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TEACHER THINKING: PREACTIVE PLANNING, INTERACTIVE, and REFLECTIVE PRACTICES DURING NEW CURRICULUM INTEGRATION

DISSERTATION

Presented in Partial Fulfillment of the Requirements
for the Degree Doctor of Philosophy
in the Graduate School of The Ohio State University

By
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The Ohio State University
2002

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ABSTRACT

Preactive planning, interactive, and reflective decisions represent the majority of teacher thinking in relation to classroom instruction. The interpretation and personal application of the curriculum directly influences teaching methods and student learning. Recent research on teacher thinking has attempted to relate teacher decisions to beliefs and practices in the classroom (Calderhead, 1991; Roskos, 1996; Morine-Dershimer, 1991; Shulman, 1987; McCutcheon, 1995; Cornett & McCutcheon, 1992). Much of this research will have relevant implications in curriculum development, instructional improvements, and teacher education programs.

This study investigated the preactive planning, interactive, and reflective decisions made by two secondary anatomy teachers. Both teachers incorporated a new microbiology curricular unit in their existing, yearlong anatomy course. This investigation focused upon the curricular decisions the teachers made during the implementation of the new microbiology course of study. The qualitative research design was a naturalistic case study. Findings from the classroom observations and teacher interviews were integrated to interpret teacher thinking.

A second portion of this investigation involved a quantitative analysis of student/class microbiology achievement. The students were given a pretest and a
posttest. Data were collected for statistical analyses to allow comparisons of the mean achievement scores of the senior classes. This quasi-experimental design provided descriptive statistics that were used to elucidate the case study findings.
Dedicated to my family

Gene, Jeana, and Joe West
ACKNOWLEDGEMENTS

I gratefully acknowledge the guidance and encouragement of my advisor, Dr. Gail McCutcheon. This study would not have been possible without her support and guidance. Dr. McCutcheon freely shared her expertise and served as both mentor and friend during the four years of my doctoral studies. I also thank the members of my general exam and doctoral committees, Dr. John Chovan, Dr. Beverly Gordon, and Dr. William Loadman. Dr. Gordon volunteered as a member of my general examination committee and offered insight into the overall dissertation process.

Dr. Chovan participated with me in multiple independent studies in the area of educational technology. He guided me through educational technology applications/programs with humor and patience, being particularly helpful during numerous computer crises. Dr. Loadman served as my advisor for the quantitative portion of this study. His statistical advice was an invaluable part of my research design.

I am indebted especially to the teacher participants of this study, “Ann” and “Beth”. They opened their classrooms to me for over two months with generosity and friendship. Both teachers shared their time, talent, and educational experience with me on a daily basis. Their insight and forthrightness made this research possible.
VITA

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Fields of Study

Major Field:  Education
Minor Field:  Educational Technology
Areas of Focus:  Curriculum Theory & Development
                Teacher Thinking
                Teacher Education
                Technology Applications in the Classroom
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CHAPTER 1

INTRODUCTION

Teaching is a complex interaction between the cognitive processes of the instructor and the students. In the classroom, a teacher must make constant decisions based upon a wide array of influences. A teacher simultaneously assesses student comprehension, student behavior, curriculum objectives, pedagogical theories, and past instructional experiences to make interactive decisions (Clark & Peterson, 1986; Calderhead, 1984; Schoen, 1983; Shavelson & Stern, 1981). Although researchers can observe teachers in action, the essence of teaching is elusive. Teacher thinking is a private enterprise that cannot be researched solely through classroom observation. Additional research methodologies must be used in conjunction with observation to delve into teacher cognition. As the very nature of teaching revolves around teacher-thinking, research can be an invaluable link between thought and actions in the classroom. Investigative findings can have implications in curricular programs, student behavioral objectives, teacher education programs, and professional development goals. The definitive purpose of this research is to create a composite sketch of teacher thinking practices, constructing an overall portrait of the many facets affecting teacher cognition.

Research literature directed toward teacher thinking has multiplied exponentially since the early 1980s (Zeichner, 1994; Calderhead, 1994). The focal areas of
investigation include research into teachers' background and content knowledge, interactive curriculum decisions made in the classroom, lesson planning strategies, classroom management decisions, reflection, and overall educational philosophy. This research is exploring the very nature of learning and teaching. Under scrutiny of investigation, the nature of teaching is a complex enterprise. School/community expectations, student ability levels, courses of study, student behavior, and time limitations confine teachers' actions. Teachers must constantly make decisions to negotiate between multiple, inter-related circumstances in order to develop a personal teaching style. Thus, curriculum planning and implementation becomes an amalgam of decisions based upon individual teaching beliefs, classroom management, and subject content. The objective of research on teacher thinking is to penetrate and elucidate the wide-range of cognitive processes that occur daily in the classroom.

A comprehensive groundwork of knowledge about teacher thinking could result in innovations and progression in educational practice. The study of expert teachers' thinking may lead to more realistic curriculum programs, with flexibility permitted for teacher individuality. New curriculum programs or course objectives must be interpreted and revised to accommodate teachers' thinking styles, beliefs, and background knowledge. Collectively, teacher-thinking research can propose methods to ease implementation of curriculum innovations and transitions (Calderhead [Ed.], 1987). Research on teacher thinking may also impact teacher education programs. By examining the interactive decisions made by practicing teachers, teacher educators can expound upon the foundational knowledge necessary
for a successful learning environment. In addition, research on reflective practices of expert teachers could stimulate other teachers to reflect upon their own classroom practices and consider possible modifications. The value of research findings on teacher cognition looks promising.

Research into teacher cognition has started to unravel the mystery and complexity of the many inter-related factors involved in teaching. A new understanding of the professional role of a teacher is coming into focus. Researchers are investigating the relationship between teachers’ personal beliefs and classroom practices. Teachers’ background knowledge and experiences are studied to determine their impact on teacher decisions. The acquisition of content knowledge is investigated in comparison to interactive and curricular planning decisions. Thus, an overall picture slowly is emerging- a picture of how teacher cognition is incorporated into action in the classroom. From this picture, research can achieve the goal to enhance and support classroom instruction.

The focus of this research project was the investigation of three major phases of teacher thinking: preactive planning, interactive decisions, and reflection. As an introduction, the significance of the research of each of these areas will be discussed.

**Theoretical Framework of the Study**

This research is grounded in the theoretical framework of three teacher-thinking phases: preactive planning, interactive decisions, and reflection. These phases of teacher thinking are discussed briefly in this section.
Preactive Planning

Preactive planning is a cognitive phase of teaching in which the curriculum is individually interpreted to correspond to action in the classroom. This phase of teacher thinking occurs prior to and in preparation of classroom instruction. Preactive planning is a fundamental area of teacher-thinking research for several reasons. Teachers plan to construct a template to guide future classroom practice. During the planning phase, teachers also coordinate classroom activities with available time and resources. In addition, the knowledge level, interests, and various learning styles of the students are related to learning objectives and lesson plans. The act of planning “transforms and modifies the curriculum to fit the unique circumstances of each teaching situation” (Yinger & Clark, 1987, p. 88).

Teacher planning is the connection between the curriculum and action in the classroom. Information from planning research can reveal two major portions of teacher thinking: curricular decisions and action decisions. Planning is an integral part of the applied curriculum. Within the constraints of the course of study, teachers must decide what to teach, how to connect the content to students’ background knowledge and interest, when to teach the material, what curriculum materials to use, and how to appropriately evaluate student achievement. Planning is also an integral key to teacher cognition. Planning can illuminate teacher interpretation of content material and reveal how they decide the best teaching strategies to implement. In addition, planning incorporates decisions about interactions with the students. “To study plans and their transformation in action provides a window through which to view the norms that govern teaching and school
learning and can make visible the ways that teachers and students negotiate the curriculum" (Clark & Dunn, 1991, p. 183). Thus, planning research can provide insight into multiple facets of the very nature of teaching. Through planning research "we can expect to acquire a fuller, more replete view of what curriculum and teaching means within schools" (Eisner, 1988, p. xi).

**Interactive Decisions**

Much of teacher-thinking research has focused upon interactive thinking. Interactive thinking is a deliberation that occurs during ‘interaction’ or communication with students (Clark & Peterson, 1987). Sometimes the ‘interaction’ with the students is in the form of cues or signals from the students during instruction. For example, experienced teachers can draw upon their previous classroom experiences and practical knowledge to interpret the comprehension of their students (Calderhead, 1993). In such cases, teachers make interactive decisions in response to a problem or situation in the classroom. The interactive decision leads to action in the classroom through a change in the teaching strategy, learning activity, or a modification of the lesson.

Several researchers have found that experienced teachers purposively do not write out structured, detailed lesson plans (Morine-Dershimer, 1993; McCutcheon, 1995; Moallem & Earle, 1998). Much of lesson planning is a mental picture or outline to guide instruction and student activities. Such an approach builds in flexibility to allow for interactive decisions and the resultant modifications. "One of the characteristics of expert teaching is the way in which teachers can employ and adapt
routines sensitively to the situation at hand. The teacher may have to draw upon their knowledge of the pupils and their interests, their knowledge of the subject matter under discussion, and their knowledge of how children react in discussion situations to guide, probe, and explain at appropriate moments, maintaining the children’s attention and enthusiasm, and stimulating them to think” (Calderhead, 1987, p. 16).

As noted by Calderhead (1987), much of interactive thinking depends upon the background knowledge and classroom experience of the teacher. This statement not only refers to the success of the interactive modifications, but also refers to the ability of the teacher to recognize when an interactive decision is necessary. Teachers must consider numerous, inter-related influences to make effective interactive decisions. The goal of teacher thinking research is to investigate the multiple layers of these influences that guide interactive thinking - complex influences ranging from the teacher’s personal beliefs and knowledge to influences from the classroom environment.

Interactive research findings can have implications in several educational areas, such as:

- Teacher education programs
- Curriculum development/ innovation
- Classroom management techniques
- Teacher effectiveness
- Professional development
- Curriculum policy
Interactive decisions are a large part of instructional practice, which accounts for the numerous possible applications of the research. The obvious objective of interactive decision research is to reveal the relationship and pathway from interactive thinking to action in the classroom. How do teachers spontaneously assess the need for change in a planned lesson or student activity? What factors influence the teacher’s interpretation of interactions with students? How does the context of the situation affect teacher decisions during instruction? “Though research on teacher thinking does not provide us with a comprehensive theoretical framework for thinking about teaching, it does provide us with a number of insights that have implications for how we approach various educational tasks” (Calderhead, 1987, p. 17). The essence of the teaching practice revolves around interactive decisions in the classroom. In turn, the importance of interactive thinking research is evident.

**Reflective Practices**

Teacher reflection is the deliberation of classroom events, curriculum objectives, student achievement, and personal beliefs. Teachers can reflect on past experiences before a lesson to guide daily planning. Reflection can occur during interactive classroom practice, signaling the need for a shift in teaching strategies to improve student comprehension. For example, experienced teachers can recognize student signals when a lesson is unclear or misunderstood. Reflection during class transforms this type of teacher cognition into action in the form of a new approach or learning activity. Reflection can also take place after a lesson, resulting in a comparison between planned objectives and learning outcomes. In addition,
reflective analysis can be in response to students' group interactions or social circumstances that are affecting instruction. Thus, reflection encompasses the wide range of teachers' knowledge that is deeply ensconced in personal beliefs and classroom practices.

Reflective research can affect many areas of educational practice. Several researchers (Yinger & Clark, 1987; Kirby & Teddle, 1989; Zeichner, 1994) assert that research into teacher reflection demonstrates that teaching is a professional practice. Reflection research findings verify that teaching demands the integration of educational theories, classroom experience, and content knowledge. Effective teaching cannot be a mere imitation of experts, but must involve the application and reflection of professional knowledge in multiple classroom settings (Kirby & Teddle, 1989). Thus, teaching is much more than the technical implementation of theoretical teaching strategies. Teaching involves reflection of the curriculum, classroom practices, student achievement, and problem-solving efforts. "Reflective practice supports the notion of teaching as a profession" (Kirby & Teddle, 1989).

Reflection during implementation of new curriculum material can be vital to educational success. During curriculum development, teachers need to reflect upon their own personal teaching style in order to incorporate new learning material. Preparation time is needed to selectively include or augment some areas of the learning unit, while refining or deleting practices that did not work with that specific class. Through experimentation and reflection, teachers can modify prepackaged curriculum objectives and materials to develop a functional, effective teaching system (Calderhead (Ed.), 1987).
Reflection research acknowledges that teachers should be active participants in curriculum innovation and planning. School reforms should take into account teachers' personal educational theories, background knowledge, and classroom experiences. Often curriculum changes are founded on theoretical concepts outside of the school environment. Reflection research can demonstrate the need for teachers’ active participation in educational reforms for optimal classroom feasibility and effectiveness (Zeichner, 1994).

Reflective practice is also being encouraged in teacher education and professional development (Hannay, 1994; Wear, 1994). The importance of continual reflection upon classroom instruction is now widely recognized. Research about teacher thinking can provide information on the reflective practices of expert teachers, relating everyday teaching practices to reflective theories. Teachers’ reflective habits can explore inter-related factors that increase student learning. Such factors include curricular modifications, student comprehension, student motivation, and subject integration. Kincheloe (1993, p.225) states that the development of a "reflective practice can help perspective teachers examine their personal experience in light of pedagogical concerns and their attempt to become professionals."

Therefore, careful deliberation can connect the new teachers’ practices to educational theories. Novice teachers need the background knowledge of reflection in order to develop professionally. Reflective research data can be utilized in the development of such coursework for student teachers.

As noted above, teacher reflection research has many potential applications in the field of education. Reflective research is an essential tool to connect teacher
thinking and routine classroom practices. Armed with reflective data, researchers can begin to understand the very nature of teaching. The complex combination of teachers' practical knowledge, personal theories, and creativity can be investigated. Thus, research on teachers' reflections can lead to an understanding of how “teachers' knowledge is organized, how it is acquired, and how it is used” in the classroom (Calderhead, 1984).

**Problem Statement**

The purpose of this study was to investigate the preactive planning, interactive, and reflective decisions of two secondary school anatomy teachers while implementing new curriculum material.

**Purpose of the Study**

The purpose of this study was two-fold. The major focus was upon the exploration of teacher thinking during the preactive planning, interactive, and reflective stages of curriculum implementation. Teaching is a complex enterprise that requires constant interactive decisions and curricular interpretations during instruction. This naturalistic case study investigation may illuminate relationships between teacher thinking and classroom practice. In turn, study of teacher reflection may illustrate correlations and discrepancies between curriculum planning and teacher actions in the classroom. Research into teacher thinking is a relatively young area of investigation, expanding over the past two decades. Initially teacher-thinking literature centered upon process-product research (Shulman, 1986). Currently,
investigators are concentrating upon the association between teacher cognition and classroom practices (Day, Calderhead, & Denicolo, 1993; McCutcheon, 1995; Clark & Dunn, 1991). This research project also will try to demonstrate the correlations between teacher cognition and everyday instructional procedures.

The purpose of a secondary, quantitative portion of this research was to discover any relationship between differences in teacher thinking and student achievement. Both teacher participants implemented the same microbiology course of study, with the same set of texts and curricular supplements. Student achievement was compared on a posttest instrument at the completion of the teaching unit. Analysis of the student achievement data in conjunction with the teacher case study findings may identify possible relationships. The effectiveness of one teacher’s curricular decisions may demonstrate a learning advantage.

The Research Problem

Teaching is an intricate process that involves constant interchange between cognition and action. Research on teacher thinking examines the complex interaction of instructors’ beliefs, background experiences, subject knowledge, and reflections (Spillane, 1999; Day, Calderhead, & Denicolo, 1993; Ross, Cornett, & McCutcheon, 1992; Connelly & Clandinin, 1988). Such research can address a variety of educational issues:

- How do teachers develop a foundation of knowledge – from both the standpoint of content knowledge and classroom management knowledge?
What factors influence teachers’ curricular decisions?

How does teacher background knowledge and educational beliefs affect curriculum implementation?

How does teachers’ cognition become ingrained in action in the classroom?

Do reflective practices modify teachers’ knowledge bases, resulting in curricular changes?

Through the investigation into teachers’ thinking processes, new insights into teaching practices are emerging. Consequently, the prospect for constructive recommendations for improvement in teacher education and classroom instruction is optimistic.

The focus of this investigation was upon the planning, interactive, and reflective decisions of two teachers. The setting was in two senior anatomy classes from separate, suburban high schools. Data was gathered during the incorporation of a new microbiology unit into the existing anatomy curriculum. The project was divided into a qualitative and a quantitative portion:
### Table 1: Comprehensive Research Design

<table>
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<th>Participants</th>
<th>Purpose</th>
<th>Data Collection</th>
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| **Qualitative**      | Two secondary anatomy teachers | 1. To investigate the planning, interactive, and reflective decisions made during new curriculum implementation | Case Study:  
  a. Classroom observation  
  b. Stimulated recall interviews  
  c. Group interview |
| **Quantitative**     | Two classes of senior anatomy students | 1. To determine the existence of any statistically significant differences in post-instruction achievement between the two classes  
  2. To discover possible connections between curricular teacher decisions and student achievement | Microbiology Assessment:  
  a. Pretest  
  b. Posttest |

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Research Questions

Several research questions were investigated in this project:

1. What are the various forms of teacher planning and how do they function within the curriculum?

2. In what ways do teachers’ beliefs and practical knowledge affect the planning stage of curriculum implementation?

3. What correlation exists between teacher planning and curriculum implementation or action in the classroom?

4. How do teachers’ interactive decisions influence the effectiveness of learning in the classroom?

5. What role does reflection play in curriculum decisions?

6. When is reflection practiced during curriculum implementation?

7. Is there evidence that the reflection that occurs during and after lessons/units guides future action in the classroom?

8. Would a statistical difference in student achievement exist between the two classes of science students?

9. Can any differences in student achievement be related to distinctions between the two teachers’ planning, interactive, and reflective decisions?

10. What are the future implications of research into teacher thinking? In what ways might this research reveal and direct instructional procedures?
Significance of the Study

The purpose of this research project was to investigate different phases of teacher thinking during new curriculum implementation. The processes of teacher thinking, reflection, and curriculum planning are intricately connected to classroom practices and student achievement. Further research into teacher thinking may illuminate the connection among teaching decisions, teacher beliefs, and the learning environment. Such investigations could lead to a better understanding of teachers' goals and actions in the classroom. A more comprehensive knowledge base about teacher thinking eventually could help identify areas for improvement teaching, student learning, teacher education, and curriculum development. In turn, recommendations for improved classroom practices may emerge. Calderhead (1987) cited widespread examples of prepackaged curriculum innovations that are commonly presented to teachers in totem without consideration for individual teachers' beliefs or planning practices. Research into teacher thinking may provide insight into why such innovations often fail in the classroom. Thus, a valuable function of teacher-thinking research is the development of curricular programs that can be implemented realistically in the classroom. In addition, such research could bring about positive changes in teacher education programs. Correlations between teacher thinking and effective teacher practices could serve to guide future educators in the classroom. Lastly, research on teachers' thinking may promote reflective practices among teachers, enabling improvement and growth of their teaching.

While multiple studies have been published about the phases of teacher thinking, a limited number have investigated the complete process from preactive planning to
interactive decisions and subsequent reflection. More importantly, this study will focus upon the phases of teacher thinking during the implementation of new curricular material. The two teacher participants incorporated a new microbiology unit into their pre-existing, yearlong anatomy curriculum. During such periods of implementation, teachers must make numerous decisions in regards to student activities, types of assessment, lecture materials, and homework assignments. All teacher decisions will be innovative in nature, in that the curriculum unit was new and previously untried in a classroom situation. As such, I purposely selected this sample population in order to specifically study the preactive, interactive, and reflective decisions of teachers during new curriculum implementation. This proposed case study in conjunction with the quantitative research design should provide a unique and constructive perspective on teacher thinking. In general, teacher-thinking research is an area of investigation that can link educational theory to practice in the classroom. The potential impact of future investigational findings looks promising.

Methodology Introduction

The purpose of this project was two-fold: to investigate teacher thinking during new curriculum implementation and to compare student assessment scores between two groups of students. A qualitative case study was implemented to examine teacher thinking. Triangulation (Denzin & Lincoln, 2000) or a multiple qualitative methodology approach was selected to provide extensive, corroborated results. Individual semi-structured teacher interviews on planning were completed in
conjunction with a review of personal unit lesson plans. For insight into teacher interactive decisions, classroom observations were augmented by stimulated recall open-ended interviews. This comparison of observational data with interview data served as a form of “member checking” (Janesick, 2000), ensuring that the teachers’ decisions were interpreted accurately. Reflection was studied through open-ended individual teacher interviews and a concluding group interview with both participants.

Quantitative methodologies were utilized to investigate possible differences in student achievement between the two classes of senior students. The student population was a convenience sample consisting of Anatomy seniors taught by the two teacher participants. As both instructors were teaching the same microbiology unit and course objectives, differences in student achievement may permit comparisons between diverse teaching decisions and styles. In this study, the classrooms were in two different high schools in separate school districts. Obviously, not all variables (i.e. differences) between the two classes could be identified or experimentally controlled. Due to such uncontrollable variables in the quasi-experimental design, all quantitative analyses were used solely as descriptive statistics (Mertens, 1997). As such, the statistical comparisons were beneficial only as an additional means to describe the students’ curricular experiences.

The quasi-experimental design involved a pretest and posttest. The intact classroom (i.e.: the student class average) was used as the unit of analysis for all statistical calculations. An $F_{\text{MAX}}$ Test was applied to the pretest scores to evaluate the homogeneity of the two student samples. A single-factor analysis of variance
(ANOVA) of the pretest mean scores also was calculated to re-affirm sample homogeneity. Finally, a second one-way ANOVA of the posttest mean scores was utilized to identify any statistically significant difference between the class’s microbiology scores.

Assumptions

Several assumptions were made in the design of this investigation. The researcher assumed that the allotted time of classroom observation was adequate to successfully meet the objectives of the study. For the quantitative data analysis, the assumption was made that the students were cooperative and answered all test questions to the best of their ability. Otherwise, the collected student achievement data would not accurately reflect student learning and progress. Furthermore, the researcher assumed that the teacher participants answered the individual and group interview questions honestly and to the best of their ability. The very nature of this investigation—research of teacher thinking—naturally relied heavily upon teacher interviews and voiced reflections. Personal thinking processes during teaching are not observable to an outsider. Thus, only through candid and complete disclosure by the participants can thinking processes be revealed.

Limitations of the Study

Several limitations were acknowledged in the experimental design of this project. In a classroom setting, regulation of all extraneous variables often is not possible. Therefore, the external and internal validity of the research conclusions may be
jeopardized. The recognition of all possible limitations serves to lessen researcher bias and experimental error. In this section, limitations are discussed in reference to the following: case study research designs, quasi-experimental designs, internal validity, external validity, and interview methodology.

**Case Study Design**

The qualitative portion of this project focused upon the thinking strategies of secondary teachers before, during, and after classroom lessons. A naturalistic case study design was the selected approach. This methodology allowed an in-depth investigation into the background knowledge, beliefs, and personal goals of the teachers. In addition, observational data was collected about the classroom environment and teacher interactive decisions.

Taking all of the advantages of a case study into account, a main limitation exists. Cases studies can be susceptible to researcher bias and subjectivity (Mertens, 1997; Isaac & Michael, 1995). The very nature of a case study requires that the researcher make judgmental decisions in regards to the importance of data. For example, the researcher may selectively exclude data judged to be irrelevant in his or her opinion. In addition, the interpretation of the research data is subjective. Limitations in these instances could influence the results of the investigation.

Conversely, the fundamental objective of a case study design should be kept in mind. The essence of a naturalistic case study is the rich description of participants’ experiences, beliefs, and theories of action. The focus of this study was on teacher decisions within the context of their classrooms. As thinking processes are not
 overtly observable, the researcher’s role required in-depth interaction with the participants. Such interaction is necessary not only as a means to collect data, but also as a means to authenticate the participants’ viewpoint. As such, the research findings often are the result of corroboration between the participants themselves and the researcher. The researcher becomes the most important tool for data collection and data interpretation. In turn, the aspiration of total objectivity in qualitative research is not warranted. "In effect, it is now possible to question whether observational objectivity is either desirable or feasible as a goal” (Angrosino & Mays de Perez, 2000, p. 674).

**Quasi-experimental Designs**

The quantitative portion of this thesis, the student achievement comparison, was a quasi-experimental investigation. Quasi-experimental designs regularly are utilized in educational studies when random assignment is not feasible, such as in this project. The participants were convenience samples of intact senior anatomy classes. Several research limitations are intrinsic to a quasi-experimental design (Best & Kahn, 1993; Isaac & Michael, 1990). Therefore, the recognition of these limitations’ influence on the external and internal validity of the research design is important. The inability to control all pertinent variables within the classroom must be considered carefully in the analysis of the data. Additionally, the lack of randomization in sample selection restricts the rigid control of all variables, thereby reducing the generalizability of the research findings. However, the overall purpose of both the qualitative and quantitative portions of this study was not
generalizability. Rather, the purpose of the research design was the thick description of teacher thinking as new curriculum was implemented in specific classrooms.

**Internal Validity**

Several factors that may affect internal validity must be addressed within the research design (Fraenkel & Wallen, 1990; Best & Kahn, 1993; Isaac & Michael, 1990). A pretest was administered to the classes of students prior to the microbiology instruction. This pretest was invaluable in the initial comparison between the two participant groups. However, the pretest may create a “practice effect” (Best & Kahn, 1993), which could result in a higher proficiency on the posttest performance. In other words, the pretest may function as a learning event and affect the performance on the posttest. Also, the performance of the students may differ due to their maturation over the term of the experiment. “Differential experimental mortality” (Iassac & Michael, 1990, p. 59) or attrition may distort the research findings if any participant students drop out of study. Another significant limitation to internal validity involves the history of the participants. The students may encounter experiences outside the classroom that influence their achievement above and beyond the microbiology instruction. Lastly, any dissimilarity between the two student groups may confound the analysis of the posttest comparison. While initial statistical comparisons will be calculated, not all preexisting differences may be identified. For example, one class of participants may be better science students than the other classes. The maturity and/or the motivation level of the classes may not be equal, which also could affect overall student achievement. Thus, posttest
score differences may be a consequence of initial dissimilarities between the groups, rather than a consequence of classroom instruction.

**External Validity**

Several external validity limitations may affect the generalizability of the research findings (Best & Kahn, 1993; Isaac & Michael, 1990.) The convenience sample of students and teachers greatly restricts the external validity of this study. The participants were involved in a senior anatomy class in conjunction with a Tech Prep Allied Health program at a community college. The specific characteristics of the participants- such as socioeconomic, background experience, and intellectual factors- may cause the microbiology instruction (Treatment X) to be more or less successful with them than for random samples in the general population.

The use of a pretest also may influence the external validity. While the pretest is invaluable in determining the homogeneity of the two student sample populations, the pretest may affect the student achievement on the posttest. The pretest can alert the students as to the nature of the posttest after the instructional unit. Thus, the findings may not be generalizable to populations that were not pretested.

Lastly, the experimental design may affect the outcome of student achievement. The participating teachers and students may modify their behavior due to the presence of the researcher in the classroom. For instance, the students may study more on their own because of the research. Thus, the achievement on the posttest may not reflect solely the impact of the classroom instruction, and the external validity would be threatened. Again, my goal of the research design was not
generalizability. As a researcher, I will leave the prospect of transferability to other educational settings to the reader’s discretion.

**Interview Methodology**

Another area of possible limitations revolves around the interview methodology. Marshall & Rossman (1987), Fontana & Frey (2000), and Singer, Frankel, & Glassman (1983) discuss many inherent weaknesses of interview procedures. By their very nature, interview validity is dependent upon participant cooperation and forthrightness. Data reliability can be affected by an incomplete or faulty interview schedule. The depth and scope of the participant’s answers often is contingent upon the interview skills of the researcher, in addition to the development of a good participant-researcher rapport. Data reliability can be affected by an incomplete or faulty interview schedule. In turn, the researcher may misinterpret the answers to their questions. Interpretation of interview data is a subjective enterprise, and interpreter biases unintentionally may be integrated in the data analysis. In a worst-case scenario, the participants purposively may be untruthful or deceptive. For example, this situation could occur if the participants skew their answers in a manner to please the researcher or match outside expectations.

The first step in addressing all of these possible research design weaknesses is the acknowledgement that the limitations exist (Fontana & Frey, 2000). As the researcher, I incorporated triangulation within the research design to decrease the
affects of several limitations. Thus, I took specific measures to reduce possible limitations of the study. These methods will be described in detail in Chapter 3, the methodology chapter.
Definition of Terms

Curriculum Implementation. Curriculum implementation is the process of putting the planned curriculum or course objectives into action in the classroom.

Emic. The emic point of view is based upon the insider’s or participants’ perspective, rather than the researcher’s observational or outsider viewpoint.

Experimental Mortality. Experimental mortality is the loss of participants in an investigation, which can threaten internal validity.

External Validity. External validity is the generalizability of the research findings to other settings.

IEP (Individual Educational Plan). An IEP is a personalized learning plan developed by teachers and special education personnel for an individual student.

Interactive Thinking/Decisions. Interactive thinking occurs during instruction through the ‘interaction’ with the students. Such decisions often result from student feedback interpreted by the teacher.

Internal Validity. Internal validity is the certainty that the treatment caused any changes in the dependent variable or posttest.

Personal Practical Knowledge. Personal practical knowledge is the knowledge that teachers access during instruction based upon their past teaching experiences, personal pedagogical beliefs, teaching strategies, and content knowledge.

Preactive Planning. Preactive planning is planning that occurs prior to and in preparation for classroom instruction.
Quasi-experimental Design. A quasi-experimental design is utilized when the researcher cannot control all significant variables. The identification of design limitations must be recognized and addressed to ensure the validity of the investigation.

Reflective Practices/ Reflection. Reflection is a deliberative practice that assesses all factors of an educational situation.

Reliability. Reliability concerns the precision or consistency of the assessment instrument.

SPSS. SPSS is a statistical computer software program by SPSS Incorporated.

Teacher Planning. A cognitive organization of short-term and long-range goals to guide curriculum instruction for the classroom. Teacher planning includes decisions about curricular materials, classroom activities, student assessments, and student motivation.

Transferability. Transferability is a comparative practice made by the reader of a research article. By comparing the details of the published study with the specifics of a different setting, the reader may be able transfer or infer the research findings to another population.

Triangulation. Triangulation is the utilization of multiple research methodologies in order to obtain multiple data sources. These numerous data sources serve to confirm or “triangulate” the research findings.

Validity. The degree in which the measurement or assessment instrument evaluates what it is designed to measure.
Chapter 1 Summary

Chapter 1 introduced the need for research in the area of teacher thinking. Three categories/stages of teacher thinking were connected to curriculum decisions: teacher preactive planning, interactive decisions, and reflection. The purpose of the study and the problem statement were discussed, and the research questions were identified. The methodology, researcher assumptions, and limitations of the project were discussed. Lastly, Chapter I concluded with the definitions of related terminology.

Synopsis of Remaining Chapters

Chapter two is structured from the theoretical literature of teacher thinking and curriculum implementation. The selected related literature focuses upon three distinctive phases of teacher thinking: preactive planning, interactive decisions, and reflection. Chapter three explains the research design of the study. The application of the selected methodologies is defended through current research literature. In addition, the process of data collection, data interpretation, and analysis is discussed. Chapter four presents the case study findings involving the two teacher participants. Observational data is discussed to provide a rich background of teacher thinking during the implementation of a new curriculum. Excerpts from multiple interviews portray a first person account of the teachers' decisions before, during, and after classroom instruction. Chapter five provides the statistical analyses of the quantitative portion of this investigation. Chapter six presents a detailed discussion
of the research findings. The study concludes with recommendations for future research and implications for changes in curriculum design, professional development opportunities, and teacher education programs.
CHAPTER 2

REVIEW OF LITERATURE

The planning, interactive decisions, and reflective practices of teachers comprise a major portion of teacher thinking. These three cognitive phases affect multiple areas of classroom instruction, such as the following:

- Interpretation of the curriculum objectives or course of study
- Development of a personal, applied curriculum
- Development of learning activities and supplemental materials
- Evaluation strategies
- Classroom management policies
- Short-term and long-term curriculum goals
- Personal teaching strategies
- Classroom environment, student achievement, discipline, and student motivation

From teacher thinking, instructional plans and goals are transformed into action in the classroom. The learning environment is shaped and established through teachers' thoughts and decisions.

Research on teacher thinking connects teachers' thought processes and personal theories to action in the classroom. A broad range of research approaches and
perspectives on teacher thinking are presented in this literature review section. However, the expectations for the application of the research findings are similar.

"The ultimate goal of research on teachers' thought processes is to construct a portrayal of the cognitive psychology of teaching for the use by educational theorists, policymakers, curriculum designers, teacher educators, school administrators, and by teachers themselves" (Clark & Peterson, 1986, p. 112). By learning more about teacher thinking, the process of curriculum implementation and the very nature of teaching can be explored.

**Teacher Thinking Introduction**

Teaching is a profession that relies upon deliberation, reflection, and problem-solving skills. A complex combination of interrelated factors - influences both from within and outside of the classroom - must be considered. Such factors include the course of study, parental and administrative expectations, school policies, curricular objectives, and students' background knowledge and aptitude levels. The teacher's classroom experience, pedagogical beliefs, and personal knowledge of the content material also affect instruction. From the complex analysis of such factors, teachers develop and apply a distinct collection of knowledge through personal development and classroom experience. That knowledge is collectively referred to as teacher thinking.

Research on teacher thinking attempts to discover the connection between teacher thinking and classroom practice. Teachers uniquely connect their own personal beliefs and experiences to teaching activities. As such, teaching is an active practice.
that requires constant interpretation, analysis, and reflection in response to a variety of classroom circumstances. Calderhead (1987, p. 16) refers to these interchanging cognitive practices as “the fluid, interactive nature of teachers’ thinking.” Teachers deliberate in a cyclical manner, going back and forth between preactive planning, interactive, and reflective decisions as necessary. Their thinking processes draw upon multiple knowledge foundations that have developed over time with educational training and teaching experience. Wilson, Shulman, & Richert (1987, p. 107) state that “teachers think about a variety of issues during the preactive and interactive stages of teaching: teachers are constantly making decisions and they draw on a rich store of knowledge when they are engaged in planning and instruction.” In turn, these interconnected cognitive practices determine action in the classroom. A common goal of teacher-thinking research is to understand how teachers develop a specialized foundation of knowledge, and how this knowledge is accessed and applied in the classroom.

Current teacher-thinking research has begun to shed light on the intricate, multifaceted characteristics of teaching. “How teachers make sense of their professional world, the knowledge and beliefs they bring with them to the task, and how teachers’ understanding of teaching, learning, children, and the subject matter informs their everyday practice are important questions that necessitate an investigation of the cognitive and affective aspects of teachers’ professional lives” (Calderhead, 1984). The teacher-thinking research findings have revealed an extensive scope of knowledge underlying in teachers’ classroom practice. This knowledge unites personal beliefs and educational theories to wisdom about
students, teaching strategies, learning objectives, student behaviors, content knowledge, school organization, and the curriculum. The future of teacher thinking research is to discover how such knowledge is acquired, applied, and perfected. In the following sections, teacher thinking is related to teachers' theories of action, types of knowledge, and curriculum implementation.

**Teachers' Theory of Action**

Recent research on teacher thinking has revolved around the decisions teachers make before, during, and after student interaction. Such decisions are interdependent upon teachers’ background knowledge, practical intelligence, and content knowledge. These types of knowledge develop over time in the context of the teacher’s classroom setting. The compilation of all these types of knowledge constitutes a teacher’s personal, educational philosophy, which is commonly termed a teacher’s ‘theory of action’ (Argyris, 1982; McCutcheon, 1992, 1995; Connelly & Clandinin, 1984; Sanders & McCutcheon, 1986; Schon, 1983; Clark & Peterson, 1986).

McCutcheon (1992, p. 191) states “a teacher’s theory of action consists of sets of beliefs, images, and constructs about such matters as what constitutes an educated person, the nature of knowledge, the society, and the psychology of student learning, motivation, and discipline.” These sets of beliefs originate from the practical experiences of teaching and are nurtured through reflection upon successful situated lessons. Argyris (1982) proposes that all purposeful actions are based upon personal theory, whether the actions appear to be consciously or unconsciously directed by the
individual. Thus, teachers must have a working theory of action to be able to teach, not only to be effective, but also to even recognize the need for action in the first place. A teacher's theory of action enables him or her to interpret the educational situation or occurrence, make meaning of the problem in context, mentally scrutinize multiple possible solutions, and select an appropriate action. This rational sequence of events constitutes a teacher's theory of action in practice (Argyris, 1982).

Since the act of teaching constantly presents new practical experiences in the classroom, a teacher's theory of action is evolutionary in nature. As such, a teacher's content knowledge, practical intelligence, and background knowledge is in a continual state of development, changing through experiences inside and outside of the classroom. “Teachers do not operate on the basis of a single theory of practice, but rather on the basis of many (of which they may or may not be aware)” (McCutcheon, 1992, p. 192). Thus, teachers continually modify and reassess their theory of action (consciously and unconsciously) through student interaction and self-reflection.

In practice, a teacher's theory of action guides the teacher's behavior and curricular decisions in the classroom. Clandinin (1985) proposes that both unconscious and conscious principles and convictions form teachers' personal practical intelligence, which in turn influences the guiding force of their theory of action. To an outside observer, many teacher decisions appear to be automatic or reflexive in nature. This can be especially true of interactive decisions made during instruction without interruption of the lesson. One example of such a decision is when a teacher correctly interprets that a particular student is not on task, and moves
toward that student during lecture to gain their attention. Another example could be when a teacher interprets that an overall class is confused about a concept, and changes instructional activities during the lesson to increase student comprehension or interest. These unexpected, spontaneous decisions may appear to be unconscious or automatic responses. However, in reality such “instinctive” actions are based rationally upon the teacher’s theory of action, which guides his or her decisions in practice (Schon, 1983; Clark & Peterson, 1986; McCutcheon, 1992). Rather than refer to established pedagogical research theorems, in practice teachers access and implement action based upon their own sets of beliefs and experiences for effective student instruction.

A personal theory of action is based upon three types teacher knowledge: content knowledge, background knowledge, and practical knowledge. These three types of knowledge are further explored in the following sections.

**Background Knowledge & Experience**

The background knowledge of teachers emerges from their own past experiences, attitudes, and notions about teaching and the educational system. Significant experiences include not only past classroom teaching experiences, but also past educational experiences as students themselves. These experiences influence the teacher’s personal belief system about the role of the teacher, instructional practices, and pedagogical assumptions (Ross, 1992; Shulman, 1986). For example, teachers may rely upon their background knowledge of a classroom from their own memories as an elementary student. If a new teacher attended a school as a child where lecture...
was the main focus of instruction, then initially the teacher may revert to that familiar lecture format. In turn, if a teacher was familiar as a student with an open forum of classroom discussion or hands-on learning, then as a new teacher he or she might implement a similar type of curriculum. On the other hand, a teacher’s beliefs about the role of education can be influenced by his or her family’s beliefs and assumptions. For example, a teacher’s personal opinion as to the integration of religious, cultural, or moral beliefs into the curriculum of public schools may be influenced by his or her own cultural experiences. This background knowledge is one of many factors that help mold a teacher’s theory of action. While background knowledge remains a part of the teacher as an individual, new experiences and fresh pedagogical information obviously changes a teacher’s background knowledge over time. “Although teacher’s background experiences are of great importance at the preservice and induction stages of teaching, teaching experiences in particular classroom and school settings also shape the teacher’s theories of action” (Ross, 1992). In addition to background experience, a teacher’s theory of action is also comprised of content knowledge and practical intelligence.

**Content Knowledge**

Content knowledge originates from two basic modes of intelligence: background knowledge about the subject matter and the methods teachers employ to convey that subject matter to their students (Calderhead, 1988; Shulman, 1986). The teacher’s personal knowledge of a subject impacts the curricular and interactive decisions of a teacher. For example, if a teacher is very familiar with the subject matter, he or she
will be better equipped to relate the content to the students’ lives inside and outside
of the classroom. A consequence of familiarity and expertise in a subject is an
increased awareness of the fundamental concepts and skills related to the topic.
Thus, the content knowledge of a teacher can impact the implementation of course
objectives.

As curriculum implementers, teachers must interpret the curriculum and decide
the most useful methods to represent the subject matter to instruct their students.
Such interpretation involves knowledge about the ways students learn, including
student differences in subject interest, motivation, and learning ability. This
philosophy backs up the position that teachers are not tools to merely transmit
knowledge. Rather, teaching involves specific, applied knowledge - content
knowledge - to enable students to learn and make meaning from the curriculum.

As with background knowledge, content knowledge is not a static condition.
Content knowledge is continuously revised through new classroom experiences and
new discoveries in the subject area. Most importantly content knowledge matures
and develops through increased interaction with students. As a teacher gains
expertise through instructional experiences, the teacher becomes more adept at
interpreting the subject matter for better student comprehension. In turn, the teacher
is better able to relate the content to students’ own background experiences,
including the students’ preexisting level of understanding of the subject matter.
Borko, Bellamy, & Sanders (1992) labels this type of knowledge as ‘pedagogical
content knowledge” or “pedagogical reasoning”. “This domain of knowledge (i.e.,
pedagogical content knowledge) consists of an understanding of how to represent
specific subject matter topics and issues in ways that are appropriate to the diverse abilities and interests of learners” (Borko, Bellamy, & Sanders, 1992). In summary, content knowledge is the stored knowledge of teachers that is referenced before, during, and after instruction to enhance the representation of the subject matter to the students. In turn, content knowledge is gained not only through an increased knowledge of the subject topics, but also more importantly through teacher experiences from student interaction.

**Practical Intelligence**

Practical intelligence is knowledge that stems from teaching experiences and classroom knowledge. Such intelligence revolves around the classroom environment and the everyday functions and occurrences that constitute daily school life (Schon, 1983; Shulman, 1986). Teachers as practitioners access their practical knowledge in order to make constant decisions about the students, the curriculum, behavior management, and assessment. The act of teaching requires continual interpretation of the situation at hand in order to make informed choices. Schon (1983) refers to this reliance upon practical intelligence as “reflection-in-action”. Thus, teachers do not rely solely upon pedagogical theories to make all classroom decisions. Rather, teachers reflect upon their own personal experiences in the classroom to arrive at effective practice. This theory of “reflection-in-action” explains the documented differences in the classroom practices of expert versus novice teachers. Expert teachers have multiple past experiences in how to handle various situations in the classroom. They rely upon their practical intelligence to make impromptu decisions.
under a variety of circumstances. Even the ability to recognize a potential problem—such as student incomprehension during a lesson—requires practical knowledge. Thus, novice teachers are at a disadvantage until they gain experience in various educational situations.

In general, practical intelligence is comprised of a teacher’s broad-spectrum knowledge base about teaching. This knowledge ranges from experiences with student interaction to experiences with the organizational structure of their school and school district. The acquisition of practical intelligence emerges over time and builds upon the teachers’ content and background knowledge (Connelly & Clandinin, 1988). Teachers assimilate their background, content, and practical knowledge into an operational theory of action. Consequently, teachers’ planning, interactive, and reflective decisions originate from their theory of action. The experienced, enacted, or ‘lived’ curriculum is constructed from these decisions and teacher-thinking processes. Thus, teacher thinking has a major impact upon curriculum implementation. The following section will discuss this connection between curriculum implementation and teacher thinking.
Teacher Thinking and Planning with Technology

The introduction of technology into the curriculum requires the connection of established instructional strategies with the effective application of computers. A change occurs in planning and decisions in regards to lesson content, assessment, educational objectives, and classroom management (Cline & Mandinach, 1994; Earle & Moallem, 1998). Often the roles of the teacher and the students are modified. The instructor’s decisions not only guide student application of the technology. Preactive planning and interactive decisions also determine the degree to which the technology enhances the original educational objectives. The technology can be implemented as another educational tool in addition to pre-established goals. In contrast, the technology eventually may evolve as an integral component of the goals, expanding the curriculum (Cline & Mandinach, 1994; Roskos, 1996). Educators must formulate decisions to productively implement technology within the core curriculum. In addition, pedagogical experience merges with the knowledge and application of the technology.

From field-based research, Sandholtz, Ringstaff, and Dwyer (1997) propose five “stages of concern” during technology integration in the curriculum. These stages reflect the changes in teacher thinking and planning as the application of technology progresses. The “entry stage” occurs during the introductory attempts to utilize the technology with students. During “entry”, teachers are still becoming familiar with the technology, and therefore most of their decisions focus upon unforeseen problems with the software/hardware and classroom behavior management.
Sandholtz, Ringstaff, and Dwyer (1997, p. 62) state the following:

"Teachers were preoccupied with their own adequacy. They spent a considerable amount of time reacting to problems instead of anticipating and avoiding them. During this entry stage, teachers felt unprepared to deal with unanticipated management problems, and focused their energies upon managing the classroom rather than becoming instructionally innovative."

In other words, initially teachers' decisions center on their own ability to effectively employ the technology and maintain classroom order.

