the interview will be about 15 minutes. Your participation in the interview will be your only commitment to this research study. Therefore, the risks involved with this study are no greater than those encountered in daily life. This study will not be anonymous since your name will be known. However, we will protect your confidentiality by: 1) not allowing any person outside of this study access to your data, 2) storing your data on a password protected computer, 3) using a pseudonym if your interview responses are reported, and 4) reporting your data in a manner that will not allow your identity to be known. The interview will be digitally recorded, and after the interview is transcribed, the digital file will be deleted. These methods will keep your name from ever being publicly associated with your interview responses.

Your participation in this study is voluntary, and you can withdraw your permission and/or discontinue participation in the study at any time without penalty. Also, your decision will not affect your relationship to your school or to BGSU.

If you have any questions about this study, please contact me, Emilio Duran (419-372-1262 or eduran@bgsu.edu). You can also contact the Human Subjects Review Board at Bowling Green State University (419-372-7716 or hsrboff@bgsu.edu) if you have any questions about your rights as a research participant.

Warmest Regards,

Emilio Duran, Ph.D.
125 Life Science Building
Bowling Green State University
Bowling Green, OH 43403
TEACHER CONSENT FORM

By signing this consent form, you give us your permission to interview you, and to use your interview responses for the purposes of the research study.

Your PRINTED Name: ____________________________________________

Your SIGNATURE: ____________________________________________

☐ Please check this box if you would like a copy of the signed consent form.
Dear Parent or Legal Guardian,

Your elementary student has been invited to participate in an educational research study. The purpose of the study is to investigate the effectiveness of an instructional model that is used to differentiate science instruction. In other words, the model helps teachers to create different instructional activities for different groups of students in order to maximize learning for all students. Previous educational research has demonstrated that teachers typically do not modify their instruction in response to the diverse academic needs of their students. Since students all learn at different rates (some slower, some faster), it is doubtful that all students will maximally benefit from a one-size-fits-all instructional model. However, when teachers differentiate their instruction, students are engaged in instructional activities that match the students' academic needs, making meaningful learning more likely.

The study will be conducted in your student's science class during two units. One will be about motion and one will be about life cycles of animals, both of which will last for about one week. Your student will receive regular hands-on instruction during one of the units, and differentiated instruction during the other unit. Therefore, your student will not receive differentiated instruction on both science topics that are taught. Please be assured however, that the "regular" instruction is high quality and engaging, so even if your student does not receive differentiated instruction on both science topics, s/he will still be receiving effective instruction about motion and the life cycles of animals. Stephanie Fletcher, an education graduate student at Bowling Green State University (BGSU), will teach the motion and life cycles of animal units in both classes.

The risks associated with this study are no greater than those encountered in daily life. Your student will not be asked to do anything out of the ordinary. S/he will be asked to complete a test about motion and the life cycles of animals before and after the units. During the unit, your student will be asked to actively participate in all instructional activities, just as s/he would for any class. After the unit, your student may be interviewed about their experiences during the unit. The interview will last about 15 minutes. Your student will directly benefit from this study by receiving differentiated instruction that is closely aligned to his/her academic needs. A general benefit of this study is the advancement of knowledge about educational instruction. If the differentiated instruction model is found to be effective, it may be applied in more classrooms, resulting in a better educational experience for all students who are taught with the model.

Students will be asked to write their names on the tests and other assessment materials completed during the unit, just as they would for any other class. Although this practice is not unusual, it removes the anonymity from the study – the researchers and teacher will see your student's name on his/her materials. However, we will protect your student's confidentiality by 1) not allowing any person outside of this study access to your student's materials and 2) only reporting the results of the test in groups – individual scores will never be mentioned. Also, a pseudonym will be used if any quotes from your student's interview are reported. The interview will be digitally recorded, and after the interview is transcribed, the digital file will be deleted. All of these methods will keep your student's name from ever being publicly associated with his/her test score and interview responses.

This study will be conducted by: 1) myself, Emilio Duran, a professor in the Department of Teaching and Learning at BGSU, 2) Jake Burgoo, an educational researcher at BGSU, and 3) Stephanie Fletcher, an education graduate student at BGSU.
Since your student is younger than 18 years old, we need your consent in order for him/her to participate in this study. In addition to your consent, we will also be seeking assent from your student. Your student’s participation is voluntary, and you and/or your student can withdraw your consent and/or discontinue participation in the study at any time without penalty. Also, your decision will not affect your student’s class grade or your or your student’s relationship to your student’s teachers and school or to BGSU. It is important to note that by “participation”, we mean allowing test scores to be used for the purposes of this research study and participation in interviews. Regardless of your decision, your student will participate in instructional activities, and will be expected to complete all assessment materials associated with those activities. Your consent simply allows us to 1) use your student’s assessment materials for the purposes of this research study, and 2) possibly conduct a short interview with your student.

If you agree to allow your student to participate in this study, please complete the attached consent form and send it back to school with your student. If you do not agree to allow your student to participate in this study, simply discard the consent form. You may keep this letter for your records. If you have questions concerning the research study, please contact me, Emilio Duran (419-372-1262 or eduran@bgsu.edu). If you have questions about the conduct of this study or your student’s rights as a research participant, you may contact the Chair of BGSU’s Human Subjects Review Board (419-372-7716 or hsrb@bgsu.edu).

Warmest Regards,

Emilio Duran, Ph.D.
126 Life Science Building
Bowling Green State University
Bowling Green, OH 43403
PARENTAL CONSENT FORM

If you agree to allow your student to participate in this study, please complete this form in its entirety and send it back to school with your student.