Increasing classroom practice with the technology allows teachers to progress beyond fundamental utilization of the technology. Sandholtz, Ringstaff, and Dwyer (1997) classify this time period as the "adoption stage". By this phase, teachers are able to predict problems and employ various techniques for resolution. The teachers' comfort level with the technology and the associated changes in the classroom enables interactive decision-making. Also, as the teachers and the students become accustomed to these classroom changes, fewer problems occur. In the third "adaptation" stage, teachers begin to utilize the technology to benefit themselves, as well as their students. This benefit is realized in regards to classroom management, record keeping of student progress, and the depth of the subject matter.

"Teachers no longer viewed the process of learning to use the computers as infringing upon the curriculum. Teachers now were able to use the technology to enhance student motivation and interest while decreasing
the number of discipline problems” (Sandholtz, Ringstaff, & Dwyer, 1997, p. 71).

The final “invention” stage is more of an adjustment of attitude in the teachers’ approach toward technology application in education. With an increase in comfort and ability, teachers increasingly view technology applications as an integral component of their curriculum. In turn, teachers reflect upon their instructional strategies to revise and improve their effectiveness in the classroom. At this point, the teachers use the technology in a collaborative effort with their students. The role of the teacher transforms from one of a giver of knowledge to one of a facilitator of knowledge.

Jonassen & Hannum (1987) recognize the importance of student success during the learning process. This impacts the planning and decisions performed by the teachers in relation to the technology-based curriculum. Effective planning of instructional strategies requires that the teacher must be able to judge the cognitive and social level of the students in the class. “A teacher’s ability to design high-success lessons depends on his or her knowledge of the subject matter as well as knowledge of the students’ rate of learning” (Jonassen & Hannum, 1987, p. 9). Often effective use of technology permits the individualization of student learning. Many technological programs allow students to go at their own pace and revisit misunderstood material. In order to make the most of this possibility, the instructor must first consider the capabilities of the individual learner and eventually assess success with the content and technology.
Teachers' reflection upon their role as educators, their instructional objectives, and their previous notions of a classroom environment is necessary to embrace the possibilities of technology. Only through such reflection can teachers visualize the advantages and incentives of technology in the curriculum (Dwyer, Fisher, & Yocam, 1996). This practice of introspection also provides insight into disadvantages and possible problems associated with the implementation of technology. In turn, such reflection promotes revision and refinement for constant instructional improvement. The implementation of technology into the curriculum reconstructs not only the organization and function of the classroom, but also the fundamental role of the teacher. Progressions evolve in teachers' thinking and planning activities. The preplanning phase often takes precedence during the initial introduction of the technology, as this is a learning experience of the instructor as well as the students. As the utilization of the technology proceeds, teachers can eventually focus on innovation of instructional strategies and curricular enhancement. By this stage, technology is no longer merely viewed as an educational tool, but rather as an indispensable component of the curriculum. The interaction between the student and teacher may even change to reflect the role of the instructor as a facilitator to learning. In addition, teachers integrate their pedagogical experience and classroom management expertise with their technology curriculum planning. In this sense, technology can provide the impetus for a radical transformation in the curriculum and classroom environment.
Common Obstacles with Technology Integration

A variety of factors may impede the process of successful implementation of new curricular technology. Some of these factors arise from the students’ perspective, some from the teacher’s perspective, and some develop from administrative or scheduling obstacles. The effective integration of technology into a preexisting curriculum can be a challenge for both students and teachers. However, the identification and anticipation of possible problems during classroom application can limit deleterious effects.

First and foremost, effective inclusion of technology into the classroom requires that the teacher be comfortable with the software and related equipment. The accessibility of hardware within the classroom and the availability of school technology support personnel are vital during the teacher’s initial planning stage. Pre-active planning time may be extensive, especially if both the subject matter and the technology are new and untested with the particular student population (Roskos, 1996). Complete familiarity with the technology allows the teachers to concentrate upon student interaction and on-task behavior, thereby increasing the productivity of the lesson.

The teacher and administration should also be receptive to changes within the classroom environment. In general, students actively engaged in computer applications are anxious to share and compare their findings with other students in the classroom (Cline & Mandinach, 1994). Teachers should expect enthusiasm and curiosity, which can lead to a more open, cooperative learning environment. Providing freedom for student movement and frequent exchanges is vital to stimulate
teamwork and problem solving skills. However, this type of constant student interaction may be in direct contrast to the more conventional classroom setting, with students remaining at their desks or group tables. Students may need to adjust to the necessary modifications in classroom management. This progression toward an unconventional, flexible classroom can be one of the most innovative aspects of technology integration. The anticipation and acceptance of such an environment by school staff, students, and parents can enhance the successful application of the technology (Cline & Mandinach, 1994).

Another concern is the increasing necessity of newly formed, appropriate evaluation techniques. The collaborative nature of lessons involving computers and technology may make traditional assessment tools obsolete (Dwyer, Sandholtz, & Ringstaff, 1997; Cline & Mandinach, 1994). As with collaborative situations, technological applications may make individual comprehension difficult to evaluate. Competency may be related to both content knowledge and overall skill with the technology. The emphasis on factual objectives may very well shift to the student's ability to locate information on-line. Conversely, the ability of a student to locate information with technology may not adequately reflect their degree of comprehension of the material. Research (Carlson & Falk, 1995; Roskos, 1996; Earle & Moallem, 1998) often indicates that while lessons involving technology are cooperative, the students are assessed individually without the use of the technology. Cline and Mandarich (1994, p. 142) summarizes the assessment problem as follows:

"Assessment procedures need to change to incorporate the emphasis on the process of learning, not just the outcomes of instruction. The
increasing emphasis on the processes and procedures of learning changes the nature of assessment, and runs counter to most traditional assessment techniques. The wide discrepancy between classroom curricular applications and evaluation needs to be addressed.”

As with the implementation of all new curricular programs, the integration of technology in the classroom will not be successful without the support of the school administration (Carlson & Falk, 1995). Teachers not only require initial training and additional planning time, but the opportunity of continued technical support as needed. The continual addition of new educational objectives, such as keyboarding and computer skills, can place an enormous strain on the teacher and students. A finite amount of time is available to cover an ever-increasing amount of material, and re-evaluation of the course of study may be required. Financial support from the administration and the community is vital to technology integration in schools, allowing students ample access to computers on a daily basis. Lastly, “logistical support” in regards to class scheduling may be necessary. “Experience has shown that flexible scheduling and interdisciplinary teaching arrangements greatly facilitates” the application of technology in the classroom (Jonassen, 1996, p. 267).

In order to adequately facilitate learning and promote student interaction during the lesson, teacher commitment to the technology integration is essential. Initially, the incorporation of technology may be a more demanding and time-consuming process than traditional curricular applications. The preactive planning stage should include proficiency with both the content area and the technology (Putt, 1996). During the lesson, the act of teaching the students to correctly use the technology
must be balanced with the successful completion of the educational goals of the
subject matter. These additional responsibilities necessitate the commitment of the
teacher and the administration to ensure beneficial technological integration. The
rewards in terms of student comprehension and interest can be well worth the extra
effort. A plethora of information is available to students through the effective
application of technology in the classroom. The tie between education and
technology can be invaluable.

Curriculum Implementation and Teacher Thinking

The definition of curriculum has undergone a metamorphosis since being
introduced as a theory early in the twentieth century. Many, if not most, current
educational researchers no longer consider the ‘curriculum’ solely as a document of
the subject content, course objectives, texts, and supplemental classroom materials.
A more complex, practical definition has emerged. Curriculum is now perceived as
a process or experience that encompasses the subject content, the teacher, the
students, and their collaborative interpretation of the subject matter (Dewey, 1902;
Calderhead, 1987; McCutcheon, 1992; Clark & Peterson, 1986; Connelly &
Clandinin, 1988). As such, the recognition of the relationship between teacher
thinking/decisions and curriculum implementation has gained importance in
educational research.
A Changing View of Curriculum

One of the earliest proposed theories of curriculum begun with Bobbitt's (1918) viewpoint of curriculum. Curriculum was defined solely on the basis of the content, teaching materials, and planned student activities. Well-defined terminology was developed to relate learning variables and student outcomes. A purposeful distinction was made between the curriculum and the actual act of teaching, diminishing the role of the teacher in practice (Elbaz, 1983). As such, the curriculum was an intact design to guide instruction regardless of the uniqueness of the teachers, students, or classroom settings. This traditional definition of curriculum remained the status quo for a long time. Perhaps even the positivistic approaches to curriculum over the past thirty years were somewhat influenced by Bobbitt's theory. Researchers such as Beauchamp (1972) also formulated their theory of curriculum around specific, scientific terminology. The goal of curriculum research was to formulate hypotheses in relation to learning variables. This utilization of the scientific method to define curriculum was a linear approach to learning. The positivistic objective of a curriculum was to combine research and pedagogical theory in order to continuously evaluate and verify learning objectives. Again, the view of curriculum was one of a static plan for instructional guidance and accountability.

Dewey's (1902; 1933) educational theories challenged the treatment of curriculum and instruction as separate entities. Dewey's pioneering characterization of curriculum was one grounded in classroom experience—experience both from the viewpoint of the students and the teacher. Curriculum was the compilation of all events in the classroom that lead to learning, whether the learning experiences were
explicit or implicit in nature. In other words, learning was not limited to the written, planned curriculum objectives of a lesson. Rather, the curriculum included all aspects of interaction between the teacher, the students, the subject matter, and their own personal background knowledge. This 'living' definition of curriculum recognized that teaching was more than the technical application of written learning objectives. Instead, the decisions that teachers made were based on the environment at hand. Teachers incorporated their own practical knowledge into the lesson and interpreted the comprehension of the students. Curriculum was the shared experience in the classroom environment (Dewey, 1920).

The purpose of this investigation was to research teacher thinking during new curriculum implementation. This research was grounded in the theoretical position of an 'experienced curriculum' in agreement with Dewey. Curriculum implementation was viewed as a shared enterprise between the teacher and the students, situated in the context of their particular classroom environment. Thus, the teacher-thinking practices were considered an integral part of the microbiology curriculum implementation.

**Curriculum Implementation: Teachers as Decision-Makers**

Curriculum implementation once was viewed narrowly as the mere application of prewritten or pre-developed curriculum objectives and activities. Curriculum specialists developed the course objectives, and teachers were considered simply as implementers (Moallem & Earle, 1998). From this stance, the possibility existed for prepackaged curriculums that could be taught to any group of students in all
educational settings by any teacher. Thus, these curriculum packages were considered to be ‘teacher-proof’, in that the role of the teacher was devalued in an effort to standardize educational practices. The interpretation and distinctive application of the curriculum by individual teachers was not acknowledged. Kimpston (1985) categorized this type of curriculum interpretation as “curriculum fidelity”. The effectiveness of instruction was measured by the degree of correlation between the written curriculum document and teachers’ actions in the classroom. For example, Kimpston (1985) proposed that teachers who strictly followed the “prespecified curriculum” placed a higher educational value on the responsibility of curriculum implementation. Thus, the active role of teacher thinking in curriculum implementation was ignored. Teacher decisions, made in view of students’ background knowledge, interests, and ability, were disregarded. This viewpoint severely limited the perceived value of teacher decisions in the educational process.

Stemming from Dewey’s philosophy of ‘experienced curriculum’, the perception of curriculum implementation has changed. Researchers such as Calderhead (1987), McCutcheon (1992), Clark & Peterson (1986), Connelly & Clandinin (1988), Schon (1983), and Cho (1998) now point toward a much broader, working definition of curriculum implementation. Curriculum implementation now not only consists of the written course objectives and activities, but also encompasses the decisions and actions of teachers in all phases of instruction. The role of the teacher and the student in the cooperative construction of meaning making is recognized as a vital part of the learning process. Thus, implementation is viewed as curriculum in action.
This more realistic definition of curriculum implementation places much more attention upon the role of the teacher during the implementation process. Curriculum as a shared experience requires the teacher to interpret the course objectives in relation to his or her particular classroom setting. For example, a teacher makes continual decisions about the application of the curriculum during all phases of instruction. During preactive planning, the teacher interprets the curriculum in consideration of the students' background knowledge of the subject matter. The introduction and approach to the content often depends upon previous student knowledge and/or life experiences of the topic. Such teacher decisions can situate the content within the realm of students' reality and understanding, making the lesson experiential in nature. Without such curriculum interpretation, the lesson can end up as an effort to passively transmit knowledge to the students – diminishing the significance of the lesson for the student (Connelly & Clandinin, 1988).

As discussed in the preceding section, curriculum implementation is now routinely perceived as an active process that incorporates teacher thinking and reflection. McCutcheon (1995) reinforces this definition through case studies of teacher deliberation during curriculum implementation. Teacher interpretation of the curriculum is seen as a critical step during the implementation and planning phases of educational practice. However, McCutcheon (1995) also emphasizes the importance of self-reflection during implementation. Self-reflection encourages teachers to contemplate the scope of their own knowledge about the topic in order to select what to teach and how best to engage the students. "Teachers select and enact
every teaching practice rationally because they are engaged in intentional, purposive action to create optimum conditions for learning to occur” (McCutcheon, 1992, p. 193). This reflection also permits a review of what has worked, what activities need refinement, and how best to instructionally meet the needs of the students. Thus, again, research findings indicate that curriculum implementation is a multifaceted, contemplative, active process that interweaves course objectives with teacher thinking.

The reassessment of curriculum implementation has resulted in a new perspective on the inter-relatedness of the teaching process and the curriculum. The role of the teacher is recognized as one of an interpreter, as well as an implementer. The significance of teacher thinking is acknowledged as vital to the successful implementation of course objectives in the context of each specific classroom setting. Researchers such as Cho (1998) are calling for a movement away from the long-standing perspective of “curriculum fidelity”. Instead, an “enactment perspective” of curriculum implementation recognizes the construction of meaning by both teachers and students (Cho, 1998). This view of curriculum as a shared student-teacher experience further reinforces the influence of teacher decisions upon implementation. Three phases of teacher thinking – preactive planning, interactive decisions, and reflection – are directly connected to curriculum implementation and a teacher’s theory of action. These three teacher-thinking phases are discussed in the following sections.
Teacher Thinking: Preactive Planning, Interactive Decisions, and Reflection

In the following sections, a literature review of the phases of teacher thinking under investigation in this study is presented. The study of preactive planning, interactive decisions, and reflection during new curriculum implementation was the overall purpose of this project.

Preactive Planning

Investigations in the area of teacher planning are an integral part of teacher-thinking research. Every teacher must utilize some type of curriculum planning, regardless of whether this constitutes a formal, written plan or an informal, mental plan. Teachers rely upon their planning decisions to guide future action in the classroom. Curriculum specialists plan course of studies for multiple grade levels. In addition, student teachers spend a large quantity of time learning planning strategies. Therefore, “to understand teacher planning is to understand a great deal about teaching; the study of how teachers prepare for instruction can reveal much about which features of subject matter, students, and the physical, psychological, administrative, and political environments actually influence classroom instruction” (Clark & Dunn, 1991, p.184).

Researcher Philosophies on Teachers' Preactive Planning

Multiple researchers have investigated teacher planning utilizing numerous methodologies in an attempt to demonstrate the significance of teacher thinking and curricular decisions. Naturally, the preactive planning decisions — that is, the
planning decisions that occur before instruction begins — have a direct impact upon student learning. Preactive planning involves an interpretation of the subject matter, so that the teacher can select the most appropriate methods of representing the material to his or her particular class. In turn, the preactive planning decisions not only effect how the lessons will be represented and taught, but also what specific objectives will not be taught.

“When the materials call for acting on a learning theory, a form of classroom organization, or teaching content with which the teacher disagrees, teachers either transform the activities to make them consonant with their theories or do not teach those activities” (McCutcheon, 1992).

During this interpretation of the subject matter, the teacher also makes decisions in regards to the students’ background knowledge and interest in the topic. This enables the teacher to select learning activities that will encourage the students to relate and apply the new knowledge inside and outside of the classroom. In general, preactive planning is a phase of teacher thinking that draws upon the teacher’s practical intelligence and content knowledge. Through reflection of their past teaching experiences, teachers can predict the potential success of planned learning activities — even in unique situations such as a new class of students or a new course of study. This reflection, in conjunction with teacher’s content knowledge, is a significant portion of the preactive planning phase. As a result, teachers can design a flexible, curricular course outline to guide their instruction within the context of their own classroom situation.

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Clark & Dunn (1991) and Clark & Yinger (1987) identify two current perspectives of teacher planning research. One research domain centers upon the theories and approaches of cognitive psychology. Planning is defined as "a set of basic psychological processes in which a person visualizes the future, inventories means and ends, and constructs a framework to guide future action" (Clark & Dunn, 1991, p. 185). The other researcher stance applies a "phenomenological or descriptive" approach. Planning is studied from the teachers' perspective through narratives, interviews, or collaborative research. From this perspective, planning includes "things that teachers do when they say that they are planning" (Clark & Dunn, 1991, p. 185). Obviously, the methodologies selected to investigate planning depend upon the initial perspective of the researcher.

Calderhead (1994, p. 79-83) discusses six main characteristics of teacher planning:

1) Planning take place at various levels according the proposed timeframe (i.e., daily vs. weekly vs. semester vs. yearly plans).

2) Planning take place at various levels according to the proposed timeframe

3) Often, teachers do not write formal, in-depth lesson plans.

4) Teacher planning is a creative effort that involves resourceful and inventive solutions to instructional problems.

5) Planning is "knowledge-based" in that teachers compile plans in consideration of multiple influences. These influences include the
subject matter, student background knowledge, student interest, curriculum materials, and time limitations.

6) Experienced teachers incorporate flexibility into their lesson plans. The unique nature of individual classes and students requires flexibility. Not all students can learn at the same pace or with the same strategies. Flexibility permits the teacher to “fine-tune” lesson plans as needed.

Calderhead (1994) states that multiple factors are considered during teacher planning, such as learning objectives, content interpretation, student interests, and cooperative learning groups. Thus, teacher cognition “includes knowledge of children, educational aims, subject matter, curriculum materials, teaching strategies, and classroom processes. Planning at ‘higher’ levels also includes knowledge of ‘self’, ‘the role of teachers’, and ‘the expectations of others’, which are particularly influential during periods of curriculum change” (Calderhead, 1994, p. 16). These relevant knowledge bases serve to guide curriculum planning and aid in the response to unanticipated situations/problems during instruction.

Morine-Dershimer (1991) and Clark & Dunn (1991) found that expert teachers often do not develop and utilize formalized, detailed, written lesson plans. Instead, experienced instructors teach from informal, rough outlines of the lesson plans they mentally constructed. “In working through lessons, veteran teachers are guided more by images of what the lesson will be like and how it should proceed (based on past experience) than by specific lesson plans” (Clark & Dunn, 1991, p. 187).
Experienced teachers understand that the unique environment of each class requires lesson plan flexibility and interactive decisions that can only be addressed during instruction. Thus, often only veteran teachers have the background knowledge and classroom experience to guide planning decisions. Overall, the time spent in creating preset, unadjustable, meticulous lesson plans may not serve either the students or the teacher. Applicable teacher plans are often developed, modified, and renovated within the realm of cognition.

McCutcheon (1995) also found that teachers depend more upon their mental plans for instruction than detailed written lesson plans. The intricacies of the mentally planned classroom activities are not recorded fully on paper. Instead, an instructional outline may be constructed to guide action in the classroom.

“A mental rehearsal of the lesson seems to be an integral part of their planning. Teachers have in mind a general approach and sequence for the lesson. They envision it in action and rehearse what they will say, what questions to ask, when to distribute materials, what to assign for practice or evaluation purposes, what difficulties are likely to occur, and how long the lesson is likely to take” (McCutcheon, 1995, p. 46).

Thus, a huge portion of teacher lesson planning is a “deliberation” of the content material, the social context of the classroom, students' background knowledge and interests, available materials, and other influences upon curriculum implementation.

Moallem & Earle (1998) propose a “conceptual model” of teacher thinking that includes teacher planning. Teachers’ planning activities take both their “personal and practical knowledge” into account. Moallem & Earle (1998, p. 17) define
personal practical knowledge as a reflection of the “classroom and the school contexts as well as their own meaning about teaching and instruction.” Thus, teachers reflect upon their beliefs and experiences to make curricular decisions on how, what, and when to teach content. The planning decisions also are based on the “social context”. These interrelated planning influences “explain why teachers should be thought of as designers of their own curriculum rather than merely implementers” (Moallem & Earle, 1998, p. 17).

Clark & Yinger (1987) also propose that teacher planning occurs in levels according to the school timeline. Planning is broken down into daily, weekly, unit, term, and yearly levels. The motivation and substance of the plans varies according to the levels. In addition, decisions in any one level are made in regard to the plans of the other levels. Clark & Yinger (1987) describe teacher planning as a continuous, cyclic process of deliberation. Teachers most often develop plans by looking back at the success of the last lesson and by looking forward to future goals. Therefore, planning is accomplished through the intertwining of multiple past, present, and future considerations.

Jackson (1968; 1990) also found that teachers commonly refer back to previous classroom experiences during planning. In addition, Jackson (1990) states that planning occurs in three phases: “preactive, interactive, and postactive.” “Preactive planning” involves deliberations about student ability levels, time constraints, contextual considerations, classroom activities, and necessary curriculum materials. “Interactive planning” occurs during classroom instruction. Obviously, the course a lesson may take during instruction always cannot be anticipated. Students’ interests
and levels of comprehension often guide the flow and direction of a lesson. In such situations, interactive decisions are on-the-spot planning sessions. "Postactive planning" is a reflective planning stage that can result in modifications or improvements of future lessons. Overall, Jackson (1968) emphasized the connection between teacher thinking research and knowledge of classroom practices.

Clark & Peterson's (1986, p. 267) research is a comprehensive study of teacher thinking/teacher planning literature. Their literature review indicates that teacher planning does have considerable influence on the "learning opportunities" available in the classroom. Several stages of planning are identified, including preactive planning, interactive planning, and postactive planning. The purpose, deliberations, and activities involved in the phases of planning are interdependent. Clark & Peterson (1986) also propose that many planning details are not written in the preactive phase. Teachers realize that the specifics of a lesson revolve around unpredictable interactions with the students during instruction. Therefore, teacher planning often is a broad outline or rough sketch of what may occur in the classroom and is flexible to allow for modifications and reinterpretations during classroom instruction. "To understand fully the operation of teacher planning, researchers must look beyond the empty classroom and study the ways in which plans shape teacher and student behavior and are communicated, changed, reconstructed, or abandoned in the interactive teaching environment" (Clark & Peterson, 1986, p. 268).
<table>
<thead>
<tr>
<th>RESEARCHER</th>
<th>RESEARCH AREA/PROBLEM</th>
<th>RESEARCH CONCLUSIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calderhead (1994)</td>
<td>Characteristics of teacher planning</td>
<td>Teacher planning is often informal, knowledge-based, and creative.</td>
</tr>
<tr>
<td>Clark &amp; Dunn (1991)</td>
<td>Perspectives of teacher planning research</td>
<td>Research is guided by cognitive psychology or by ethnographical perspectives</td>
</tr>
<tr>
<td>Clark &amp; Peterson (1986)</td>
<td>Review of teacher thinking research</td>
<td>Teacher planning has a significant impact upon student learning opportunities</td>
</tr>
<tr>
<td>Clark &amp; Yinger (1987)</td>
<td>Planning levels: daily, weekly, unit, semester, yearly</td>
<td>Deliberative practices change depending upon the level of planning</td>
</tr>
<tr>
<td>Jackson (1990)</td>
<td>Planning Phases</td>
<td>Teacher preactive, interactive and postactive planning occurs at various times and with multiple intentions</td>
</tr>
<tr>
<td>McCutcheon (1992;1995)</td>
<td>Deliberation of the curriculum/teacher thinking</td>
<td>Much of teacher planning is a mental deliberation, rather than a detailed written account</td>
</tr>
<tr>
<td>Moalle &amp; Earle (1998)</td>
<td>Conceptual models of teacher thinking</td>
<td>Planning is dependent upon a combination of personal and practical teaching knowledge</td>
</tr>
<tr>
<td>Morine-Dershimer (1991)</td>
<td>Teacher planning: complexities and influences</td>
<td>Complex planning deliberations are done mentally in consideration of past classroom experiences</td>
</tr>
</tbody>
</table>

**TABLE 2: TEACHERS' PREACTIVE PLANNING RESEARCH SUMMARY**

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Planning is a vitally important component in teaching and student achievement. Planning research can illuminate multiple characteristics of educational practice. Not only can such research provide information about teacher thinking, interactive decisions and actions, and teacher beliefs, but information about the students also emerges. The findings from planning research often can be applied directly in the classroom to enhance learning. By learning more about the cognitive practices of teachers as they plan, researchers can make the huge theoretical jump from teacher thinking to action in the classroom. Such information can have an impact upon teacher education programs. What is the best instructional method to sharpen the planning skills of novice teachers? How can educational students learn to interpret and explain curriculum at the students' level, plan short-term and long-term learning objectives, and incorporate flexibility within their lesson plans to take advantage of unplanned learning opportunities during instruction? Data from planning research can address these novice teacher issues. In addition, planning research can make an impact upon courses of study, standardized tests, and district or state curriculum decisions. In view of teacher planning research, are prepackaged published curriculum units effective? How can textbooks incorporate the flexibility and individuality of lessons that are needed for successful curriculum implementation? Does the organization of schools allow enough planning time for teachers to adequately prepare for innovative lessons? Such questions may be addressed through teacher planning research. "The field of educational research has reached a stage of development at which more comprehensive studies are possible and

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desirable, and in which attention to teachers’ planning, to teachers’ intentions, and to classroom routines is essential” (Clark & Dunn, 1991, p. 198).

**Interactive Decisions**

Interactive thinking encompasses the decisions that teachers make during instruction. These decisions are conscious deliberations based upon the interaction and communication with students. Often, such decisions involve student comprehension, student interest, or behavior issues. An ‘expert’ teacher can identify such areas for concern while teaching. The interactive decision then requires a choice of action for classroom application.

**A Definition of Interactive Thinking**

The early history of research on teacher thinking included a debate on the definition of interactive thinking. Shavelson (1976) shared the viewpoint that all teacher actions during classroom instruction are founded upon interactive thinking. “Any teaching act is the result of a decision……. This reasoning leads to the hypothesis that the basic teaching skill is decision making” (Shavelson, 1973, p. 19). However, as thinking investigations proceeded, researchers searched for a more precise definition of interaction thinking. Obviously, all aspects of teaching involve cognitive processes, but does all teacher thinking fit into the interactive category?

Clark & Peterson’s (1986) review of numerous interactive studies found common characteristics of “interactive thinking.” Interactive thinking usually is a problem-solving response and involves a conscious choice to consider and employ
alternatives. Therefore, initially the teacher must recognize a problem or situation during the lesson. Often an experienced teacher can interpret cues from the students in regards to comprehension, interest, or motivation. The teacher would then need to assess possible solutions or modifications and decide upon a specific action for implementation. Based upon their literature review, Clark & Peterson (1986, p. 274) define interactive thinking as follows: “an interactive decision is a deliberate choice to implement a specific action” during instruction.

Overall, an approximate consensus from the research literature likely would include the following characteristics of interactive thinking or interactive decisions (Clark & Peterson, 1986; McCutcheon, 1992; Buchmann, 1990):

- Interactive thinking occurs during classroom instruction.
- The teacher identifies the possible need to make a change during the lesson.
- The teacher evaluates alternative choices to accommodate the need for change.
- The teacher makes a conscious decision resulting in a change of action in the classroom.

**Researcher Philosophies on Interactive Thinking**

Clark & Peterson (1986) found several consistencies from multiple interactive thinking investigations. Only a small percentage of interactive decisions are concerned with instructional goals, subject matter, or instructional strategies. The majority of researchers found that most interactive decisions revolve around the
learner. Such decisions include assessment of student comprehension, behavior, and interest. Other “learner” interactive decisions involve teacher interpretation of student responses and an anticipation of the direction the lesson should take. In addition, teachers state that many contributory issues—other than learner influences—guide interactive decisions. For example, teachers report that they also consider the classroom environment and the suitability of the lesson or learning activity. From the research review, Clark & Peterson (1986, p. 277) define an interactive decision as “making a deliberate choice to implement a specific action rather than a choice of actions from several possible alternatives.” Thus, multiple, interdependent factors influence teachers’ interactive decisions.

Peterson & Clark (1978, p. 556) found that interactive thinking strategies followed one of three inter-related courses of action. Initially, a teacher interprets a student cue as one that may require action. According to the researcher, these ‘cues’ could include anything from student behavior problems to indications of a lack of subject comprehension. Once the classroom situation is assessed, Peterson & Clark (1978, p. 556) propose that the teachers follow three common deliberative routes or “paths”. These “paths” are chosen after the teacher has interpreted cues from the students that indicate that student behavior and/or comprehensions in not at an acceptable level:

1. The teacher is unable to draw upon a feasible lesson modification from past classroom experiences. Thus, the teacher resumes the original lesson plan.
2. The teacher has a repertoire of lesson modifications, but purposely chooses not to alter the lesson plan.

3. The teacher refers to past teaching experiences to identify and implement a change or modification in the lesson.

Peterson & Clark’s (1978) research indicates that the majority of interactive decisions fall into the first deliberative route or “path”. Thus, according to this early interactive-thinking research, the majority of teachers do not feel the need to alter lesson plans or activities based upon cues from their students.

Shavelson & Stem (1981) present a similar model of interactive thinking phases with one significant exception. Shavelson & Stem state that the pathway of interactive decisions becomes “routine”. Initially, student cues alert the teacher that possible action may need to be taken. These cues are labeled as “interruptions” in the teaching process that requires immediate evaluation. Similar to the proposed paths of Peterson & Clark (1978), Shavelson & Stem’s (1981) model of interactive thinking states that teachers rely upon past classroom experiences. However, Shavelson & Stern found that teachers commonly have developed a “routine” of a few alternate actions to deal with multiple classroom situations. This “routine” limits the number of actions a teacher must consider before making a decision. As a consequence, the lesson modification requires less deliberation, and the rhythm of instruction is less likely to be interrupted.

Hargreaves (1979) found that teachers can draw from a sizeable collection of routines or “treatments” during interactive thinking. These treatments are habitually applied during instruction in reply to unexpected classroom circumstances. In
agreement with the "routine" theory of Shavelson & Sterns (1981), Hargreaves suggests that teachers initially recognize and interpret student cues, indicating that some part of the instruction needs modification. The use of a repertoire of "treatments" in no way diminishes the degree of interactive decisions that are made by the teacher. Instead, the experienced teacher wisely employs "treatments" or modifications that are tried and tested in their own classroom. The use of familiar treatments reduces the interruption of the flow of instruction (Hargreaves, 1979).

Buchmann's (1990) research connects teachers' interactive thinking with a more meditative phase of teacher thinking. Buchmann identifies interactive thinking as a constant, immediate deliberation that occurs during instruction. The decisions stem from 'interactions' between the teacher and the pupils and often relate to student achievement and comprehension. In contrast, an introspective or contemplative phase of thinking centers upon educational objectives. The influences of introspection upon the intention of the curriculum inherently are implied in interactive thinking. Thus, the two types of thinking intertwine in the practice of instruction to guide the teacher in deliberation (Buchmann, 1990).

McCutcheon (1992, p.201) states that teachers who have "unearthed their theories of action" perform interactive thinking. The modification of a lesson during instruction requires reflection upon the teacher's background knowledge and pedagogical content knowledge in relation to the students' learning perspective. This reflection of personal learning theory permits a teacher to react appropriately upon unexpected classroom situations. Such situations cannot be predicted during
preactive planning. Therefore, teachers must rely upon teacher-thinking practices to proceed.

“The reshaping of plans takes place because of unforeseen circumstances (e.g., the students need less help with directions than envisioned, necessary material is not available, time is too short, a fire drill interrupts the lesson at midpoint). Many of these extemporaneous actions occur in the blink of an eye, thousands are taken each day..... They (i.e., teachers) must, and do, act on the basis of their own theories, not out of simple, random reactions” (McCutcheon, 1992, p. 200).

This quote underlies an important point that is repeatedly documented in the research literature. Interactive thinking is not a reflexive, unconscious reaction during classroom instruction. Rather, interactive thinking is the purposive reflection and reasoning of a teacher’s theory of action.

Wilson, Shulman, & Richert (1987, p. 107) also place a great emphasis on the importance of interactive thinking during instruction. “Teachers think about a variety of issues during the pre-active and interactive stages of teaching: teachers are constantly making decisions and they draw upon a rich store of knowledge when they are engaged in planning and instruction.” The concerns that teachers address during instruction include not only knowledge about student comprehension, curricular objectives, and various learning and teaching styles. Teachers also need a working background knowledge about the subject matter. These interconnected
influences guide interactive decisions and thus direct the resultant instructional practices.

<table>
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<th>RESEARCH CONCLUSIONS</th>
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<tbody>
<tr>
<td>Buchmann (1990)</td>
<td>Phases of teacher thinking</td>
<td>Teacher thinking is a combination of interactive deliberations and contemplative phases on educational objectives.</td>
</tr>
<tr>
<td>Peterson &amp; Clark (1978)</td>
<td>Interactive teacher thinking model</td>
<td>Most interactive decisions revolve around the learner, not instructional objective or teaching strategies.</td>
</tr>
<tr>
<td>Clark &amp; Peterson (1986)</td>
<td>Review of teacher thinking research</td>
<td>The majority of interactive teacher thinking was concerned with the learner, not with content or learning objectives. “On average, teachers make one interactive decision every two minutes (p. 274).”</td>
</tr>
<tr>
<td>Hargreaves (1979)</td>
<td>Teacher thinking; Classroom discipline</td>
<td>Teachers construct a collection of educational “treatments” to apply in response to interactive decisions.</td>
</tr>
<tr>
<td>Shavelson &amp; Stern (1981)</td>
<td>Teacher interactive thinking model</td>
<td>During interactive thinking, teachers rely upon a few alternative practices in response to unexpected situations during instruction.</td>
</tr>
<tr>
<td>Wilson, Shulman, &amp; Richert (1987)</td>
<td>Teacher thinking</td>
<td>Teachers must assess a multitude of influences during interactive deliberation; these influences include factors about students, curriculum, and subject matter.</td>
</tr>
</tbody>
</table>

**TABLE 3: INTERACTIVE THINKING RESEARCH SUMMARY**

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Interactive thinking is a complex deliberative process that occurs during instruction. An initial interpretation of the classroom environment and students’ cues is an elemental prerequisite to interactive thinking. Thus, interactive decisions commonly are a teacher’s response to an observable behavioral or a comprehension problem. The teacher’s implemented action can range from an alteration in the original lesson to a totally new instructional direction. An example of one interactive decision occurs when a teacher interprets a cue during a lesson that the students do not have a firm grasp on prerequisite knowledge about the subject. Therefore, the teacher modifies the original lesson plan to re-teach foundational principles before returning to the planned lesson activities. As in this example, the end result of an interactive decision is often teacher action.

Multiple research methodologies are commonly employed to investigate teacher thinking. While the actions behind interactive decisions readily are observable, the teacher’s personal deliberation steps are indiscernible. To add to this problem, teachers regularly express difficulty in describing and explaining their own interactive decisions (Brown & McIntyre, 1993). Therefore, a triangulation of methods routinely is utilized to delve into the cognitive processes of the teacher in action. Through methods such as classroom observation, teacher think-aloud studies, and stimulated-recall interviews, researchers are beginning to understand the process of teachers’ interactive deliberations. In turn, the fundamental nature of teaching is beginning to emerge.
**Teacher Reflection**

Teacher reflection is a purposeful and careful deliberation of previous beliefs, behaviors, and classroom practices. Reflection connects teacher thinking and action through careful analysis. The reflective process can occur after the classroom experience. However, reflection also can occur during instruction, guiding teacher decisions about immediate modifications or improvements. This process of reflection permits the teacher to address problems that are unique to their classroom situation. In addition, through the development of a reflective practice, teachers can explore their classroom practice and their pedagogical beliefs. A more perceptive and self-cognizant teaching practice can be the result. "The nature of practice is such that improvement can only be fostered by the professional's own understanding of self and of the nature of the practical. Reflection obviously plays a major role here" (Clark & Yinger, 1987, p. 101).

**Researcher Philosophies on Reflection**

Reflection can focus upon the deliberation of numerous educational issues, such as the following:

- The teacher's personal educational beliefs and philosophies
- Student achievement and comprehension
- The classroom environment
- The usefulness of specific learning activities
- The match between the curricular objectives and the students’ background knowledge or interest

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Several researchers have discussed the definition and role of teacher reflection in education, originating with John Dewey. Dewey’s (1933) concept of reflection centers on the milieu of teaching practices. As such, reflection is constructed from the communication and interactions between teachers and students, as well as between teaching peers. According to Dewey (1933), reflection upon classroom experience can result in the creation of new meanings and a reconceptualization of the teaching experiences. “Reflective action” is identified as deliberation intended to change the classroom experience, either for the teacher and/or the students. In addition, Dewey encourages teachers to reflect upon everyday occurrences and social interactions and examine their significance. Teachers should reflect upon the beliefs and assumptions that motivate classroom routines, in order to understand more of themselves as well as the environment. Therefore, Dewey (1933) asserts that reflective knowledge develops from an integration of the individual, practical knowledge of teachers and the knowledge of the learning environment. Dewey (1933) also encourages reflection of instructional problems to predict the possible outcomes of future actions. In doing so, teacher reflection can improve instruction through deliberation of past predicaments or mistakes. Overall, Dewey (1933) equates thinking itself with reflective practice. In contrast to classroom routine,
reflection is what characterizes intelligent teaching practice (Dewey, 1933; Clark & Yinger, 1987).

Schoen (1983) presents a philosophy of “reflection in action” that differentiates between the experienced teacher and the novice. Reflection-in-action is a progression of deliberative steps: analyze and restructure the problem, experiment with possible solutions, apply the technique in class, and evaluate the outcomes (Schoen, 1983; Munby & Russell, 1989). “Reflection in action” requires the teacher to apply tacit knowledge of teaching drawn from extensive classroom experience and expertise. This knowledge permits a reflective ability to guide lesson planning, curricular decisions, activity modifications, and student behavioral approaches. In Schoen’s (1983) view, a teacher must have teaching experience in order to reflect upon strategies that work in various classroom situations. Teaching expertise permits the teacher to assimilate educational theories, current research findings, and past classroom experiences in order to solve instructional problems. Reflection also promotes experimentation and renovation as a means of problem solving. Reflection used in this type of investigational realm results in action. Schoen (1983) proposes that the school environment purposely should be conducive to reflective teacher practices.

Griffiths & Tann (1992) categorize reflection according to the level and timing of deliberation. “Rapid reflection” denotes instantaneous and unplanned reflection, often performed during instruction. An example of “rapid reflection” includes interactive decisions made during instruction after a teacher deliberates about the effectiveness of a lesson plan in action. The teacher might reflect on the students’...
comprehension of an activity or lesson and make immediate changes to enhance learning. While the terms instinctive or intuitive come to mind, the success of "rapid reflection" obviously lies within the teacher's expertise and classroom experience. "Reflective review" is performed after instruction and requires time for deliberation. A teacher practicing "reflective review" might consider the effectiveness of a learning unit to make improvement modifications for the next school year. "Research reflection" occurs over a longer period of time of several weeks. In addition, Griffith & Tann (1992) categorize "research reflection" as a more intense, concentrated type of contemplation. Lastly, "retheorizing and reformulating" is listed as a precise, meticulous type of reflection occurring over many months.

Calderhead (1987, p. 715) defines teacher reflection as a "retrospective analysis". "Teachers consider what can be learned from recent experience, the significance of the day's or week's events, and what the implications are for future teaching." Based upon the research of van Manen (1977), Calderhead (1987, p. 714) identifies three categories of reflection: the "technical, practical, and critical levels". "Technical" reflection focuses upon practical instructional matters, such as the student achievement, completion of learning objectives, or student behavior. Reflection at the "practical level" involves deliberation about the consequences of their instructional decisions and classroom actions. Calderhead (1987, p. 714) states that at the "critical level", teachers not only question their "actions and their effects, but the ideological and material contexts in which those actions take place. Consequently, reflection at the critical level involves questioning the purposes of education and the assumptions that underlie practice." Therefore, an experienced
teacher that is critically reflective is connecting personal instructional practices to the rationale and philosophy of education. Additionally, critical reflection analyzes the overall value of educational objectives in consideration of all students and various learning abilities. In turn, Calderhead (1987) proposes that many teachers do not rise beyond “practical reflection” due to enormous educational responsibilities and pressures. In fact, the “school culture generally values action above reflection” (Calderhead, 1987, p.714). An emphasis upon reflective skills in teacher education and professional development courses is recommended.

In contrast, Zeichner (1994) rejects the whole notion of the leveling of reflection. Zeichner does not accept the common stance that the nature of public education restricts reflection. Nor does he adhere to the idea that highly developed, complex reflection is limited to expert teachers. “The idea of levels of reflection implies that technical reflection at the level of action must somehow be transcended so that teachers can enter the nirvana of critical reflection. This position devalues technical skills and the everyday world of teachers which is of necessity dominated by reflection at the level of action” (Zeichner, 1994, pp. 14). Instead, Zeichner identifies “domains” of reflection that are equally important and constructive.

In addition, Zeichner (1994, p. 16-18) distinguishes between several educational, reflective practice “traditions in North America”. The “academic tradition” of reflection focuses upon subject context and the teacher’s interpretation of the topic for successful instructional techniques. Zeichner (1994) calls the second tradition the “social-efficacy tradition.” This tradition involves teacher reflection upon the degree of correlation between their personal instructional practices and current educational
theories. In turn, the teachers can address classroom problems through consideration of research findings. The “developmentalist tradition” of reflection “prioritizes reflection about students, their thinking and understandings, their interests, and their developmental growth. Classroom practice is to be grounded in close observation and study of students either directly by the teacher, or from reflection on a literature based on such studies” (Zeichner, 1994, p. 16). Therefore, during the “developmentalist tradition” of reflection, teachers reflect upon their instructional strategies in relation to student comprehension and achievement. The end result of such reflection is to guide the subsequent learning objectives and activities. The “social-reconstructionist” tradition of reflection centers upon the social and political implications of educational practices. For instance, a teacher may reflect upon the effect of their classroom practices in relation to racial, cultural, or gender student issues. This tradition of reflection has an emancipatory goal similar to critical theory research. Lastly, Zeichner (1994) recognizes a “generic tradition” of reflection in North American education that encompasses all types of reflection without a preexisting purpose or stance.

Kincheloe (1993) relates the amount and degree of reflective deliberation to the quality of instruction. “As teachers become reflective researchers, they acquire the ability to adapt larger emancipatory ideas to specific teaching contexts. Qualitative educational researchers have found that what is known as good teaching is a highly subjective construct that varies with context” (Kincheloe, 1993, p. 224). Reflection is important as an instrument to interpret the “numerous layers of communications that shape the classroom (p.224).” Kincheloe states that such interpretation is vital in

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the quest to understand the student, access students' background knowledge and ability levels, and connect the student to the instructional objectives.

<table>
<thead>
<tr>
<th>RESEARCHER</th>
<th>RESEARCH AREA</th>
<th>RESEARCHER'S TERMINOLOGY</th>
<th>RESEARCH CONCLUSIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dewey (1933)</td>
<td>Teacher reflection of action and the social environment of the classroom</td>
<td>&quot;Reflective action, Reflective routine&quot;</td>
<td>Reflection is a result of deliberations regarding human interactions and the learning environment.</td>
</tr>
<tr>
<td>Griffiths &amp; Tann (1992)</td>
<td>Levels of reflection</td>
<td>&quot;Rapid, Review, Research, and Retheorizing/ Reformulating&quot; reflection</td>
<td>Reflection degrees relate to the time period of deliberation and the correlation between personal philosophies and research theories.</td>
</tr>
<tr>
<td>Zeichner (1994)</td>
<td>Reflection traditions and domains in North American education</td>
<td>&quot;Academic, Developmentalist, Social-reconstructionist, and Generic&quot; reflection traditions</td>
<td>&quot;All of the domains of reflection are important and necessary.&quot; Zeichner &quot;rejects the idea of levels of reflection&quot; that correspond to teacher experience.</td>
</tr>
</tbody>
</table>

**TABLE 4: REFLECTION RESEARCH SUMMARY**
Reflection Impediments and Researcher Suggestions

Several researchers question the feasibility of in-depth reflection within the current educational environment (Skrtic & Ware, 1992; Zeichner, 1994; Sykes, 1986). The numerous duties and responsibilities of the average classroom teacher leave very little time for comprehensive individual reflection or group deliberation.

"It is often argued that one of the main reasons that we find so little of the so-called 'higher' levels of reflection among teachers or why it is so hard to develop it, is because of the fact that most schools are hostile to critical inquiry" (Zeichner, 1994, p. 12). Zeichner also proposes that reflective practice needs to be incorporated in teacher education programs.

Skrtic & Ware (1992, p. 208) argue that "reflective teaching is not a real possibility in schools as they are currently organized, managed, and governed. Reflective teaching, in the sense of inventing and reinventing educational practices to solve unexpected problems, requires a reflective discourse within a community of interests." Sykes (1986) also contends that a reorganization of schools needs to occur to promote teacher reflection. "The tilt is towards conditions that do not favor inquiry. The physical structure of the school, the work patterns, the need to process clients in batches, the absence of time....all work against any regular reliance on critical inquiry" (Sykes, 1986, p. 239). In view of the current reflection research findings, the organizational structure of schools may need renovation to support and encourage teacher reflection.

Hatton & Smith (1995) assert that the accepted definition of teaching needs modification to include reflective practice. Several impediments to reflection are
presented. Often the nature of the school’s social structure places an emphasis on action. Teachers need time for interim and long-term reflection to address classroom problems and develop instructional modifications for learning improvement. Hatton & Smith (1995) also recommend an extension of teacher education curriculum to include a year of mentorship after graduation. The value and nature of reflective practice cannot be demonstrated clearly outside of a teaching environment. An extended mentorship with an expert teacher could guide novice teachers in the art of reflection and subsequent action.

Ross (1992) recommends one specific approach to address reflective constraints in schools: the use of action research. Ross (1992, p. 188) defines action research as a “form of collective self-reflective inquiry” that can “guide thought and action about the commonplaces of schooling.” Action research allows teachers to reflect upon their own actions in the classroom, their beliefs behind those actions, and the resultant effects upon student learning. Ross (1992) also suggests “collaborative action research” to encourage reflection of personal theories and practice. Reflective discourse between teaching peers can unveil the significance of classroom routines and practice. The common theme among teacher-thinking research is that reflection is a vitally important aspect of successful teaching. Reflection, while done independently or as a group of peers, can result in an improved environment for learning.

Teacher reflection is a purposeful and careful deliberation of previous beliefs, behaviors, and classroom practices. Reflection connects teacher thinking and action through careful analysis. The reflective process can occur after the classroom
experience. However, reflection also can occur during instruction, guiding teacher
decisions about immediate modifications or improvements. This process of
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and self-cognizant teaching practice can be the result. “The nature of practice is such
that improvement can only be fostered by the professional’s own understanding of
self and of the nature of the practical. Reflection obviously plays a major role here”

Chapter Summary

The main purpose of this investigation was to study teacher thinking during new
curriculum implementation. The research plan, which will be presented in the
following chapter, employed a case study of two teachers implementing a new
microbiology curriculum. The study design was grounded in the theory of
curriculum implementation as a shared experience constructed by both the teacher
and the students, with a specific focus upon teacher thinking. This literature review
chapter presented the research findings by many scholars on teacher thinking and
curriculum implementation. An overview of teacher-thinking research was
discussed, which included theories concerning teachers’ theory of action, types of
teacher knowledge, and curriculum implementation. In addition, specific research
was presented about the preactive, interactive, and reflective decisions of teachers.
CHAPTER 3

METHODOLOGY AND RESEARCH DESIGN

Teacher-thinking research has employed multiple, resourceful investigative methodologies. Most of these methodologies are qualitative in nature and involve triangulation of data. This use of multiple data sources especially is important in teacher thinking studies. Obviously, observation cannot be the sole means to investigate teachers' imperceptible deliberations and principles. “Cognitive acts under investigation are normally covert and beyond immediate access to the researcher” (Calderhead, 1984, p. 711). Therefore, researchers utilize a combination of qualitative methods, such as interviewing, narratives, observations, and case studies.

The qualitative and quantitative portions of this project are described in this chapter. As an introduction, a comparative literature review on the purpose and functions of qualitative and quantitative research is presented. The research design of the project is discussed in detail. Several methodological issues are addressed:

- The research problem and research questions are discussed.
- Naturalistic case study methodology is reviewed.
- Participant selection methodology is presented.
- The setting of the investigation is described.
- Qualitative and quantitative investigative methodologies are described.
Ethical concerns are presented.

The possible limitations of the study are addressed.

The representation, interpretation, and analysis of the data are explained.

Chapter three concludes with a summary of the research design and the methodological considerations of this investigation.

PART I: QUALITATIVE METHODOLOGY

Introduction

The fundamental nature of qualitative research is described in this chapter section. The characteristics of a naturalistic case study and the complete research design of the qualitative portion of this investigation are explained. This design explanation includes information about the research problem, the research questions, the participants and setting, and data collection. Data interpretation and ethical considerations are also presented.

Qualitative Research

Qualitative research investigates human activities and interactions without an emphasis on measurement or quantification. “Qualitative researchers stress the socially constructed nature of reality, the intimate relationship between the researcher and what is studied, and the situational constraints that shape inquiry” (Denzin & Lincoln, 2000, p. 8). The qualitative epistemology centers upon the participant’s perspective and experiences. Merriam (1998, p. 6) describes the central
philosophy of qualitative research as follows: “The reality is constructed by individuals interacting with their social worlds. Qualitative researchers are interested in understanding the meaning people have constructed, that is, how they make sense of their world and the experiences that they have in the world.” As such, qualitative research focuses upon the interactions of all influences in a situation to achieve an overall picture. This inductive approach is in direct contrast with the deductive, objective approach of deconstructing phenomena. In addition, qualitative research places an emphasis upon the participants'/insiders' viewpoint or “emic”, rather than the researcher or observer's viewpoint or “etic” (Merriam, 1998, p. 7; Mertens, 1998, p. 165). To illustrate and interpret the participants’ viewpoint, qualitative research requires fieldwork. The object is to maintain a naturalistic environment to conduct observations and interviews. As a result, the qualitative researcher can construct theories from a combination of direct observation, participant interaction, and the resultant intuitions as an investigator.

Janesick (2000, p. 385) lists several characteristics of qualitative research:

- Qualitative research is “holistic” in that the researcher searches for an understanding of the “whole picture”.
- Often the purpose of the research is to develop an overview of the relationships or themes within the environment, rather than the development of predictions.
- Qualitative research requires an emersion in the investigative setting; an equal amount of time often is spent in data analysis.
- The researcher “becomes the research instrument”.
Ongoing analysis is essential during and after data collection.

Each qualitative study is unique; the research strategies “are intimately connected to how the researcher views the purpose of the work” (p. 384).

Patton (1990) defines qualitative research as an endeavor to understand a unique environment in regards to the interactions and circumstances of the setting. The focus of the research is to gain knowledge about the nature of the relationships between the participants, the setting, the conditions, and the influences in the naturalistic environment. The objective is not to make generalizations or predictions for other settings. Patton emphasizes the importance of the participants' mindset and viewpoints. Thus, the research conclusions revolve around the perspective of the participants, rather than the perception of the researcher.

Denzin & Lincoln (2000, p. 8) state that qualitative researchers “stress the socially constructed nature of reality, the intimate relationship between the researcher and what is studied, and the situational constraints that shape inquiry. They seek answers to questions that stress how social experience is created and given meaning.” The emphasis of the research is not the objective analysis or statistical measurement of experimental variables. Rather, the emphasis is an overall understanding of the unique characteristics of the participants in their own environment. One specific qualitative research methodology that fits Denzin & Lincoln’s definition is the naturalistic case study.
Naturalistic Case Study Design

Mertens (1998, p. 166) defines a case study as a "type of interpretive research that involves intensive and detailed study of one individual or a group as an entity." The general purpose of a case study is to construct an in-depth description and interpretation of a particular situation or environment. The whole environment surrounding the study is investigated to give a complete picture of the case. Often, the data collection methodologies include observation, interview, and record review (Merriam, 1998; Mertens, 1998). The case study is "bounded" by the phenomenon to be investigated (Merriam, 1998; Mertens, 1998; Stake, 2000). For example, this case study was bounded by the preactive planning, interactive, and reflective decisions of the participating teachers. These boundaries gave definition and purpose to the research design, as all data interpretation was completed with these topics in mind.

Stake (2000, p. 437) identifies three common types of case studies. An "instrumental case study" is performed to investigate a particular issue or "secondary interest". The research purpose is to modify or augment understanding of the issue. This is in contrast to an "intrinsic case study" that is performed for the sole purpose of discovering information about a specific case. A "collective case study" is performed when the research investigates several separate cases in order to research a common phenomenon. The type of case study will guide the methodologies and the research design. However, the case study types may overlap within one investigation. Stake (2000, p. 448) listed commonalities for all three types of case study research:

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➢ The boundaries of the case will characterize the objectives of the study.

➢ Triangulation supports data analysis and interpretation.

➢ The researcher should search for patterns within the data sources to identify commonalities and themes from the findings.

➢ The researcher should consider “alternative interpretations” to thoroughly analyze the data.

➢ The researcher may determine that the findings are generalizable.

However, transferability is often left to the readers’ discretion.

In this teacher-thinking project, the research design incorporated aspects of instrumental, intrinsic, and collective case studies. The teacher interview questions were prepared in relation to teacher-thinking theory. Thus, the case study had an “instrumental” slant in that the data was evaluated with current theory taken into consideration. However, this case study also had an “intrinsic” slant. The classroom observations, teacher interviews, and document reviews were performed to gain insight about this distinctive situation. Therefore, the overall rationale of the research was two-fold: to develop a holistic picture of the teacher-thinking decisions made in this case and to attempt to relate the investigative findings to current teacher-thinking theory and research.

Merriam (1998, p. 29) classifies a case study as being “particularistic, descriptive, and heuristic.” Particularistic is listed because a case study concentrates upon a “particular situation, event, or phenomenon.” Descriptive refers to the in-depth or “rich” description of the phenomenon in the investigative report. Often quotations from observations and interviews are included in the analysis and data

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representation. Thus, the researcher attempts to describe the participants’ perspective in as much detail as possible. Merriam (2000) defines “heuristic” as meaning that the end product should explain all portions of the unique situation. The researcher explains the “reasons for a problem, the background of a situation, what happened, and why” (Merriam, 2000, p. 31).

In order to complete an in-depth analysis consistent with a case study, the researcher should gather data from a wide variety of sources (Mertens, 1998; Merriam, 1998; Patton, 1990). Numerous data sources enrich the description of the studied phenomena. The accuracy of participant representation in the data will increase. In turn, the reliability or trustworthiness of the researcher’s interpretation and analysis will benefit. As the researcher, I planned the qualitative research design by taking the aforementioned literature concepts into consideration. The sources of data for this investigation were the main methodologies of qualitative research: document and record reviews, interviews, and observations.

**Credibility/Trustworthiness of a Case Study**

A case study is an in-depth observation and interpretation of a specific environment or situation. In general, the objective of such research is not research predictions or generalizations to other settings. In the words of Janesick (2000, p. 394), “the value of the case study is its uniqueness; consequently, reliability in the traditional sense of replicability is pointless here.” Reliability is defined as the degree in which the study findings can be replicated, which is often the objective.
of quantitative research (Best & Kahn, 1993; Merriam, 1998; Frankel & Wallen, 1990). In contrast, qualitative educational research involves human interactions and experiences, which most often are unique to the particular situation and set of participants. There is no one, "true" reality that can be repeatedly observed. Instead, qualitative researchers attempt to discover the phenomenon as experienced by the participant. Additionally, if the goal of the case study is to gain insight into the participants' perspective, generalizability to other environments is not a major issue. Thus, several researchers (Lincoln & Guba, 1985, 1989; Schofield, 1990; Eisner, 1998) offer alternative means or 'criteria' for qualitative research evaluation — methods that are distinct from the validity and reliability paradigms of quantitative analysis. "These criteria (credibility, applicability, dependability, confirmability) are constructed to parallel conventional inquiry criteria (internal validity, external validity, reliability, and neutrality) and thus can be recognized as familiar and understood as legitimate by critical evaluation audiences" (Greene, 2000, p. 991).

Lincoln & Guba (1989; 1985) discuss the trustworthiness of qualitative research findings from four perspectives:

1. Findings are credible when they are consistent with the experiences and meanings of the participants.
2. Findings are dependable if the applied methodologies are logical and practical in the context of the research environment.
3. Researcher interpretations are confirmable through data paths that directly relate back to the grounded theory of the research.
4. Research findings are *applicable* to other settings only when the reader determines transferability is possible.

Eisner (1998) suggests two basic methods to ensure the trustworthiness of research findings: "structural corroboration" and "consensual validation". In agreement with Lincoln & Guba (1989, 1985), Eisner promotes a movement away from the positivistic, quantitative standards of validity and reliability.

"Structural corroboration" refers to the practice of triangulation, in which "multiple types of data are related to each other to support or contradict the interpretation and evaluation of a state of affairs. In seeking structural corroboration we look for recurrent behaviors or actions, those theme-like features of a situation that inspire confidence that the events interpreted and appraised are not aberrant or exceptional, but rather characteristic of the situation. (Eisner, 1998, p. 110).

Thus, 'structural corroboration' is the gathering of interpretive evidence through multiple, interwoven research methodologies. Eisner also contends that "consensual validation" is another method that can increase the credibility or trustworthiness of qualitative research. "Consensual validation is agreement among competent others that the description, interpretation, evaluation, and thematics of an educational situation are right" (Eisner, 1998, p. 112). Thus, a researcher can defend his or her interpretation and analysis of a naturalistic case study through the precise documentation of relevant data. In turn, other educational researchers can independently assess the credibility of the research findings.
In this investigation, two anatomy teachers were involved as participants. As the researcher, I made the decision to limit the number of participants to enable an in-depth, exhaustive investigation of teacher thinking. The teacher participants interpreted and implemented the new microbiology curriculum in consideration of their own personal educational theories. The decisions and actions the teachers made were based upon the context of their own classrooms. To understand the teachers’ perspective as the researcher, I needed to discover the individualistic, lived experiences of each teacher. Thus, I selected a naturalistic case study to investigate teacher thinking in action – before the lessons, during instruction, and after classroom interaction. In concurrence with much of the case study literature, the objective of this project was not generalizability to other schools or teachers. Instead, my goal was a comprehensive study of the unique situation at hand. As such, I implemented several tactics to increase the trustworthiness of this research project:

- Prolonged observation of the classroom environments (i.e., daily observations over a period of nine weeks)
- Triangulation through classroom observation, document review, teacher interviews, stimulated recall interviews
- Member checking: data interpretations and interview transcriptions were reviewed with the two teacher participants
Grounded theory analysis: all data was analyzed through the emergence and categorization of similar concepts in relation to the teacher-thinking phases of preactive planning, interactive decisions, and reflection.

The incorporation of such tactics into the research design should serve to increase the credibility and trustworthiness of my qualitative investigation.

Merriam (1998, p. 27 & 65) defines a case as a “single unit, an intrinsically bounded system, or a unit of analysis.” In other words, the case has boundaries that limit and/or guide the investigation. The phenomenon to be studied in this investigation was teacher thinking in relation to new curriculum implementation. The boundaries of this teacher-thinking project—preactive planning, interactive decisions, and teacher reflection—guided the proposed fieldwork, observation, and interpretation of the data. The research design of this investigation centered upon the case study methodology in the classroom of two teachers. The overall qualitative research design is presented in the next section.

Research Design

The research design of this investigation was constructed around the research problem and the purpose of the study. Merriam (1998, p. 44) identifies the collection of research questions as the “theoretical framework” of the investigation. “The theoretical framework is derived from the orientation or stance that you bring to the study. It is the conceptual structure, the scaffolding, the frame of your study”
(Merriam, p. 45). In other words, the researcher’s theoretical or “disciplinary orientation” directly influences the overall research design. The design of this study centered upon a naturalistic case study of two teachers in relation to teacher thinking. Thus, this portion of the investigation relied upon qualitative methodologies, such as classroom observation and participant interviews. In addition, the majority of relevant literature was qualitative in nature.

The following design considerations are addressed in this section: the research problem, research questions, participant selection, research setting, and teacher participants.

The Research Problem

The purpose of this project was to investigate three phases of teacher thinking during the implementation of new curriculum: teacher preactive planning, teacher interactive decisions, and reflective practices. The rationale behind research in this area of education is to discover the relationship between the phases of teacher thinking and action in the classroom. In turn, the research can illuminate the connection between curriculum planning, curriculum implementation, and classroom practice. Reflection is useful in the investigation of curriculum refinement or modification after implementation.

Teaching is a complex activity that is based upon multiple layers of influences, such as teachers’ personal beliefs, pedagogical theories, background knowledge, classroom skills, and cultural experiences (Clark & Peterson, 1986; Calderhead, 1987, Ross, Cornett, & McCutcheon, 1992; de Fatima & Sanchez, 1994). Research
can explore how, when, and why teachers apply this knowledge in the workplace. Findings from teacher-thinking research may eventually enrich curriculum innovations, teacher education programs, curriculum policy, and classroom practice.

**Research Questions**

Mertens (1998) discusses several types of research questions that fit into qualitative research. Often qualitative research is centered upon an overall process or program in a naturalistic setting. Thus, the research questions focus upon an extensive investigation of the participants and the program/curriculum. The goal of generalizability of findings usually is not a driving force behind the research questions. Instead, the uniqueness of each educational setting is acknowledged and explored. Lastly, the purpose of qualitative research questions is an understanding of the influences, relationships, and assumptions that guide action within each situated environment.

Several research questions guided the qualitative portion of this investigation:

1. What are the various forms of these teachers’ planning and how do they function within the curriculum?
2. In what ways do teachers’ beliefs and practical knowledge affect the planning stage of curriculum implementation?
3. What relationships exist between teacher planning and curriculum implementation or action in the classroom?
4. How do teachers' interactive decisions influence the effectiveness of learning in the classroom?

5. What role does reflection play in curriculum decisions?

6. When is reflection practiced during curriculum implementation?

7. Is there evidence that reflection that occurs during and after the lessons/units guides future action in the classroom?

8. What are the future implications of research into teacher thinking? In what ways might this research reveal and direct instructional procedures?

Participant Selection

Sample selection obviously depends upon the research problem at hand. Thus, many researchers (Merriam, 1998; Fraenkel & Wallen, 1990; Mertens, 1998) emphasize the importance of relating the purpose of the investigation with participant selection. Fraenkel & Wallen (1990) declare that the starting point in any research project should be an assessment of the proposed research questions. The intention, significance, and relevance of the project should guide the overall research design and sample decisions.

Merriam (1998) asserts that participant selection in field research should only begin once the research problem has been specified in detail. After this initial step, the researcher can develop a relevant list of “selection criteria” in relation to sampling decisions. The criteria include careful consideration of what, where, when, and whom to observe (Burgess, 1982, p.76; Merriam, 1998, p.60). Merriam labels this method “purposive or purposeful sampling”. “The criteria you establish for
purposeful sampling directly reflect the purpose of the study and guide in the identification of information-rich cases” (Merriam, 1998, p. 62).

Taking the aforementioned theoretical concerns into consideration should maximize the significance and future application of the research findings. I began the participant selection for this investigation after the discovery of planned curriculum changes in an Allied Health Program. The Allied Health Program is a national Tech Prep program that prepares students for a variety of healthcare careers. The career pathways available to students include nursing, radiology, mental health, occupational therapy, and surgical technician. The “Tech Prep” Program is a national four-year program for high school students, starting with the junior high school year. The students take two years of high school courses that relate to their chosen career field, and then continue their education for an additional two years at a state community college. The end degree is an Associate Degree, with the option to continue at a four-year college. The local community college in which I had interest was located in Southwestern Ohio. The community college built a consortium of Tech Prep programs with eight local high schools. The high schools were in four surrounding counties in Southwestern Ohio. Eight anatomy high school teachers were involved in the Tech Prep consortium. All of the teachers were incorporating a new microbiology unit into the preexisting Allied Health anatomy curriculum. I therefore found the opportunity to investigate teacher thinking during new curriculum implementation. The community college held a brief meeting to introduce the microbiology course of study and provide sample curriculum materials. The consortium’s plan was to integrate an additional subject, microbiology, into the
yearlong anatomy high school course. The estimated classroom instructional timeline for the new microbiology unit was seven to eight weeks. I was invited to this meeting to present my research plan. After explaining my research proposal at the meeting, I asked for volunteer participants in this project. All eight teachers consented to participate in the study.

My next step in the “purposive sampling” process was to develop selection criteria to correspond to the research problem. I planned to proceed with a small sample size in order to allow for an intensive, in-depth analysis. Denzin & Lincoln (2000) declared that in qualitative research, the goal was not a positivistic attempt for generalizability to other populations. Each investigative setting will be unique. Mertens (1998) stated that the “researcher’s task is to provide sufficient ‘thick description’ about the case so that readers can understand the contextual variables operating in that setting. The burden of generalizability then lies with the readers, who are assumed to be able to generalize subjectively from the case in question to their own personal experiences” (p. 255). In agreement with these theoretical positions, my research project was designed as an in-depth investigation in a unique educational environment. With plans to use a naturalistic case study methodology, I wanted to limit the number of participants to a small sample of teachers. Therefore, my next step was to develop criteria to select participants from the total population of eight anatomy teachers. One portion of my proposed investigation was a quantitative analysis of student achievement. Therefore, I further narrowed the participant sample in an attempt to find homogeneous student populations. I investigated several factors for uniformity between the potential high schools and
teachers: high school population, student diversity, college enrollment rate, instructor teaching experience, curriculum resource availability, and program success/graduation rate. Two of the eight initial volunteer instructors, "Ann" and "Beth", taught in similar high school environments. In addition, their background experience in teaching was similar.

I developed several distinctive criteria to select purposive samples that were appropriate for my research design:

- The teacher participants were teaching Tech Prep anatomy and were implementing the community college's new microbiology curriculum.
- The selected teacher participants had similar teaching experience.
- Access to the classroom for daily observation during the naturalistic case study was feasible and within an hour drive from my home.
- The high school populations were similar in regards to the number of students, student diversity, graduation rate, college enrollment rate, and school district characteristics.
- The student samples were similar in regards to the passage rate of Ohio's ninth grade proficiency tests. In addition, the student samples had similar gender ratios and a comparable number of students on I.E.P.s (i.e., individual education plans).

By applying these criteria, I selected two teachers as research participants: "Ann" and "Beth". The distinctive purpose of participant and setting selection is to investigate from field cases with a wealth of accessible information. In choosing
these two participants for this study, I believed that a plethora of information could be discovered – information that directly related to the research problem and questions.

**Gaining Entry**

My first action was to re-contact Ann and Beth after the initial community college meeting. Briefly via a telephone conversation, I reconfirmed their willingness to participate in my study. During this time, I also discussed my research design. In particular, I wanted their feedback in regards to my daily classroom observations and proposed teacher interviews. As a researcher, I valued their opinion about the feasibility and convenience of the overall plan. My main concern was that I would not disrupt their normal classroom activities and not demand an inordinate amount of their planning time during and after the school day. From this first contact, both teachers agreed that a shorter, half-hour weekly interview would be less intrusive than a longer bimonthly, after school interview.

Secondly, I drafted an ‘informed consent/confidentiality’ letter describing the purpose and plan of my investigation (See Appendix A.). This letter included information in regards to the overall timeline, observation schedule, and confidentiality. I particularly stressed that my role would be as a passive participant observer. I would not interact with the students per se, as I was researching teacher thinking. I also assured confidentiality for the high schools, the community college, the teachers, and the students involved in the study. Pseudonyms were assigned in my personal field notes, as well as in my investigative report. I also stated that the
audiotaped interviews would not be kept at the conclusion of the investigation, and that teacher responses would not be linked to their identity. In addition, I requested that student scores be reported to me as a class set with no student names. I also explained the Human Subject Review process at Ohio State University. The Human Subject Review Committee had granted permission for my research proposal as planned. Lastly, I developed a consent form for participation (See Appendix B). I sent the introductory letter and the consent form to the following individuals: the participating teachers, the high school principals, and the community college’s Tech Prep coordinator.

After a period of a week, I contacted each high school principal and the Tech Prep coordinator to schedule an individual meeting at their convenience. During these meetings, I reviewed the purpose and design of my project. I also encouraged their questions and asked for their opinion about the proposed course of action. I also wanted to assure each contact that I would remain open to suggestions or necessary changes during the length of the study.

**Setting**

The participants taught in two separate school districts located in Southwest Ohio. Both high schools were located in suburban areas with city populations between 35,000 - 50,000 inhabitants. “Ann” taught at a county vocational high school with a student population of seven hundred. Ann stated that the school’s minority population was “about three percent”. The ages of her students ranged from fifteen to nineteen. She believed that a wide range in economic diversity existed within the
student population. Information from the high school guidance counselor confirmed that approximately five percent of the students qualified for the free lunch program. There were no extra-curricular activities at the vocational school, so students "traveled back to their home high school to play sports." The school administration stated that over sixty-five percent of students progressed to college upon graduation.

"Beth" taught at a suburban high school in a neighboring county, with a population of fourteen hundred students. Beth stated that the school's minority population was under one percent. The ages of her students also ranged from fifteen to nineteen. Beth stated that "the majority of the students come from middle-class homes"; about two percent of students qualified for the free lunch program. There were multiple academic and sport extra-curricular programs available. The school administration stated that over eighty percent of students progressed to college upon graduation.

Overall, the setting of the two participant high schools appeared to be similar. More importantly, the two selected participants' teaching backgrounds were comparable. Information about the teacher participants will be presented in the next section.

**Teacher Participants**

The two volunteer participants of the study were secondary anatomy teachers working in conjunction with a Tech Prep Consortium at a local community college in Southwestern Ohio. The teachers instructed senior Allied Health Students. The Allied Health Tech Prep Program was a "two-plus-two" program for high school students interested in a health care career. Students enrolled in the program
completed two introductory years at the high school level. Upon high school graduation, the students were awarded scholarships by the local community college to earn an Associate’s Degree in a health field. Degrees were available in twelve health fields such as nursing, physical therapy, and radiology. Both instructors taught three Allied Health science courses: Advanced Chemistry, Introductory Anatomy, and Advanced Anatomy & Physiology. The curriculum objectives and texts were universal for all Allied Health courses for schools in the community college’s Tech Prep Consortium. Thus, both instructors taught from identical courses of study and texts. In addition, the teachers had access to identical curricular materials, such as textbooks/workbooks, dissection animals, microscopic slides, and anatomy models. The community college had received a grant from the state in 1998 to purchase curricular materials for the eight high schools in the Tech Prep consortium.

Teacher ‘A’ (“Ann”)

Ann was a female with a Master’s Degree in Education, with a concentration in secondary education. After receiving a Bachelor’s Degree in Biology, Ann entered a graduate teacher certification program. She earned a Master’s Degree with an Ohio (grade 7-12) certification in chemistry and biology. Ann had been teaching for a total of eight years at her high school, all of which had been with the Allied Health students. Ann taught five class periods per day, with each period lasting fifty-five minutes. Her daily teaching schedule was as follows:
This investigation into teacher thinking focused upon Ann’s 7th period Senior Advanced Anatomy class.

**Teacher ‘B’ (“Beth”)**

Beth was a female with a Master’s degree in Science Education. She earned a Bachelor’s Degree in Science Education, and had an Ohio (grade 7-12) teaching certificate in general science. Beth had been teaching for a total of twelve years, with five years of experience with the Allied Health Program. Prior to teaching Allied Health students, Beth taught high school physics in Indiana for seven years. Beth taught five classes per day, with each period lasting fifty minutes. In addition to her teaching duties, Beth tutored students one period for two days per week. These were high school students who had failed Ohio’s ninth grade proficiency test.
This tutoring assignment was optional, and Beth received an additional stipend for volunteering. Her daily teaching schedule was as follows:

<table>
<thead>
<tr>
<th>Period</th>
<th>Course</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Advanced Chemistry</td>
<td>Allied Health juniors</td>
</tr>
<tr>
<td>2</td>
<td>General Biology</td>
<td>Sophomores/Juniors</td>
</tr>
<tr>
<td>3</td>
<td>Preparation Period</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>Lunch</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>General Biology</td>
<td>Sophomore students</td>
</tr>
<tr>
<td>6</td>
<td>Introductory Anatomy</td>
<td>Allied Health juniors</td>
</tr>
<tr>
<td>7</td>
<td>Tutoring Period</td>
<td>10th, 11th, 12th grades</td>
</tr>
<tr>
<td>8</td>
<td>Advanced Anatomy &amp; Physiology</td>
<td>Allied Health seniors</td>
</tr>
</tbody>
</table>

The investigation into teacher thinking focused upon Beth’s 8th period Senior Advanced Anatomy class.

Both instructors were incorporating a new microbiology unit into the senior high school anatomy/physiology curriculum. The microbiology unit objectives and curriculum materials were supplied to both teachers by the local community college. Neither of the teachers previously had taught microbiology.
Data Collection

Qualitative data collection frequently occurs in normal educational settings. Researchers often wish to investigate participants' natural behavior. In contrast to quantitative statistical measurements, the "researcher is the instrument in qualitative research" (Mertens, 1998, p. 317). Thus, data collection is completed through the eyes of the investigator via interviews, observations, and document review. In this data collection section, the overall qualitative design is presented in detail.

Qualitative fieldwork is discussed, with an emphasis on interview techniques, observational plans, and document examination. Lastly, ethical concerns involved with qualitative data collection are considered.

Qualitative Design Framework

During the design phase, several qualitative research issues should be addressed. The central theme of the methodological design should revolve around the objective of the research (Merriam, 1998; Frankel & Wallen, 1990). In this research project, three distinct phases were conducted: teacher preactive planning, interactive reasoning, and teacher reflection.

To develop a solid, background knowledge of the schools' environment and anatomy programs, I began with a review of several pertinent documents. The community college in the consortium with the schools had specific entry prerequisites for student enrollment in the Tech Prep Program. The high school course requirements and minimum grade point average were listed in the
community college's Tech Prep brochure. In addition, the written guidelines and objectives of the Tech Prep Program proved helpful. I reviewed the microbiology course of study that both teachers used during the study. I also examined the mission statement and printed objectives of each high school.

Teacher planning was investigated through two methodologies. I began with individual semi-structured teacher interviews (See Appendix C). The initial interview centered upon personal background information about each teacher. The second interview schedule focused upon the personal planning philosophy, planning techniques, and short-term/long-term curriculum goals of each teacher. The interviews were audiotaped to allow future transcription and analysis. At the beginning of the school year and throughout the microbiology unit, I also reviewed the individual, written lesson plans of each teacher. The teachers were asked to expand upon and/or explain their written lesson plans during this interview phase.

Interactive decisions were investigated through classroom observations and teacher interviews (See Appendix D). In both schools, microbiology was taught for approximately one-hour periods for seven to eight weeks. During the observation, I took notes about teaching decisions made during instruction time. These notes served as a guide for stimulated-recall interviews at the end of each week. In so doing, I was able to question each teacher about the specific reasoning behind some of her interactive decisions. I also reviewed the curriculum materials prepared by each teacher, which included lecture notes, homework, classroom assignments, and tests/quizzes.
Teacher reflection was investigated from open-ended individual teacher interviews (See Appendix E). The teachers were asked to provide information about the role of reflection in their decisions in the planning and interactive phases of teaching. In addition, questions were asked about the role of reflection in future planning. A concluding group interview with both teachers allowed a comprehensive reflection of the entire process of the microbiology implementation.

A graphic representation of the qualitative design is represented below:

### TABLE 7
Qualitative Design

<table>
<thead>
<tr>
<th>Step</th>
<th>Data Collection Methodology</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Record review of the Tech Prep Microbiology Course of Study and Curriculum materials</td>
<td>To gain insight into the new curriculum objectives prior to the start of classroom instruction</td>
</tr>
<tr>
<td>2</td>
<td>Record review of student information: scores from proficiency test and college entrance exam</td>
<td>To develop background information of the case study student populations</td>
</tr>
<tr>
<td>3</td>
<td>Individual semi-structured teacher interviews (audiotaped)</td>
<td>To investigate each teacher’s daily, weekly, and long-term preactive planning decisions</td>
</tr>
<tr>
<td></td>
<td>TABLE 7 continued</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Document review of individual lesson plans with each teacher</td>
<td>To correlate the teacher’s abbreviated, written curricular decisions with her stated planning goals</td>
</tr>
<tr>
<td>5</td>
<td>Classroom observations: 5 hours per week for 9-10 weeks</td>
<td>To observe interactive decisions made by each teacher during new microbiology implementation</td>
</tr>
<tr>
<td>6</td>
<td>Stimulated-recall teacher interviews (audiotaped weekly sessions)</td>
<td>To ask teachers to expound upon their reasoning with interactive decisions</td>
</tr>
<tr>
<td>7</td>
<td>Open-ended individual teacher interviews (audiotaped)</td>
<td>To investigate each teacher’s reflective practices; learn future plans for curricular modifications</td>
</tr>
<tr>
<td>8</td>
<td>Concluding group teacher, open-ended interview (audiotaped)</td>
<td>To study reflection through group interaction</td>
</tr>
<tr>
<td>9</td>
<td>Data interpretation with individual teachers</td>
<td>Member checking of researcher’s data interpretations</td>
</tr>
</tbody>
</table>

**Fieldwork**

Case studies require that the investigator delve into the research environment, observing the participant and the physical surroundings. The ultimate objective for the researcher is to investigate the phenomenon or activity in the naturalistic setting.
While extraneous variables may be addressed to a higher degree in a controlled laboratory setting, such experiments may not be sensitive to the social organization and interactions that occur in the natural environment. As Angrosino (2000, p.692) states, "Human action must always be interpreted in situational context, and not in terms of objective 'codes'." For example, an attempt to study interactive teacher thinking outside of the classroom would be futile. Therefore, the cornerstone of this case study was fieldwork.

Merriam (1998, p. 7) asserts, "Most investigations that describe and interpret a social unit or process necessitate becoming intimately familiar with the phenomenon being studied." Such intimacy can only be achieved through direct observation and contact with the participants within their own environment. In this project, the most feasible methodology to investigate teacher thinking was the naturalistic case study. The fieldwork included teacher interviews, document and record reviews, and classroom observations. The multiple methodologies resulted in triangulation of the data (Stake, 2000). In turn, the multiple sources of data served to add trustworthiness to the final data interpretations and analysis.

There is an additional, distinct advantage of fieldwork in a naturalistic case study. Naturalistic fieldwork "does not interfere with the people or activities under observation" (Angrosino & Mays de Perez, 2000). In this research project, the non-disruption of class was vitally important. To observe the participant teachers at work, both the students and the teachers needed to feel comfortable and unconstrained. I planned to be a nonparticipant observer. With a daily routine of observation over a period of two months, my presence eventually should not be a
factor in the classroom activities. However, during data interpretation, I will have to address the possibility that my observation may have affected curriculum teacher decisions to some degree.

Lastly, the evolving nature of case study fieldwork should be expected to have a factor in this project. Fieldwork often is a circuitous process, in which data from one methodology may guide the researcher to additional, unforeseen data sources (Mertens, 2000; Merriam, 1998). “Even though the case is decided in advance (usually), there are subsequent choices to make about persons, places, and events to observe. The primary criterion is the opportunity to learn” (Stake, 2000, p. 447). Therefore, even though I have explicitly planned the field study methodologies, the data may direct me to further investigative sources.

**Interviewing**

Interviewing is an essential qualitative research tool. Merriam (1998, p. 72) states “interviewing is necessary when we cannot observe behavior, feelings, or how people interpret the world around them.” The focus of this research project was to investigate teacher thinking during curriculum change. Thinking is not an activity that is directly observable. Only the actions that result from intimate, individualistic decisions can be perceived. Therefore, interviews were a vital portion of data collection in this project.

“We interview people to find out from them those things we cannot directly observe. We cannot observe feelings, thoughts, and intentions. We cannot observe how people have organized the world and the
meanings they attach to what goes on in the world. We have to ask people questions about those things” (Patton, 1990, p. 197; Merriam, 1998, p. 72).

During this study, individual semi-structured interviews were scheduled. The purpose of these interviews was to investigate the preactive planning processes of the teacher participants. Daily, weekly, and long-term plans and objectives were addressed. The teachers’ instructional philosophy, overall goals, and curriculum planning decisions also were addressed. The same interview schedule was used with both teachers. However, the semi-structured format permitted the inclusion of individual issues brought up by each teacher.

The individual stimulated-recall interviews permitted the teachers to expound upon their interactive decisions. The research plan was to conduct a brief stimulated-recall interview at the end of each week. This frequency served two major functions. By conducting the interviews on a weekly basis, the classroom experiences should be fresh in the minds of the teachers. If the interviews were conducted further apart, the incidents in the daily classes may begin to blur. The danger lies in ending up with vague impressions of teachers’ interactive decisions, rather than a detailed account of their thinking processes. Secondly, weekly interviews required a shorter time commitment from the teachers after their long workday. A total of seven to eight stimulated-recall interviews were conducted throughout this investigation. My field notes taken during the classroom observations sessions served as a guide for the open-ended questions. Obviously, I was not able to directly observe the thinking and decision processes of the teachers.
during instruction. I was merely able to observe and record decisions that resulted in teacher action. By relating the observational data with the interview methodology, I was able to address several teacher-thinking issues. Thus, the interview data and analysis were a vital part of this research project.

One open-ended or unstructured individual teacher interview was scheduled at the end of the last week of observation. The purpose of this interview was to research reflective practices (See Appendix E). The informal interview questions centered upon the teachers' contemplation on the overall success of the new microbiology unit. The teachers were asked to compare their original implementation plans with the actual in-class application of the subject material. I also asked about decisions that resulted in curricular changes. Thoughts about what worked and what did not work with the students were explored. This interview also gave me the opportunity to relate the teachers' reflection habits to their future plans for teaching microbiology. For example, I asked what changes for improvement did they plan to implement now that they have taught the unit for the first time. This reflective interview illustrated the role of reflection in the individual teacher's decisions.

The group teacher interview was conducted at the conclusion of the study. The set-up was in a group discussion format with open-ended questions. The interview schedule included five to six general questions or topics to guide the discussion. The open-ended questions were designed to allow the teachers to elaborate upon previous interviews and observational data. Questions in addition to the interview schedule arose in order to clarify or further investigate the teachers' responses. Mertens (1998, p. 232) describes the goal of open-ended or unstructured interviews is to
"have a human-to-human relationship with the respondents and to understand their perspective." Therefore, I encouraged the teachers to ask questions of me as well. The anticipated advantage of this group interview/discussion was the additional perspective from the interactions of the two teacher participants. Ideas not shared during the individual interviews were expressed in this informal format. I also was able to identify commonalities and differences in the experiences and viewpoints of the teachers.

Both participants agreed to the audiotaping of all the interviews. This allowed for the future transcription of the interview data. I tried to transcribe each discussion directly after the interview. In doing so, I reviewed the teacher responses in detail and formulated any elucidatory questions for the next interview session. Also, the final transcription notes were invaluable for later coding, interpretation, and analysis. Silverman (2000, p. 830) emphasizes the importance of interview transcriptions for analysis: The transcripts "involve close, repeated listenings to recordings that often reveal previously unnoted recurring features of the organization of talk. Audiotapes can be replayed and transcriptions can be improved, and analyses can take off on different tacks." In other words, the repeated replay of the interview tapes can guide the researcher in new, analytical directions. Based upon these theoretical considerations, I undertook the arduous task of transcribing all the interviews myself.

Another important benefit of the audiotapes was to my advantage. I did not have to attempt to simultaneously take notes, listen, and interact with the teachers. By taping the interviews, I could concentrate on the participants’ responses and form additional questions when necessary for clarification. All the individual interviews
took place in each teacher’s classroom, for the convenience and comfort of the participants. Obviously, the secret of meaningful, relevant data is in the interview questions. The data will only be as good as the interview schedule (Fontana & Frey, 2000; Merriam, 1998). Therefore, my primary ambition in the use of this methodology was to develop pertinent, probing questions that could lead to new discoveries in teacher thinking.

One additional consideration was the interpretation of any nonverbal cues, which could be significant in the analysis of the data. The duration of silence before a response can be an important aspect of the interview. The tone and volume of the voice can indicate stress or uncertainty. The body language of the participants may be noteworthy. As stated by Fontana & Frey (2000, p. 661), “The researcher should carefully note and record respondents’ uses of ‘nonverbal’ modes, for interview data are more than verbal records and should include, as much as possible, nonverbal features of the interactions.” Therefore, I also took notes on the nonverbal cues of the teachers during the audio taping of the interviews.

**Classroom Observations**

Observation is a fundamental component of qualitative research. Through observation the researcher can investigate participants’ actions and interactions in their own environment. The most common goal of the researcher is to gain insight into the participants’ world from an insider’s perspective. “The researcher is interested in observing people’s behaviors as they occur naturally in terms that appear to be meaningful to the people involved” (Mertens, 1998, p. 317).

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Spradley (1980) and Mertens (1998) classify various types of observation:

➢ “Complete participation” – The researcher becomes a member of the studied group through total participation as an insider.

➢ “Active participation” – The researcher fully participates while maintaining some distance as an investigator.

➢ “Moderate participation” – The researcher selectively participates in activities with those being studied.

➢ “Passive participation” – The researcher’s main role is one of a nonparticipant observer. Interaction with the participants is limited to the researcher’s presence.

➢ “Nonparticipation” – The researcher observes without contact with the participants, such as observation of videotapes.

Merriam (1998, p. 101) identified one additional category of observation: the “collaborative partner”. The researcher is a complete participant. As such, the “investigator and the participants are equal partners in the research process—including defining the problem to be studied, collecting and analyzing data, and writing and disseminating the findings.”

Several researchers present suggestions for successful observation fieldwork (Adler & Adler, 1994; Patton, 1990; Merriam, 1998; Mertens, 1998). The researcher should describe the setting in enough detail to allow visualization by other readers. The human interactions should be categorized and include descriptions of interaction frequency and participant characterizations. The activities in the environment should
be described in detail, including an explanation of the behaviors, decisions, and action patterns of the participants. The observation of nonverbal communication or body language can be an important detail for later analysis. Lastly, the researcher should be cognizant of recording what does not occur or might be missing from the observed activities of the participants.

Field notes are a major factor in the success of observation as a methodology. Expanded field notes should be written as soon as possible after the observation, in order to elaborate upon the initial observational notes. Detailed notes about the environment, the participants, and the interactions will later provide the fodder for a rich description. “Observations must be recorded in as much detail as possible to form the database for analysis” (Mertens, 1998, p. 111). Merriam (1998) suggests the inclusion of direct quotations, setting diagrams to map movements, and researcher comments. These “observer comments” can stimulate the memory of the researcher during data interpretation and analysis. During my observation sessions, I incorporated a classroom diagram in my field notes to record teacher and student movements. I also included as many pertinent quotes as possible in my field notes. In addition, I designed a coding system to categorize observations as I took the field notes. The coding system served as a reminder of my initial, on-the-spot interpretations of teacher thinking for subsequent field note elaborations and analyses.

In this study on teacher thinking, I planned to be a passive participant observer. While I was present in the classroom during microbiology instruction, I did not interact with the teachers or with the students. My goal was to observe teacher
interactive decisions, student/teacher interactions, curriculum implementation, and teaching/learning activities. My only activity was to take notes. These notes served in future interviews to stimulate teacher recall about their decisions made during instruction.

While my presence in the room may have altered the natural environment of the classroom, any affects should have decreased over the observation timeline. My role as an outsider was to observe teaching activities, as well as commonplace actions. By observing the obvious and the customary practices of the teacher participants, I gained insight into the context of teacher thinking. Furthermore, the observational data was used to triangulate the research findings from teacher interviews and document reviews.

**Documents and Records Review**

An additional source of data is the collection and examination of pertinent documents. Mertens (1998) states, “the qualitative researcher must turn to documents and records to get the necessary background of the situation and insights into the dynamics of everyday functioning” (p. 324). The review of documents permitted me to construct a framework of background information surrounding the research problem. Lincoln & Guba (1985, p. 277) differentiate between records and documents based upon the original intention of use. Records are identified as material intended for official transactions, while documents are intended for personal use. Denzin & Lincoln (2000, p. 703) state this difference is important in that
“documents are closer to speech and require more contextualized interpretation.”

The following types of documents and records were reviewed in this investigation:

<table>
<thead>
<tr>
<th>TABLE 8</th>
<th>RECORDS</th>
<th>DOCUMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Microbiology Course of Study</td>
<td>Daily, weekly, and long-term</td>
</tr>
<tr>
<td></td>
<td>Microbiology Pretest and Posttests</td>
<td>written teacher lesson plans</td>
</tr>
<tr>
<td></td>
<td>Ohio 9th grade proficiency test scores</td>
<td>Classroom observation field notes</td>
</tr>
<tr>
<td></td>
<td>Community college entrance exam scores</td>
<td>Teacher interview responses</td>
</tr>
<tr>
<td></td>
<td>I.E.P. student records</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Class data records (race, ethnicity, age)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Allied Health Program graduation records</td>
<td></td>
</tr>
</tbody>
</table>

The findings and research interpretations of the reviewed records and documents are presented in Chapter 4.

Data Analysis

Data analysis in qualitative research is an ongoing process, often completed simultaneously with data collection (Mertens, 1998; Merriam, 1998; Lincoln & Guba, 1985). Researchers purposively analyze the data while collecting the information, so that the data may direct future methodological decisions in the study.
“A rich and meaningful analysis of the data will not be possible if analysis is begun after all data are collected” (Merriam, 1998, p. 177). In other words, analysis during data collection may expose additional, unpredictable research issues in need of further investigation. The substantial volume of most qualitative studies also encourages early reflection and analysis of the data. This process of continual data analysis is in direct contrast to the data analysis of quantitative studies, which is usually done after all data is collected.