If you do not agree to allow your student to participate in this study, simply discard this form.

I hereby give my consent for my student to participate in the previously described educational research study. I acknowledge that participation in this study means that my student's assessment materials will be used for research purposes, and that those conducting the research study may interview my student after the photosynthesis unit.

Student's Name: ____________________________

Parent/Legal Guardian's PRINTED Name: ____________________________

Parent/Legal Guardian's SIGNATURE: ____________________________

☐ Please check this box if you would like a copy of the signed consent form.
Hello,

You are invited to be in a project that is being done by a group of people from Bowling Green State University who are interested in learning about science classes. Their goal is to use the project to make science classes better!

If you help with the project, you will not be asked to do anything strange. You will do your regular class activities, and you will answer some questions about your science knowledge. Also, you might be asked some questions about the activities you did during your science class. Answering the questions should only take about 15 minutes, but if you don’t want to answer questions about your class activities, you don’t have to.

Your answers will only be seen by your teacher and the people doing this project. No one else will know how you answered the questions, or what you said about the class activities. If you agree to help with the project, your answers will be used to find out how to make science classes better. Of course, you can tell your teacher anytime that you don’t want your answers to be used for the project. No one will be mad if you decide that you don’t want your answers to be used for the project.

If you have any questions about the questions you are asked and the activities that you participate in, you can ask your teacher. Also, if you have any questions at all please know that you can ask any question at any time.

Thank you for your help!
APPENDIX C
Student Interview Protocol

1. What did you think of the activities? Were they too difficult? Were they too easy? Or were they just right?

2. Did you notice other students doing different activities? If so, what did you notice? (After 6E only)

3. Did you ever feel bored when you were doing the activities? Or did you feel excited making you want to participate?

4. What did you like about the activities you did? What did you dislike?
TEACHER INTERVIEW PROTOCOL

1. Your students just participated in two units. One was about motion and the other was about the life cycles of animals. Some were taught using the 5-E model, and some were taught using the 6-E model of differentiated instruction. What differences did you notice between the two types of instruction?

2. Do you think the 6-E was effective at differentiating instruction? How?

3. Describe how your students responded to each type of instruction. How engaged were they? What were their attitudes about each type of instruction?

4. How comparable were the three tiers of instruction in terms of content, difficulty, and cognitive demand?

5. What did you see as the major challenges involved with using the 6-E model?

6. What did you see as the major benefits involved with using the 6-E model?
Three friends were walking outside when they came across some Mexican Jumping Beans. Each of them decided to create their own habitat for the Mexican Jumping Beans. Each friend wanted to build a habitat that would take care of the Mexican Jumping Bean’s needs so that it would survive and remain active or jumping. Below is each friend’s description of what his or her habitat would look like:

Susie: “I want to build a box with a sheet over it so that the Mexican Jumping Bean stays cool and will remain active”

Bobby: “I think I will put my Mexican Jumping Bean in a small bowl and keep it outside near the sun so that it jumps a lot with the warm temperature”

Freddy: “I am going to keep my Mexican Jumping Bean on a small cloth near a light so it is active and occasionally put it in my hand so that it becomes very active.”

Which friend would you most agree with? 
Explain your thinking of why the habitat you chose would work best for the Mexican Jumping Bean so that it would not die and still remain active and jumping. Please also describe what would happen to the Mexican Jumping Bean if it survived and the life cycle it would go through.
APPENDIX E
### Connection of Research Question to Interview Question

<table>
<thead>
<tr>
<th>Type of Interview</th>
<th>Research Question</th>
<th>Interview Question</th>
</tr>
</thead>
</table>
| Student           | Question 3: What are the students’ perceptions and attitudes about differentiated instruction | Perceptions:  
Question 2: Did students notice others doing different activities  
Attitudes:  
Questions 1, 3, and 4: How engaged were the students? |
| Teacher           | Question 4: What are the teachers’ perceptions and attitudes about differentiated instruction? | Perceptions:  
Questions 1 and 3: What differences were there between each type of instruction and how students responded  
Attitudes:  
Questions 2, 4, and 5: What were the benefits and challenges of the 6-E model? |
APPENDIX F
## Rubric for Life Cycle Unit

<table>
<thead>
<tr>
<th>Question</th>
<th>Point Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 or 0 multiple choice</td>
</tr>
<tr>
<td>2</td>
<td>1 or 0 multiple choice</td>
</tr>
<tr>
<td>3</td>
<td>1 or 0 multiple choice</td>
</tr>
<tr>
<td>4</td>
<td>1 or 0 multiple choice</td>
</tr>
</tbody>
</table>
| 5        | 1= did not answer all parts of the question, said something incorrect  
          2= answered all parts of the question, but did not give an explanation  
          3= answered all parts of the question and indicated that temperature and light cause larvae to move |
| 6        | 1= did not answer all parts of the question, said something incorrect  
          2= answered all parts of the question, but did not give an explanation  
          3= answered all parts of the question and indicated all life cycle stages in the correct order |
<table>
<thead>
<tr>
<th>Question</th>
<th>Point-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</tr>
<tr>
<td>5</td>
<td>1 or 0 multiple choice</td>
</tr>
<tr>
<td>6</td>
<td>1 or 0 multiple choice</td>
</tr>
</tbody>
</table>
| 7        | 1= student did not answer all parts of the question  
2= student answered most of the question, however, some facts were incorrect  
3= student answered all parts of the question, but did not explain about air resistance  
4= student answered all parts of the question and discussed air resistance |