Several researchers have addressed the distinctive issues surrounding analysis of qualitative data. Stainback and Stainback (1988) identify common steps in data analysis. Initially the researcher reflects on the data during collection to identify connections, common themes, or relationships. This early analysis enables the researcher to gain insight into the research problem and develop initial impressions. In turn, these impressions can guide stages of future observation and interview during data collection.

The second phase of analysis occurs when the researcher organizes and codes the collected data. Such organization can occur throughout the investigation, which encourages the researcher to discover unifying themes or connections within the data. The conclusive analysis of the data is a compilation of researcher interpretations based upon the continual evaluation of the findings (Stainback & Stainback, 1988).

Merten (1998) agrees with many qualitative researchers that data analysis is an ongoing process throughout an investigation. Merten recommends that analysis begin with a segmentation of the data into “meaningful” categories. “The main
analytic process is comparison; that is, the researcher uses comparison to build and refine categories, define conceptual similarities, find negative evidence, and discover patterns” (Merten, 1998, p. 351). This strategy is inductive and allows for adaptations and modifications within the analytic process. In other words, the data categories originate from the data itself and can change when new, relevant information is discovered.

Merriam (1998) suggests that the researcher start with a speculative hypothesis as a foundation for initial analytic steps. Again, early analysis is encouraged to manage voluminous data and to guide additional data collection. “Capture your reflections, tentative themes, hunches, ideas, and things to pursue that are derived from the first set of data. Then note things you want to ask, observe, or look for in your next data collection activity” (Merriam, 1998, p. 161). Once again in contrast to a strict deductive process in quantitative research, the data is collected and analyzed simultaneously. Thus, the data findings may steer the direction of the study as the research progresses. The final outcome of the investigation is a compilation of data collection, inductive reasoning, and analytic questions.

Ryan & Bernard (2000) present a “Boolean approach” to analysis of qualitative data. The researcher develops “causal explanations” of the research findings. Each new case is assessed to judge if the fresh information correlates or fits with the original causal explanation. Similar to Merten’s (1998) “meaningful categories” process, Ryan & Bernard (2000, p. 787) recommend that data analysis continues until a “universal explanation for all known cases” is derived.
Several other analytic methods can be used with case study data, either singularly or in combination (Ryan & Bernard, 2000). “Key-words-in-context” and word counts are techniques that promote close scrutiny of text in the search for “patterns of ideas” (p.776). “Structural analysis” of the data discovers relationships or commonalities within the fieldwork text via computer software programs. “Cognitive mapping” combines the utilization of word counts with intuitive coding and interpretation of the data. According to Ryan & Bernard (2000, p. 780), “coding is the heart and soul of whole-text analysis.” By coding, the researcher not only identifies significant findings within the data, but also begins the process of data interpretation. All of the techniques discussed by Ryan & Bernard serve to construct categories of meaningful ideas from massive amounts of qualitative data. By analyzing and compartmentalizing the text data, the researcher is equipped to begin data interpretation.

Distinct from quantitative mathematical measurements, no definitive research step concludes a qualitative investigation. The guidelines to terminate data collection and analysis are at the sole discretion of the researcher. Lincoln & Guba (1985) suggest that data collection and analysis end when no new findings surface or when data recurrences become regular. Lincoln & Guba (1985, p. 351) discuss several suggested guidelines to indicate that analysis is complete:

- The researcher has “exhausted all sources”.
- The researcher recognizes an “emergence of regularities” in both the data collection and data analysis phases.

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A “saturation of categories” is noticed in that all new information fits easily into previously categorized data. Therefore, the researcher has the responsibility to identify when no further benefits will be derived from continued analysis. In this teacher-thinking investigation, I observed the teachers throughout the entire microbiology unit. Therefore, my data collection concluded after the students had been tested on the overall microbiology concepts.

The purpose of this study was to investigate the phases of teacher thinking during the implementation of a new curriculum unit. Qualitative methodologies and data management techniques were planned around this goal. This section will introduce the representation of the data, the qualitative data analysis methodology, and the data interpretation plans of the study.

**Representation of Data**

Unlike quantitative statistical data, data representation in a qualitative study cannot be uniform or standard. The data collection methodology, and therefore the data itself, is unique to the research purpose and setting. The researcher often must design an individual system of data collection and representation that best fits the circumstances. The massive amount of qualitative data demands a detailed plan for precise representation. Without a feasible plan, the quantity of data may become overwhelming for the researcher.

Many researchers suggest various proposals for data management and representation. Reid (1992) partitions data representation into three manageable
sections. In the “preparation” phase, the researcher transcribes interviews and condenses observational field notes. During this preparation phase, the researcher also can begin the “identification” or interpretation phase. At this stage of data representation, the researcher identifies and defines categories in which to classify the data. The researcher looks for similar themes, unifying topics, or significant occurrences that can group the data prior to analysis. The last of Reid’s phases is “data manipulation”, in which the data is further coded by content or meaning. All of these phases of data representation are techniques to aid future interpretation and analysis.

Merriam (1998) stresses the importance of coding qualitative data and suggests several phases to facilitate future analysis. The first level of coding is a fundamental organization of the document reviews, observational notes, and interview transcripts. Merriam recommends that a researcher add “identifying notations” or personal notations to the raw data. This step should be beneficial as a memory aid for analysis and categorization of the data as the investigation progresses. A “rudimentary analysis” is then suggested to prepare a separate catalog of the researcher’s initial impressions, instincts, or suppositions. By this point in the data representation, the researcher may select to complement the manual data representation with a computer software program for qualitative research.

Mertens (1998) also recommends the utilization of qualitative computer software programs for both data representation and data management. The newly developed software has a wide range of functions, from data organization to code/conceptual categorizations. Merten (1998) emphasizes the need to select a computer program
that correlates with the specific types of field data and the purpose of the investigation. An organized representation of large amounts of qualitative data is a vital step towards a coherent analysis of the research findings. By carefully designing a methodology to structure incoming data, the researcher can readily identify significant findings.

Two senior anatomy teachers were the participants of this teacher-thinking project. The data from each case study was analyzed and will be presented in five major categories: teacher interviews, document review, classroom observational field notes, evidence of student learning, and curriculum modifications. Within each of these categories, the three main objectives of the research will be addressed during data analysis: teacher preactive planning, interactive decisions, and teacher reflection. Further categorizations may be included in the data representation of the naturalistic case studies based upon the findings during data collection. The overall plan was to present the data from each teacher in this predetermined pattern to ease data representation and future interpretation.

**Qualitative Data Analysis Methodology**

My strategy for data analysis closely followed the recommendations of current qualitative researchers. I began data analysis in conjunction with data collection. All of the teacher interviews were audio taped. By transcribing the interviews, I was able to code the data, forming categories of information. Simultaneously, I recorded my initial impressions of the findings. For example, during classroom observation note taking, I coded occurrences into one of the three studied phases of teacher
thinking. As an additional aid to later data analysis, I prepared elaborated field notes as soon as possible after the observation or teacher interview. These initial analysis steps progressed within the parameters of my original research purpose and questions. This process of analysis early in the research design permitted me to reflect on the initial research questions. I was then able to modify the direction of the study to relate to the data collected to date.

Merriam (1998, pp. 183-184) provides several guidelines in the formation of data categories in qualitative research:

- “Categories should reflect the purpose of the research” as they are “answers to your research questions” (p. 183).
- Categories should be “mutually exclusive” in that data should not fit into more than one category.
- All relevant data should fit into a category.
- Categories should be “conceptually congruent” in that all categorizations should fit into your “category scheme”. In other words, all developed categories should relate to the purpose of the study and the research questions.

In this investigation, categorizations and coding of the classroom observational data was completed in a similar mode of the interview data. I reviewed and analyzed the classroom observation data on a daily basis in order to manage the large amount of field notes and to recognize any developing trends.

The qualitative design framework of this study was divided into three data segments: teacher preactive planning, interactive thinking, and teacher reflection.
These three segments lead to convenient stopping places for more in-depth analysis of the field notes, data codes, and recorded personal impressions. Upon completion of the data collection phase, an overall analysis and interpretation of data from all investigative areas commenced. The findings from this qualitative portion of the study will be presented in Chapter 4.
PART II: QUANTITATIVE METHODOLOGY

Introduction

The fundamental nature of quantitative research is explained in this part of the chapter. The overall research design of the quantitative portion of this investigation is described in detail. This design explanation includes information about the quantitative research problem, the research questions, and the student participants. In the data collection section, the quantitative framework of the quasi-experimental design is presented. The homogeneity of the participating classes is addressed, and the pretest/posttest evaluation tools are examined. Lastly, data analysis is discussed, and the possible limitations of the research design are addressed.

Quantitative Research

Quantitative research centers upon the relationships between variables. One variable, normally the treatment variable, often is quantifiable to allow statistical analysis of the relationship. This treatment or independent variable is intentionally manipulated or controlled in the experimental methodology. Often, a null hypothesis is developed prior to the experiment, and the research design is developed around this hypothesis. Whereas qualitative research relies upon descriptions of observations without quantification, quantitative research depends on data that are directly measurable (Best & Kahn, 1986). As such, "quantitative studies emphasize the measurement and analysis of causal relationships between variables" (Denzin & Lincoln, 2000, p. 8). In addition, such quantitative studies may investigate the relationships between variables.
Best & Kahn (1986, p. 145) defines quantification as “a numerical method of describing observations of materials or characteristics.” An experimental design is developed to test the quantification of the studied characteristic. Often the design of a quantitative study involves two major steps: to control the multiple variables extraneous to the treatment, and to scientifically manipulate the treatment variable to assess the result. The degree to which all extraneous variables can be controlled directly relates to the validity of the treatment effects. In other words, if all variables are controlled except the treatment variable, then the treatment is most likely the cause for any quantifiable changes. This method of experimentation permits the development and testing of a hypothesis.

Mertens (1998, p. 60) separates quantitative research into two categories: “descriptive studies that use quantitative data to describe a phenomenon and studies aimed at discovering causal/correlational relationships.” Several qualitative methodologies fit into these two, broad categories (Mertens, 1998; Best & Kahn, 1985; Fraenkel & Wallen, 1990):

- **Experimental design** – a randomly assigned control group and treatment group are compared after exposure to the treatment

- **Quasi-experimental design** – either a control group or randomization of the participant sample is not feasible. Therefore, the homogeneity of the samples must be assessed prior to the treatment variable.

- **Correlational or causal comparative design** – used to investigate variables that can not be manipulated in order to make comparisons
between groups or investigate the extent of the relationship between the variables.

The design is developed in relation to the research purpose, the research questions, the study environment, and the participants.

Lastly, the quantitative researcher should remember that measurement of human characteristics and actions is not seamless. Many human actions are not openly observable. For example, in the quantitative portion of this study, the microbiology expertise of the students will be compared after instruction. The comprehension of microbiology of the students is not directly observable. Therefore, a measurement tool (i.e., the microbiology posttest) must be designed to represent student comprehension. The degree in which the measurement tool corresponds to the studied variable (i.e., comprehension in this case) is vital to the research design. Obviously, the validity and reliability of the assessment instrument depends upon a strong correlation with the course objectives. Thus, the research findings are only as valid as the research design and measurement tools. “The fact that numerical data are generated does not ensure valid observation and description, for ambiguities and inconsistencies are often represented quantitatively” (Best & Kahn, 1986, p. 147). However, the researcher has the opportunity to address such areas of ambiguity through the development of a valid research design.
Research Design

The research design of this portion of the investigation centered upon the quantitative research problem and purpose. The design was constructed to correspond with the research questions surrounding the classrooms of the participating teachers, “Ann” and “Beth”. The main objective of this quantitative section was to compare and contrast the class achievement scores using the microbiology assessment instruments- the pretest and posttest. By relating the student achievement data with the qualitative research findings, the possibility existed for a descriptive analysis of the effects of teacher decisions. The microbiology course of study and the provided curricular materials were identical for the two classes. Thus, one major difference between the classes was the planning, interactive, and reflective teacher decisions made by the instructors.

The following quantitative design considerations are addressed in this research design section: the quasi-experimental design, the research problem, the research questions, and the participating anatomy classroom descriptions.

Quasi-experimental Design

A quasi-experimental research design is utilized for this quantitative portion of this investigation. A true experimental design requires random selection and assignment of participants to the sample conditions. In this project, random selection and assignment was not feasible. Intact science classes of students were utilized. Therefore, the students were not randomly assigned to classrooms, and the teachers were not randomly assigned for instruction. The result is that this project is quasi-

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experimental in nature. In turn, with such non-randomization, the generalizability of the results is not valid. Therefore, two important factors must be considered. The results of the quantitative analysis will not be generalizable to other student populations. In addition, the non-randomization will require the assessment of homogeneity between the science classes prior to any statistical tests. Secondly, the quantitative analyses will only be used as descriptive statistics to "describe" the science classroom environments. The purpose of this quantitative portion of the project is to expound upon the case study findings in the qualitative analysis. In other words, can the quasi-experimental results elucidate any observed findings in the case studies? In turn, will the case study findings substantiate the descriptive statistical interpretations of the researcher?

This project revolved around the incorporation of a new curricular unit – microbiology- into an existing Advanced Anatomy & Physiology course. Eight high school anatomy teachers were involved in this implementation. The eight teachers at eight different high schools were members of a "Tech Prep Consortium" with a local community college. The Tech Prep Program is a national community college program that involves two years at the high school level and two years at the college level, with an Associate’s Degree as the exit degree. As Tech Prep teachers, the anatomy course of study was supplied by the local community college, and the students could receive college credit for the course upon completion. In essence, the high school anatomy teachers were instructors for the local community college’s science course.
In the qualitative portion of this investigation, the case study focused upon two of the eight Tech Prep high school teachers. [Note: The selection process of the two teaching participants is explained in detail in the qualitative section of this chapter.] As such, the descriptive statistics of the quasi-experimental design will be related back to the case study findings of these two teachers, “Ann” and “Beth”. However, in order to increase the power of the statistical analyses, the data from all eight Tech Prep anatomy classes were analyzed. The unit of analysis will be the classroom means on a microbiology pretest and posttest.

**The Research Problem**

The purpose of the quantitative portion of this study was to compare the achievement effect of the microbiology curriculum instruction. The eight teacher participants integrated the same microbiology curriculum objectives into their preexisting anatomy coursework. The teachers used the same microbiology course of study, texts, and curriculum supplements. However, an observable difference in the integration of the new topic existed. Each teacher understandably made her own unique, independent decisions in regards to the microbiology instruction. The preactive planning, interactive, and reflective decisions of the teachers were addressed in the qualitative case study. These three phases of teacher thinking most likely had an impact the learning environment and student activities. The question is whether or not the thinking strategies employed by the teachers to teach the
microbiology unit had an effect on the students’ achievement. The hypothesis, research questions, and quantitative methodologies were formulated around this research problem.

**The Hypothesis**

There is no statistically significant difference in the microbiology posttest mean scores between the eight anatomy classrooms.

\[ H_0 = \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7 = \mu_8 \]

Where \( \mu_1 \) represents the mean posttest score of classroom 1, \( \mu_2 \) represents the mean posttest score of classroom 2, etc.

The alternate hypothesis is as follows:

\[ H_A = \text{There will be at least one significant difference in the posttest mean scores of the eight participating classrooms.} \]

**Research Questions**

Several research questions guided the quantitative portion of this investigation:

1. Using the classroom as the unit of analysis, would a statistical difference in student achievement exist between the classes of science students?

2. In conjunction with the findings from the qualitative case study (i.e., Ann and Beth’s classrooms), can any differences in student achievement be linked to distinctions between the case study teachers’ preactive planning, interactive decisions, and reflective practices?
3. What are the future implications of research into teacher thinking? In what ways might this quantitative research reveal and direct instructional procedures?

**Student Participants**

The population for the quasi-experimental study consisted of the students in the eight anatomy classrooms. Eight Tech Prep Consortium teachers at different high schools near the local community college instructed these classes. The math and science courses for all the Tech Prep classes were relatively standardized. As juniors, the students from all eight high schools completed Chemistry, Introductory Anatomy, and Algebra II. The prerequisites to enter the Allied Health Tech Prep Program were also standardized by the local community college. All students must have earned a letter grade of “C” or better in Biology and Algebra I prior to their junior year. A descriptive table allows a preliminary comparison of the data from the eight senior anatomy classes:
Table 9  
Demographic Data of the Eight Anatomy Classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Number of Students (n)</th>
<th>Female: Male Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Ann)</td>
<td>25</td>
<td>23:2</td>
</tr>
<tr>
<td>2 (Beth)</td>
<td>22</td>
<td>19:2</td>
</tr>
<tr>
<td>3</td>
<td>22</td>
<td>22:0</td>
</tr>
<tr>
<td>4</td>
<td>23</td>
<td>22:1</td>
</tr>
<tr>
<td>5</td>
<td>21</td>
<td>19:2</td>
</tr>
<tr>
<td>6</td>
<td>25</td>
<td>23:2</td>
</tr>
<tr>
<td>7</td>
<td>20</td>
<td>20:0</td>
</tr>
<tr>
<td>8</td>
<td>25</td>
<td>23:2</td>
</tr>
</tbody>
</table>

n= 183

[Note: To facilitate later research interpretation, I have denoted all of Ann and Beth’s statistical results in red. Ann and Beth were the teacher participants in the naturalistic case study.]

For entrance into the Allied Health Tech Prep Program, a passing rate on all four parts of Ohio’s ninth grade proficiency test was strongly encouraged, but not required. In addition, Allied Health students initially took the community college’s entrance placement exam in the beginning of the senior year. The entrance exam tested comprehensive knowledge in writing, math, and reading. Students not passing all parts of the community college entrance exam must take developmental courses upon high school graduation. The entrance exam was designed for high school graduates and, therefore, a one hundred percent passing rate was not expected in September of the senior high school year. However, the results provided additional
descriptive data for the student populations. In addition, I was able to review records that listed the number of students on an individual education plan (I.E.P.). Such students were identified by their high schools as having a learning disability. The I.E.P. is an individualized plan to accommodate learning and physical disabilities. These descriptive factors are presented below:

<table>
<thead>
<tr>
<th>Class</th>
<th>Passage % Ohio’s 9th Proficiency</th>
<th>Passage % Community College’s Entrance Exam</th>
<th>Number of I.E.P Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Ann)</td>
<td>92%</td>
<td>80%</td>
<td>2</td>
</tr>
<tr>
<td>2 (Beth)</td>
<td>90%</td>
<td>77%</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>86%</td>
<td>73%</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>80%</td>
<td>82%</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>96%</td>
<td>76%</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>88%</td>
<td>72%</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>90%</td>
<td>80%</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>92%</td>
<td>76%</td>
<td>3</td>
</tr>
</tbody>
</table>

The initial comparisons from document reviews of the eight senior anatomy classes indicated that the student populations appeared to be similar. The number of students and the male/female ratio was similar. There were no major discrepancies in the passing percentages on the Ohio 9th Grade Proficiency test. The passage percentages for the community college’s entrance exam also appeared to be similar.
Lastly, all classes had a low number of students requiring remediation through an individual education plan (IEP). However, in order to justify the comparison of posttest scores between the eight classes, a statistical substantiation of homogeneity was needed. Therefore, statistical analyses were preformed to further evaluate homogeneity prior to student achievement comparisons. A detailed plan for homogeneity assessment is located in the data analysis section of this chapter.

Data Collection

Data collection in a quantitative study revolves around the research measurement instrument. Before selecting an instrument, the researcher should review the purpose of the measurement. "The researcher chooses the most appropriate instruments and procedures that provide for the collection and analysis of data upon which hypotheses may be tested" (Best & Kahn, 1986, p. 201.). The participants, the study setting, and possible formats are all important factors in the proposal for data collection. The researcher then should determine if an existing measurement tool will function in the study, or if a new instrument must be developed specifically for the investigation (Mertens, 1998).

In this data collection section, the variables of the quasi-experimental design are presented. The methodology of data collection is discussed. In addition, the data sources and the authorizations of data collection from each participating school are explained.

The purpose of this quantitative portion of this investigation was to statistically compare student achievement after the implementation of a new microbiology unit.
The microbiology unit was incorporated into an existing senior, yearlong anatomy course. Eight high school anatomy classrooms, in different high schools near the local community college, were included in the statistical analyses. In this investigation, the measurement instruments already were in existence. The microbiology pretest and posttest were assessments developed at the participating community college. The Ohio 9th grade proficiency test and the community college’s placement exam were standardized tests already in use. Therefore, no instrument development or pilot test was completed for this investigation.

Data collection began with the construction of a consent form (See Appendix A). Initially, I requested the following documents from the local community college’s “Tech Prep” office: the Microbiology course of study, the Microbiology Pretest and Posttest, and the community college’s entrance exam mean scores for each of the eight high school anatomy classes. The community college’s Tech Prep Coordinator signed the consent form and provided the requested records to me via mail. As I requested, only Ann and Beth’s class means were identified. The data from the remaining six anatomy classes were not associated with any specific school. Also, in accordance with my data release/consent form, no student names were identified. Thus, the anonymity of the students was protected. The consent form was then sent to the principal of each participating high school. I collected the mean class scores for Ohio’s 9th grade proficiency test, as well as class records. The class records provided information on the number of students in each anatomy class, the female to male ratio, the age of the students, and the number of students of individualized
education plans (I.E.P.). Again, no students were identified in the records that I requested.

Immediately prior to the implementation of the new microbiology unit, the students at all eight high schools took a microbiology pretest. This pretest was developed by the local community college. The community college provided the student pretest scores for each anatomy class. This microbiology pretest was the data source for homogeneity analyses between all eight participating anatomy classes. Again, only Ann and Beth’s classes – the classes that were also involved in the qualitative case study of this project – were identified. After the completion of the microbiology unit, the community college’s Tech Prep Coordinator also provided me with the student posttest scores of the eight anatomy classes. As with the pretest, the students in each class were only identified by number, not by individual name. This microbiology posttest was the dependent variable in the statistical analysis of microbiology achievement.

Quantitative Framework: Quasi-Experimental Design

Two teachers, Ann and Beth, participated in the qualitative case study portion of this investigation. Ann and Beth were both Tech Prep science teachers that were incorporating a new microbiology unit into their existing senior anatomy course. The anatomy course was part of the Tech Prep curriculum in association with a local community college. Ann and Beth were members of the local community college’s “Tech Prep Consortium.” This consortium included eight total high schools in different school districts. As in the case with Ann and Beth, all eight senior
anatomy teachers received the same microbiology course of study and curricular materials. In addition, all the teachers gave their students the same pretest and posttest (See the Pretest and Posttest sections in this chapter), which was developed by Tech Prep instructors at the community college. To enhance the statistical power and validity of the quantitative research, the quasi-experimental design included the pretest and posttest results of all eight Tech Prep anatomy classes. The decision to incorporate the student data from all eight science classes, rather than just from Ann and Beth’s classes, improved the statistical potential to identify significant differences in class scores.

A quasi-experimental design is used when sample randomization is not feasible or desirable. In this investigation, eight intact senior anatomy classes were studied. The students were at separate high schools in different school districts. Random selection of the students was not possible, prohibiting the use of a true experimental design. In addition, the anatomy teachers at the high schools were not randomly assigned to the eight science classes. Therefore, a quasi-experimental design was selected for the descriptive quantitative portion of this study. The overall objective of the quantitative portion was to further describe the effects of teacher thinking during the implementation of a new microbiology curriculum. Causal/correlational relationships between teacher decisions and classroom achievement may be discovered (Mertens, 1997).

Several statistical steps were taken to analyze the students’ achievement after the microbiology instruction. An Analysis of Variance (ANOVA) was selected to compare the posttest mean scores. The classroom was used as the unit of analysis,
thus the ANOVA compared the microbiology posttest means from the eight participating high schools. In doing so, any significant difference between the class posttest means could be identified. For the ANOVA, the dependent variable was the microbiology posttest and the independent variable was the microbiology instruction.

The research design was quasi-experimental due to the following factors:

- Non-random assignment of the eight high school teachers who were integrating the new microbiology unit into their existing anatomy course of study
- Non-random assignment of the students in each class (i.e., intact classes were used in the study)
- Lack of independent observations within each classroom due to student-student and teacher-student interactions
- Uncontrollable, confounding variables other than the identified dependent and independent variables

Due to these factors, the quantitative analyses were quasi-experimental. As such, the findings were used as descriptive statistics to further elucidate the qualitative case study interpretations. Additional detailed information about the proposed ANOVA is presented in the next section and the data analysis section.

In this quantitative framework section, the overall quantitative research design is presented in detail. The quasi-experimental methodology is outlined, and the plan for homogeneity assessment is discussed. The pretest and posttest statistical plans of
analyses are presented. The overall quantitative design is summarized in table form. This section concludes with a discussion on the ethical considerations of student participation.

**Analysis of Variance (ANOVA)**

A one-factor ANOVA was run with an alpha level of 0.05 on the SPSS computer program. The number of students in each of the eight classes was different. With an unbalanced (i.e., unequal n) design, the SPSS program automatically weighted the means during the computation of the F value. With an unbalanced design, the researcher may decide to apply a stricter alpha level of 0.01. However, the n values of the eight science classes were relatively close, ranging from 20 to 25 students per class. In view of the narrow range of n values in conjunction with the weighted means for the SPSS computer program, I decided to retain the alpha level of 0.05 for the ANOVA.

In addition to the analysis of variance, descriptive statistics and the confidence intervals of the test scores were calculated. Prior to running the ANOVA on the microbiology posttest scores, several assumptions associated with the analysis of variance were considered. The ANOVA assumptions of independent observation, interval level measurement, normal distribution of the population, random sampling, and homoscedasticity are addressed in the following portions of this section.
**Independent Observation ANOVA Assumption**

The assumption of independent observations is particularly important with an ANOVA. Independence stipulates that the observations within the groups are not influenced by one another. Because of this stipulation, the unit of analysis could not be the individual student. Thus, in this investigation, the unit of analysis was each individual classroom from the eight Tech Prep high school science classes. However, while between class independence existed, the within group independence assumption was violated for the posttest ANOVA. Students in each class interacted with one another, as well as with their respective science teacher. As such, student/student and teacher/student communications would be unique, and these interactions could confound the analysis. Therefore, the condition of independence would be impossible to prove. A violation of the within class independence often results in a “positively biased” F result, meaning that the F value can be unjustly high (Kennedy & Bush, 1985). As such, a violation of independent assumptions would most likely affect the internal and external validity of the research findings. In recognition of this lack of independence of observations, the analyses were used as descriptive statistics, rather than as inferential statistics. The results will not be generalizable to any other student populations.

**Interval Measurement Level ANOVA Assumption**

Another assumption of ANOVA is that the scale of measurement or score data on the dependent variable are at the interval level or ratio level. This assumption demands that order and distance exists in the measurement scale. The data in this
investigation are the microbiology posttest mean scores of the science classes. These scores are the raw scores of the students, with each question equal to one point on a 100-point test. Thus, the variables in this investigation are at the interval level. The ANOVA assumption of interval measurement is met.

**Normality ANOVA Assumption**

Normality, another assumption that must be met for a valid one-factor analysis of variance, is the assumption that the residual errors for the scores are normally distributed in the treatment population. If the normality assumption is met, then the score distribution of the population should also be normally distributed. To test normality in this investigation, a normal Q-Q plot was prepared through the SPSS computer program. The results and plot of this assumption check will be presented in the result section of chapter 4.

**Random Sampling Assumption of ANOVA**

The assumption of random sampling is vital to a research design utilizing an ANOVA. Through randomization, the internal validity of the study can be strengthened. True randomization increases the probability that the samples are comparable prior to the treatment. In turn, the probability increases that any significant difference in the sample groups after treatment is due to the independent variables. In this investigation, the students were not randomly assigned to a classroom. Intact classrooms of students were compared. In addition, the teachers of the eight science classrooms were not randomly assigned, as they were
convenience samples. The only true resolution of the confounding variable of non-randomization would be to repeat the study with a truly randomized design. As a quasi-experimental study, the external validity of the research findings is in jeopardy. However, as mentioned previously, the goal of this investigation was not generalizability. The purpose of the quantitative analysis was use of the statistical analyses in a descriptive mode, as an augmentation to the qualitative case study findings. Even without randomization, the issue of homogeneity or homoscedasticity can be assessed.

**Homogeneity Assumption of ANOVA**

The assumption of homogeneity or homoscedasticity states that each treatment group will have an equal error variance on the dependent variable. In order to justify achievement comparisons between the classes of students, the homogeneity or equality of the samples must be assessed. Best & Kahn (1986) define “homogeneity of variance” as equality between samples. Homogeneity/homoscedasticity “does not literally mean that the variance of the samples to be compared must be identical, but only that they do not differ by an amount that is statistically significant” (Best & Kahn, 1986, p. 268). In other words, without a statistical equality between the various microbiology classes, the significance of any achievement differences would be invalid. Without homogeneity, previously existing differences in aptitude might account for any posttest statistical discrepancies in overall microbiology achievement. In turn, the analysis of the effect of the treatment (i.e., the
microbiology instruction by eight separate teachers) upon student achievement would be difficult.

The quantitative portion of this investigation statistically compared the microbiology achievement scores of the separate classes of students. The student population consisted of convenience samples of eight senior science classes, individually taught by the secondary teachers. Two of these teachers, “Ann” and “Beth”, were the participating teachers in the qualitative case study. All of the eight instructors taught from the same course of study with identical curriculum materials and texts. The curriculum objectives, materials, texts, pretest, and posttest were provided to the instructors by the local community college. At the end of the microbiology unit, the students were given a posttest assessment. Used in conjunction with the teacher-thinking case study data, this quantitative analysis may reveal a relationship between teacher thinking/interactive decisions and student achievement. For instance, if a significant difference in the posttest mean was found between one of the two observed classrooms and the overall mean of the eight classrooms, the observational data about that specific teacher’s curricular decisions might provide clues to the cause of the disparity.

In the quasi-experimental design of the project, eight intact senior science classes were the subjects of the quantitative analysis. Several methodological steps were taken to assess the homogeneity level between the senior anatomy classes. Mertens (1998) identifies “differential selection” or non-homogeneity as a significant threat to the quasi-experimental design. When “randomization is not possible, a researcher should try to match participants on variables of importance – for example, gender,
age, ethnicity. It is very important with this design to collect as much background information as possible about the two groups to determine how they differ” (Mertens, 1998, p. 78 & 80). In the design phase of this investigation, I addressed both of these recommendations by Merten.

During the selection of teacher participants/participant high schools for this investigation, I purposively assessed factors such as age, gender, and college enrollment rate in an effort to match teacher and student participants (Note: See Tables 9 & 10 in this chapter). The total number of students and the male to female ratio in each class were similar. Also, a similar number of students were participating in an IEP program for reading, writing, or math. In appearance only, the background information between the two participating teachers’ classrooms seemed to be comparable. Thus, in the selection of the two teachers that participated in the case study, I attempted to match variables of importance.

In addition to the background comparisons of the two classroom samples, a pretest given prior to the microbiology unit was used to statistically analyze homogeneity. This pretest assessed homogeneity among all eight of the anatomy classes. The pretest design is discussed in the next section.

**Pretest Assessment Tool**

Homogeneity between participant samples is an important issue to validate the statistical comparisons of posttest achievement. If homogeneity is statistically suggested, the ANOVA will have increased validity in the microbiology posttest assessment (Fraenkel & Wallen, 1990; Best & Kahn, 1986). The pretest evaluation
was given prior to the microbiology instruction (i.e., the treatment). All of the
students in the eight classes from the separate high schools had completed a biology
course as sophomores and a physical science course as freshman. However, the
courses of study for these classes were prepared independently. The science material
included in the courses was at the discretion of the individual school district and
science teacher. Therefore, the general pretest was an invaluable assessment of the
students’ basic science aptitude and homogeneity.

The pretest was an evaluation prepared by Allied Health Tech Prep instructors
from the community college. I questioned the Allied Health Tech Prep coordinator at
the community college in the fall:

“We had a team meeting last spring with all the instructors (i.e.: the
college instructors) and most of the anatomy (i.e., high school) teachers.
We wanted some test to give to the students at the beginning of the year....
(pause)..... mainly to see what they were coming in with. They’re all
supposed to have biology and algebra I, but some are coming in with
Algebra A and B, which is more like a pre-algebra. And then we have
some students that have had honors biology and others have a ‘C-’ in
general. We just wanted to check up on their overall science knowledge.
We came up with some general questions we thought they should know
by the eleventh grade. We actually just typed it up right there using the
tenth grade biology books. We thought that later we could use these
scores to see if the test is a good predictor of who will pass or fail
(i.e., the microbiology unit). But I think if the majority of them pass, then
The pretest was given to the incoming anatomy seniors. Therefore, the stability of the pretest over time was not demonstrated. For this investigation, the pretest was only used to determine the homogeneity of the student sample. The pretest was not for use as a comparative indicator of student achievement in microbiology. However, the pretest validity and reliability was still central to this investigation.

The pretest was assessed using one statistical analysis: Cronbach's coefficient alpha for each subscale.

**Pretest Reliability: Cronbach's Alpha**

The test was arranged in four general science categories: biology, genetics, locating information, and anatomy. The biology, genetics, and anatomy portions of the test contained basic, foundational knowledge questions on those subjects. The locating information portion contained graphs and reading material to be interpreted or analyzed by the student. The biology, genetics, and anatomy subsections contained basic information on those topics. The pretest consisted of 50 multiple-choice questions, with each correct question equaling one point. Each subsection was represented by twelve or thirteen questions on the pretest. The students answered the questions on a scantron sheet with a time limit of two hours. A test proctor from the
community college administered the pretest at each high school. Therefore, the
participant teachers did not view the test prior to the students.

Reliability and subset analyses were used to evaluate the reliability of the pretest.
The measurement of scale or subsection reliability centered upon the correlations of
scales or subsections comparative to the variances (Lomax, 2001). With the pretest,
the reliability was computed using the four pretest subsections: biology, genetics,
locating information, and anatomy. Cronbach's alpha analysis was utilized to assess
the reliability of the pretest. The analysis was based upon the correlations between
the pretest subsections, and therefore was a measure of "inter-item consistency"
(Lomax, 2001). For example, did all of the pretest subsections concentrate upon one,
unified construct or theme?

Cronbach's alpha presumes that only a single construct is being evaluated. The
SPSS computer statistical program calculates Cronbach's alpha using both the raw
and standardized variables. The alpha from the raw variables relies upon subset
correlation; the higher the degree of inter-relation between the subsets, the greater
the probability that the pretest is consistent. The alpha from the standardized
variables relies upon subset covariance (i.e., a computation of the distribution of the
two variables). As the value of the correlation coefficient increases, the degree of
covariance or reliability increases (Lomax, 2001). Thus, a higher alpha score is
proportional to a higher test reliability or inter-item consistency. Nunnally (1978)
and Glass & Hopkins (1996) state that an alpha at or above 0.70 is a high alpha
score.
Pretest Summary

The reliability of the pretest was assessed through the utilization of Cronbach’s alpha on the pretest subsets: biology, genetics, locating information, and anatomy. The overall purpose of the pretest in this investigation was to test the class samples for homogeneity prior to microbiology instruction. This was accomplished through the utilization of the pretest mean scores with three statistical procedures: the ANOVA, Levene’s test, and a residual plot of student scores. If these three analyses indicated that homogeneity between the eight science classes existed, then the posttest ANOVA could be utilized for mean comparisons at the 0.05 alpha level. If the homogeneity assumption was violated, the ANOVA will need corrective action. The use of a more stringent alpha level of 0.01 may be necessary to alleviate some of the bias of such a violation. The result of the analysis for homogeneity is presented in the quantitative result section of Chapter 5.

Posttest Assessment Tool

The posttest evaluation was given upon completion of the microbiology instruction (i.e., the treatment). This posttest was an evaluation prepared by Allied Health Tech Prep instructors from the community college. I interviewed the Allied Health Tech Prep coordinator at the community college about the posttest construction:

"All of the Allied Health instructors (i.e., at the college level) got together over the summer to review the objectives....(pause)...the ones we made up and gave science teachers (i.e., anatomy high school teachers) last spring."
We wanted to make up the test questions directly from those objectives and the micro book. We took a lot of the essay questions... (pause)... the ones at the end of each chapter... and reworded them as multiple choice. Then we took a look at the vocab list in the course objectives. We made up quite a few questions from it. We followed the units in the book and came up with four basic areas to focus upon. The hardest part to agree on was the culturing part... (pause)... it has a lot of calculations about growth rate and generation time. We basically used the review questions (i.e., the review problems at the end of each chapter) and put in different numbers and growth times. That way we knew the students would have had those types of word problems before.

The whole test took us about one whole day."

The two-hour test included four areas of microbiology in a 100-question, multiple-choice format: bacteriology/virology, immunology, culturing, and pathogenic diseases. One point was awarded for each correct answer. The community college instructors purposively tried to match the curricular content of the course objectives to the test questions, a common demonstration of content validity (Messick, 1989; Moss, 1992). Therefore, the posttest did have content validity in the judgment of the test developers. Content validity in the case of the posttest was central to this investigation. The posttest mean scores of the anatomy classes were statistically assessed to compare class achievement after instruction. Therefore, the posttest had to directly relate to the taught curriculum for a practical relation to microbiology achievement. In other words, without content validity, a posttest might not measure what was taught in the classroom – the basic purpose of this posttest.
Reliability was defined in quantitative literature as the consistent measurement of an instrument over time. In other words, reliability concerned the stability of a test in measuring what the test was designed to measure through multiple applications (Messick, 1989; Moss, 1992). As with the pretest, the first occasion for utilization of posttest was during this investigation. Therefore, the posttest reliability was assessed through Cronbach's coefficient alpha. An alpha level at or above 0.7 (Nunnally, 1978; Glass & Hopkins, 1996) was viewed as a high alpha. In addition, Pearson's correlation coefficients were generated to further assess subscale correlations.

Pearson's correlation measures the degree to which the posttest subsections are proportional to one another. According to Cramer (1998), "Pearson's correlation assesses the strength, direction, and probability of the linear association between variables and varies from -1 to +1." Thus, a +1 Pearson correlation would indicate a maximum degree of correlation between the posttest subsets. With both Pearson's correlation and Cronbach's alpha, if a high degree of subsection correlation was proven, the subsections corresponded well to the overall posttest. If no or very low correlation between the subset scales was found, then the posttest subsets did not relate to one another. In such a case, only separate ANOVA on each microbiology posttest subset would be statistically valid.

The presence of content validity and reliability should make the posttest a justifiable instrument to compare class achievement after microbiology instruction.
In addition, a test proctor from the community college administered the posttest at each of the eight high schools. Thus, the high school anatomy teachers did not have access to the test prior to administration.

**Posttest Summary**

The purpose of the posttest was to permit statistical analysis of the mean test scores of the anatomy classrooms. The null hypothesis was as follows: There is no statistically significant difference in the microbiology mean posttest scores between the classrooms of student participants. If the null hypothesis is not rejected, then the unique planning, interactive decisions, and the reflective practices of the two participating teachers did not result in a difference in the microbiology achievement or posttest scores of their individual classrooms. In other words, even though the teachers made individual, distinctive curricular decisions during microbiology instruction (i.e., the treatment), no statistical difference in posttest achievement was found. If the null hypothesis is rejected, then the teacher-thinking practices of the teachers may have affected student posttest proficiency. A relationship between the posttest mean score differences and teacher-thinking differences may or may not be identified. However, an attempt was made to relate significant, posttest achievement differences with information from the teachers’ case study data. For example, through classroom observation and teacher interviews, I researched the curricular decisions made by the two participating teachers, Ann and Beth. The microbiology unit instruction was limited to a ten-week timeline to allow ample coverage of the preexisting anatomy curriculum. I discovered through qualitative methodologies that
both teachers omitted and/or rushed through various microbiology objectives due to time constraints. By utilizing the quantitative analyses in a descriptive manner, I may be able to relate any discrepancies in posttest achievement to the curricular decisions made by the teachers.

If homogeneity is suggested through the pretest analysis with the ANOVA, Levene’s test, and a residual plot of student scores, then the posttest mean scores will be compared with an ANOVA at the 0.05 level of significance. The Allied Health community college instructors set the standard for student performance. The passage rate for the test was set at 70%, where the college grade scale was set as follows:

- 90-100% grade of ‘A’
- 80-89% grade of ‘B’
- 70-79% grade of ‘C’

This same passage rate existed for the entire anatomy high school course. Since the microbiology unit was only a 10-week portion of the yearlong anatomy course, a student could fail the microbiology unit and still feasibly pass the anatomy course. Students that achieved a minimum of 70% on the overall anatomy course received college credit from the community college. The advantage of the Tech Prep anatomy curriculum was that if students did not pass with a ‘C’ or better, the grade did not remain on their college record and would not affect their college grade point average. In addition, the high school Tech Prep students did not have to pay for the five college credits of the anatomy course. Therefore, several external incentives for passage of the microbiology posttest existed.
Through document research, I believed that the posttest was a valid instrument of performance assessment for the microbiology unit. I studied the Allied Health program goals, the microbiology course objectives, the microbiology textbook, the pretest, and the posttest. From an outsider’s viewpoint, the posttest strongly correlated to the course objectives, the written teachers’ plans, the classroom instruction, and the textbook units.

**Ethical Concerns: Student Participants**

Ethical issues in research should be considered in the preliminary stages of research design, prior to interaction with the participants (Mertens, 1998; Merriam, 1998). The quantitative portion of this investigation involved a statistical analysis of several student evaluation scores. The pretest and posttest assessments were given during the natural progression of the microbiology unit. Thus, the students were not tested in any manner other than in the normal classroom situation. The data were accessed solely through record review. Data representation was concluded in a manner such that no student names were used. Both participating teachers agreed to provide me with student scores without using individual student names. In addition, the statistical analyses only used the mean test scores of the classroom samples. Therefore, the anonymity of the students was maintained during and after the investigation.

During the qualitative case study, classroom observations were undertaken. However, the case study purpose was to investigate teacher thinking. Therefore, most of the observational data involved teacher actions and decisions rather than
student data. As a non-participatory classroom observer, the research was non-intrusive in nature. My presence in the classroom should have had a negligible affect upon the curriculum and the learning outcomes of the students (Mertens, 1998). Thus, the ethical issues should be minimal, as the research was “conducted in an established or commonly accepted educational setting, involving normal education practices” (Mertens, 1998). However, any potential researcher affects will need to be considered in conjunction with the study findings. Through consideration of possible ethical issues during the design phase, the overall risk of confidentiality and/or moral issues in the quantitative portion of this project should be greatly reduced.

Data Analysis

Data analysis in a quantitative study centers upon descriptive statistics. Best & Kahn (1986, p. 206) define statistics as “a body of mathematical techniques or processes for gathering, organizing, analyzing, and interpreting numerical data.” The main benefit of statistics is that the researcher can present large amounts of numerical data in a concise manner. Enormous amounts of numerical data can be reduced to more manageable statistics. Measures of central tendencies (i.e., mean, median, and mode) are an example of such statistical representations. Because quantitative studies generate numerical data, statistical analysis is the fundamental instrument for data evaluation. In this investigation, numerous statistical analyses of the data were conducted. The quantitative data analysis methodology and the
representation of the quantitative data are discussed in this section. In addition, the possible limitations of the quantitative research design are discussed.

**Quantitative Data Analysis Methodology**

A table listing the planned quantitative analysis steps is presented in the following table:

<table>
<thead>
<tr>
<th>Step #</th>
<th>Statistical Test</th>
<th>Mean Score Source</th>
<th>Null Hypothesis</th>
<th>Purpose of Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cronbach’s Alpha</td>
<td>Pretest</td>
<td>The pretest is a unidimensional test.</td>
<td>Reliability of Pretest</td>
</tr>
<tr>
<td>2</td>
<td>Cronbach’s Alpha &amp; Pearson’s Correlation</td>
<td>Posttest</td>
<td>The posttest is a unidimensional test.</td>
<td>Reliability of Posttest</td>
</tr>
<tr>
<td>3</td>
<td>ANOVA, Levene’s, Residual score plot</td>
<td>Pretest</td>
<td>There is no significant difference between the mean pretest scores.</td>
<td>Homogeneity of eight class samples</td>
</tr>
<tr>
<td>4</td>
<td>ANOVA, Levene’s, Residual score plot</td>
<td>Posttest</td>
<td>There is no significant difference in the mean posttest scores between the eight classrooms</td>
<td>Posttest mean score comparison</td>
</tr>
</tbody>
</table>

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Representation of Data

"Statisticians recommend that you always graph your data before you start conducting analyses" (Mertens, 1998, p. 337). In doing so, the researcher becomes more familiar with the data and can begin the selection of data categories. The method of data representation depends upon the research design and data types. The purpose of data representation in a quantitative study is to present the multiple numerical data in a concise, meaningful manner. Tables and graphs often are utilized to present large amounts of data in a reader-friendly format. Best and Kahn (1986, p. 196) recommend data "tabulation" in order to "transfer data from the data-gathering instruments to the tabular form" for future analysis.

Data representation is an important aspect of research reporting. During the research design phase, the researcher should consider the most beneficial and logical method of presenting the data to the reader. Often the hypothesis and the purpose of the study can guide data organization and representation (Best & Kahn, 1986). An additional advantage of carefully planned data representation is the facilitation of data analysis.

The main benefit of concise quantitative data representations is the organization of the data for both analysis and representation. Often the presentation of all of the extensive numerical data is not necessary or desired. Instead the presentation of statistical calculations, such as means, medians, or percentages, can graphically explain the data. This manipulation of the raw data scores presents an overview of the observable trends or patterns, enabling the reader to summarize the material in an expedient manner.
In this investigation, the raw score data were represented utilizing descriptive tables and graphs. Distribution curves included the depiction of the standard deviations and the means. The individual students' multiple test scores were not presented. Instead, the measures of central tendency of each test score were presented in table form. The statistical analyses of the data also were represented in table form. The quantitative data and statistical computations will be presented in Chapter 5.

Addressing Limitations of the Qualitative & Quantitative Research Design

The possibility of conducting a flawless experiment in an educational setting is low. Investigations within the classroom cannot be interpreted in the same manner as investigations conducted in a sterile, highly controlled laboratory environment. Each classroom is a unique social situation with distinctive student-teacher interactions. As such, many purposes of educational research could not be served through the use of a simulated laboratory setting. Therefore, a variety of unforeseen variables can affect the experimental design. The imperative task of the researcher is to identify and address the possible limitations of the study. In this investigation, the possible limitations of both the qualitative and quantitative portion of the study must be addressed.
Possible Qualitative Limitations

Merriam (1998, p. 204) proposes several strategies to address the internal validity of a qualitative study. The important role of triangulation for data corroboration is emphasized. Meriam (1998, p. 24) defines triangulation as the use of “multiple investigators, multiple sources of data, or multiple methods to confirm the emerging findings.” Member checking is suggested to substantiate the data, data interpretation, and analysis of the investigation. In a similar argument, “participatory or collaborative” research methods are recommended. By involving the participants in many phases of the research, the internal validity of the findings may be increased. Peer examination is also mentioned as a possible benefit. Lastly, Merriam (1998) advises the investigator to be diligent in the identification and consideration of any possible researcher biases.

Several researchers emphasize the importance of triangulation in qualitative research. Stake (2000, p. 443) cites that triangulation will decrease the possibility for misinterpretation of the data and findings in three ways: triangulation can elucidate the meanings of the data, triangulation can corroborate the “repeatability of an observation or interpretation, and lastly triangulation can connect the researcher’s interpretations of the data from the multiple data sources. In other words, triangulation can illuminate the rationale behind a researcher’s interpretations of multiple sources of data. Fontana & Frey (2000) recommend triangulation in conjunction with the interview methodology to broaden the data base. Mertens (1998, p. 183) states that triangulation examines the findings for a “consistency of evidence across sources of data.” Denzin & Lincoln (2000, p. 5) state that
triangulation is not a “tool for validation, but an alternative for validation.” Instead, triangulation permits a rich description of qualitative data, and promotes an “in-depth understanding of the phenomenon in question.”

In order to address possible limitations, this project was designed in consideration of the current literature on qualitative research methodologies. Multiple sources of data were acquired through interviewing, observation, and document review. By securing data through multiple methodologies in the case study, the breadth and accuracy of the research findings was improved. Member checking was a part of the data analysis. A final meeting with the two participating teachers was conducted upon the completion of the interview transcripts and observation notes. The teachers had the opportunity to clarify any of their responses or actions in the classroom. I believe the utilization of member checking offered legitimacy to the data interpretations during the analysis phase of this project.

**Possible Quantitative Limitations**

The possible limitations of the quantitative research design also must be addressed. Mertens (1998), Best & Kahn (1986), and Fraenkel & Wallen (1990) identify two major threats to the validity of a quasi-experimental design: lack of homogeneity due to non-randomization and experimental mortality. The lack of homogeneity between the two sample classes would be a severe threat to the validity of this investigation. Sample homogeneity was assessed through statistical analyses of the students’ pretest scores. The overall experimental design was intended to statistically compare the student’s posttest performance after instruction. Therefore,
initial homogeneity between the two student sample groups was important for validity of the design. The findings of the homogeneity assessment of the pretest will dictate further statistical analysis of the posttest.

With the relatively small number of students in this study, experimental mortality could have an impact upon the results. "The survivors might represent groups that are quite different from the unbiased groups that began the experiment. Those who survive are likely to be healthier, more able, or more highly motivated." (Best & Kahn, 1986, p. 121). For example, in this investigation the most likely students to drop out of the anatomy sample classes during the investigation were the students who were failing. The loss of less able students in only one class sample could "confound the results." A document review of last year's senior classes at the two high schools indicated that only one out of forty-five Tech Prep juniors left the program before graduation. If attrition occurred in either class, I would investigate the cause, and evaluate the effect upon the experimental design.

By recognizing possible limitations and assumptions in both the qualitative and quantitative phase if this investigation, I reduced the possible effects through a thorough and detailed research design. However, any possible study limitations will have to be addressed in the result section.
Methodology Conclusion

Chapter III presented the overall research design of this investigation. A qualitative, naturalistic case study was chosen as the most appropriate methodology to investigate teacher thinking. Fundamental features of the qualitative research design were specified, such as the research problem, research questions, participant selection, and setting depiction. The teacher participants were described. In addition, the qualitative design framework was explained in detail. The interview procedures, the observation plans, and the document review were described. Lastly, qualitative data analysis, data interpretation, and ethical concerns were addressed.

The quantitative portion of this study also was illustrated in Chapter 3. The quantitative research problem, the research questions, and the student participants were identified. The data collection technique – including the quasi-experimental design and homogeneity assessments – was described. The pretest and posttest evaluation tools were explained. Ethical concerns involved in qualitative investigations were considered. In addition, the future analysis and interpretation of the quantitative data were addressed. Chapter 3 concluded with an examination of limitations of the overall study, and included methodological techniques to reduce threats to validity.
CHAPTER 4

A NATURALISTIC CASE STUDY WITHIN THE REALM OF TEACHER THINKING

Introduction

This chapter presents the data and researcher interpretations of the case study findings of the investigation. The qualitative portion of the investigation focuses upon the naturalistic case studies of the two secondary anatomy teachers. The purpose of the case studies was to investigate teacher-thinking practices during the implementation of new curriculum. The teacher participants incorporated a new microbiology unit into an existing anatomy course of study. The case studies are described concurrently within the realm of preactive planning, interactive decisions, and reflection. At the beginning of this section, the document review findings, the instructional timeline, and the existing curriculum materials are described. The case study findings begin with a presentation of the personal background, high school environment, and classroom environment of both participating teachers, “Ann” and “Beth”. Thus, a comparison of the case study research settings is presented. The observational and interview data of each case study is then portrayed jointly in the
three main areas of focus: preactive planning, interactive decisions, and reflection.
The final section of this chapter reports the researcher’s interpretation of the case study findings.

The New Microbiology Curriculum

Prior to the start of the microbiology implementation, I reviewed several documents relevant to the planned microbiology course. In addition, I interviewed multiple Tech Prep counselors, teachers, and college personnel. In the following section, the factors that led to the decision for a new microbiology unit is presented. The microbiology course of study and class background data is described. The Tech Prep entrance requirements and the Tech Prep brochure are represented. Lastly, the instructional timeline for the microbiology unit and the available curriculum materials is discussed.

The Decision to Incorporate a New Microbiology Curriculum

How was the decision made to incorporate a new microbiology unit into the existing senior Anatomy course? Both teacher participants and the Tech Prep Coordinator at the community college provided information about the development of the microbiology course through separate, preliminary interviews. The participating teachers’ students had completed a yearlong introductory anatomy course as juniors in the Allied Health Program. During their senior year, these students were scheduled to take an “Advanced Anatomy & Physiology” course. The students could earn five hours of college credit for the Advanced Anatomy course.
through the local community college. The community college provided the anatomy
teachers with five college-level, multiple-choice tests for this senior anatomy course.
The high school teachers administered these tests throughout the year, which allowed
them to work at their own pace in their respective classrooms. If the students passed
all five tests with an average of a ‘C’ grade or better (70% or better), then the
students qualified for the college credit hours. If the high school students scored
under a 70% on the five tests, then they did not receive college credit, and the course
grade would not be reflected on their college transcripts. During an introductory
meeting/interview at the local community college, the Tech Prep Coordinator stated
the following:

Tech Prep Coordinator: "At last year’s team meeting...(pause)...All
the college instructors and high school teachers (i.e., those involved with
the Tech Prep Program) meet every spring. Only the math and science
teachers are involved because they are the only ones that teach Tech Prep
college classes in the high schools. We meet to talk about any changes
or problems that come up during the year on either side. Several of the
high school anatomy teachers stated that most of the Advanced Anatomy
was review material. So we started talking about how we could improve
the senior science year. The chair of our nursing program suggested that
we add a microbiology unit. About half of the Tech Prep students go into
nursing...(pause)....and according to “Pat” (i.e., the nursing department
chair), most of these students were coming in with a great background in
anatomy, but knew nothing about diseases and pathogens. We asked the
anatomy teachers what they thought, and they were pretty receptive....

(pause). especially when we said we would try to get grant funding
for some lab materials. We (i.e., the community college instructors)
got together last spring and reworked the microbiology objectives to
fit into about one quarter (i.e., nine weeks at the high school). We
did have grant money from the state to cover equipment for each
high school. This will be our first try at micro. I'm sure we'll have
to fine tune it when we get back together next spring.”

Thus, the college instructors noticed a deficient area of study from the incoming
Tech Prep freshman students. The high school anatomy teachers agreed that the
curriculum content for the senior year was not challenging to the students. The
proposed solution to both problems was the addition of a short microbiology unit to
the already existing, yearlong senior Advanced Anatomy course. The Tech Prep
Coordinator concluded the interview by explaining that the high school Tech Prep
students now had the opportunity to earn almost twenty hours of college credit in
math and science before graduation. In addition, these credits were accepted upon
transfer to the majority of Ohio’s four-year state universities.

**Record Reviews**

I reviewed several documents and records prior to the start of the microbiology
instruction. In agreement with Denzin & Lincoln (2000), I classified any text
designed for official use as a record. Written teacher plans were classified as
documents, as the text was designed only for personal use. As such, the document
reviews are presented later in the individual case studies of the two teacher
participants. The records I reviewed were as follows: the microbiology course of
study, class data records, I.E.P. student records, the Allied Health Tech Prep entrance
requirements, curriculum materials, and the community college’s Allied Health Tech
Prep brochure.

Record 1: Microbiology Course of Study

The microbiology course of study was a document developed by the Allied
Health Tech Prep instructors at the community college. As with the posttest, the
course was divided into four basic units: bacteriology/virology, immunology,
culturing, and pathogenic diseases. The course of study consisted of 25 pages of text
in a table format under the headings of unit area, instructional objective, and
suggested activities.

Within each of the four sections, instructional objectives were listed. In addition,
each instructional objective had a corresponding set of suggested activities and
resources. A total of 28 objectives were described within the four units of the
microbiology course of study.

Within the bacteriology/virology unit, the main objectives and activities included
the following:

➢ Historical review of microbiology: germ theory, terminology, microbe
classifications, and microbial slide identification
➢ Bacteriology: classification, bacterial nomenclature, slide identification, common bacterial diseases, transmission modes, pathogenic mechanisms, and treatment

➢ Virology: classification, viral components, common viral diseases, transmission modes, treatment

➢ Biosynthetic processes: micrometabolism and aerobic/anaerobic microbes

Within the immunology unit, the main objectives and activities included the following:

➢ Nonspecific host defenses: physical barriers, stages of phagocytosis, inflammation stages, and fever

➢ Specific immunity/immunization: types of immunity, antigens-antibodies, humoral immunity, cell-mediated immunity, and immunizations

➢ Immunological diseases: hypersensitivities, organ transplant rejections, immunodeficiency diseases, and AIDS

Within the culturing unit, the main objectives and activities included the following:

➢ Generation time calculations

➢ Bacterial culturing: petri and continuous culturing techniques

➢ Bacterial slide staining: gram negative and gram positive

➢ Metabolic processes of microbes

➢ Viral culturing techniques
Within the pathogenic disease unit, the main objectives and activities included the following:

- Pathogenic diseases of the respiratory, digestive, nervous, reproductive, integumentary, and cardiovascular systems
- Public Health issues: Vaccination programs
- Animal-transmitted Diseases
- Foodborne/Waterborne Diseases

The course of study provided a broad overview of the field of microbiology. While the Brock class textbook (Madigan, Martinko, & Parker, 1999) was much more detailed in the content area, the course of study activities and unit topics appeared to be at an introductory level for a ten-week microbiology high school course.

**Record 2: Class Data Records**

In an effort to better understand the student makeup of the two participating high school classes, I reviewed several records. The class lists provided information about the number and gender of students in each class. Ann’s class had 25 students, in which 23 were female. Beth’s class had a total of 21 students, in which 19 were female. Therefore, the overall size and gender ratio of the two participating classes were comparable. I also reviewed the program application forms of the current students. These records indicated the passage or failure of Ohio’s 9th grade proficiency test with a ‘P’ or an ‘F’. From these records, I was able to calculate the passage rates for each area of the test:
Table 12
Ohio’s 9th Grade Proficiency Passage Rates

<table>
<thead>
<tr>
<th>Proficiency Area</th>
<th>Ann’s Class</th>
<th>Beth’s Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math</td>
<td>80%</td>
<td>80.9%</td>
</tr>
<tr>
<td>Science</td>
<td>96%</td>
<td>95.2%</td>
</tr>
<tr>
<td>Reading</td>
<td>96%</td>
<td>100%</td>
</tr>
<tr>
<td>Writing</td>
<td>96%</td>
<td>95.2%</td>
</tr>
<tr>
<td>Citizenship</td>
<td>100%</td>
<td>95.2%</td>
</tr>
</tbody>
</table>

I additionally reviewed the student passage rates on the community college’s placement exam. In the Tech Prep program, the high school students take the community college’s placement exam. The function of the exam is to place students in the appropriate course level in math, reading, and writing during their freshman year at college. If a student does not pass all parts of the placement exam, then “developmental courses” are required before admission into a specific health care program at the community college. In addition, the Tech Prep Community College Scholarship does not cover the cost of developmental courses. Thus, the advantage of the Tech Prep Program is that the students repeatedly can take the placement exam as junior and senior in high school at no cost. Again as a comparative factor, I was interested in the overall passage rates of the two participating high school classes. The students had taken the placement test once as a junior and once as a senior at the beginning of the school year:
Table 13  
Community College Placement Test Passage Rates

<table>
<thead>
<tr>
<th>Proficiency Area</th>
<th>Ann’s Class</th>
<th>Beth’s Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math</td>
<td>80%</td>
<td>81%</td>
</tr>
<tr>
<td>Writing</td>
<td>88%</td>
<td>85.7%</td>
</tr>
<tr>
<td>Reading</td>
<td>84%</td>
<td>90%</td>
</tr>
</tbody>
</table>

Overall, the passage rates on each part of the college placement exam were relatively similar. Since a pretest was the assessment tool for homogeneity between the two classes, my examination of the Ohio Proficiency Test and the community college’s placement test was completed solely to gain initial information about the students prior to the start of the case study observations. No statistical analyses were performed from these records.

Record 3: Student I.E.P. Forms

An I.E.P. is an “individual education plan” that is prepared by special education specialists and teachers for students identified with various learning disabilities. As the microbiology unit was part of the yearlong senior Advanced Anatomy course, the subject content purposively was developed as a college-level course. The students would receive five college credits if they achieved an overall anatomy grade of 70% or above. I was interested in the presence of I.E.P. students in Ann and Beth’s classrooms for two major reasons. Firstly, I was interested in the
participating teachers' instructional decisions in regards to their I.E.P. students. Would the teachers make alternative preactive plans to modify the microbiology lessons for their I.E.P. students? Would student assessments be modified, and if so, how would the teachers select these modifications? Such issues naturally would involve the teacher-thinking phases of interest in this research project. Secondly, the quantitative portion of this investigation compared the posttest achievement scores between Ann and Beth's classes. Although I used a pretest to assess homogeneity, I also wanted to look at comparative factors between the two classes. Obviously, if one class had a disproportionately large number of I.E.P. students, the success rate of the overall class during a college-level course might be affected. Both teachers discussed their instructional modifications in regards to I.E.P. recommendations. In addition, I was permitted to review the students' I.E.P. documents. As with all of the student data in this project, student confidentiality was protected. Throughout the classroom observations, I did not know the identity of the students on an individual educational plan.

Ann's class included three students (students "A", "B", and "C") on individual education plans. Two of the students were identified as learning disabled in math. The I.E.P. document of "Student A" indicated that the senior student was identified with an eighth-grade math ability level. Several instructional modifications were recommended on the I.E.P: "Student A" was permitted to do any math-related work with a special education tutor, a calculator was permitted for use at all times, and all equations were to be provided for the student. The I.E.P. document for "Student B" stated that the student was identified with a seventh-grade math ability level. The
I.E.P. modifications were identical to the ones for “Student A” with the exception that the student was permitted to make up a “cheat sheet” for any math-related tests with examples of each type of math problem. The I.E.P. of Ann’s “Student C” indicated that the senior student was identified with an eighth-grade reading level. The I.E.P. modifications included the following: a word bank was to be provided with any oral or written assessment, the student could go to the special education tutor for reading or comprehension help, and tests could be read to the student by the tutor. I interviewed Ann in regards to her teaching decisions about the I.E.P. modifications:

**Ann:** “We have only been in school for about a month, but I think I’ve worked out a good system with each student. Actually, I found that I haven’t had to make any changes with the two math I.E.P. students. We’ve only covered body planes, the skin, and the endocrine system so far......and there’s no math involved. But one section of the micro involves a lot of math. I’ll have to look over the calculations myself......I’ve never taught it before. And I noticed that you have to use logs and antilogs to calculate....(pause)....I think it was with growth rates or something. Anyway, they (i.e., students “A” and “B”) can go to work with the math tutor if they need more help. I plan on letting them use their class notes on tests so they will have all the formulas and examples. They can even use their study guides. Before every test I make up a study guide that sums up what they (i.e., all the class) need to study. So there will be plenty of problem examples on that. I
am more concerned with "Student C" on a reading I.E.P. because the
textbook is at the college reading level. I've noticed that she (i.e.,
"Student C") has trouble even forming a connected paragraph on my
short essay questions. I think I'll plan to have this student take each
test with the tutor. If she has trouble with a question, she can have it
read to her there. On the oral lab tests, I plan to let her use a word guide.
But I don't know how realistic that is, because she needs to be able to
memorize the body parts to function on the job. And I'm not sure if the
community college will make the same allowances for her. So I'm
hoping that by the end of the year, she will be able to get by in here
without many modifications. Part of my job is to help these students
succeed here (i.e., at the high school level). But the other part is to
prepare them for college, where they won't get the one-on-one attention."

Thus, Ann made mental proactive planning decisions to address the needs of her
I.E.P. students prior to starting the microbiology instruction.

I also interviewed Beth and reviewed the I.E.P. documents of her students. The
I.E.P. documents indicated that two senior students ("Student D" and "Student E")
were identified with a seventh-to-eighth grade reading/writing level. One other
student ("Student F") was on an individualized educational plan for math, and tested
at a seventh grade math level.

Bath: "We haven't used any math so far in anatomy... and we usually don't
use any. But there is a short section in the new microbiology that has
a lot of math in it. She's (i.e., "Student F") taking Algebra II, which is
the lowest level of math offered to Tech Prep seniors, and her math
teacher is telling me that he sends her to the tutor for help almost
everyday ..... (pause) ..... We actually have a tutoring room open during
every period, so students can go there to get help or take tests any time.
So I'm going to have to make some modifications for her. The math
looks more complicated than what she is taking now. But on the other
hand, if she can plug in numbers in the equations, she should do all right.
The other students are on an I.E.P. for writing, which to me is about the
same thing as reading. So far both of them have had trouble on quizzes
and tests, no matter what type of test I give. I think for my microbiology
quizzes, I'm going to let them go to the tutor for the short answer questions.
In the past I have even let students answer the questions orally while the
tutor writes down their answers. But I think both of them are having
trouble with the anatomy book. The reading level is difficult and very
detailed ..... (pause) even though they seem to be able to answer the
homework questions from the book. And I'm not certain how much help
they are getting on that from other students. Sometimes I let students
work together in groups at the end of class, and I know they have some
free time to work together in some of their other classes. I'll do what I
can to help them, but we will have to see if they can earn the college credit.
My main concern is that they pass my class with at least a "C"."

In a similar manner with Ann, Beth had made preactive planning decisions about
I.E.P. modifications prior to the start of the microbiology unit. With both teachers,
these preactive planning decisions were mental reflections based upon their past experiences with these particular students during the previous school year. Both teachers had taught the same I.E.P. students as juniors in an introductory anatomy course. In addition, Ann and Beth reflected upon how these students had done so far in their senior year to devise a plan for instructional modification. Both teachers planned on taking a flexible approach in that they would try some initial modifications, and assess how their students progressed.

In relation to my concern for the quantitative portion of this investigation, the number of I.E.P. students was comparable between the two classes. In addition, the types of individual education plans were similar, in that the students were identified as learning disabled in only the areas of math and reading/writing. Thus, the comparable presence of I.E.P. students in the classes should not dramatically affect the overall class scores on the posttest. As stated previously, a pretest will be given to Ann and Beth’s classes to test for homogeneity.

**Record 4: Allied Health Tech Prep Entrance Requirements**

I reviewed two records in regards to the high school entrance requirements to the Allied Health Tech Prep Program. The community college’s Tech Prep Coordinator provided me with the Tech Prep contractual agreement between the community college and the high schools in the Allied Health Consortium. The only stipulation about student entrance was that students must have earned a letter grade of a ‘C’ or better in both Algebra I and Biology prior to their junior year. There was no percentage rate correlated with the ‘C’ grade, so each high school could apply their
individual grading scale. Also in this document, the community college stated their stipulations for a Tech Prep college scholarship upon high school graduation. All students that successfully completed the high school Allied Health Tech Prep program with a minimum grade point average of 2.5 automatically would receive a $3000.00 scholarship at the community college. According to the Tech Prep Coordinator, this scholarship would basically cover all tuition expenses for two years, with an end result of an Associate Degree.

The second document concerning program entrance requirements was a document drafted by the high schools participating in the Tech Prep Consortium. All of the participating eight high schools used this document to standardize the entrance requirements. As with the community college’s document, all incoming students must have received a letter grade of a ‘C’ or better in Algebra I and Biology. Students that did not meet this requirement were permitted to attempt to earn the needed credit during summer school after their sophomore year, and reapply upon successful completion. Incoming students also were required to “have no credit deficiencies and be in-line to graduate”. One additional statement was included in the record: “Passage of all parts of Ohio’s 9th grade Proficiency Test is strongly recommended.” Ann, one of the two participating teachers in this study, informed me during an interview that legally the high schools could not exclude a student that had not passed the proficiency test.

*Ann:* "This would discriminate against students with any type of learning disability, and prevent their inclusion in the Allied Health program. It has become a slight problem for us, though. Occasionally
we have one or two students that have not passed the test and are not on I.E.P.s. These students won’t get their high school diploma unless they pass all parts. The I.E.P. students are usually exempted out of the test before the end of their senior year. At any rate, we (i.e., Ann’s high school) have started a proficiency tutoring session for students that haven’t passed."

The Tech Prep entrance requirement records from both the community college and the high schools were very similar. The implied goal of the entrance requirement records was to ensure that students would be able to successfully complete the Allied Health subjects during their junior and senior years. During the instruction of the microbiology unit, I was invited to attend a high school guidance counselors’ meeting at the community college. All of the counselors from the eight participating Tech Prep high school programs (i.e., the “Tech Prep Consortium”) were present at the meeting. I asked about the selection procedure for student admission to the Allied Health Program. Apparently, the selection procedure was very similar at each high school. The students must submit an application for admission during the spring of their sophomore year. The high school counselors then determine which students qualify based upon all of the entrance requirements. These students were automatically accepted into the program, which could accept a maximum of 25 students per high school. If more than 25 students qualified for the program, the counselors then reviewed both the application date and the past attendance record of the students. As one counselor stated, “Even if they’ve met all the other requirements, they aren’t going to survive in this program if they miss 20 to

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30 days of school each year.” If additional program space remained, the high school
counselors would contact the students that could feasibly meet the entrance
requirements with additional summer school credits.

Record 5: Allied Health Tech Prep Brochure

The Allied Health Tech Prep brochure was developed by the community college
for use at the participating high schools. The brochures were handed out to
prospective students by the high school guidance counselors after a student
expressed interest in the Allied Health Program. In addition, the brochure was
mailed to prospective students’ parents during the sophomore year. I gained
information about the brochure during a meeting with Tech Prep guidance
counselors at the community college. The brochure was developed with three main
intentions: the brochure would be used as a marketing tool with prospective students
and their parents, the brochure would be used to describe the Tech Prep “Two-Plus-
Two” Program, and the brochure would be used to define the program entrance
requirements.

The brochure was a glossy 8 by 11 inch form folded in a pamphlet style. The
front of the brochure pictured a student dressed in hospital scrubs, working inside an
Allied Health learning lab. The inside front flap described the community college
and the national Tech Prep Program. The timeline of the program – two introductory
years at the high school and two years at a local community college (i.e., the ‘Two-
Plus-Two’ concept) - was explained. The advantages of Tech Prep, such as available
college credit during high school, also were presented. The middle portion of the
pamphlet listed ten healthcare fields associated with the Tech Prep Program. Incoming students could specialize in the following areas: nursing, radiology, physical therapy assistant, occupational therapy assistant, surgical technology, dietetics, mental health, dental hygiene, massage therapy, and medical assistant. The projected, optimistic local job market for graduates was also discussed. The pamphlet stated that over 98 percent of Allied Health graduates were placed successfully in healthcare positions. The third section of the pamphlet listed the program prerequisites at both the high school and community college levels. The high school entrance requirement was a letter grade of ‘C’ or above in Algebra I and Biology. The college entrance requirements were a grade point average of 2.0 (on a 4.0 grading scale) and the successful completion of the high school Tech Prep Program. The back of the pamphlet listed financial aid options at the community college. In addition, the requirements for the Tech Prep community college’s scholarship program were presented. Each Tech Prep high school senior that graduated with a minimum grade point average of 2.5 was awarded a $3000 scholarship. The pamphlet stated that this scholarship would cover all tuition expenses of the two-year associate degree program, with the exception of books and developmental coursework. Overall, the pamphlet was concise and informative.

**Record 6: Instructional Timeline**

The instructional timeline for the new microbiology unit was developed with input from the community college’s Tech Prep instructors and the participating high school anatomy teachers. The college instructors that developed the microbiology course of
study felt that the objectives could be met easily within a 9 to 10 week period. During the summer, the college’s Tech Prep Coordinator mailed the course of study to the high school anatomy teachers. Afterwards, an e-mail was sent to each teacher for an opinion about the feasibility of the proposed objectives and completion timeline. The Tech Prep Coordinator stated that the teachers responded that they were comfortable with the proposed course curriculum and the projected timeline. The ten-week timeline would equal approximately one high school quarter out of the yearlong Advanced Anatomy course. However, while all the high school teachers were starting the microbiology unit at the same time (around the first of October), the teachers were free to go at their own pace, and spend as much time as they wanted on the course. No deadline for the posttest was given by the community college. According to Beth, a participant in this study, the only driving force to complete the microbiology unit would be the amount of anatomy material left to complete by the end of the year. Therefore, the 10-week timeline was a flexible guideline for teachers during this initial trial of microbiology implementation.

Record 7: Curriculum Materials

During an interview with the community college’s Tech Prep Coordinator, I was provided with a list of curriculum materials to be used with the microbiology unit. The community college had received grant money to be allocated to high schools in their Tech Prep Consortium. During the summer the Tech Prep college instructors had met to develop the microbiology course of study. At that time, the instructors also selected equipment and supplies to purchase with the Ohio grant money for donation to the eight participating high schools. In addition, a textbook was selected for each high school to
purchase for the microbiology unit. Thus, each high school anatomy teacher would be provided with an identical set of supplies for demonstrations and labs. The following supplies were donated to the high schools:

- A set of twenty microscope slides of bacterial samples
- A class set of petri dishes and nutrient agar for bacteria culturing labs
- A set of microbiology wire loops for plating bacterial samples
- A class bacterial slide staining kit
- One continuous culturing kit
- A class cheese-making kit
- A class fungus growth kit
- Two wall charts on virus and bacteria
- One culturing incubator

The donated supplies included all the necessary materials needed to complete the recommended labs in the microbiology course of study. Thus, the two anatomy teachers in this investigation started the microbiology unit with the same set of student texts, lab supplies, and course objectives.

**Record 8: Microbiology Textbook**

The student textbook used for the new Microbiology unit was titled “Brock Biology of Microorganisms” by Prentice Hall (Madigan, Martinko, & Parker, 2001). The publishing company listed the text as a post-secondary book. Each of the participating high schools purchased a class set of books, assigning each student a
text for the school year. The textbook was divided into six units (Madigan, Martinko, & Parker, 2001):

- “Principles of Microbiology” - ten chapters of introductory microbiology information ranging from microbial nutrition, growth, virology, and genetics
- “Evolutionary Microbiology and Microbial Diversity” – six chapters including the topics of microbial diversity and viruses
- “Metabolic Diversity and Microbial Ecology” – three chapters on metabolic diversity and nutrient cycles
- “Pathogenicity, Host Responses, and Immunology” – five chapters on immunology and clinical microbiology
- “Microbial Diseases” – five chapters on various microbial diseases
- “Microorganisms as Tools for Industry and Research” – two chapters on genetic engineering and microbiology in industry

I interviewed Ann and Beth, the two participating anatomy teachers in this investigation, about the selection of the textbook, as well questions about the match between the microbiology unit objectives and the text.

Beth: “The college instructors selected the book last summer when they worked on the curriculum. I think it will work very well, although when I looked over the book...(pause)... I wondered if it was just a tad too detailed for our students. Thus unit is only for ten weeks, and the book is very comprehensive. So we will only cover about a third of the book, if that. The
good thing about the book is that there are plenty labs and activities for each chapter. I just hope we have the time to do them. This first year will be a good test run....(pause) ...I'll learn as much as the students. I spent a lot of time reading the book and just becoming familiar and comfortable with the material.”

Ann: “The best thing about this book is the extra materials and the teacher supplements that come with it. I can use most my planning time on preparing for class, rather than making up my own quizzes and worksheets. I definitely will use the technology – the students like those kind of computer-interaction CDs. And the CDROMs really seem to give a good overview of the most important concepts in each chapter. We are only planning to complete eleven of the chapters- this is just a basic introduction to microbiology. I’ll have to see how this year goes, but I personally think a whole year of microbiology might be better for the seniors, rather than another year of anatomy. But I think the text will work out well. There’s plenty of different ways for the students to learn the material.”

The participating high schools in the Tech Prep Consortium also purchased supplementary “Interactive CDROMs” from Prentice Hall. The CDROM pack included an interactive, ‘animated tutorial’ section for each chapter. Questions were presented in multiple-choice and fill-in-the-blank format with hints provided for incorrect answers. Artwork diagrams of various microbial structures also were provided for student labeling. Culturing “time-generation” word problems were
available for student practice, with detailed calculation examples. In addition, each chapter included a “case study”, which presented a “patient” with a specific microbial disease. The case studies provided information through both text and sound tracks. Students could progress through the symptoms, diagnosis, treatment, and prognosis of each case study patient with the option to view multiple diagnostic and laboratory test results. The Brock textbook also included an “Online Student Media Package”. This was an interactive web site that included “self quizzes”, an index, a terminology glossary, and web site links related to the text material (Madigan, Martinko, & Parker, 2001).

The community college’s curriculum materials grant was used to purchase “instructor supplements” for each teacher. The materials included an instructor’s manual and test CD, a set of text transparencies, and an instructor’s resource CD. The instructor’s manual contained instructional guides, test questions, and answer keys to textbook questions. At the start of each chapter, a lecture outline was presented with referenced textbook pages. Several lab activities and teacher demonstrations were also included with each chapter, along with a list of necessary science materials. Additional student activities, such as sets of multiple-choice and short essay questions, were printed in copy-ready format. A suggested unit timeline for lecture and lab activities concluded each chapter’s instructional guideline section.

Upon review, the Brock text and supplementary materials provided a comprehensive instructional package for use by the participating anatomy teachers. The teachers could select a wide range of activities for application in the classroom.
Case Study Settings

The qualitative investigation involved two secondary anatomy teachers at separate high schools and school districts. This case study setting section includes an overview of the participating teachers' background information. In addition, the high school and classroom environment in each setting is also discussed.

Setting 1: Teacher “Ann”

Ann’s Background Information: Personal Theories & Experiences

I met with Ann ten days before the microbiology unit was scheduled to begin. The purpose of our meeting was to review my upcoming observation/interview plans and to discuss Ann’s teaching background. I had a prepared, open-ended interview schedule to use during the initial meetings with both Ann and Beth (See Appendix B).

Ann was a married female in her mid-thirties with one teenaged child. She originally earned a Bachelor’s Degree in Biology. The year after graduation, Ann entered a graduate program to obtain an Ohio teaching certificate. Within twelve months she earned a Master’s Degree in Education with an Ohio (grade 7-12) certification in chemistry and biology. Ann’s entire eight years of teaching experience was with her current high school, all of which involved the Allied Health science courses:

*Ann: “I decided to go into the teaching field after I got married. I had enjoyed working as a biology lab teaching assistant while I was a senior in college. That’s when I found out that I enjoyed teaching..."*
and I also knew a teacher's schedule would fit with being a new mom. When I first started, I taught four chemistry classes and one anatomy class. We (i.e., Ann's high school) had just gotten involved with the Tech Prep Program at the community college. And since I had a background in both chemistry and biology, I was picked to teach the new junior Allied Health anatomy. We've added new science courses along with the other Allied Health schools (i.e., the seven other local high schools in the community college Tech Prep Consortium). We've added Advanced Chemistry, and Advanced Anatomy. (pause) so at the beginning, every year I would have a new science class to plan out. But the course of study and the texts... (pause)... they were all provided by the community college. That did help, but it was still a lot of work to get the AHT Program (i.e., Allied Health Tech Program) up and running.

Now I teach two General Chemistry classes, one Advanced Chemistry, Intro Anatomy, and the seniors take the Advanced Anatomy."

Ann teaches five fifty-five minute periods a day, with a fourth period preparation period and a sixth period lunch schedule. Three of her five teaching periods were with Allied Health juniors and seniors. Ann stated that her Allied Health students were her best classes:

Ann: "The Allied Health students are motivated. They know what they want to do..(pause).. or at least know that they want to get into the healthcare field. They're already interested in the material before they ever step into the classroom. So I find it easy to grab their attention. I tie
the material to real-life medical situations and examples, so they can relate to what they’re learning. It also helps that there are prerequisites to get into the AHT Program. They have to have been successful in Biology and Algebra I before their junior year. So, in general, they are ready for the math and reading level of my classes. These are hard classes. The books are the same that are used at the college level. So the students have to be capable and motivated to work hard.”

I asked Ann to describe the school atmosphere and what it was like to work at the vocational high school. She stated that she liked working at the high school because she had the freedom to teach as she liked. Ann said that her “direct supervisor” supported the Allied Health Program in particular because of the program’s past successes. In addition, Ann stated that she worked closely with the Allied Health lab and math teachers:

**Ann:** “I think we (i.e., the Allied Health teachers at her high school) have a unique working relationship.... (pause)... one that I don’t often hear of in a regular public high school. We try to teach as a team. For example, if I’m teaching the heart in anatomy, their lab teacher is showing them how to do EKGs (i.e., electrocardiograms) in lab. And at the same time the math teacher is showing them how to calculate heart medication dosages. Or if I’m teaching the juniors the metric system in chemistry, their math teacher is also doing metrics at the same time. I think our teamwork has really paid off... (pause)... I know the students are learning the material and, more importantly, retaining the material. It took a lot of team
planning at first... (pause)... we only coordinated about two units each summer together. But now we work together on just about every chapter. It saves a lot of time because we aren't all going over the same material at different times of the year. We're trying to get the senior English teacher involved, too, so she can grade their term papers for composition, while I grade for anatomy content. I just don't hear about this kind of teamwork from teachers at other schools... (pause)... and that's one of the reasons I like working here."

I asked Ann to describe her classroom environment. Ann stated that she tried not to lecture more than three days a week. She expected the students to also be able to learn on their own, either through reading or use of related technology. Ann said she had a good group of senior students in the Advanced Anatomy & Physiology class, and that she expected that they would do well with the new microbiology unit. Ann stated that these same students as juniors had a class average grade of a "B", which equaled an 80% to 89% on her high school's grading scale.

Ann: "The seniors this year will have no trouble with the added microbiology section. The problem in class will be the lack of time to fit everything into the school year. We'll see how things go.... (pause).... how well the students do......then we'll (i.e., Ann and the other Tech Prep anatomy high school teachers) meet over the summer and improve the unit. It's going to be a work in progress, like the other classes."
**Ann’s High School Environment**

Ann teaches at a county vocational high school located in Southwest Ohio. The vocational school acquires students from three rural and two suburban public high schools within the area. Approximately 700 junior and senior students attend the high school. The building is located on a large 12-acre plot in a rural section of the surrounding city, about a fifteen-minute drive from the downtown area and about eighteen miles from the local community college. The adjoining land is farmland, with a few homes directly across the street.

I had made an appointment with the school director to discuss the possibility of including Ann in my investigation. At 8:00 A.M., I entered the building from the guest parking lot and walked into the school lobby. To my right was an office marked “Attendance” and approximately twenty students were lined up at a long counter. To my left was an office marked with a large “Front Office” sign. The office was glass-enclosed, and I could see a large front desk counter and several desk cubicles in the background. No students were in this front office. As I signed in for my appointment, I was asked to wear a “Visitor” identification card on my lapel. I waited for the director approximately 10 minutes, watching the line of supposedly tardy students slowly decrease in the opposite office.

The school director was a middle-aged female with an open, friendly demeanor. She had been the “school director” (a position she equated to that of school principal) for over eight years. The director explained that the vocational school had just undergone major renovations, with the addition of a new wing over the summer. Prior to the interview, she suggested that we tour the building. We first entered the
library and “technology center”. The library also had been remodeled recently with noticeably new tables in the center of the room. Three of the surrounding walls were lined with books, although the actual quantity of books did not appear to be high. The fourth wall was lined with twelve computer workstations. No students were in the library at this time. The technology center connected to the library through a double set of open doors. The director stated that the computers were “state of the art”, and that teachers reserved the center for their classes as needed. The connected computer tables were arranged in a large semicircle. The teacher’s computer station was connected to a large-screen television in the center of this semicircle. This large-screen TV was also used for long distance learning satellite connections. In addition, I was shown the mobile computer cart. “Teachers can reserve this cart to use in their classrooms. There are 25 laptops with Internet chips. Technology is a vital part of our curriculum, and when teachers can use it in their own classrooms, the students get more use out of it.” As we were leaving the technology center, a large class of students was entering the center.

The director guided me through the three main sections of the school building. One “wing” consisted entirely of “tech labs”, such as automotive, carpentry, and robotic student labs. The middle wing was designated as the “business area”, with computer graphing, computer data entry, and drafting labs. The wing furthest from the front office was the “science area”, which contained the allied health, dental assistant, and environmental science labs. The overall appearance of the school was one of a well-maintained environment. The floors were newly tiled and the lockers appeared to be painted recently. The staff room, however, was rather sparse,
containing one well-worn couch, three small dining tables, and a refrigerator. A large copier and crates of copy paper took up almost one-half of the room. We headed back to the director’s office. I began the interview by recapping the purpose and research design of my investigation. Although the director had agreed and signed my mailed research permission form (See Appendix A), I wanted to review the objectives of the study person-to-person. Afterwards, I requested permission to record the interview for future transcription. She agreed and I began by asking about the history of the school:

**Director:** “The direction of this school has totally transformed over the past few decades. Fifteen years ago the large majority of our students were enrolled in the tech lab programs, such as small motor repair and autobody repair. Over 70% of our students were males that had not been successful in a regular academic setting. Over the past 20 years, we have added multiple business, computer, and health programs. These programs have resulted in a more diverse student body. Now some of the home schools (i.e., one of the five public high schools within the vocational school’s district) are sending us their best and brightest students. These students have a chance of working with state-of-the-art technology to learn skills such as computer programming and drafting. One big change in our academic courses came about because of the Tech Prep Program. A higher level of math and science was added to our curriculum to serve students that planned to continue on to college. Last year about 65% of our graduates enrolled at two and four year colleges. Because of
these changes, we have increased our staff to 98 teachers. Over half of
these teach academic courses in standard classrooms. The rest are lab
teachers that teach for about half the day to the students in their lab areas."

I then asked the director for more information about the teaching staff:

**Director:** “We have a great teaching staff. I respect all their hard work.
The academic teachers teach five classes a day. We have seven periods,
so they also have an enrichment period. This can be used as their prep
period or some teachers volunteer to tutor students. We’ve added a lot
of staff in the past 10 years, mainly in science and math. About half
of our academic teachers have earned their Master’s Degree (i.e., the
director made a distinction between ‘academic teachers’ that taught
standard school subjects and ‘lab teachers’ that taught the hands-on
courses). The school pays for 60% of the teachers’ tuition (i.e., for
graduate level education courses). All of our lab teachers have had
extensive work experience outside of education. I think it is very
important to teach current skills to the students from each field. The
businesses that hire our students expect them to be up to date.”.

I asked the director about her personal educational theory and her vision for the
school:

**Director:** “I believe that education must be related to the everyday lives
of the students ....(pause).... especially in a vocational setting. Our goal
is to provide instruction so that each student is ready for employment
after graduation from high school. Each program has a specific exit
skill-allied health students are certified as nurse assistants, autotech
students are certified as mechanics. While we also prepare students for
college, our students can normally find employment right after graduation
in their chosen field. Because they already have hands-on and work
experience, they can be hired at entry level positions in their field while
they go to college. That makes a big difference- in both pay and work
references. The seniors go out on job placement for half the school day.
Not only do they learn a lot on the job, but they also make contacts in
their field. A lot of students are automatically employed after graduation
where they worked as seniors. This work experience is one big difference
between our school and typical non-vocational schools. In the past, our
school was geared toward students who had no plans for college. All that
has changed. And the Tech Prep Program is just one example of the success
of our changes."

To end the interview, I asked for her view of the teachers’ role in curriculum
implementation:

**Director:** "Over the past four or five years, each academic department
has worked together to write the course of study for each class. For
example, the science department has written six separate courses of study.
For starters, I think it is important for teachers in the classroom to be
involved in the writing of curriculum. They know what works with their
students, they know the objectives that need to be covered, and they have
the experience to make the curriculum a working document. In the past,
we used completed courses of study from the district office. And our teachers used those as guidelines this time. But by writing what they actually teach in the classroom, the new courses of study are much closer representations of student learning."

**Ann's Classroom Environment**

After the interview and building tour with the school director, I accepted Ann's invitation to stop by her classroom. It was 8:30 A.M. on a Monday morning, and Ann was in the middle of first period. She greeted me at the door and told me she had given her students a written assignment so she could have time to talk with me. The students were seated at blacktopped, rectangular science tables. The tables were pushed together in pairs, so that four students were seated around a large square working surface. There were six such square sets arranged in the center of the room. Three of the walls of the room were lined with gray science counter tops, with three sinks per counter. In the corner near the door stood a lab shower and a separate eye wash station. Above the counters were gray cabinets, which matched the counters. The fourth counter at the back of the room was lined with seven computer stations, with stools pushed under each setting. Two open bookshelves were hung at the corners of this computer wall. The only open wall space was directly above the computer stations, and several science posters were hung there. A large white marker board on rollers was pushed into the corner near the computer stations. The teacher's desk was in the far left corner at the back of room. A computer sat on her desk, along with several stacks of papers and books. Overall, Ann's room appeared

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crowded, yet organized for a variety of student activities. Ann and I weaved through the student tables to get to her desk

**Ann:** "When I started teaching Allied Health, this was a regular classroom. We had extra funds available... (pause)... I think because it (i.e., the Allied Health Program) was a new program. So within a week after I was hired, I was sitting down with my supervisor to turn this into a science room. This was in early August – three weeks before school started. The first things I knew we needed were chemical sinks and lab counters. The water hook-ups were installed by maintenance right away. Rather than look through catalogs, we (i.e., Ann and her supervisor) went to see a newly remodeled science lab at another high school. I really liked the set-up there – with the work counters off to the side and plenty of room for desks in the center. We decided to go with the same cabinet company. I was excited until I found out it would probably be after winter break before the lab was done. This meant that every time I wanted to do a lab, I’d have to ask another science teacher to switch rooms with me. It was done in February and it made such a difference to have all this work room and running water. There’s still no room in here for a fume hood, so we still switch rooms, but only about three to four times a year. The thing I really miss is a separate storage room for the chemicals. I have to run across to get them from the other science lab. But I have plenty of room to store everything else I need for labs. And I like the set-up of the
tables, because during lab we can push them all in the center and have plenty of free space to work. It kind of looks crowded, but it really works.”

Setting 2: Teacher “Beth”

Beth’s Background Information: Personal Theories & Experiences

I met with Beth two weeks before the microbiology unit was scheduled to begin. During this meeting, I reviewed my research/observation plans and briefly interviewed Beth about her teaching experiences. I used the same open-ended interview schedule as with Ann’s preliminary interview (See Appendix B).

Beth was a middle-aged, married female with two elementary-aged children. She earned a Bachelor’s Degree in Science Education, and was certified in general science for grades seven through twelve in Ohio. Six years after receiving her initial teaching certificate, Beth earned a Master’s Degree in Science Education. Beth had been teaching for a total of twelve years. The first seven years of her teaching experience was in Indiana in the position of a high school physics teacher.

Beth: “I had a great teaching position in Indiana. It really was a great way to start off my career and get classroom experience. I taught three classes of junior physics and two senior advanced physics classes. So I only had two preps. And I was lucky to have great students...... ... (pause) ... really the best of the best. I really learned a lot about how to connect with the class and how to plan out a course. I moved here with my husband when he was transferred, and I’ve been at this
Beth currently teaches four different “preps” (i.e., courses): Advanced Chemistry, General Biology, Introductory Anatomy, and Advanced Anatomy & Physiology. Two days a week, Beth voluntarily tutors sophomores, juniors, and seniors that have not passed the science portion of Ohio’s 9th grade proficiency test, which is a requirement for high school graduation in Ohio. She receives an additional stipend for tutoring. Beth’s school schedule consists of eight, 50-minute periods. She has a third-period preparation period and a fourth-period lunch. She stated that the adjustment to teaching four different courses took a few years:

Beth: “The four different preps made a big difference. When I started, I basically had to teach straight out of the book. I was just trying to survive. There was no time to be creative with projects or labs. We did do labs, but only about once a week. I don’t think administrators realize the amount of time that is needed to prepare labs in general, let alone labs in four different subjects. But after about two years, I had enough material so that I could expand the curriculum a little…(pause)…do more activities that are fun for the students and still meet the course objectives. If I didn’t plan in the summer, I’d still be teaching straight out of the books.”

Beth had been the science teacher for all the Allied Health students for the past five years. She stated she really enjoyed working with these students because, in general, they were motivated and excited about learning. She told me about the full scholarship from the local community college provided to all Allied Health students.
that met a 2.5 grade point average. Beth stated that this was a motivating factor for both her juniors and seniors. In addition, Beth acknowledged that both junior and senior students were competitive with each other for good grades, so that the majority of students handed in homework and studied well for tests. Beth discussed the school atmosphere as being a “positive place to work and learn”. She said the administration was supportive in that they approved of creativity in the classroom, and financially provided her with the equipment she needed.

Beth: “In science, that type of support is vital to the success of your students. My supervisor has been very supportive in purchasing whatever I feel is necessary. That makes my job a whole lot easier, especially in anatomy. Each year I need fresh dissection specimens and lab supplies. And if I find new software or lab kits or new anatomy videos, my reqs (i.e., requisition order forms) are approved for the next year. That keeps the class up to date... (pause)... medicine is a field that is constantly changing. It’s not a subject that is going to stay the same year after year.”

I asked Beth to describe her classroom environment and her current senior Allied Health students. This interview took place at the end of September, so Beth’s school had been in session for approximately six weeks. This was the second year that Beth had taught these students. She was their junior Chemistry and Introductory Anatomy teacher last year. Beth stated that so far she felt the senior Allied Health students were doing well and “getting back into the study groove”. The class average of these
students in the junior anatomy course was 88%, which equaled a letter grade of ‘B+’ on her high school’s grading scale.

**Beth:** “Overall, this is a really good class. I give them a lot of work....(pause)... and I expect a lot from them. At this point they know my routine and feel comfortable with me. They know what they have to do to succeed in here. ‘Senioritis’ won’t set in until about February... that’s when it is hard to keep them on track. I think this class will do well with the micro unit. It will be a break from standard anatomy and there are a lot of fun labs we can do.”

Beth described her classroom environment as “challenging and rewarding.” She stated that she lectures about three days a week, plans one lab per week, and assigns homework about four nights per week. Beth voiced concern over the amount of time she spent lecturing at the overhead, but stated there was a lot of material to cover and not enough time.

**Beth:** “The students feel very comfortable with me, so during a lecture there is a lot of give and take. They are constantly either asking questions or telling the class about a personal medical story that connects with the lecture. You’d be surprised. No matter what disease we are studying, one of them will know someone that had it, is getting it, or died from it (laughing). And I think that helps them learn more... (pause) more than they would learn reading the book on their own. So I think the environment is pretty relaxed, but the students know that when they come into my class, there will be work to do.”
Beth's High School Environment

Beth teaches at a public high school in a suburban area with a population of roughly 50,000 residents. The high school is located on a main road in the city, about seven miles from the local community college. Approximately 1400 students attend the school, ranging from freshman to senior status.

My initial visit to the high school was to interview the principal of the building. My interview was scheduled at 3:45 P.M., one half hour after the students had left school for the day. As I walked from the parking lot to the school front door, I passed the track field full of running students. Further away on my right was a large field, where football players in full uniform were practicing. As I entered the largest set of doors, I found myself near the cafeteria. There were no signs leading to the front office, but I was able to get directions from a passing student. As I circled my way through the halls, I passed rows of classrooms – the majority of which were still open and occupied with a teacher. The hallways looked well kept, with the exception of the odd bits of paper still on the floors from the school day.

The “front office” was actually a large complex of offices, with one common lobby and front desk. The high school principal, a middle-aged man in his fifties, came out to greet me. He had been principal for over 15 years. I began the interview by asking about background information of the school.

**Principal:** *"The goal of our school is to offer a college prep curriculum in a setting that's challenging and exciting. Over 90% of our students go to college after graduation. That's a very high rate. So we have to meet the needs of these students and take their individual differences into*
account. We have several clubs... (pause)... let’s see.... Spanish, Latin, French, science, math, computer. We also offer several advanced placement courses in math and science. Students can get college credit for these classes. And if we don’t offer a higher-level class, our students can take the class at a local college for credit. This year we only had about 10 students sign up for Spanish IV, so we just couldn’t run the class. So almost all of these students are taking Spanish together as college students. We worked with their schedules so they could leave school early to do this. We have a large arts program... (pause) ... a marching band and a concert band, choir and show choir, theatre groups. And we offer a full range of sports. So we try to meet the academic needs of our students while helping them develop other interests, too.”

I asked the principal about the teaching staff at the school:

**Principal:** “I can truly say that our teachers are wonderful. They give 110 percent every single day. I really feel lucky that so many of them want to be here, want to get involved, and are willing to try new things.”

I asked what role the teachers played in the development of the curriculum:

**Principal:** “Our curriculum specialists prepare the course objectives. So the teachers know what needs to be covered in a year. But the teachers have a lot of leeway in implementing the curriculum. They can choose the activities that best fit their students’ needs... (pause)... and what they think is most important to learn. Some departments work...
together to plan and develop curriculum ideas. For example, we just revamped our English curriculum. The English teachers came up with new curriculum goals and activities that focus on critical thinking ..... (pause) more of a focus on how to interpret what you read. The number of our students passing the reading and writing parts of the proficiency test (i.e., Ohio’s 9th grade proficiency test that is required for high school graduation) is above the state’s average. So we wanted to challenge the students .... (pause). to push them beyond grammar and essay writing. “

I asked what was done for students that had not passed the proficiency test in reading and writing:

Principal: “Oh, we have an intervention class for them. It focuses only on the skills needed to pass the test. And they do practice tests in class..... that really helps. A lot of time the problem is just test stress. The students stress out when they know that graduation is riding on it. So we work with them until they pass, and then they can move forward. “

After the interview, the principal briefly showed me around the building. The building had been renovated entirely within the past four years, with the two newly-constructed areas increasing the size of the school building by a third. One of the new wings contained a gym, athletic changing rooms, and a music department. The other wing housed an expanded library, four new computer labs, and the teacher’s lounge. By this time (around 4:30 P.M.), most of the classrooms were closed and dark. We headed upstairs to the new library. The library was very large- about the size of six or more standard classrooms. A bank of approximately 20 computers was
along the front and right side walls as we entered. In the center of the room was a large, round “information desk”. The library had around 25 stand-alone rows of books in the three corners of the room. Student work modules were interspaced throughout the room. Upon sight, this library housed more than quadruple the number of books in Ann’s vocational school library. The computer labs were directly down the hall from what the principal called “the library wing”. Each lab had about 30 computer stations:

**Principal:** “Most of our classrooms have at least two to three computers in them. That’s enough so that students can look up information on the internet or work individually on a project. These labs are reserved by teachers that want all of their students to have computer access for a specific lesson. They’re booked every single day. Matter of fact, we’ll probably be adding one more lab in the next year or two.”

In addition, we toured the new gymnasium and the music hall. In the music hall, eight small practice rooms lined the corridor. Each room was soundproof and equipped with an installed tape recorder, so that the band teacher could listen to practice and test tape recordings of each student. A new band room and a choir room had been added in this wing. A new auditorium for music and dance recitals had also been added recently. As we headed through the adjacent cafeteria toward the teachers’ lounge, we passed a security guard.

**Principal:** “We have three full-time security guards. We normally have very little trouble from our students, but occasionally there are some fights. And they help out during lunches and in the parking lots after school.”
think the students feel more secure with them here, too."

In Beth's school the teachers' lounge held six round dining tables, two small couches, a wall-mounted television set, a refrigerator, and two vending machines with snacks and drinks. In contrast to Ann's teacher lounge, Beth's lounge clearly was for dining and relaxation.

The overall appearance of the school exceeded my expectations for a middle-to-upper middle class suburban high school. The tour gave evidence that a large amount of tax dollars had been spent on the recent construction and refurbishment of the building. Particularly noticeable to me was that a large portion of the construction went towards nonacademic programs, such as the gymnasium, weight-lifting room, and auditorium. However, this may have been more conspicuous to me as an observer since Ann's school did not have extracurricular activities (i.e., students at the vocational high school traveled back to their home schools for extracurricular activities). While the application of state-of-the-art technology was emphasized during my tour at Ann's school, Beth's high school principal called my attention to the various activities offered to the students.

**Beth's Classroom Environment**

I met with Beth after my introductory interview with her high school principal. School was over for the day, and Beth was seated at her desk grading papers when I entered. Beth's desk was at the front and center of the room. The room was clearly divided into a standard classroom setting on the right and a lab setting on the left side. Judging by sight alone, the room appeared to be about 1 1/2 times the size of a
normal academic classroom. On the right, individual student desks were lined up in rows, facing the teacher's desk and the overhead projector screen. The back wall behind the student desks held a counter with five computer stations. The walls around the student desks were covered with anatomy and chemistry posters. A large bulletin board behind the teacher's desk was filled with science newspaper articles and science comic strips. On the sidewall of this section of the classroom, two large bookcases were filled with workbooks, dictionaries, and texts. On the left/lab side of the room, four long rows of lab counters extended from the back of the room. Each side of the counter had two sinks on either end. A row of storage cabinets hung above each counter. A large chemical tub sink was at the front end of each counter, with a drying rack for glassware hanging off the overhead storage cabinet. A chemical shower stood in the front corner of the lab side of the room. Through an open door on the lab side of the room, I could see a chemical storage area about the size of a walk-in closet. The chemicals were stored on wooden shelves. I asked Beth about her room:

**Beth:** "I have plenty of room in here to do labs, which is nice. There are enough sinks so that students can work in pairs... (pause)... I have found any more than that and someone gets left out. If we're doing a difficult lab or using dangerous chemicals, I usually have half the class do a written assignment. I can watch them and still work in more detail with the ones doing the lab. I did put in for a portable fume hood for this year, but I don't know if I'll get it or not. The science department shares just one portable hood right now. I have room in the back for..."
a vented hood....(pause) ...which is what we’re supposed to have in a chemistry class. So for right now, I just stay away from organics (i.e., organic chemicals). I just got the lab supplies (i.e., the microbiology lab supplies) from the community college. I think I’m going to set up the incubator in the chemical storage room.”

From my observer’s viewpoint, Beth’s class was a more standard chemistry classroom, with the exception that the lab was not in a separate room from the academic classroom. Beth stated she really liked the way her room was organized because it gave her the freedom to do a lab any day of the week and because there was no rush to complete a lab in one day.

**Case Study Settings Summary**

The information presented thus far in Chapter 4 served as an introduction to the qualitative portion of the investigation. The decision to incorporate a microbiology unit was discussed, and the microbiology written curriculum was reviewed. Several documents were reviewed, including class data records, Tech Prep entrance requirements, and the Allied Health Tech Prep brochure. The curriculum materials and the microbiology textbook, provided to both participating teachers by the community college, were evaluated. In addition, the case study settings of both teachers were presented, which included information about each teacher’s background, high school environment, and classroom. In the following section, the case study findings will be presented.
Case Study Findings:

Teachers' Preactive Planning, Interactive Decisions, and Reflective Practices

During New Curriculum Implementation

The purpose of this study is to investigation three phases of teacher thinking: preactive planning, interactive decisions, and reflective practices. In this section of the qualitative study, the case studies of the two participating science teachers are portrayed. The findings are analyzed and the researcher's interpretations are explained. In an effort to facilitate comparison and interpretation, the case study findings of the two teachers are presented jointly within the realm of the three teacher-thinking phases. At the conclusion of this section, the researcher interpretations of the case study data are presented.

Preactive Planning Findings: Ann and Beth

Teacher planning was investigated through two qualitative research methodologies: interview and document review. Two weeks prior to the start of the microbiology unit, I individually interviewed both participating science teachers, Ann and Beth. I used a semi-structured interview schedule (See Appendix C). This approach provided some uniformity between the two interviews, but also permitted each teacher to elaborate upon their individual perspectives on planning. After the start of the microbiology instruction, I reviewed the written lesson plans of each teacher. These documents included both the daily and long-term written lesson plans by each teacher.

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Ann's Preactive Planning

I met Ann in her classroom at the end of the school day. Her school had been in session for approximately five weeks. To start the interview, I asked Ann how much planning she had done so far for the new microbiology unit and what goals she had for her senior science students.

Ann: "The college (i.e., the local community college) mailed the course of study to us in mid-July, along with the lab materials. But I didn’t come in until the first week of August. That’s when I really started going through the material and the textbook, trying to map out the unit. We basically only have about nine to ten weeks to finish this micro... (pause)... but that’s O.K. because this is only supposed to be an introduction. My main concern is getting through this material and having time to go into some depth with my students. I don’t see the purpose of just trying to gloss over a lot of material without spending some time applying it to what they already know about healthcare. So most of my time last August was spent on trying to plan out the timeframe of the unit... (pause)... getting a mental plan of the whole picture. I want to do as many labs as possible, so that means I’ll have to think about how to cover all the important topics without using only lectures... (pause)... and that’s harder than it sounds. These students are used to lecture notes. And in the past I’ve found that they only think the topics covered in lecture are what is important... (pause)... that they won’t be tested on any info that they’ve learned on their own from their assignments."

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At this point, Ann pulled out a planner notebook. She had marked off ten weeks for the microbiology unit, starting the first week of October. The planning notebook had writing space for each day of the week, but Ann only had written at the top of the planner across all five weekdays. This left about half the original space per day blank. For each planned week, Ann had penciled in chapter numbers from the text and the names of the corresponding labs. Often, Ann used personal abbreviations and topic symbols that would only be recognizable to her. Ann stated that her first step in planning the new unit was to go through the provided “hands-on” materials, which were needed for the microbiology labs.

*Ann:* “First I went through each chapter (i.e., in the microbiology text) and picked out the labs that went with each topic. There are about fifteen labs that we can do. Some of the chapters had two or three labs suggested (i.e., suggested as possible labs by the Tech Prep community college instructors that developed the course of study), but that left other chapters with no labs. So I wrote out a plan to space the labs out evenly over the unit. Then I tried to predict how long each lab would take. I knew that some would take more than one day, and that others could be set up fast, but would need almost daily attention… (pause) like the culturing labs. They (i.e., the students) will have to write down their observations every day and add nutrients. That will take time out of each period. So I’ve marked off the time (i.e., in the planner) I think these labs will take. That’s how I worked it out to predict how much class time we would have left. So I’ve pretty much
mapped out how I think the unit will go. What I haven’t done is plan out the lectures... (pause)... what we will discuss in class, what I will assign to read, and how I’ll have them use the technology.

From the interview responses and the written planning notebook review, a picture of Ann’s planning theory was emerging. Ann focused her long-range planning around hands-on activities. I asked Ann to predict the amount of time she would spend on preactive planning during the implementation of the new microbiology unit.

Ann: “Well, I spent one whole work day going over the chapters and the lab supplies. In that time I was even able to lay out the lab supplies and stock them. [Note: Ann showed me that she had cleared out two cabinets over a lab counter for the new microbiology materials.] But that was the easy part. The time-consuming part will come once I start the unit. I normally don’t write out detailed lessons plans for each day of the week. I just go through each section and make out a guideline for lectures.... (pause).... usually on the weekend before. I can then kind of pencil in homework assignments or computer assignments for the week. That way I don’t have to spend a lot of time making up written plans. It gives me flexibility, especially since this is the first time we’ve taught this. I’ve gotten to the point where I sort of mentally go through how I think the lesson will go without having to write it all out. So most of my planning time is spent choosing the important topics to go over and setting up the labs...(pause).... getting my notes ready for a lecture or class discussion.
The other thing that is going to take a lot of planning time is the technology. So far I have just had time to scan through all the technology, and I know that these kids do well with that kind of learning. Luckily, I am pretty set with my other classes. So I’ll be free to spend a lot of time getting this up and running. This’ll be a learning process for both of us (i.e., for herself and her class). And next year I’ll be able to revise and re-plan. I’ll know what works, what holds their interest, and what they might have trouble with.”

I asked Ann how she decided on what to include or modify during the implementation of new learning unit. Ann stated that her first step was to review the amount of material that needed to be covered within the remainder of the school year. Both participating high school teachers, Ann and Beth, were incorporating the new microbiology unit into an Advanced Anatomy and Physiology senior course. So obviously, both teachers would somehow have to decide how to fit the nine or ten-week microbiology unit into the existing anatomy course. Ann told me that she felt comfortable adding a new unit into the senior year, because the students had completed an Introductory Anatomy course as juniors. I asked Ann how she would decide to modify the yearlong anatomy course to accommodate the addition of the microbiology unit.

Ann: “I looked over the anatomy schedule for this year, and I basically decided what we could skim over and what we could even delete. Some body systems are less complicated than others, so instead of reviewing them in detail, I’ll probably just give the students review assignments for
homework... (pause) ...like with the respiratory and urinary systems. Other systems, like the nervous and muscle systems, are more complicated. I'll probably spend the same amount of time on the physio (i.e., physiology) and anatomy as I did before (i.e., before the inclusion of the microbiology unit)."

Ann had not documented these modifications in her planner. Matter of fact, after the microbiology unit, there was nothing written further in her planner notebook for the remainder of the year. However, Ann already had made plans mentally on how to incorporate a new curricular unit into the existing yearlong anatomy course. She had reflected on the classroom experiences of previous years in order to decide and predict necessary changes for the current year.

I asked Ann how her personal teaching theory related to her planning decisions. Ann stated the following:

**Ann:** "My personal theory of education is centered on connecting the curriculum to the life experiences of my students... (pause) ...helping them find ways to apply what they have learned in the classroom to their everyday world. To me the 'curriculum' is not just a document. That only serves as a guide. The real curriculum is the big picture... (pause)...how the students learn and use the new material. And I think my role as a teacher is to help students make those kind of connections - not to focus on the memorization of facts. They can look up facts all day long on the internet. They need to learn how to think, how to apply and understand. That's especially important in the
health care field. I think labs help them link the facts in the textbooks to everyday life...(pause)....to not only read about microbiology, but also see how micro is used in medicine...(pause)...to see how those lab techniques are used to save lives. And that's why I focus on hands-on activities and start all my planning from there.”

In regard to the new microbiology unit, Ann stated that her overall goals for her students were two-fold. She wanted the students to be successful on the community college’s posttest at the end of the unit, which would be administered by a proctor. Ann stated that one disadvantage to this system was that the test may not correlate specifically to what she emphasized in her classroom. She added that the high school science teachers would not have access to the test prior to the test date. Therefore, she would have to “guess” what would be on the test from the course of study. However, Ann stated that her primary goal was for her senior students to gain some background knowledge to relate microbiology to the information they learned during their junior anatomy course. Ann again emphasized that she hoped her students would make connections about previously learned body systems and the new disease information in the microbiology unit.

For the duration of the microbiology unit, Ann also provided access to her short-range, daily lesson plans. I reviewed her lesson plan calendar and teacher-developed activities on a weekly basis. In addition, I was able to ask Ann for any necessary clarification of her short-range lesson plans during each end-of-the-week teacher interview. As explained earlier, Ann had written chapter topics and labs at the top of her planner for each projected week of the microbiology unit. She did this prior to
the start of the implementation of the new curriculum. Ann stated that she expanded upon these initial preactive plans on a “week by week basis”.

Ann: “I usually end up tightening up my lesson plans a week in advance. That’s when I write in specific homework assignments or when I plan computer or lab time. And you’ll notice that I don’t write in something for each and every day. I prefer to work things out a week at a time....(pause)....I know what I’m going to do each day, but I like to leave room for flexibility. I don’t feel the need to write down everything I plan to do. After I’ve thought out the week, I’d rather spend my time planning labs or finding the right activity....(pause)....finding things to supplement the text.”

Ann’s implementation of the new microbiology unit lasted a little over nine weeks. I observed Ann in her classroom on a daily basis during that time. As such, I was able to review all the activities Ann herself developed for her students. On average, Ann developed two original learning activities per week. Ann planned and typed a “guideline” for students to use during lectures and class discussions for each textbook chapter. Other original documents included chapter quizzes, review worksheets, Internet assignments, and worksheets to correspond to the microbiology software. Ann stated that she planned these extra activities to supplement the course of study. From my daily classroom observations, I could see that Ann used her written preactive plans merely as an adaptable guideline. Based upon Ann’s
interactive and reflective decisions (Note: see the following case study sections), her preactive plans were constantly refined and changed. The majority of Ann’s preactive plans were mentally developed, rather than recorded in a written format.

**Beth’s Preactive Planning**

I met Beth in her classroom at the end of the school day. Her school had been in session for just over six weeks. To start the interview, I asked Beth how much planning she had done so far for the new microbiology unit and what goals she had for her senior science students.

**Beth:** “I started planning about 2 weeks before school. I like to plan out ahead of time how I think the year is going to go. Of course, each year is different ...(pause)...depending on the students. But I can generally chart how the year will progress.”

Beth pulled up a file on her computer. The file was labeled “Senior Anatomy” and consisted of a weekly calendar for the school year. Beth scrolled down to view the first two weeks in October. For each week she had typed in one to two microbiology chapters, with chapter topics listed beside each chapter number. Chapter assignments were typed in below each chapter topic. For example, for the first week of the microbiology unit, Beth had typed in the following:

“Chapter 1 Intro

*History, germ theory, pathogens, types of microbes*

*Read Ch 1; chapter summary, definitions, micro slides ID*”
Beth scrolled down through the remaining, planned eight weeks for the microbiology unit. Scrolling down past that timeframe, Beth pointed out how the rest of the year also was “charted”.

**Beth:** “I looked over the course of study and I don’t know how it will pan out the first time. There seems to be a lot of material there, with labs for each chapter. And we’re trying to fit this into an already full year of anatomy and physiology. Something is going to have to go. So I plan to speed through a few sections in the micro. With the Anatomy, I kind of already know what chapters we can breeze through... (pause)... just based on how they did with me last year. [Note: Like Ann, Beth had taught her senior Allied Health science students last year as juniors for an introductory Anatomy course.] But I’ll have to wait and see how they do with the microbiology. A few chapters look easier and less detailed than the rest.”

Beth stated that her first step in planning (i.e., what is referred to as preactive planning in this investigation) was always to look at the ‘whole picture’ quarter-by-quarter. Beth explained how she recorded her lessons plans.

**Beth:** “I really start a new curriculum by doing some long-term planning. That’s why I use the computer to enter in lesson plans. I can estimate where I should be each quarter of the year and go from there. That kind of tells me how much time I can spend on each unit... (pause)... how much time we have for labs or projects. Naturally, it (i.e., the original weekly lesson plans) changes and the assignments change. It just depends on how the students are doing... (pause)... how
much review time they need. And this planning calendar (i.e., on her computer) lets me make changes as we go along. I can move everything back a week with a click. We never seem to get through everything listed by the end of the year. But by starting with the course of study, I can at least get a grip on what needs to be covered.”

I asked Beth about preactive planning for her daily lessons. Beth told me that she writes down a lecture outline for herself, and that sometimes she gives her students a copy of her outline to fill in during the lecture. She stated that she tries to use a classroom discussion format when possible.

Beth: “With this much material I could end up lecturing every day all period long. So I usually give the students a copy of my outline and they fill it in as we go. That gives us more time for questions and answers, rather than having them write notes the whole class period. It becomes more of a discussion... (pause)... and I don’t have to stand up at the overhead the whole time. I will tell you that if I don’t write it down or give them an outline, they seem to think we are just talking and they won’t take any notes. So I want to kind of ease them into a less structured format to get them ready for college next year. So a lot of my planning time with a new unit like this is spent on preparing for lecture. The rest of the time is spent on getting activities ready.... labs or worksheets or quizzes. All of that has to be made up from scratch the first time through.”

I asked Beth how her personal teaching theory related to her planning decision, and Beth stated the following:
Beth: “I’ve changed my perspective on this over the years. I think when I first started teaching, I was used to the teacher being the one to provide knowledge...(pause)... that the teacher was responsible for telling the students everything they would need to know from the course of study. That’s really how I remember school. The students were passive learners. But I’ve grown as a teacher. Now I think more of myself as a facilitator to learning...(pause)... that the students need to take an active role in learning. Rote memorization without really understanding a topic requires no critical thinking. A student that has a good memory could do well without really being able to apply the knowledge outside the classroom. So my theory of learning has moved toward a theory of active learning...(pause) where the students can relate new information to what they already know in the real world. And that has helped me evolve as a teacher, to the point where I think of the students as my partners in learning. And that’s definitely the case when I’m teaching a new curriculum.”

In regard to the new microbiology unit, Beth stated that her overall goal was to provide a “solid overview” of microbiology for her students. Beth related that while she wanted her students to do well on the community college’s microbiology posttest, her main objective was to introduce microbiology principles to serve as a backdrop for a career in health care.

Beth: “Of course I want them to do well on the test (i.e., the microbiology posttest), but I think it’s more important that then really understand the
principles....(pause)...not just memorize facts. The test will only count for one-fourth of their grade. Their grades from anatomy and physiology for the next three quarters will be averaged in with their micro grade. So I really don’t want to 'teach to the test', as they say. I want to focus on introducing diseases and how those diseases affect the human body. They already have a good background in anatomy, so now I will use this (i.e., the new microbiology unit) to help them make some connections....(pause)...
connections from what they already know about anatomy to what can go wrong when the body is invaded by pathogens. And it also gives me a little peace of mind to know that if they don’t get an overall grade of a ‘C’ for the year, the grade won’t show up as a credit. They won’t have to start college next year with a low grade point average if they don’t do well.”

For the duration of the microbiology unit, Beth also allowed me to review her short-range, daily lesson plans. As noted earlier, Beth used a computer file to type in her long-term instructional plans. She had typed in microbiology topics and chapters for each week of the unit. Beth added to this file to type in detailed, daily lesson plans. I reviewed these preactive plans on her computer file on a weekly basis. This permitted me to ask Beth about her preactive planning decisions during the weekly teacher interview sessions. Each Friday after school, Beth would type in additional lesson plan notes for each day of the upcoming week. These typed plans included homework assignments, quiz dates, class reviews, and lecture topics. Beside each student assignment, Beth typed the assignment date, as well as the due date. In a separate computer file titled “Sr. AHT Micro”, Beth stored all of the worksheets,
tests, and quizzes that she developed as the microbiology unit progressed. Beth also kept typed lecture notes that included possible classroom discussion questions.

Beth: “I have found over the years that if I stay very organized, I’ll have everything I need to teach it again next year...(pause)... I’ve even gotten to the point that I can leave all of the assignment titles in my grade book for next year’s class.”

I asked Beth how she decided what topics to include in her lectures and homework assignments.

Beth: “I do try to work from the course of study...(pause)... but I eventually decide based on what I think is important for the students to know. I can’t say that I keep going back the course objectives to what I think will be on the final test (i.e., the community college’s posttest). It’s hard to explain in words, but I just decide what to cover and what to skim. There is so much information, you can’t cover each and every topic in class...(pause)... each and every disease and treatment. From looking over each chapter, I can tell what the key points are...(pause)... what they students will have to understand to move forward. I certainly wasn’t able to do this when I first started teaching, so it comes from teaching experience...(pause)... from interacting with the students and the subject matter. That’s how I pick assignments and discussion topics. I want to build up a base of information so they can relate it to what they learned before and to new info in the future.”
Beth’s implementation of the new microbiology unit lasted ten weeks. I observed Beth in her classroom during the implementation on a daily basis. From my observer’s viewpoint, Beth’s written preactive plans were very detailed and organized. In addition, I found from my daily classroom observations that Beth rarely diverged from her preactive lesson plans.

**Interactive Decision Findings: Ann and Beth**

Interactive teaching decisions – decisions made during classroom instruction – were investigated through two qualitative research methodologies: observation and interview. For the duration of the microbiology implementation process, I observed Ann and Beth’s classrooms on a daily basis. During the observation, I recorded field notes about the classroom environment. I specifically was diligent in the documentation of the teachers’ interactive decisions. Such decisions encompassed a wide range of teacher-student interactions, including disciplinary, motivational, learning, and curricular issues. In relation to this research project, I was particularly interested in the interactive decisions related to two specific areas: student learning and the implementation process of the microbiology unit. Prior to each classroom lesson, I reviewed each teacher’s written lesson plans. In addition, I interviewed both teachers about their preactive plans for each lesson. Therefore, in the role of an observer, I was usually aware when a teacher’s interactive decision resulted in a lesson modification. However, observation alone could not explain a teachers’ reasoning behind interactive decisions. In order to gain insight into the teachers’
imperceptible, private interactive-thinking processes, I relied upon interviews. I met with each teacher at the end of the week for a stimulated-recall interview about her interactive decisions. I used my field notes from the daily classroom observations to remind me to ask about specific interactive decisions. After a few days of classroom observation, I developed a field note guideline (See Appendix G for an example) to facilitate coding of observational data as each class progressed. Using this system, I was able to code for observed planning, interactive decisions, and reflection by the participating teacher. This personal coding system prompted me to inquire about the teachers' interpretations of events that stimulated interactive decisions. Thus, the majority of my interactive-thinking interview questions stemmed from my field notes. However, I did develop a basic interview schedule to serve as a starting point (See Appendix E). In using the observation data in conjunction with the interview data, I was able to delve into the essence of the participating teachers' interactive thinking processes.

**Ann's Interactive Decisions**

For the interactive-decision interviews, I met with Ann after school each Friday during the ten-week microbiology instructional unit. These stimulated-recall interviews typically lasted about one half hour. As I originally planned, most of the interview questions related to my observations of Ann’s interactive decisions during classroom instruction. I started each weekly interview session by asking if Ann had made any unexpected curricular changes during the week. Invariably, Ann was able to talk about multiple modifications from her preactive plans during each week of the
microbiology unit. The large majority of Ann’s interactive thinking revolved around student comprehension of the curricular material. I asked Ann how she gauged student understanding during her instruction.

**Ann:** “I’ve always had a very open atmosphere in my classroom. My students know that not only can they stop me to ask a question, but that I expect them to. So that is one way...(pause)... if they are asking very basic questions about what I’ve just presented, then I know that the material isn’t very clear to them and that we need to slow down or go back. If they was asking questions above and beyond ...(pause)... ...like bringing up the symptoms of a relative or friend or asking ‘what-if’ types of questions...(pause)... that usually indicates that they not only are understanding, but that they are applying the new info to other situations. If I’m not getting any response, I slow down and make it a point to ask them questions. And I can tell by their answers if they are on the same page with me.”

From Ann’s personal account, her interpretation of student comprehension had a direct influence upon her interactive decisions to make ‘on-the-spot’ modifications of a lesson or activity. Ann reported that she was “usually quite good” at estimating her students’ background knowledge, which enabled her to plan new lessons at an appropriate cognitive level. However, she acknowledged that each class is unique, which made her on-going evaluation all the more important.

**Ann:** “Every once in awhile I’m really surprised. Like the bloodborne pathogen lesson this week. I really thought that as juniors they would
understand that AIDS is not the only disease they need to worry about.

But during the discussion after my lecture, it became quite clear to me that they weren't worried about other transmittable diseases, like hepatitis or TB. And that kind of misunderstanding can impact their clinical practice when they're working on the job. Are they just going to take precautions with AIDS patients and then be lax with their personal safety the rest of the time? By the time bell rang, I realized that I needed to add more material about bloodborne pathogens ...(pause)...so I prepared another lesson for the next day. Did that get me off my original schedule for the chapter? Yes. But was it (i.e., the topic of healthcare worker safety precautions) important enough to revisit and drive the matter home? I thought so. So I changed the lesson in midstream and went from there."

The above situation exemplified the majority of Ann's interactive decisions. During a planned lesson, Ann interpreted the level of student comprehension through obscure signals from her students. As an observer in the classroom, these student signals were not always apparent. Often, what Ann interpreted as student "confusion" appeared to an outside observer as mere student-teacher discussion. Thus, through experience in the classroom, Ann had developed her own form of gauging student comprehension and based many of her interactive decisions upon her theory of action as a teacher.

The observational field notes of Ann in action in her classroom proved invaluable as a tool of investigation. During the third week of the microbiology unit, Ann planned to introduce her students to the microbiology textbook's accompanying
software. Ann's preactive written plans indicated that she planned two days for the microbiology tutorial program. Ann scheduled her class in the school technology center so that all the students could work on the software program at once. After the students were all seated at their computer stations, Ann handed out an assignment sheet and the textbook CD-ROM. The assignment sheet specifically instructed the students as to how to start the software tutorial program and how to access the current chapter information. In general, the students had little trouble using the software program and were working independently. About fifteen minutes into the lesson, Ann and I heard a lot of continuous beeping noises. Ann knew that each beeping noise indicated that a student had missed an answer to a specific question on the interactive tutorial program. The program was set up to beep each time a student clicked on a wrong answer. Ann walked around the technology center, looking over the shoulders of the working students. After a period of an additional five minutes of constant beeping from the students' computers, Ann asked the students to "logoff" and return to their classroom. Back in the classroom, Ann instructed the students to use the remaining class time to work on their homework assignment. She explained that they would return to the technology center the following day. I asked Ann what led to the change in her preactive plans that day..

**Ann:** "Well, you could hear all the noise. The students must have been guessing on each and every answer, missing most of them. The software was great, but the segment before the question/answer section was very detailed. Even though it (i.e., the microbiology computer program that came with the textbook) was interactive, there was a lot
of info packed in there. So, either they were rushing through the program or they didn’t understand the material. And, the students had nothing to refresh their memories after they logged off. So I decided to stop the lesson and come with something else. That night I went through the program and made up a short review sheet for them to answer as they clicked through the program. That way they’d have something to use during the self-quiz. And they can use that to study later on, too. Now I’ll probably do that for every chapter. That’s the type of thing I can’t plan for ahead of time...(pause)...I have to read how the students are doing during the activity and decide if it’s (i.e., the lesson or activity) working or not."

During my classroom observations, I noted that Ann made the most interactive decisions during laboratory activities. Students were continually asking questions and seeking solutions. The interaction between Ann and her students was much greater during Ann’s lab lessons. I asked Ann if she agreed with my analysis.

Ann: “Oh, definitely. Labs are harder to preplan (i.e., more difficult than lectures or discussions). It’s hard for me to judge what is going to be straightforward for them and what’s not. And then most of these labs I have never set up before. So I’m learning right along with them. So I try to be very flexible when it comes to labs. If one direction doesn’t work, I try to improvise or encourage the students to come up with workable changes. Then some labs take longer than others...(pause)...a few didn’t work at all, like the antibiotic disc lab. So before I can even modify it, I have to find out what went wrong, and then decide if there’s time to redo
it, or wait until next year. But for most labs, I have to make decisions about what to do if something unexpected comes up. Labs are a learning experience and don’t always work like a step-by-step blueprint from the book.”

While the majority of Ann’s interactive decisions centered upon student comprehension, other factors affecting the classroom routine also resulted in interactive thinking. Throughout the ten-week microbiology unit, unplanned classroom interruptions caused Ann to make immediate modifications in her lesson plans. Many of these interruptions, such as a fire drill and an English fieldtrip, reduced class time that Ann had planned for a lecture or lab. When a class period was unexpectedly cut short, Ann would change her plans in accommodation. In one instance, when almost half of the students were on a field trip, Ann canceled her lab plans for that day, and came up with an alternative computer assignment for the students in attendance. The absent students were then assigned the same computer lesson for homework the following day. Therefore, some of Ann’s interactive decisions were influenced by time limitations in class.

Ann also made lesson modifications during a lecture if an unanticipated question or topic was mentioned. For example, during a lecture/discussion on streptococcal infections, a student mentioned that a relative had died from ‘flesh eating strept’. Many students had questions about this disease, and Ann deviated from her preactive plans to expound upon the disease. Near the end of the lesson, Ann then gave an unplanned homework assignment that covered the topics she had planned to discuss.
in class. The following day, Ann changed her planned lesson at the beginning of the period to briefly review their homework assignment.

Very few of Ann’s interactive decisions revolved around student discipline. Ann’s students were remarkably well behaved, and during the ten-week unit Ann did not write one disciplinary referral for an after-school detention. As an observer, I only documented one interactive decision that was initiated by student misbehavior. During one 30-minute video on the microbiology lab, Ann stopped the videotape when she noticed several students had their heads down on their desks with their eyes closed. Ann stopped the video and then proceeded with a review for an upcoming quiz. When I asked Ann about this at the end of the week, Ann explained that she had a “class rule that students could not lie down in class”. Ann then reported that she, too, felt the video was “redundant and pretty boring”. Therefore, she decided to spend class time doing something more “productive” and stopped the videotape.

All of Ann’s interactive decisions resulted from her interpretations of the classroom environment. Ann’s teaching experience enabled her to decipher explicit and implicit clues from her students. These clues guided her interactive decisions during instruction. In turn, Ann was able to enrich her preactive lesson plans for better student comprehension.

Beth’s Interactive Decisions

I met with Beth after school each Thursday during the ten-week microbiology instructional unit. These stimulated-recall interviews commonly lasted more or less twenty minutes. While I did ask some of the questions from the interview schedule
(see Appendix E), most of my interview questions came from my daily classroom observations during Beth’s instruction. I started each weekly interview session by asking Beth to discuss any modifications to her original lesson plans. Occasionally, Beth would describe an instructional situation in which an interactive decision had affected her preactive plans.

**Beth:** “This week was sort of discombobulated (laughing). I had planned to have the students observe and try to identify different colony formations on their agar plates. But I think the incubator was set too high over the weekend. So by Monday, all they had left was dry, cracked agar. Not a living thing in sight...(pause)...and most of the agar totally evaporated. So I had a choice. Do we backpedal and get off track by totally redoing the lab? Or do we go on. I decided to go on with the next day’s class notes. But then the next lab, I asked the students to double the amount of agar they mixed and poured (i.e., into petri dishes) so that they could do both labs at once. In the end, it worked out. But that left us with less time to fully investigate the labs.”

In this instance, Beth immediately came up with an example of an interactive decision for the preceding week. However, other weeks Beth would merely state that she had been able to “stay on schedule”. I asked Beth to explain her perception of an interactive decision.

**Beth:** “I really think of an interactive decision as a major change in a lesson...(pause)...more than just a slight tweaking. Take the history of microbiology section of chapter one. I had planned on

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covering this topic in-depth in one class period, and then assigning an Internet search for each group. [Note: Beth assigned her students into prearranged “lab/research” groups of four students.] I thought they would be interested in finding out historical theories of disease and treatments, like bleeding the patient or herbal remedies. But then we lost a day to a school assembly. So, to stay on schedule, I had to choose what to change. I ended up covering just half of the material and assigning the rest using the end-of-the-chapter questions. That left no time for the Internet search, which they probably would have enjoyed. I’ll probably offer that as an extra-credit assignment, which only about a third of them will do. Either that, or wait until the end of the year when we have some time to do some extra activities.”

As in this example, a majority of Beth’s interactive decisions centered upon “staying on schedule.” Beth explained that she felt more comfortable “sticking” to her preactive planning schedule, “especially the first time teaching a unit.” As a classroom observer, I noticed that many of Beth’s interactive decisions revolved around her long-term planning. Often her on-the-spot lesson modifications were the result of either too little class time or unexpected, extra class time. On one occasion, her students were able to finish a computer assignment (i.e., a self-tutorial assignment from the textbook’s software product) ahead of schedule. On the second day of the tutorial, all of the students had completed the assignment within fifteen minutes, leaving the remainder of the class time free. Beth explained her interactive decision in this situation.

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Beth: “First of all I wanted to make sure they hadn’t just breezed through the assignment... (pause) ...that they really understood the concepts from the tutorial. So I picked out questions from the chapter section and reviewed with them. It was pretty obvious that they had a good grasp of the micro terms. So I decided to use the remaining half of the class to introduce the next chapter... (pause)... to try to get them to make some connections with their background in anatomy. I didn’t want to press on too fast, and for once I had some extra time... (pause)... which never, ever happens... (pause)... so I opened up a discussion on viruses (i.e., the next chapter topic). Why are antibiotics not effective against viruses? Why haven’t they found a cure for the ‘common cold’? How long does it take for you to get over a viral infection like the flu? How can you be infected with a virus like AIDS for twenty years? I used the extra time to start a spur-of-the-moment discussion. It helped me get a handle on their previous knowledge and it helped them by introducing the next topic.”

Thus, Beth’s personal definition of an ‘interactive decision’ focused upon major changes in a lesson. In addition, Beth appeared to associate an interactive decision as one that resulted in a significant deviation from her long-range plans. This may have explained why Beth often could not identify and discuss what she defined as interactive decisions during the end-of-the-week interviews. From my viewpoint as an observer, one of Beth’s major instructional goals was to “stay on task/schedule”. Therefore, unless some dramatic interference occurred during the week, Beth remained faithful to her preactive lesson plans. Secondly, Beth’s definition of an
interactive decision was not synonymous with my definition. As a researcher, I was
interested in the guiding force behind all types of a teacher’s interactive decisions,
regardless if a major lesson modification was the result. Therefore, while I had
coded multiple occasions of interactive decisions in my field notes for the week,
Beth would deny that she had made any noteworthy interactive decisions. After
talking through my interpretation of an interactive decision after the third week of
the microbiology unit, Beth made the following statement.

Beth: “If that is what you are looking for, then I make constant
interactive decisions every time I’m in front of the class! It’s part of
be a good teacher... (pause) ...it’s being connected to your students. While
I’m lecturing, I watching their reactions. Are they doodling or talking or
zoning out? Are they asking relevant questions or are they off topic? Are
they three paragraphs behind me in their note-taking? Or are they just ready
for a short break? As long as I am in front of the class, I’m assessing their
connection... (pause) ...their connection to me and to the subject matter.
That’s how I decide whether to keep going, go back, or try another method.
And sometimes I make the purposeful decision not to make any change.
But I’ve still had to rethink on the classroom situation to decide to stay
with the status quo.”

As an example, Beth discussed a recent lecture on the chicken pox virus, Herpes
zooster.

Beth: “I thought we had just about covered everything there was to say
about chicken pox. It’s not that complicated a disease processs, and all
of them have had it first hand. So I hadn't really planned on even one full
class lecture about it. But then they were coming up with questions about
cold sores, and would the chicken pox virus protect against all types of
herpes infections. Then a student mentioned that she still was going to
purposely expose all of her kids at once to chicken pox, which is what
her mom did when she was little. I knew right then and there that we
weren't done with the lecture after all! Those are the clues that you
have to untangle while you're teaching. As the instructor, you think you
have made everything as clear as possible. Invariable, the students
surprise me... (pause)...they bring me down to earth and remind me that
I need to take their background experiences... (pause)...their life
experiences... into account."

I asked Beth to reflect back upon her early years as a teacher. Had her ability to
assess student comprehension changed over the years? Beth stated that the
difference was "like night and day". She explained that when she first started as a
teacher, she was "fixated" with the notion of "staying on schedule".

Beth: "Oh, I kind of could tell when the students weren't quite with
me or were slightly confused. But I just went on with whatever I had
planned... (pause)... I had no back-up plans in reserve to try. So, if my
planned lesson wasn't working, I had no choice but to keep on going. But
as you grow as a teacher, you sort of develop a mental filing cabinet of
alternative plans... (pause)... a conglomeration of techniques to rely upon
that has worked for you in the past. It comes with experience, plain and
simple. I don’t think it can be taught, either in a college class or during a short student-teaching gig. It comes with constant interaction with students...(pause)...students at all ability levels and with all types of background experiences."

While many of Beth’s interactive decisions did stem from her interpretation of student comprehension, an overwhelming predominance of them centered upon her long-range planning schedule. An example of such interactive decisions was observable during a culturing chapter in the text. The chapter’s main theme was microbial generation time calculations. These calculations enabled the students to predict the number of bacteria that would be present after a set time. Beth defined the ‘generation time’ of a microbe in class as “the time it takes for one microbe to replicate.” All of the formulas contained either logs or antilogs, and Beth quickly found out that many of her students were not familiar with these math functions.

Beth: “As soon as I wrote the equations on the board, the students balked. Not only were they unfamiliar with logs and antilogs, but they weren’t even clear how to use their calculators for these functions. And naturally everyone had a different calculator, so it took the whole class period to get everyone on the same page.”

Beth’s students were very vocal about their confusion with the equations and their calculator function keys. Thus, Beth’s interactive decision resulted in the cancellation of her lesson plan in order to give some background information about logs and antilogs.
Beth: "The next day didn't really go any better. I had planned on going over just a couple of examples and then letting them try the few sample questions in their groups (i.e., five sample calculation problems at the end of the chapter). But even in their groups they still were having problems. So I used the rest of the period to go through every single problem...(pause) ...and the problem set-up for each one. I think part of the problem was that the examples in the book were word problems. It wasn't quite clear to the students what to calculate or where to even start. That's why I made up a practice worksheet for a homework assignment. I decided to have them practice the calculations using just the given number (i.e., Beth made up a worksheet that did include any word problems.) We ended up way behind schedule for the week, with only two weeks till the end of the unit. If we had more time this week, I would have spent a few more days on the math problems. As it stood, I decided to try to finish up the unit and come back the calculations right before the test."

As in the above interview excerpt, many of Beth’s interactive decisions focused upon two classroom issues: her long-range preactive planning schedule and student comprehension. Other interactive decisions did stem from classroom interruptions, such as a tornado drill in one instance. In addition, a few interactive decisions were initiated by student misbehavior. On a few occasions over the ten-week microbiology unit, Beth stopped a lesson or activity after observing several inattentive or talking students. In such instances, Beth would pause the lecture or an activity to ask more student-questions, drawing the inattentive students and others
into the conversation. However, from the interactive interviews and the classroom observational data, a large number of Beth’s interactive decisions were based upon a combination of schedule and student comprehension factors.

**Reflective Practice Findings: Ann and Beth**

The reflective practices of the participating teachers were investigated through open-ended individual teacher interviews at the end of the microbiology unit and one concluding group open-ended interview (See Appendix E and F). Open-ended interview schedules were used to permit each teacher to give voice to their own reflective practices. As the researcher, I did not want to limit their personal insights about the microbiology implementation process through a rigid interview schedule. Rather, my intent was to access the individual, meaning-making reflective processes of Ann and Beth. In the sections below, the case study data from the individual and group reflective interviews are presented.

**Ann’s Reflective Practices- Individual Semi-structured Interview**

I met with Ann in her classroom on a Monday afternoon, the first day after the completion of the microbiology unit. As with the other teacher interviews, the dialogue was audiotaped for future transcription and analysis. I started the interview by asking Ann about the implementation process. Did she think the unit was constructive in terms of student learning? Ann enthusiastically stated she thought the microbiology unit was a great curricular addition to the senior anatomy course. Her students were interested in the material and the lab activities, and Ann found
evidence that her students applied their anatomy background knowledge to the new
microbiology topics.

Ann: “I think the unit went very well, even better than I expected. My
students learned a lot of new info and they showed real interest. And the
lessons I planned went well. The students were involved, especially with
the hands-on labs. This was all new material for them, so I was pleased
that they did so well.”

I asked Ann how the implementation went for her as the teacher. She stated that she
was pleased that they had “covered” as much as they did, but that she felt that they
were rushing through the material.

Ann: “Now that I see how much this (i.e., the microbiology unit) relates
to what we studied last year, I would like to see this extended to a whole
semester course. I think that would benefit the students...(pause)... we
could cover more chapters and expand a little bit. My students did well
on the posttest, but my main focus was mainly on introducing them to
diseases. They learned what happens in a healthy body in intro anatomy
as juniors. This was a chance for them to find out what happens when the
body is invaded by microbes. I could tell by their questions...(pause)..by
their responses during class discussion...(pause).. I could tell that they
were thinking back to the basic functions of the body to figure out the
symptoms and prognosis of diseases. They were applying the micro to
what they already knew, and I know it will really benefit them when they
go on to college. That’s what I was trying for....(pause)...not a passing
test grade, but for them to make the connection... (pause)... to actually apply their knowledge in another area."

I asked Ann if she would recommend changes in the curriculum materials for next year. Ann stated that she was very satisfied with the variety of lab supplies that had been provided by the community college. Not only was she able to do “most” of the recommended labs in the course of study, Ann also “stretched” the lab supplies and incorporated several additional labs into the unit.

I asked Ann if she would make changes in her preactive planning for next year. I also asked how she decided that lesson modifications were needed.

Ann: “Oh, this was the first time through. I already have several changes in mind for next year. I sort of know how I want a lesson or lab to go... (pause)... what kinds of issues or questions should come up from the students. Or if a lab is kind of confusing... (pause) ... that’s my clue that something needs to be changed. It’s hard to always predict what’s going to be easy or hard for them. So I don’t always choose the best way to present the material. So as I think back on it, I know what I’ll try next time.”

I asked Ann if she wrote these reflective plans down for the following year. She stated that she usually did not record her ideas for changes. However, she sometimes made changes to her lessons before she stored them for her future senior anatomy students.

Ann: “Normally I don’t write any changes or modifications down for the next school year. I usually just remember, or I will once I start the lesson. But if I have time, I’ll make the changes to worksheets or labs...”
right after the lesson. Like the last culturing lab we did. None of the
students followed all the instructions. It was total chaos, with all of them
repeatedly coming to me for directions. So I changed my lab write-up
that day, before I filed it away. Or if I notice they all of them misunderstood
a question on a test, I’ll change that right then. But I would have to say
that most changes, like changes in my lecture examples or if I decide to
do a lab earlier or later in the unit, those changes I just remember the next
year."

Ann indicated that most of her reflection was done immediately after a lesson or lab.
She attributed her ability to gauge the success of a lesson or activity to “classroom
experience.”

Ann: “I can tell you right now that when I first started (i.e., teaching),
I didn’t have the time or the experience to reflect on anything. Oh, I
could kind of tell if things weren’t going well. But I didn’t have the
experience or know-how to change or adapt. And I wasn’t really able
to tell if the students were relating to what I was saying...(pause)...
were they really getting it or just spitting it back out to me on tests. I
think my teaching has improved because now I can read how their
doing....(pause).... and how I’m doing as the instructor. Now reflection
is sort-of second nature to me. I don’t even consciously stop to ask
what worked and what didn’t. I can just tell, and now I have a lot of
alternatives to try if something is not working. I think of reflection as
a continual process. As long as I’m teaching, I’m considering how the
To conclude the interview, I asked Ann if she saw a downside or negative aspect to the new microbiology implementation. Ann stated that the only disadvantage in regards to the planning time to get a new curriculum “up and running”. Ann told me that she had underestimated the amount of time she would need to go through the supplementary software tutorials. In addition, Ann stated that she underestimated the amount of time she would need to “bone up” on the material to get ready for class discussions and/or lectures.

**Beth’s Reflective Practices- Individual Semi-structured Interview**

I met with Beth in her classroom one week after the completion of the microbiology unit. I started the interview by asking Beth to reflect upon the implementation process. From her personal standpoint, did she feel the microbiology curriculum implementation was a success? Beth replied that she did think the unit was successful and that her students “learned a lot of new material”.

**Beth:** “I think the value of adding this unit (i.e., the microbiology unit inserted into the yearlong anatomy curriculum) was very evident. The students learned a lot of new material and it really worked as a supplement to what their junior anatomy year. And the topics really related to what they do in their lab (i.e., the student’s health lab taught by a health care profession). For example, I know they are repeatedly taught about the importance of sterile technique when working with patients. But when we covered blood-borne pathogens in here, it really dawned...
on them that they can get a life-long infection from a patient...(pause)... just by not taking the full precautions of gloves and needle disposal. And I can say in general the students were interested. They were able to relate to most diseases from someone they knew or had read about. They were able to make a personal connection to most disease topics, which will help them retain the new info."

Thus, Beth was in agreement with Ann as to the significance of the microbiology curriculum for the Allied Health senior students. Both teachers thought that the new curriculum would serve to augment the existing anatomy course. However, once Beth had finished her supportive statement about the new unit, she immediately expressed her uncertainty about the implementation process. Beth stated that she had found the implementation process itself very stressful. She voiced concerns over the lack of adequate time to “properly plan” the unit, as well as the “rushed pace” of instruction.

Beth: "I do think some changes need to be made for next year, though. I felt the pace was too rushed, and I know my students did, too. We didn’t have the time to do the labs I would have liked, no time for any group projects...(pause). I just think we (i.e., all the anatomy teachers at the eight participating high schools) have to decide about the length of the unit. Do we want to just gloss over the topics to get done on time? Because if we don’t rush, then we can’t finish up the rest of the anatomy lessons by the end of the year. I know that next year will go better. I won’t have to spend as much time getting familiar with the material. So I’ll have
more time to plan and set up labs, and have them do some internet research on current events. But, I think we should either teach this as a whole course ...(pause)... either for a semester or the whole year ...(pause)... or have them take it at the college level. I think it was more than a little stressful for the students, too. We basically had to push on no matter what, and I don't like to teach that way."

I asked Beth if anything could have made the process less stressful or demanding. She stated that looking back she now realized that she should have done “a lot more” planning (i.e., preactive planning) ahead of time. In addition, Beth admitted that she was a “planning fanatic”. She relied upon her preactive planning to envision the long-term progression of a curriculum. Beth explained that she liked to plot out the year in detail (i.e., on her computer) and work from those preactive plans as the year progressed.

**Beth:** “It’s always hard to judge the first time through...(pause)... hard to estimate how long each section will take or what areas might be difficult for the students. But this time it was hard for me to get a handle on planning for labs and activities. By the time we had discussed the important ideas in the chapter, there was no time for many activities. And I found that I hadn’t counted on the software (i.e., the microbiology text’s accompanying student computer tutorials) taking so much time. The graphics were awesome and the students liked the program, but it would take them a minimum of two days on the computer to get through one chapter. So while they were learning from the independent computer
lessons, it cut into my class time with the students. Next year I will know to plan my class discussions around what is not covered in detail on the tutorials. I can really use the software to supplement what I do in class... (pause)... to use the computer to animate our class discussions. Then we will have more time for the labs. I guess I felt the pace was demanding because there was so much more we could have done if we hadn't been on a deadline.”

When I questioned Beth about this instructional “deadline, she explained that the teachers were given leeway to extend the microbiology unit. There was no real deadline for the community college’s microbiology posttest. However, the new microbiology unit was incorporated into an existing senior Anatomy & Physiology course. If the participating anatomy teachers elected to extend the microbiology unit, more of the remaining anatomy curriculum would have to be deleted. Beth went on to explain the original plan by the Allied Health science teachers:

**Beth:** “The original plan was to add the micro into the senior anatomy course without deleting a lot of anatomy material. We all had planned on just speeding up a little for the last two quarters of the year to get through the rest of the anatomy. But now I think I’ll have to choose to skip some anatomy...(pause)... or I may just make the students responsible for more material on their own. In hindsight, now that the micro is over, we were probably a little too optimistic. Too optimistic in thinking we could cover all those micro chapters in ten weeks, and that we could still finish all of the anatomy before the end of the year.”
I asked Beth how she would choose what to delete from the remaining anatomy curriculum. She stated that she would “think back” on what they had covered last year in the Introductory Anatomy junior course. Her strategy was to reflect on the areas that were “difficult or complicated” for these same students last year, and to concentrate on those physiology topics.

Beth also related that reflecting on the implementation process was helpful. She stated that she routinely reflected over each course at the end of the school year. Beth explained that she normally made modifications to her lessons at this time.

**Beth:** “For me, reflection is a chance to make some changes for the next year from what I've learned. I spend about a week after school, going through the past year... (pause) ...while I can still remember what really worked or connected with my students and what didn’t. That’s when I make changes, changes on quizzes or maybe delete an assignment that seemed redundant. For the micro, I will go through my lecture notes... (pause) ...see how I can tighten them up, and then plan out a lot more labs and more computer time. This time around there just wasn’t the time to do all the labs that I wanted. I just need to rethink the whole unit, decide how to go best guide them through the material and move from a teacher-centered stance to more of a collaborative effort.”
Reflection Group Interview

The group interview was conducted with Ann and Beth at the local community college (See Appendix F). Both teachers were attending a Tech Prep symposium along with other Allied Health math and science high school teachers. I met with Ann and Beth over lunch, so the atmosphere was relaxed and informal. Both participants agreed to the audiotaping of the discussion for future transcription. I started the group interview with the following introductory question: What are your impressions of the new microbiology unit? Do you both feel the implementation was beneficial to your students? Both teachers agreed that the microbiology implementation was successful. In addition, Ann and Beth were in agreement that the microbiology unit augmented the senior anatomy course.

**Beth:** "Looking back, I think this unit really helped my students... (pause) helped them to understand how the human body is affected by disease."

**Ann:** "I agree. I think it (i.e., the microbiology unit) was long overdue. We were only concentrating on the structures and functions of the body. Before, I just added little tidbits about diseases when we studied each system... (pause) and that was only when we had extra time. Thus unit really connected what they learned as juniors to diseases and pathogens. Before they weren't getting the whole picture."

**Beth:** "And my students liked the change. It was something new for them, yet they could relate to the material. They were familiar with some of the diseases just from their own experiences, but just hadn't had the chance to study the symptoms and treatments."
Ann: “Same here. My class really got into the diseases... (pause) not so much with the microbes, but they were interested in how someone got a specific infection... (pause)... how it was transmitted and how contagious something was.”

Both Ann and Beth seemed to concur on the advantages of incorporating the microbiology unit into the existing senior anatomy curriculum. I asked them to reflect upon their preactive planning activities in regards to the success of the microbiology unit. I also asked each of them if they had successfully predicted the amount of time necessary for preactive planning.

Ann: “I think that I was pretty accurate in planning out the unit. I did try to be very flexible, especially as this was the first run-through. But in general I was trying to get through the material I thought was most important. The only thing that took extra planning time was the software... (pause)... and definitely the math section. I spent a lot of time going through the tutorials (i.e., the computer software tutorials that came with the textbook)... (pause)... making up worksheets to go along with them. And I had to take the time to learn the equations (i.e., the microbe generation time equations) myself. I didn't think the book was all that clear.”

Beth: “That's really the same trouble spot we had. There were so few examples in the book. And I really didn't have the time to make up more examples for practice. I hadn't really counted on the math being such a large part of the posttest. So I'll definitely do some work over the summer to beef up that section in class. I don't think I really understood the amount of planning time I'd have to spend getting this unit ready. So I more or less made up a few assignments as I went...”
along. I did pretty much stick with my original timeline, though...(pause)...even
though that meant we didn't get through all the labs we could have. In retrospect
I wasn't all that realistic in what we could do in ten weeks. "

Both Ann and Beth agreed that they had underestimated the amount of preactive
planning that was needed to implement the unit. Both teachers were particularly
concerned with the amount of preactive planning that was necessary for the math
portion of the microbiology curriculum. They both stated that they were not familiar
with the equations prior to teaching the unit, and that this resulted in increased
preparation time prior to classroom instruction. In addition, they both indicated that
their students were having trouble with the log and antilog portions of the equations.

**Ann:** "Even though these were seniors and they've all had Algebra II,
almost every student had trouble with the antilogs. Maybe that is covered
until Trig. But I basically had to just stop and teach math for two days.
And that was after I reviewed the equations on my own. That's why I
didn't quite get through with all the topics I had planned on. I had a
choice...(pause)...either rush through the math without them understanding
what they were actually doing, or stop and slow down a bit."

**Beth:** "Well I'm glad to hear my students weren't the only ones having
a hard time. But I chose the other path. We were already a little behind
schedule, so I just had them practice in the few examples in the chapter
and then we moved on. Looking back, I now know that was a mistake
...(pause)...especially now that I've seen the posttest (i.e., the community
college's microbiology posttest). I'll definitely change my lesson plans"
before next year. But this was our first year. Things will improve as we go along. And we'll (i.e., all the Tech Prep high school anatomy teachers) probably get together some time this summer to bounce ideas off each other.”

Ann explained that, just like last year, the Tech Prep teachers from the eight participating high schools met each summer to share ideas, lesson plans, and labs. The Tech Prep community college instructors also joined in this “Tech Prep Consortium” meeting, and all the participants could offer improvements or suggestions in a group discussion format. Ann and Beth then proceeded to discuss their students’ common difficulty with the math section of the microbiology unit. Over a period of fifteen minutes of collaboration, the two teachers came up with several possible modifications to implement the following year. Ann offered to share the math practice worksheets she had developed for her students. Ann also planned to share copies of the math worksheets she had developed to go along with the software tutorials. Beth and Ann also decided to ask their high school math teachers for additional log/antilog practice problems and to share this information with each other. Lastly, the two teachers agreed to bring up this math topic at the summer Tech Prep Consortium meeting to get input from the other science teachers.

Beth: “This type of communication is invaluable to me as a teacher. So often we’re off by ourselves with no time for group planning or discussion. So it was nice to hear that my students were not the only ones having trouble with this section (i.e., the math section)....(pause)....and that another teacher thought some changes were needed for next year, too.”
I asked both teachers if they felt the posttest was an accurate measurement of student achievement in microbiology. Both Ann and Beth felt that the multiple-choice test did match the implemented curriculum.

**Beth:** "I'd have to say that the test was very fair... very close to the course of study objectives. Most of the questions were taken right from either the course of study or the review section at the end of each chapter. So I'm glad that I had the students do those reviews sections. And I didn't really see any questions that were ambiguous or confusing. If the students knew the material from the unit, they could pass."

**Ann:** "I think so, too. It was a fair test and most of my students did pretty well on it... (pause)... about like I expected. The students that took the time to review and study did really well. And I'm kind of glad that we (i.e., the high school anatomy teachers) didn't see the test beforehand. Otherwise, I would have been tempted to cut back on the number of labs and spend more time lecturing. And now that I can look back, I don't think I'll change too much for next year. I want to be able to go at a pace that's comfortable for the kids... (pause)... at a pace that gives us a little wiggle room to do lots of hands-on activities. I may try to speed up on a few sections just to cover all that may be on their test, but otherwise I'm going to try to stay flexible again."

In light of the fact that both teachers though the community college's posttest was an accurate assessment, I asked the teacher to reflect on the test itself. Would either of them like to see a change in the assessment instrument in the future?
Ann: "Oh, I'd definitely like to see some type of lab practical added. Some slide identification or maybe of culturing techniques... (pause)...
or even on the new micro equipment. I think that's very important... (pause)...
to see if the students can apply what they learned out of the book. Other
than that, I really think a few short answer questions may be in order. I like
to see my students explain what their thinking. You can't get that from only
multiple-choice questions."

Beth: "I agree with you on the lab practical, although I'd like to see a list
of the specific lab skills in advance. And I know in anatomy they (i.e., the
community college) do have lab practicals, so the students need to get used
to doing them. But I think the essay questions may be too hard to grade. It
may be too hard to develop a fair, uniform way of grading them... (pause)...
...let alone the time it would take for the college to grade them all."

Both Ann and Beth stated that they had met their original instructional goals for
the microbiology unit. Upon reflection of the microbiology unit, they both thought
that their preactive plans had been implemented effectively. Additionally, both
teachers indicated that their students’ accomplishment on the posttest met or
exceeded their original expectations. Ann and Beth also agreed that the
incorporation of microbiology into the existing senior anatomy class was beneficial
to their students.
Case Study Conclusions – The Researcher’s Interpretation of the Data

The researcher’s interpretation of the qualitative data is presented in this section. From the triangulation of data from document reviews, interviews, and classroom observations, the researcher’s perspective is presented after a comprehensive analysis of the findings. The analysis and interpretation of the preactive planning, interactive decisions, and reflective practice case study findings are discussed. Lastly, the subject of qualitative research authentication and credibility is taken into consideration.

Preactive Planning Data Interpretation

Ann and Beth routinely relied upon short-term and long-term preactive planning decisions. Both teachers chose to start the implementation process by completing long-term preactive planning. Initially, they charted a timeline for the entire curricular unit. Both teachers relied upon the microbiology course of study to make these long-term predictions. The hands-on labs recommended by the community college instructors in the course of study guided Ann’s long-term plans. Prior to making any preactive planning decisions, Ann inventoried all of the lab supplies provided by the community college. Ann then “mapped out” each microbiology lab, estimating the required amount of class time to complete all lab activities. Only then did Ann proceed to chart out the text chapters and course of study objectives for the ten-week unit.

Beth relied more heavily upon the course of study for her long-term preactive planning. She began her plans for implementation by reviewing the chapter contents
in order to ensure that all textbook material would be completed within the ten-week timeframe. Beth meticulously planned each chapter, including class time estimates for lectures and computer activities on a week-by-week basis. In addition, Beth penciled in possible text assignments for each chapter. Only then did Beth incorporate possible lab activities into her preactive, long-term plans.

Both teachers also relied upon short-term preactive planning to enhance student comprehension. These plans were usually modifications to their long-term preactive plans. Often such modifications were the result of interactive decisions made during classroom instruction. For example, both Ann and Beth made changes in lecture and learning activities based upon their assessment of student comprehension during their instruction. Ann’s primary goal was that the students could relate microbiology to their own personal experiences outside the classroom, as well as to their prior knowledge about anatomy. Thus, once Ann implemented her long-term preactive plans, she would incorporate new classroom discussions or learning activities to further guide her students toward such “application”. For instance, Ann would continually assess comprehension through interaction with her students. If Ann noticed a particular area of confusion or interest, she would modify the next day’s lesson plans (i.e., her long-term preactive plans) to accommodate her students’ needs. This process of continual lesson modification seemed particularly unproblematic for Ann. My interpretation as the researcher was that Ann’s long-term preactive plans were very flexible, and therefore eased lesson modifications based upon her interactive decisions. This interpretation was corroborated through
individual interviews, where Ann explained the reasoning behind her preactive planning techniques.

Beth also made modifications to her long-term, preactive curricular plans. However, she made relatively fewer modifications per week during the implementation process. Beth's long-range plans were very detailed, which may have resulted in fewer lesson changes. While some of these modification related to her interpretation of student comprehension, an equal number of lesson changes related to the overall timeframe of the microbiology unit. For example, if a lab or lecture activity took longer than predicted, Beth either would shorten the next day's lecture or assignment a planned classroom activity for homework. Such modifications permitted Beth to “stay on schedule” and complete almost all of her preactive, long-range goals. Thus, continual reflection upon the progress of the new curriculum was a guiding force behind Beth’s short-term preactive planning decisions.

**Preactive Planning Conclusions**

The preactive planning activities of both participating teachers were similar in nature, yet were unique. While Ann and Beth made long-term and short-term curricular plans, the forces guiding their preactive planning decisions were divergent. Ann’s preactive planning decisions were guided by the incorporation of lab activities. In addition, Ann concentrated upon the ability of her students to “apply” newly learned microbiology information. Beth’s preactive planning decisions
principally were guided by the course of study and the microbiology schedule. Both participating teachers relied upon their preactive planning strategies to implement the new curriculum.

**Interactive Decision Data Interpretation**

The interactive decisions of both participating teachers involved multiple, interrelated factors. For the purpose of this study, interactive decisions were categorized as teacher deliberations made during classroom instruction (i.e., during student interaction). As a researcher, I encountered three major obstacles in the investigation of interactive decisions. Obviously, the teachers’ deliberations were not discernible to a classroom observer. Secondly, from an observer’s standpoint, an enormous amount of simultaneous events occur within any given classroom environment. This made the task of identifying all interactive decisions impractical. Lastly, I found that both Ann and Beth did not always recognize all of their decisions during instruction as “interactive” deliberations. In other words, often the participating teachers would take many of their interactive decisions for granted. I attributed this phenomenon to the fact that teachers make continual, almost innumerable interactive decisions during classroom instruction. My interpretation of these ‘taken-for-granted’ interactive decisions was substantiated during the individual and group teacher interviews. For example, both Ann and Beth repeatedly assessed their classroom environments in terms of their students’ comprehension, interest, behavior, and motivation. Most of these assessments did not result in a decisive action on the part of the teacher. However, the choice not to act or modify a
lesson was still an interactive decision. More often then not, these were the types of interactive decisions that were taken for granted by the participating teachers. As such, these were often not reported, unless I specifically asked a question from my observation notes during an interview session. With prior acknowledgment of the aforementioned interactive-thinking research challenges, I came to rely heavily upon the corroboration of my classroom observations by the participating teachers themselves. The stimulated-recall interviews at the end of each week became an invaluable research tool.

As with the preactive planning deliberations, Ann and Beth's interactive decisions shared common factors, yet were individualistic in nature. Ann’s interactive decisions almost invariably were in response to her continual in-class assessment of student comprehension. Thus, her midstream, spontaneous lesson changes often took two divergent paths: either her interactive decision would result in a learning activity modification to increase student comprehension of a difficult topic or result in a totally new, unexpected activity. For example, if Ann assessed that the students were confused about a particular topic during a lecture, she might initiate an impromptu, additional class discussion or hands-on activity. A common tactic would be to stop the current lesson in progress, and guide the lesson in a new direction. On multiple occasions, Ann would interrupt a lesson to find additional curricular materials, such as pictures in a medical dictionary or on the Internet. Ann stated that while such an action might disrupt the flow of a lesson or cause a delay in the chapter, she would take a few minutes to further "drive the lesson home." From an observational standpoint, Ann would most often disrupt a lesson in response to a
related, personal question from a student. From her interview explanations of such
interactive decisions, Ann felt that these decisions centered upon her students’
application of the new material. For example, a student asked the difference between
chicken pox and small pox during a virus lecture. Small pox had been a recent
current event topic in the media, being represented as a possible terrorist threat.
Although Ann’s preactive plans focused upon chicken pox for that day, she delayed
the lecture to find photos of small pox patients on the Internet and in a personal
reference book. The reminder of the class period was spent on the similarities and
dissimilarities of the two disease processes. The majority of Ann’s interactive
decisions that resulted in spontaneous lesson modifications were guided by student
comprehension and interest.

Beth’s interactive decisions also were commonly guided by her assessment of
student comprehension. However, Beth’s reactions often did not greatly interfere
with her preactive lesson plans. Once Beth assessed that students were having
difficulty with a particular topic, she frequently would go back over the same lesson
content, and then continue as planned. If students still did not comprehend the
material, then Beth might add an additional activity or discussion the next day.
Thus, her original preactive lesson plans for each day were adhered to closely. From
her stimulated recall interview sessions, Beth explained that her instructional goals
were two-fold. She wanted her students to be prepared for the microbiology posttest,
and therefore she “stuck close” to the course of study. Thus, the ten-week time limit
for the new unit prevented her from making major additions or modifications to her
preactive, long-term plans. In some cases, Beth did make major modifications by
adding unexpected lesson activities or allotting additional time for a planned lab. However, Beth would then make corresponding changes to her long-term unit plans, to accommodate for instructional time loss.

While the instructional theories guiding their interactive decisions were different, Ann and Beth shared common influences during classroom instruction. Both participating teachers continually made interactive decisions during instruction. While many of these deliberations did not result in a specific action or change of course, all of the decisions were deliberate in nature. In other words, while their interactive decisions were based upon their previous teaching experiences, they were conscious, deliberate choices made during instruction. In the researcher’s opinion, such interactive decisions were not mere reflexes to common classroom situations. In addition, both Ann and Beth maintained that their ability to assess their students and make interactive decisions came with classroom experience. Both teachers independently related that as a beginning instructor, they were not able to routinely make practicable, beneficial interactive decisions. The ability to ‘think-on-their-feet’ (i.e., simultaneously instruct, assess, and deliberate) only came with teaching experience.

**Reflective Practice Data Interpretation**

Both Ann and Beth routinely reflected upon their classroom experiences throughout the implementation of the new microbiology unit. Their reflection practices included short-term and long-term deliberation. For the purpose of this investigation, short-term reflection was characterized as deliberation soon after
classroom instruction. Long-term reflection was characterized as reflection at the end of a curricular unit, grading quarter, semester, or school year. The short-term reflective practices of both teachers focused upon several issues associated with the microbiology unit.

During the group reflective interview, the teachers discussed their long-term reflection upon the entire implementation process. Both Ann and Beth identified areas of instruction that would require some modification for the next school year. In general, their recommendations were quite similar. Ann and Beth felt that their students would benefit from a longer microbiology course. The two teachers discussed the feasibility of changing to a semester-length microbiology unit, and they jointly decided to make this suggestion at the next Tech Prep community college meeting. Their deliberations also led them to concur that more class time would enhance student learning from lab activities. In addition, both teachers conveyed that the course of study objectives were relevant and challenging. In hindsight, Ann and Beth agreed that the new microbiology course was very beneficial to their students, and directly related to their future healthcare careers. Thus, the long-term reflective decisions of the two participating teachers were very similar. Their retrospective deliberations incorporated reflection about multiple facets of the implementation process, including student comprehension, student posttest achievement, the instructional timeframe, and their own personal feelings of competence as the instructors. As the researcher, I initially questioned Ann and Beth’s similar reflective conclusions. I thought perhaps they merely were arriving at a consensus through the group discussion process. However, upon review of their
individual reflective interview transcripts, the similarities between the long-term reflections of Ann and Beth remained evident.

As expected, short-term reflective practices were the focus of the weekly individual teacher interviews. Ann and Beth separately discussed lesson modifications that they would make during the following school year. For Beth, many of these short-term reflections centered upon the overall schedule of the microbiology unit. Such proposed revisions included either an anticipated increase or decrease in class time for certain portions of her lesson plans. However, Beth also reflected upon her personal assessment of student comprehension, and shared possible modifications to enhance student learning. For example, Beth stated that she would like to increase “slide staining and microscopic identification” exercises, but only if the length of the microbiology unit was extended. In contrast, Ann’s short-term reflections centered more upon the “hands-on lab” activities. Ann was often interested in making modifications to either add additional labs or expand the existing hands-on activities. Ann’s individual deliberations also included the incorporation of “patient simulations”. Ann disclosed her plans to develop “patient case studies” of symptoms so that students could practice the “art of diagnosis and treatment”.

Ann and Beth reflected not only upon their students’ success, but also upon their own success with the microbiology instruction. However, the criteria each teacher applied to measure “success” greatly differed. Ann gauged the success of her microbiology implementation through her students’ ability to “apply the new knowledge” to microbiology lab activities, current news events, and prior anatomy
background knowledge. During multiple interviews, Ann repeatedly stressed her opinion about the value of such application to the "real world". Thus, Ann's reflective practices mirrored her theory of action regarding the importance of relevance outside of the classroom in conjunction with subject comprehension. Ann cited numerous examples of what she termed "application of knowledge" from student class discussions and lab activities. Upon reflection over the entire microbiology unit, Ann stated that she felt the new curriculum implementation was successful from her standpoint, "irregardless of the overall test scores" (i.e., the community college's posttest scores).

Beth employed a different set of criteria to measure 'success' in regards to her role as the microbiology implementer. Beth's short-term and long-term reflections about success often focused upon two themes: the completion of her preactive plans and the student posttest score. Beth placed great emphasis upon her completion of all aspects of the curriculum. From my classroom observations and teacher interviews, I was able to discern that Beth did include almost all student objectives from the microbiology course of study. In contrast to Ann's reflective practices, Beth reflected upon her classroom practice in tandem with her interactive decisions. Many of Beth's interactive decisions stemmed from her reflection over her planned timeline of the entire unit. In other words, on several occasions Beth would change her classroom instruction midstream after reflecting about "staying on schedule".

Thus, Ann and Beth mutually had recognized lessons that could be improved through modifications the next year. While neither teacher had recorded any of these reflective changes in writing, both teachers obviously had mentally noted
modifications they would implement the following school year. Both teachers
recognized modifications in the preactive planning of the math section as necessary.
For example, Ann and Beth discussed that they both had identified student
comprehension problems with the log/antilog growth calculations. During the group
reflection interviews, the two teachers deliberated about the math problem and
jointly arrived at some possible solutions for the next school year. When asked what
factors influenced their reflective decisions, the Ann and Beth stated that multiple
factors were involved. Often the teachers asserted that their reflections upon the
success of a lesson/chapter/unit occurred during or immediately after instruction.
This type of short-term reflection appeared to be a commonality between both
teachers. When asked about their long-term reflection upon the completion of the
ten-week unit, both Ann and Beth individually indicated that their long-term
reflections substantiated their short-term reflective decisions. In other words, both
teachers seemed to rely mainly upon their immediate reflective decisions at the
conclusion of individual lessons. As such, their future modification plans most often
relied upon these short-term reflections made soon after classroom instruction.

Conclusions of Reflective Practices

Both Ann and Beth agreed that the incorporation of the new microbiology unit
had been advantageous and a positive experience for their students. Both teachers
agreed that curricular changes could enhance the learning experiences of their
students the following school year. In addition, both Ann and Beth would like
additional instructional time for microbiology, as they equally recommended the
possibility of teaching the unit over an entire semester of the school year. Neither
teacher made detailed or specific notes about their short-term or long-term
reflections, although they separately indicated that they would make instructional
modifications based upon their reflective practices the following year. In other
words, the participating teachers normally implemented lesson plan changes wither
as preactive plans or during classroom instruction the subsequent school year. From
the researcher's perspective, Ann and Beth both utilized reflection for various,
interrelated reasons. Teacher reflection in this case study was used to enhance future
student comprehension, improve instructional classroom practices, deliberate upon
self-accomplishments as the instructor, and guide future professional development as
a classroom teacher.

Data Authentication: Member Checking and Triangulation of Data

Data analysis in a qualitative research project is a continual process that
commences at the start of an investigation. Since qualitative methodologies require
the researcher to act an investigative tool, the concepts of project credibility and
authenticity may emerge. How can the reader be assured that the analysis by the
researcher is grounded and verifiable? Four common qualitative methods
specifically address this question: a detailed explanation of the researcher's
analytical approach, triangulation of data, member checking, and grounded theory.

The purpose of this project was the investigation of three areas of teacher thinking
in relation to the implementation of a new curriculum: preactive planning,
interactive decisions, and reflection. The research design purposively encompassed
several different qualitative methodologies. These included individual teacher interviews, group interviews, classroom observations, and record/document reviews. To further aid in the analysis of the data, I developed a universal coding system. The coding system identified the three teacher-thinking phases with the data during the collection process. For example, classroom observation field notes and teacher interview notes were coded in progress to ease future researcher analysis and interpretation. Such coding also enabled me to develop new interview questions based upon my interactions with each teacher. The result was interview questions and responses that focused upon the emic (i.e., the participating teachers') viewpoint and meaning-making, rather than the researcher's perspective. As the researcher, I transcribed all interviews myself, which aided in my familiarity with each teacher's responses and allowed the insertion of coding throughout the transcript. In addition, the transcription of the interviews shaped forthcoming interview questions. For example, if I found a particular interview response to be vague or unclear, the transcribed data was shown to the participating teachers for further questioning and clarification. This type of member checking served to validate and guide my personal interpretations of the data. All interview transcripts were offered for review to Ann and Beth. However, both teachers declined to personally read the voluminous interview transcripts. Instead, both Ann and Beth read and responded to the case study presentation in this section, allowing them to expound upon and/or respond to the presentation of their situations. This member checking proved to be an invaluable tool for my personal assessment of the data interpretation process. Thus,
the documentation of the case studies in this section evolved from a collaborative process of researcher analysis and participant participation.

Lastly, the overall research design of this investigation was centered upon grounded theory methodologies (Charmaz, 2000). Charmaz defined grounded theory as an organized system of data collection to aid interpretation and analysis. “Grounded theorists develop analytic interpretations of their data to focus further data collection, which they use in turn to inform and refine their developing analytical theories” (Charmaz, 2000, p. 509). Embracing this constructivist theory, the data was concurrently collected and analyzed. Coding was performed as the data was collected to encourage continual comparisons among the various qualitative methodologies. The result was a theoretical scaffold that supported all aspects of the investigation, from the research design, to the collection of data, to the analysis and presentation of the findings. The combination of grounded theory, member checking, triangulation of data, and the elucidation of the researcher’s interpretative procedures should serve to promote the credibility and authenticity of the research findings. The over-riding goal of this investigation was to illuminate the thinking processes of the participating teachers. Through a systematic and conscientious process of data collection, analysis, and researcher/participant collaboration, I believe the study conclusions remained faithful to the participating teachers’ perspectives.
Case Study Summary

The case study findings were presented in Chapter 4. The information about the new microbiology unit was described, including a discussion about the decision to add the unit. The findings of document reviews were represented, which included information about curricular materials, Tech Prep entrance requirements, and the AHT brochure. The case study settings were explained. This subsection discussed the background information, the high school environment, and the classroom environment of each participating teacher. The case study findings were documented, focusing upon the preactive planning, interactive decisions, and reflective practices of both teachers. The qualitative section concluded with a presentation of the researcher’s interpretation and analysis of the data. In addition, the topic of data authentication was presented via a discussion of member checking, grounded theory, and triangulation. Chapter 5 will represent the quantitative results of this investigation. In Chapter 6, the researcher will propose a theory of action for each participating teacher from the integration of the case study data and the quantitative data.
CHAPTER 5

QUANTITATIVE ANALYSIS – A DESCRIPTIVE STATISTICAL ANALYSIS

Introduction

The purpose of the quantitative portion of this investigation was to assess student achievement after microbiology instruction. Eight senior science classes participated in the study, each with a separate teacher and within a separate high school. The science teachers incorporated a new microbiology unit into their preexisting senior anatomy course. The students were given a pretest prior to any instruction. The purpose of the pretest was to assess homogeneity between the eight science classes. After a ten-week period of microbiology instruction, the students were given a posttest. The posttest was used as an instrument to evaluate and compare class means after instruction. The overall project was a quasi-experimental design, due to a lack of sampling randomization and possible confounding variables other than the microbiology instruction. The results of the quasi-experimental portion of the study were intended to augment the qualitative case study findings surrounding two of the eight participating teachers, “Ann” and “Beth”. Therefore, the statistical results were used descriptively, as generalizability was not the overall objective of the research design.
Microbiology Pretest Assessment and Analysis

The pretest was designed to evaluate the homogeneity between the eight science classes prior to microbiology instruction. In this subsection of the quantitative result chapter, the pretest descriptive statistics are described. A histogram and confidence intervals are portrayed. The pretest ANOVA results, including a summary of the ANOVA assumptions, are presented and interpreted.

Pretest Descriptive Statistics

The overall mean score for the 50-point pretest was 37.57 (SD=4.73). Class 6 had the highest mean of 39.44 (SD= 4.18). Beth’s class, Class 2, had the lowest pretest mean of 36.36 (SD= 5.06). The summary of descriptive statistics was as follows:

[Note: As in Chapter 3, the findings of Class 1 and Class 2 are denoted in red. From the qualitative case study, Class 1 is Ann’s classroom and Class 2 is Beth’s Classroom.]
Table 14

**Dependent Variable Means and Standard Deviations by Levels of the Independent Variable**

<table>
<thead>
<tr>
<th>Class</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>95% Confidence Interval for Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>25</td>
<td>37.16</td>
<td>4.84</td>
<td>35.16 to 39.16</td>
</tr>
<tr>
<td>Class 2</td>
<td>22</td>
<td>36.36</td>
<td>5.06</td>
<td>34.12 to 38.61</td>
</tr>
<tr>
<td>Class 3</td>
<td>22</td>
<td>36.91</td>
<td>4.59</td>
<td>34.88 to 38.94</td>
</tr>
<tr>
<td>Class 4</td>
<td>23</td>
<td>38.26</td>
<td>4.52</td>
<td>36.30 to 40.22</td>
</tr>
<tr>
<td>Class 5</td>
<td>21</td>
<td>36.67</td>
<td>4.71</td>
<td>34.52 to 38.81</td>
</tr>
<tr>
<td>Class 6</td>
<td>25</td>
<td>39.44</td>
<td>4.18</td>
<td>37.71 to 41.12</td>
</tr>
<tr>
<td>Class 7</td>
<td>20</td>
<td>37.25</td>
<td>5.20</td>
<td>34.82 to 39.68</td>
</tr>
<tr>
<td>Class 8</td>
<td>25</td>
<td>38.16</td>
<td>4.67</td>
<td>36.22 to 40.09</td>
</tr>
<tr>
<td>Total</td>
<td>183</td>
<td>37.57</td>
<td>4.73</td>
<td>36.88 to 38.26</td>
</tr>
</tbody>
</table>

An estimate of the confidence intervals was calculated using the following formula:

\[ \mu \pm t(\sigma_M) \]

where \( t = 1.96 \) was a table value based upon the 175 df_{SA} in the study. From the data, each mean had a deviation plus or minus 1.98. Thus, the confidence intervals calculated and reported in the above table were approximately 5% plus or minus around the mean. At the designated alpha of .05, the confidence intervals indicated that the mean difference would fall between the lower and upper bound levels 95% of the time. Overall, the confidence intervals were small around the mean.
The histogram and mean plot of the pretest scores were performed with the following result:

**Figure 1**

*Pretest Histogram with Standard Deviation*

![Histogram with Standard Deviation](image)

**Figure 2**

*Pretest Means Plot*

![Means Plot](image)
Pretest Reliability: Cronbach’s Alpha

Cronbach’s alpha analysis was used to evaluate the reliability of the pretest. This test computed the correlation of the four subsections of the pretest and served to measure the inter-subsection or internal uniformity (Cramer, 1998). As discussed in the quantitative section of Chapter 3, the alpha depended on the inter-item correlation within each subsection. A high alpha score would indicate a high degree of pretest subsection correlation. In turn, the reliability of the overall pretest would be high. Nunnally (1978) and Glass & Hopkins (1996) proposed that an alpha over 0.7 would be a high correlation result. Cronbach’s coefficient alpha reliabilities and correlations were computed for each pretest subsection with the following results:

Table 15
Cronbach’s Coefficient Alpha Reliability for Pretest Subsections

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Correlation with Total</th>
<th>Raw Variables</th>
<th>Alpha</th>
<th>Standardized Variables</th>
<th>Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>.7154</td>
<td>.6229</td>
<td>.8341</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genetics</td>
<td>.6472</td>
<td>.5489</td>
<td>.7859</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locate Info</td>
<td>.7419</td>
<td>.6321</td>
<td>.8518</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anatomy</td>
<td>.7346</td>
<td>.6269</td>
<td>.8470</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N= 183

The total subsection reliability was .77. Strong correlations between each subsection and the total ranged between .64 for ‘Genetics’ to a high of .74 for the
'Locating Information' pretest subsection. The Cronbach alpha reliabilities for each subsection of the pretest were also high, with the standardized variable alpha ranging from a low of .79 for the 'Genetics' subsection to a high of .85 for the 'Locating Information' subsection. Therefore, both the inter-item Cronbach alpha reliabilities and the total correlation statistics strongly indicated that the pretest was consistent across the subsections. Thus, the pretest was a reliable, unidimensional assessment instrument. An overall pretest ANOVA would thereby be a valid statistical analysis.

Pretest ANOVA

The purpose of the ANOVA on the pretest was to check for homogeneity prior to the microbiology instruction. If the eight science classes were homogeneous before instruction, then the ANOVA on the posttest scores was a valid statistical analysis. The pretest one-way ANOVA was calculated using the SPSS computer program. This program was particularly beneficial as the computer automatically weighted the means in this unbalanced design. The \( n \) values from the eight science classes ranged between 20 to 25 students. The ANOVA analysis was applied with a .05 alpha level. Prior to the analysis, each ANOVA assumption was assessed and reported. These ANOVA assessments included the assumptions of independent observation, interval measurement, normality, random sampling, and homogeneity.

Pretest ANOVA Independent Observation Assumption

The senior students took the pretest assessment prior to any microbiology instruction or interaction in the classroom. Therefore, the pretest score of any one
student did not influence the pretest score of any other student within the class. The assumption of independent observation for the pretest was met, and was not a factor in the ANOVA results.

**Pretest ANOVA Interval Measurement Assumption**

The data from the pretest were raw test scores. The students received one point for each correct answer on the 50-point multiple choice pretest. The interval level assumption demanded that order and distance existed in the measurement scale. The pretest scores met this demand, and the interval measurement assumption was accepted.

**Pretest ANOVA Normality Assumption**

Normality is the assumption that the residual errors for the scores are normally distributed in the treatment population. The ANOVA relies upon the assumption that normality exists. Lomax (2001) recommends either a histogram of the residuals or Q-Q plots of each treatment group. The normal Q-Q pretest score plots for the eight science classes are presented below:
Figure 3
Normal Q-Q Pretest Score Plots

Normal Q-Q Plot of SCORE
TRT: 1.00 Treatment 1

Normal Q-Q Plot of SCORE
TRT: 2.00 Treatment 2

Ann's Class

Beth's Class

Normal Q-Q Plot of SCORE
TRT: 3.00 Treatment 3

Normal Q-Q Plot of SCORE
TRT: 4.00 Treatment 4

Observed Value

Expected Normal Value
In looking at the Q-Q plots of the pretest scores for each class, the assumption of normality appears to have been met. Although there is some disparity in all of the Q-Q plots from the eight science classes, there does not appear to be any logical pattern. As the Q-Q plots did not provide a definitive answer of normality, I also utilized a box plot:
The scores for Class 1 (Ann’s), Class 4, and Class 8 in particular appeared to have a slight unequal distribution around the mean, although a significant violation of normality did not appear. With a small sample size, such as n=8 in this study, the violation of the normality assumption could result in a Type I or Type II error. However, overall the ANOVA test is "robust" to modest normality violations (Glass & Hopkins, 2001). Therefore, no correction was made in the one-way ANOVA.

**Pretest ANOVA Random Sampling Assumption**

In this investigation, the students were not randomly assigned to a classroom. The unit of analysis was the intact classroom. Therefore, the students were not randomly assigned, and the eight science teachers were not randomly assigned. A
violation of random sampling may impact the ANOVA through three major factors: a loss of generalizability, the existence of confounding variables, and a lack of homogeneity. A loss of generalizability meant that the external validity of the study was in jeopardy. However, the purpose of this quantitative analysis was to use the statistical analyses in a descriptive method in conjunction with the qualitative case study. The possible existence of confounding variables dictated that this research design was quasi-experimental. With non-random sampling, the substantiation of homogeneity will be vital to the legitimacy of an ANOVA. Homogeneity of the eight classes will be addressed statistically in the next subsection.

**Pretest ANOVA Homogeneity Assumption**

The assumption of homogeneity states that each treatment group will have an equal error variance on the dependent variable (i.e., the pretest). A violation of this assumption would correspond to a positive bias of the $F$ value and an increased probability of a Type I error.

In this study, three common assessments of homogeneity were used with the pretest data: the residual plot, Levene’s test, and the $F_{\text{MAX}}$ test. In looking at the error bars of the pretest data of the eight classes, the homogeneity assumption appeared to be met. The scores were equally distributed around the mean within each classroom. The error bars are presented below:
A second statistical test for homogeneity is Levene’s test. Utilizing the SPSS computer program, the following output was obtained:

Table 16
Pretest: Levene’s Test for Equality of Error Variances
Dependent Variable: Pretest Score

<table>
<thead>
<tr>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>.099</td>
<td>7</td>
<td>175</td>
<td>.998</td>
</tr>
</tbody>
</table>

*p<.05

The p value of .998 was greater than the alpha level of .05, and therefore the Levene’s test was not significant. The Levene’s test results indicated that the
variances of the eight science classrooms were not significantly different. The null hypothesis that the variances are equal was accepted.

A third test for homogeneity is the $F_{\text{MAX}}$ test. Utilizing the following equation $F_{\text{MAX}} = s_{\text{largest}}^2 / s_{\text{smallest}}^2$, the pretest $F_{\text{MAX}} = 1.24$. Keppel (2001, p.98; p. 124) states "the F test becomes seriously biased in the positive direction when the largest within-group variance divided by the smallest within group variance is 9 or greater. An $F_{\text{MAX}} > 3$ may increase type I error sufficiently for us to take action." As the Pretest $F_{\text{MAX}}$ value of 1.24 was low when applying the pretest as the dependent variable, the assumption of homogeneity was upheld.

The error bars, Levene's test, and the $F_{\text{MAX}}$ test all indicated that the eight science classes were homogenous based upon the pretest scores. The ANOVA assumption of homogeneity was met.

**Pretest ANOVA Results**

Taking all of the assumption assessments into consideration led to the conclusion that the one-way ANOVA at an alpha of .05 was a valid statistical analysis for the pretest, and no alpha correction was needed. The pretest ANOVA null hypothesis was as follows:

There is no statistically significant difference in the microbiology pretest mean scores between the eight anatomy classrooms.

$$H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7 = \mu_8$$

Where $\mu_1$ represents the mean pretest score of classroom 1, $\mu_2$ represents the mean pretest score of classroom 2, etc.
The alternate hypothesis was as follows:

$$H_A = \text{There will be at least one significant difference in the pretest mean scores of the eight participating classrooms.}$$

The pretest ANOVA results were as follows:

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta.Sqr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>7</td>
<td>172.11</td>
<td>24.59</td>
<td>1.11</td>
<td>.362</td>
<td>.467</td>
</tr>
<tr>
<td>Error</td>
<td>175</td>
<td>3894.64</td>
<td>22.26</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>182</td>
<td>4066.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*P < 0.05

$$R^2 = .042$$

Based upon the pretest ANOVA, the difference between the means from the eight classes was not significant, $F(7,175) = 1.11, p<.05$. Thus, at an alpha level of .05 with 7,175 degrees of freedom, the $F$ value of 1.11 caused a failure to reject the null hypothesis. There was no statistically significant difference between the pretest means of the eight science classes.
**Pretest Analysis Summary**

Pretest reliability was assessed through Cronbach's alpha. The results indicated that the pretest was a reliable, unidimensional instrument. All of the ANOVA assumptions for the pretest were met. Therefore, the overall pretest ANOVA was computed at the .05 alpha level.

The pretest ANOVA at the 0.05 alpha level indicated that there was no significant difference between the pretest means for the eight science classes, \( F(7,175) = 1.11, p<.05 \). The purpose of the pretest was to assess homogeneity prior to microbiology instruction and the microbiology posttest. The pretest null hypothesis was accepted, and homogeneity between the sciences classes was indicated. Therefore, a microbiology posttest ANOVA was a valid statistical test to assess post-instructional student/class achievement.
Microbiology Posttest Assessment and Analysis

The posttest was designed to compare the posttest mean scores of the eight science classes after microbiology instruction. In this subsection of the quantitative result chapter, the posttest descriptive statistics are presented. A histogram and confidence intervals are computed. The ANOVA assumptions are addressed, and the posttest ANOVA results are presented and interpreted.

Posttest Descriptive Statistics

The overall mean score for the 100-point posttest was 74.81 (SD=5.48). Class 1 (Ann's class) had the highest posttest mean of 75.56 (SD= 6.36). Class 7 had the lowest posttest mean of 74.10 (SD= 5.55). The summary of descriptive statistics was as follows:
**Table 18**

**Dependent Variable Means and Standard Deviations by Levels of the Independent Variable**

<table>
<thead>
<tr>
<th>Dependent Variable: Posttest Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Class 1</td>
</tr>
<tr>
<td>Class 2</td>
</tr>
<tr>
<td>Class 3</td>
</tr>
<tr>
<td>Class 4</td>
</tr>
<tr>
<td>Class 5</td>
</tr>
<tr>
<td>Class 6</td>
</tr>
<tr>
<td>Class 7</td>
</tr>
<tr>
<td>Class 8</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

An estimate of the confidence intervals was calculated using the following formula:

\[ \mu \pm (t)(\sigma_M) \]

where \( t = 1.96 \) was a table value based upon the 175 df\(_{SA} \) in the study. From the data, each mean had a deviation plus or minus 3.38. Thus, the confidence intervals calculated and reported in the above table were approximately 4.5% plus or minus around the mean. At the designated alpha of .05, the confidence intervals indicated that the mean difference would fall between the lower and upper bound levels 95% of the time. Overall, the confidence intervals were small around the mean.
The histogram and mean plot of the posttest scores were performed with the following result:

**Figure 6**
Posttest Histogram with Standard Deviation

![Histogram with Standard Deviation](image)

**Figure 7**
Posttest Means Plot

![Means Plot](image)

Score
Posttest Reliability: Cronbach's Alpha

Cronbach's coefficient alpha reliabilities were computed for each posttest subsection with the following results:

Table 19
Cronbach's Coefficient Alpha Reliability for Posttest Subsections

<table>
<thead>
<tr>
<th>Raw Variables</th>
<th>Subsection</th>
<th>Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Immunology</td>
<td>.7857</td>
</tr>
<tr>
<td></td>
<td>Bacteriology</td>
<td>.6662</td>
</tr>
<tr>
<td></td>
<td>Culturing</td>
<td>.6052</td>
</tr>
<tr>
<td></td>
<td>Pathogenic</td>
<td>.6461</td>
</tr>
</tbody>
</table>

N= 183

The total posttest Cronbach alpha was .71. The Cronbach alpha reliabilities for each subsection of the posttest were moderately high, with the standardized variable alpha ranging from a low of .60 for the 'Culturing' subsection to a high of .79 for the 'Immunology' subsection. Overall, the Cronbach reliabilities for all four subsections of the posttest were similar in value. The Cronbach alpha test indicated that inter-item reliability was strong and that the posttest was consistent across the subsections. Thus, the posttest was a reliable, unidimensional assessment instrument. An overall posttest ANOVA would thereby be a valid statistical analysis.
**Posttest Reliability: Pearson Correlation Coefficients**

The posttest was partitioned into four main subsections: Immunology, Bacteriology, Culturing, and Pathogenic Diseases. Prior to assessing the total posttest score means with an ANOVA, the degree of correlation between the posttest subsections was analyzed. A high correlation between the subsections would indicate that the posttest subsections corresponded to the overall test scale. If no correlation between the subsections were demonstrated, the validity of an ANOVA with the overall class means would be in jeopardy. In other words, only individual ANOVA on each subsection would be advisable. The Pearson correlation coefficients for the four posttest subsections were as follows:

<table>
<thead>
<tr>
<th>Correlations</th>
<th>Immunology</th>
<th>Bacteriology</th>
<th>Culturing</th>
<th>Pathogenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immunology</td>
<td>1</td>
<td>.272</td>
<td>.245</td>
<td>.208</td>
</tr>
<tr>
<td>Bacteriology</td>
<td>.272</td>
<td>1</td>
<td>.584</td>
<td>.634</td>
</tr>
<tr>
<td>Culturing</td>
<td>.245</td>
<td>.584</td>
<td>1</td>
<td>.534</td>
</tr>
<tr>
<td>Pathogenic</td>
<td>.208</td>
<td>.634</td>
<td>.534</td>
<td>1</td>
</tr>
</tbody>
</table>

Listwise N = 183
The data from the posttest scores indicated that there was a moderate correlation between the majority of the posttest subscores, with the exception of the Immunology posttest subsection. Lomax (2001) proposed that a correlation of .70 or more would be indicative of a high correlation. The highest correlation existed between the Pathogenic and Bacteriology subsections with an $r(183) = .634$, $p<.01$. The Bacteriology and Culturing subsections also showed some correlation at $r(183) = .584$, $p<.01$. And the Pathogenic and Culturing subsections showed a correlation of $r(183) = .534$, $p<.01$. However, the Immunology subsection showed extremely low correlation with the other three posttest subsections.

Since the Pearson correlation coefficients indicated that the Immunology posttest subsection was not related to the other three subsections, two corrective steps were modified from the original quantitative research design. An overall posttest ANOVA was run at the .05 alpha level, but only with the Bacteriology, Pathogenic, and Culturing subsections. The Immunology subsection scores were not included in the overall ANOVA. Secondly, an ANOVA was computed separately on each individual posttest subsection to compare these subsection means for the eight science classes.

**Posttest ANOVA**

The purpose of the posttest ANOVA was to identify statistically significant differences between the means of the eight science classes. The class was the unit of analysis for the one-way posttest ANOVA. As with the pretest ANOVA, the SPSS statistical computer program automatically weighted the means due to the
unbalanced design of this study. The n values from the eight science classes ranged from 20 to 25 students. The ANOVA was applied at the .05 alpha level, utilizing the class scores from only the Bacteriology, Culturing, and Pathogenic subsections of the posttest. Prior to the analysis, each ANOVA assumption was assessed and reported. These ANOVA assessments included the assumptions of independent observation, interval measurement, normality, random sampling, and homogeneity.

**Posttest ANOVA Independent Observation Assumption**

The posttest was given to the students in each of the eight science classes after a ten-week microbiology unit. During this instructional period, the students interacted with each other and with the teacher. Therefore, the ANOVA assumption of independence was violated. The result of non-independent observations has a direct impact upon the external validity of the study. Therefore, as planned, the posttest ANOVA findings were used as descriptive statistics, rather than inferential statistics. The study will lack generalizability to other student populations. In addition, the ANOVA results must be interpreted with some caution due to the violation of the independent observation assumption. However, the intended function of the posttest analysis was to elucidate and/or confirm observational interpretations from the qualitative case study. Therefore, the researcher chose to continue with the ANOVA at an alpha level of .05, as planned.
Posttest ANOVA Interval Measurement Assumption

The data from the posttest were raw test scores. The students received one point for each correct answer on the 100-point multiple-choice posttest. The interval level assumption demanded that order and distance exist in the measurement scale. The posttest scores met this demand, and the interval measurement assumption was accepted.

Posttest ANOVA Normality Assumption

Normality is assumed if the residual errors for the scores are normally distributed in the treatment population. Normality was assessed with normal Q-Q plots, which are presented below:

Figure 8
Normal Q-Q Pretest Score Plots

<table>
<thead>
<tr>
<th>Normal Q-Q Plot of SCORE</th>
<th>Normal Q-Q Plot of SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT: 1.00 Treatment 1</td>
<td>TRT: 2.00 Treatment 2</td>
</tr>
<tr>
<td>Observed Value</td>
<td>Observed Value</td>
</tr>
<tr>
<td>Expected Normal Value</td>
<td>Expected Normal Value</td>
</tr>
</tbody>
</table>

Ann's Class

Beth's Class
Normal Q-Q Plot of SCORE
TRT: 3.00 Treatment 3

Normal Q-Q Plot of SCORE
TRT: 4.00 Treatment 4

Normal Q-Q Plot of SCORE
TRT: 5.00 Treatment 5

Normal Q-Q Plot of SCORE
TRT: 6.00 Treatment 6

Observed Value

Expected Normal Value

Observed Value

Expected Normal Value

Observed Value

Expected Normal Value

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In looking at the Q-Q plots of the posttest scores for each class, the assumption of normality appeared to have been met. As with the pretest, there was some disparity in all of the Q-Q plots from the eight science classes. However, there did not appear to be any logical pattern. As the Q-Q plots did not provide a definitive answer of normality, I also utilized a box plot:
The scores for Class 3 in particular appeared to have an unequal distribution around the mean. The other classes appeared to have a more equal distribution. A violation of the normality assumption could result in a Type I or Type II error with the ANOVA. However, Glass and Hopkins (2001) proposed that the ANOVA test is “robust” to modest normality violations. Therefore, no corrective action was made in the one-way posttest ANOVA.

**Posttest ANOVA Random Sampling Assumption**

As with the pretest, the random sampling assumption of the ANOVA was not met. The students and teachers were not randomly assigned to a classroom. The major result of non-randomization will be the lack of generalizability to other student
populations. As a quasi-experimental study, the analyses will be used as descriptive statistics, rather than inferential statistics. However, the lack of randomization may have a major impact upon homogeneity. The issues of homogeneity will be addressed in the next subsection.

Posttest ANOVA Homogeneity Assumption

The assumption of homogeneity states that each treatment group will have an equal error variance on the dependent variable (i.e., the posttest). A violation of this assumption would correspond to a positive bias of the $F$ value and an increased probability of a Type I error. As with the pretest, three common assessments of homogeneity were used with the posttest data: the residual plot, Levene's test, and the $F_{\text{MAX}}$ test. In looking at the error bars of the posttest data of the eight classes, the homogeneity assumption appeared to be met. The scores were equally distributed around the mean within each classroom. The error bars are presented below:
The results of the Levene's test are reported below:

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.646</td>
<td>7</td>
<td>175</td>
<td>.717</td>
</tr>
</tbody>
</table>

*p<.05

The p value of .717 was greater than the alpha level of .05, and therefore the Levene's test was not significant. The Levene's test results indicated that the variances of the eight science classrooms were not significantly different. The null hypothesis that the posttest variances were equal was accepted.
A third test for homogeneity was the $F_{\text{MAX}}$ test. Utilizing the following equation

$$F_{\text{MAX}} = \frac{s_{\text{largest}}^2}{s_{\text{smallest}}^2},$$

the pretest $F_{\text{MAX}} = 1.42$. Keppel (1991) proposed that an $F_{\text{MAX}} > 3$ might require corrective steps in the ANOVA. As the Posttest $F_{\text{MAX}}$ value of 1.42 was low when applying the posttest as the dependent variable, the assumption of homogeneity was upheld.

The error bars, Levene's test, and the $F_{\text{MAX}}$ test all indicated that the eight science classes were homogenous based upon the posttest scores. The ANOVA assumption of homogeneity was met.

Overall Posttest ANOVA Results

Taking all of the assumption assessments into consideration led to the conclusion that the one-way ANOVA at an alpha of .05 was a valid statistical analysis for the posttest, and no alpha correction was needed. The ANOVA assessed the overall class means of the Bacteriology, Culturing, and Pathogenic posttest subsections. The posttest ANOVA null hypothesis was as follows:

There is no statistically significant difference in the microbiology posttest mean scores between the eight anatomy classrooms.

$$H_0 = \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7 = \mu_8$$

Where $\mu_1$ represents the mean posttest score of classroom 1, $\mu_2$ represents the mean posttest score of classroom 2, etc.
The alternate hypothesis was as follows:

\[ H_A = \text{There will be at least one significant difference in the posttest mean scores of the eight participating classrooms.} \]

The overall ANOVA results for the Bacteriology, Pathogenic, and Culturing subsections of the posttest were as follows:

Table 22
Posttest One-Way ANOVA Summary Table
Dependent Variable: Total Posttest Scores

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta.Sqr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>7</td>
<td>37.13</td>
<td>5.30</td>
<td>.171</td>
<td>.991</td>
<td>.096</td>
</tr>
<tr>
<td>Error</td>
<td>175</td>
<td>5434.56</td>
<td>31.06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>182</td>
<td>5471.68</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\*p < 0.05  
\[ R^2 = .007 \]

Based upon the posttest ANOVA, the difference between the means from the eight classes was not significant, \( F(7,175) = .171, p < .05 \). Thus, at an alpha level of .05 with 7,175 degrees of freedom, the F value of .171 led to a failure to reject the null hypothesis. There was no statistically significant difference between the posttest means of the eight science classes.
Due to a lack of correlation between the Immunology posttest subsection and the other three subsections, an ANOVA also was computed on each subsection separately. These ANOVA results are presented in the following section.

**Posttest Subsection ANOVA**

An individual ANOVA was computed on each posttest subsection at the .05 alpha level. These computations could identify statistically significant differences in the posttest subsection class means, even though the null hypothesis of the overall posttest ANOVA was not rejected. In other words, although there was no statistical difference in the overall posttest ANOVA (i.e., with the exclusion of the Immunology subsection), there may be a significant mean difference in the individual posttest subsection means. The posttest was divided into four subsections: Immunology, Bacteriology, Culturing, and Pathogenic Diseases. Each posttest subsection consisted of 25 multiple-choice questions. One point was awarded for each correct answer. The posttest subsection ANOVA results are presented in the following sections.

**Immunology Posttest Subsection ANOVA**

The overall mean score for the 25-point Immunology posttest subsection was 18.98 (SD=1.87). Class 2 (Beth's class) had the highest mean of 19.73 (SD= 1.93). Class 4 had the lowest mean of 18.61 (SD= 1.99). The summary of descriptive statistics was as follows:
## Table 23

**Dependent Variable Means and Standard Deviations by Levels of the Independent Variable**

<table>
<thead>
<tr>
<th>Dependent Variable: Immunology Subsection Posttest Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
</tr>
<tr>
<td><strong>Lower Bound</strong></td>
</tr>
<tr>
<td>Class 1</td>
</tr>
<tr>
<td>Class 2</td>
</tr>
<tr>
<td>Class 3</td>
</tr>
<tr>
<td>Class 4</td>
</tr>
<tr>
<td>Class 5</td>
</tr>
<tr>
<td>Class 6</td>
</tr>
<tr>
<td>Class 7</td>
</tr>
<tr>
<td>Class 8</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

The histogram and normal Q-Q plot of the posttest scores were performed with the following result:
The histogram of the Immunology posttest subsection scores shows a relatively normal mean plot with an overall mean of 18.97 (SD=1.87). The Q-Q plot demonstrated normality within the Immunology subsection. Levene’s test was computed as follows:

### Table 24
**Posttest: Levene’s Test for Equality of Error Variances**

<table>
<thead>
<tr>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>.618</td>
<td>7</td>
<td>175</td>
<td>.741</td>
</tr>
</tbody>
</table>

*p<.05*
The p value of .741 was greater than the alpha level of .05, and therefore the Levene's test was not significant. The Levene's test results indicated that the variances of the Immunology posttest subsection scores between the eight science classrooms were not significantly different. The null hypothesis that the Immunology posttest subsection variances were equal was accepted.

The ANOVA results were as follows:

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta.Sqr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>7</td>
<td>20.19</td>
<td>2.88</td>
<td>.822</td>
<td>.570</td>
<td>.35</td>
</tr>
<tr>
<td>Error</td>
<td>175</td>
<td>613.72</td>
<td>3.51</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>182</td>
<td>633.91</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.05

R² = .032

Based upon the Immunology posttest subsection ANOVA, the difference between the means from the eight classes was not significant, $F(7,175) = .822, p<.05$. Thus, at an alpha level of .05 with 7,175 degrees of freedom, the F value of .822 led to a failure to reject the null hypothesis. There was no statistically significant difference between the Immunology posttest subsection means between the eight science classes.
Bacteriology Posttest Subsection ANOVA

The overall mean score for the 25-point Bacteriology posttest subsection was 18.97 (SD= 2.18). Class 1 (Ann's class) had the highest mean of 19.28 (SD= 3.60). Class 6 had the lowest mean of 18.79 (SD= 2.30). The summary of descriptive statistics was as follows:

<p>| Dependent Variable Means and Standard Deviations by Levels of the Independent Variable |
|---------------------------------------------|---------------------------------------------|---------------------------------------------|---------------------------------------------|
| Dependent Variable: Bacteriology Subsection Posttest Scores |</p>
<table>
<thead>
<tr>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>95% Confidence Interval for Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
</tr>
<tr>
<td>Class 1</td>
<td>25</td>
<td>19.28</td>
<td>3.60</td>
</tr>
<tr>
<td>Class 2</td>
<td>22</td>
<td>19.14</td>
<td>2.29</td>
</tr>
<tr>
<td>Class 3</td>
<td>22</td>
<td>19.05</td>
<td>2.17</td>
</tr>
<tr>
<td>Class 4</td>
<td>23</td>
<td>18.83</td>
<td>2.10</td>
</tr>
<tr>
<td>Class 5</td>
<td>21</td>
<td>18.90</td>
<td>2.36</td>
</tr>
<tr>
<td>Class 6</td>
<td>25</td>
<td>18.76</td>
<td>2.30</td>
</tr>
<tr>
<td>Class 7</td>
<td>20</td>
<td>19.00</td>
<td>2.04</td>
</tr>
<tr>
<td>Class 8</td>
<td>25</td>
<td>18.88</td>
<td>1.69</td>
</tr>
<tr>
<td>Total</td>
<td>183</td>
<td>18.97</td>
<td>2.18</td>
</tr>
</tbody>
</table>

The histogram and normal Q-Q plot of the posttest scores were performed with the following result:
The histogram of the Bacteriology posttest subsection scores showed a relatively normal mean plot with an overall mean of 18.92 (SD=2.35). The Q-Q plot demonstrated normality within the Bacteriology subsection. Levene’s test was computed as follows:

<table>
<thead>
<tr>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>.715</td>
<td>7</td>
<td>175</td>
<td>.659</td>
</tr>
</tbody>
</table>

* p<.05

The p value of .715 was greater than the alpha level of .05, and therefore the Levene’s test was not significant. The Levene’s test results indicated that the variances of the Bacteriology posttest subsection scores between the eight science 301
classrooms were not significantly different. The null hypothesis that the Bacteriology posttest subsection variances were equal was accepted.

The ANOVA results were as follows:

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta.Sqr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>7</td>
<td>4.66</td>
<td>.666</td>
<td>.135</td>
<td>.995</td>
<td>.086</td>
</tr>
<tr>
<td>Error</td>
<td>175</td>
<td>861.25</td>
<td>4.92</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>182</td>
<td>865.91</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based upon the Bacteriology posttest subsection ANOVA, the difference between the means from the eight classes was not significant, $F_{(7,175)} = .135$, $p<.05$. Thus, at an alpha level of .05 with 7,175 degrees of freedom, the $F$ value of .822 led to a failure to reject the null hypothesis. There was no statistically significant difference between the Bacteriology posttest subsection means between the eight science classes.
**Culturing Posttest Subsection ANOVA**

The overall mean score for the 25-point Culturing posttest subsection was 17.91 (SD= 2.17). Class 4 had the highest mean of 18.47 (SD= 2.41). Class 2 (Beth’s class) had the lowest mean of 16.36 (SD= 2.03). The summary of descriptive statistics was as follows:

<table>
<thead>
<tr>
<th>Dependent Variable Means and Standard Deviations by Levels of the Independent Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent Variable: Culturing Subsection Posttest Scores</td>
</tr>
<tr>
<td>N</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Class 1</td>
</tr>
<tr>
<td>Class 2</td>
</tr>
<tr>
<td>Class 3</td>
</tr>
<tr>
<td>Class 4</td>
</tr>
<tr>
<td>Class 5</td>
</tr>
<tr>
<td>Class 6</td>
</tr>
<tr>
<td>Class 7</td>
</tr>
<tr>
<td>Class 8</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

The histogram and normal Q-Q plot of the posttest scores were performed with the following result:
The histogram of the Culturing posttest subsection scores showed a relatively normal mean plot with an overall mean of 17.91 (SD=2.17). The Q-Q plot demonstrated normality within the Culturing subsection, although some deviation at the upper range was apparent.

Levene’s test was computed as follows:

<table>
<thead>
<tr>
<th>Table 30</th>
<th>Posttest: Levene’s Test for Equality of Error Variances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent Variable: Culturing Posttest Subsection Scores</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>df1</td>
</tr>
<tr>
<td>.491</td>
<td>7</td>
</tr>
</tbody>
</table>

*p<.05
The p value of .840 was greater than the alpha level of .05, and therefore the Levene's test was not significant. The Levene's test results indicated that the variances of the Culturing posttest subsection scores between the eight science classrooms were not significantly different. The null hypothesis that the Culturing posttest subsection variances were equal was accepted.

The ANOVA results were as follows:

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta.Sqr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>7</td>
<td>102.20</td>
<td>14.60</td>
<td>*3.41</td>
<td>.002</td>
<td>.960</td>
</tr>
<tr>
<td>Error</td>
<td>175</td>
<td>751.21</td>
<td>4.29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>182</td>
<td>853.42</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based upon the Culturing posttest subsection ANOVA, the difference between the means from the eight classes was significant, $F_{(7,175)} = 3.41$, $p<.05$. Thus, at an alpha level of .05 with 7,175 degrees of freedom, the $F$ value of 3.41 led to a rejection the null hypothesis. There was a statistically significant difference between the Culturing posttest subsection means between the eight science classes.

$R^2 = .120$
The power and strength association of the Culturing subsection posttest ANOVA was calculated with R-squared and Omega-squared comparisons. A harmonic mean of 22.73 was calculated and used for the power estimate calculations due to the unbalanced design of this study. The Power estimates were as follows:

Table 32

<table>
<thead>
<tr>
<th>F</th>
<th>R²</th>
<th>ωₐ²</th>
<th>θₐ²</th>
<th>θ</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.41</td>
<td>.120</td>
<td>.0849</td>
<td>2.11</td>
<td>1.45</td>
<td>.87</td>
</tr>
</tbody>
</table>

α = .05;  nₑ=22.73
dfₑn = 175

The θ = 1.45 resulted in a value of power = .87, p<.05,  nₑ=22.73. Thus, the power estimate indicated that a researcher duplicating the experiment would have an 87% chance of detecting significant differences between the means on the Culturing posttest subsection. Therefore, the Culturing posttest ANOVA detected a significant difference in the class means on the Culturing subsection of the posttest with a relatively high power. However, this high power value may be biased. The assumption of independent observation was violated in this case, as the students and the teacher from each classroom interacted throughout the microbiology instruction. Therefore, the power value must be interpreted with prudence.

Although the ANOVA resulted in a significant omnibus F value, an ANOVA does not identify the source of disparity. In other words, what class means were significantly different than the others? The Scheffe’ test is a post hoc analysis.
performed after an ANOVA to identify where the mean difference exists. Cramer (1998) recommended the Scheffe’ test as a post hoc analysis because the Scheffe’ was not sensitive to an unbalanced design, as in this case. Also, Keppel (1991) stated that the Scheffe’ was conservative in that the test decreased the chance of a Type I “familywise” error. Therefore, there would be less probability of rejecting the null when there was no difference between the means. In looking at the descriptive table for the Culturing posttest subsection, two class means appeared to be lower than the others: Class 2 (Beth’s class) had the lowest mean of 16.36 (SD=2.04), and Class 7 had a low mean of 16.80 (SD=1.85). The Scheffe’ test was computed with the harmonic mean of 22.727 at the .05 alpha level. The results of the Scheffe’ test were as follows:
### Table 33
Scheffe' Post Hoc Analysis of Culturing Posttest Subsection Means

<table>
<thead>
<tr>
<th>(J) TRT</th>
<th>Mean Difference</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 3</td>
<td>2.04</td>
<td>0.13</td>
</tr>
<tr>
<td>Class 4</td>
<td>-0.05</td>
<td>1.00</td>
</tr>
<tr>
<td>Class 5</td>
<td>-0.07</td>
<td>1.00</td>
</tr>
<tr>
<td>Class 6</td>
<td>0.30</td>
<td>1.00</td>
</tr>
<tr>
<td>Class 7</td>
<td>0.24</td>
<td>1.00</td>
</tr>
<tr>
<td>Class 8</td>
<td>1.60</td>
<td>0.47</td>
</tr>
<tr>
<td>Class 3</td>
<td>-2.09</td>
<td>0.14</td>
</tr>
<tr>
<td>Class 4</td>
<td>-2.11</td>
<td>0.12</td>
</tr>
<tr>
<td>Class 5</td>
<td>-1.73</td>
<td>0.38</td>
</tr>
<tr>
<td>Class 6</td>
<td>-1.79</td>
<td>0.28</td>
</tr>
<tr>
<td>Class 7</td>
<td>-0.43</td>
<td>1.00</td>
</tr>
<tr>
<td>Class 8</td>
<td>-1.88</td>
<td>0.22</td>
</tr>
<tr>
<td>Class 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 5</td>
<td>-0.02</td>
<td>1.00</td>
</tr>
<tr>
<td>Class 6</td>
<td>0.36</td>
<td>1.00</td>
</tr>
<tr>
<td>Class 7</td>
<td>0.29</td>
<td>1.00</td>
</tr>
<tr>
<td>Class 8</td>
<td>1.65</td>
<td>0.47</td>
</tr>
<tr>
<td>Class 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 4</td>
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<tr>
<td>Class 5</td>
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<td></td>
</tr>
<tr>
<td>Class 6</td>
<td>0.38</td>
<td>1.00</td>
</tr>
<tr>
<td>Class 7</td>
<td>-0.65</td>
<td>1.00</td>
</tr>
<tr>
<td>Class 8</td>
<td>1.29</td>
<td>0.78</td>
</tr>
<tr>
<td>Class 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 7</td>
<td>-0.14</td>
<td>1.00</td>
</tr>
<tr>
<td>Class 8</td>
<td>1.36</td>
<td>0.69</td>
</tr>
<tr>
<td>Class 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 8</td>
<td>-0.08</td>
<td>1.00</td>
</tr>
<tr>
<td>Class 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 8</td>
<td>-1.44</td>
<td>0.62</td>
</tr>
</tbody>
</table>

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The post hoc Scheffé test \((p<.05)\) did not identify any pairwise differences of the Culturing Posttest Subsection means between the eight classes. However, the Scheffé table does show that Class 2 (Beth’s class) had the highest mean differences. In contrast, the less conservative ANOVA resulted in a significant \(F(7,175) = 3.41, \ p<.05\).

As the researcher, I interpreted the Culturing Posttest Subsection results as follows:

1. There was a statistically significant difference between the class means of the eight science classes on the Culturing Posttest Subsection, as indicated by the Culturing Subsection ANOVA with an omnibus \(F(7,175) = 3.41, \ p<.05\). Thus, at an alpha level of .05 with 7,175 degrees of freedom, the \(F\) value of 3.41 led to a rejection the null hypothesis.

2. The Scheffé post hoc analysis did not identify the pairwise origination of the significant difference indicated by the Culturing Subsection ANOVA. No class mean pairs were shown to be significantly different.

3. The Scheffé post hoc test is a conservative analysis, in that the familywise error is rigorously controlled. In order to reduce the type I familywise error, each pairwise alpha is reduced in the analysis. Keppel (1991, p. 173) estimated that each pairwise or “PC - per comparison” significance level would be equal to an \(\alpha = .0025\). Thus, only considerable pairwise differences may be identified.

4. A future study could include a repeated measures ANOVA and/or a multivariate analysis of variance (MANOVA). The resultant increase in
power may identify the source of significant mean difference indicated by
the Culturing Posttest Subsection ANOVA. An additional analysis for
future consideration also could include the use of the pretest as a covariate
in order to check for pretest – posttest correlation.

5. While the Scheffe’ post hoc analysis did not identify a significant
difference between the culturing means, a graph of the Culturing
Subsection means suggests the most likely cause of the omnibus F:

The markedly significant differences appear to be between the class means of Class 2
(Beth’s class) and Class 1 (Ann’s), Class 3, Class 4. However, as mentioned
previously, additional quantitative analyses would be necessary to prove a
statistically significant difference.
Pathogenic Posttest Subsection ANOVA

The overall mean score for the 25-point Pathogenic posttest subsection was 18.81 (SD=2.12). Class 7 had the highest mean of 19.15 (SD= 2.16). Class 3 had the lowest mean of 18.45 (SD= 1.99). The summary of descriptive statistics was as follows:

Table 35
Dependent Variable Means and Standard Deviations by Levels of the Independent Variable

<table>
<thead>
<tr>
<th>Dependent Variable: Pathogenic Subsection Posttest Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Class 1</td>
</tr>
<tr>
<td>Class 2</td>
</tr>
<tr>
<td>Class 3</td>
</tr>
<tr>
<td>Class 4</td>
</tr>
<tr>
<td>Class 5</td>
</tr>
<tr>
<td>Class 6</td>
</tr>
<tr>
<td>Class 7</td>
</tr>
<tr>
<td>Class 8</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
The histogram and normal Q-Q plot of the posttest scores were performed with the following result:

**Figure 14**

*Pathogenic Posttest Subsection Histogram and Q-Q Plot*

The histogram of the Pathogenic posttest subsection scores showed a relatively normal mean plot with an overall mean of 18.81 (SD=2.12). The Q-Q plot demonstrated normality within the Pathogenic subsection.

Levene’s test was computed as follows:

**Table 36**

*Posttest: Levene’s Test for Equality of Error Variances*

Dependent Variable: Pathogenic Posttest Subsection Scores

<table>
<thead>
<tr>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.40</td>
<td>7</td>
<td>175</td>
<td>.209</td>
</tr>
</tbody>
</table>

*p<.05*
The p value of .209 was greater than the alpha level of .05, and therefore the Levene's test was not significant. The Levene's test results indicated that the variances of the Culturing posttest subsection scores between the eight science classrooms were not significantly different. The null hypothesis that the Culturing posttest subsection variances were equal was accepted.

The ANOVA results were as follows:

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta.Sqr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>7</td>
<td>14.17</td>
<td>2.02</td>
<td>.441</td>
<td>.875</td>
<td>.191</td>
</tr>
<tr>
<td>Error</td>
<td>175</td>
<td>803.51</td>
<td>4.59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>182</td>
<td>817.68</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*\( p < 0.05 \)

\( R^2 = .022 \)

Based upon the Pathogenic posttest subsection ANOVA, the difference between the means from the eight classes was not significant, \( F(7,175) = .441, p < .05 \). Thus, at an alpha level of .05 with 7,175 degrees of freedom, the \( F \) value of .441 led to a failure to reject the null hypothesis. There was no statistically significant difference between the Pathogenic posttest subsection means between the eight science classes.
Quantitative Analysis Summary

The purpose of the quantitative analysis was to compare the posttest means of the eight participating science classes after the implementation/instruction of a new microbiology unit. The overall design was quasi-experimental, due to non-randomization and the probability of confounding variables. However, the main objective of this quantitative portion of the investigation was to identify any statistical significance that might elucidate the qualitative case study findings. Two of the eight senior science teachers, Ann and Beth, also were participants in the case study. Therefore, I observed their classrooms on a daily basis for ten weeks during the microbiology implementation. In the concluding chapter, the quantitative findings will be correlated to the case study findings. A summary of the quantitative findings included the following researcher interpretations:

1. The pretest was found to be a reliable, unidimensional assessment instrument using Cronbach’s alpha for reliability. Therefore, the use of the pretest to evaluate homogeneity between the eight participating classrooms was statistically valid.

2. The differences between the means on the pretest ANOVA was not significant at $F(7,175) = 1.11, p<.05$. Thus, at an alpha level of .05 with 7,175 degrees of freedom, the $F$ value of 1.11 caused a failure to reject the null hypothesis. There was no statistically significant difference between the pretest means of the eight science classes. This validated the use of a posttest after the microbiology instruction, as the eight classes were homogeneous.
3. The posttest was found to be a reliable, unidimensional assessment instrument using Cronbach's alpha and Pearson's correlation coefficients for reliability. However, the Immunology subsection of the posttest did not correlate with the other subsections. Therefore, the overall posttest ANOVA only included the other three subsections, Bacteriology, Culturing, and Pathogenic Diseases. These factors lead to the computation of an ANOVA of each individual posttest subsection.

4. The overall posttest ANOVA was performed on the total data from the Bacteriology, Culturing, and Pathogenic subsections. The differences between the means on the posttest ANOVA was not significant at $F(7,175) = .171$, $p<.05$. Thus, at an alpha level of .05 with 7,175 degrees of freedom, the $F$ value of .171 lead to a failure to reject the null hypothesis. There was no statistically significant difference between the posttest means of the eight science classes.

5. Four individual ANOVA were computed on the individual subsection of the microbiology posttest. On the Bacteriology, Immunology, and Pathogenic posttest subsection, the ANOVA $F$ values caused a failure to reject the null hypotheses. There were no statistically significant differences of the means between the eight science classes from these posttest subsections.

6. The ANOVA on the individual Culturing subsection of the posttest did indicate a significant difference between the means, $F(7,175) = 3.41$, $p<.05$. Thus, at an alpha level of .05 with 7,175 degrees of freedom, the $F$ value of 3.41 lead to a rejection the null hypothesis. There was a statistically
significant difference between the Culturing posttest subsection means between the eight science classes.

7. All of the posttest ANOVAs must be interpreted with some caution due to the violation of the independent observation assumption. Such a violation can become a confounding variable within the study. In addition, the estimated power of the ANOVA could be positively biased (i.e., inflated).  

8. A post hoc analysis was computed on the Culturing subsection of the posttest. The Scheffe’ test (p<.05) did not identify any pairwise differences of the Culturing posttest subsection means between the eight classes.  

9. The researcher interpreted the statistical significance between the Culturing posttest subsection and the other posttest subsections to be present, yet minimal. The Scheffe’ post hoc analysis was unable to identify the specific pairwise significant differences.

10. Possible recommendations for a future continuation of this investigation include a repeated measures ANOVA and/or a MANOVA. In addition, the correlation between the pretest and posttest might prove valuable.  

Quantitative Analysis Chapter Summary

This chapter focused upon the pretest and posttest microbiology assessments of the students. An introductory section addressed the purpose of the quantitative portion of this investigation. The statistical analysis results of the pretest and posttest assessments were presented, along with the explanation of the researcher’s
interpretations. Chapter 6 will present the researcher's interpretation and correlation between the qualitative case study findings and the quantitative analysis of the students' posttest achievement.
CHAPTER 6
CONCLUSIONS AND IMPLICATIONS

Introduction

Chapter 6 presents the findings of the study. Initially, a summarization of each preceding chapter is discussed. Each of the original research questions is addressed from the qualitative and quantitative portions of the investigation. Significant conclusions are described, along with an explanation of the researcher's interpretations. These significant findings are then related back to the teacher-thinking theories that grounded this study. Finally, the implications of the study are discussed in conjunction with recommendations for future research.

Thesis Summary

The purpose of this study was to investigate preactive planning, interactive, and reflective teacher deliberations during new curriculum implementation. The research design involved qualitative methodologies in conjunction with a quantitative analysis. A naturalistic case study revolved around two teacher participants that were implementing the same microbiology course of study. The quantitative research plan analyzed the class means with a pretest/posttest strategy in a quasi-experimental design. The findings from the quantitative portion were used as
descriptive statistics, with the purpose of adding information to the case study findings.

In Chapter 1, the theoretical framework of the investigation was presented, along with the research questions and significance of the study. Chapter 2 focused upon past and current teacher-thinking research. Teacher thinking was connected to teachers' theories of action, background knowledge, practical knowledge, and content knowledge. Research on preactive planning included the findings of McCutcheon (1992; 1995), Clark & Dunn (1991), Calderhead (1994), and Clark & Yinger (1987). Preactive planning was defined as teacher planning prior to classroom instruction. Such planning included teacher deliberations about lesson plans, student background knowledge, learning activities, student motivation, and assessment. Research on interactive thinking included the findings of Peterson & Clark (1978; 1986), Buchmann (1990), and Shulman (1987). Interactive thinking was defined as spontaneous teacher thinking during classroom instruction. Such deliberations involved teacher interpretation of student cues in regards to comprehension, interest, and behavior. These interpretations guided teacher reflection upon possible 'on-the-spot' lesson modifications. Research on teacher reflection included the findings of Schoen (1983) and Griffiths & Tann (1992). Reflection in this study was defined as either short-term or long-term reflection after classroom instruction. Short-term reflection was performed soon after the classroom experience, while long-term reflection involved contemplation over an instructional unit, school quarter, or school year. Chapter 3 presented the overall research design. The qualitative portion of the investigation was explained and the plan for classroom
observation, record review, and teacher interview was discussed. The quantitative portion of Chapter 3 described the statistical analyses based upon a pretest and microbiology posttest. Chapter 4 portrayed the qualitative research findings. The information acquired from the document/record review was interpreted and presented. Classroom observation data were interpreted and analyzed. In addition, the data from teacher interviews were described, and multiple interview transcript excerpts were included to give voice to the participating teachers. Chapter 5 represented the quantitative research findings. Each planned statistical analysis was described, and the findings were presented. Statistical summary tables and figures were included to visually corroborate the researcher interpretations. This chapter, Chapter 6, recapitulated the research design and findings. In particular, the researcher interpretations of the relationship between the case study data and the quantitative data were the focus of the chapter.

Original Research Questions and Researcher Interpretations

This research project applied a grounded theory methodology, in that the research design and research questions stemmed from current teacher-thinking theories. Several research questions guided the qualitative and quantitative portions of this project. In this section of Chapter 6, each of the original research questions was addressed individually. The response to each question was developed from the case study and quantitative data and was augmented by researcher interpretations.
1. What are the various forms of these teachers’ planning and how do they function within the curriculum? What relationships exist between teacher planning and curriculum implementation and action in the classroom?

Preactive planning, or planning that is performed prior to classroom instruction, was investigated in this study. Comparisons between Ann and Beth’s’ preactive planning decisions revealed some similarities, but also revealed the unique perspective of each teacher. Both teachers relied upon the textbook and the microbiology course of study as a guide to their long-term and short-term preactive plans. This was especially true with Beth, as she made extremely detailed preactive plans for the entire unit prior to the start of the school year. In Beth’s classroom, a very close relationship existed between her preactive plans and her implemented course of action in the classroom. While Beth did not record all of her lesson plans, to an outside observer, her actions closely matched her written preactive plans.

Ann also used the course of study as a guide, but mainly as a reference to preplan lab activities for the complete unit. Ann’s preactive plans were sparse and coded in personal symbols. Ann specifically explained that she did not feel the need to record many of her preactive plans, but usually began a new course of study by penciling in a long-range plan. Ann’s planning book contained very little information, other than chapter titles and lab activities. However, Ann’s stated planning goal was to incorporate flexibility within her long-term plans. As the teacher, she continually modified her planned lesson activities, textbook assignments, and lab book activities based upon her interactive and reflective
decisions. From a researcher's standpoint, these continual modifications explained her ambiguous written preactive plans. Ann's preactive planning activities agreed with McCutcheon's (1995) proposal that many teachers depend upon mental, rather than written, preactive plans.

Both teachers' preactive planning activities centered upon their personal theories of action. In agreement with Calderhead (1994), Moalle & Earle (1998), and Morine-Dershimer (1991), their planning decisions were founded upon their respective content knowledge, classroom experience, and teaching knowledge. Thus, the implementation of the same curriculum resulted in two unique applications of the microbiology unit.

2. In what ways do teachers' beliefs and practical knowledge affect the planning stage of curriculum implementation?

The findings of this investigation unmistakably demonstrated that the implementation process of a curriculum is a personal venture based upon a teacher's theory of action. In this case, Ann and Beth uniquely interpreted the course of study to make personal preactive plans. They both chose classroom actions that correlated with their individual educational beliefs. Thus, Ann and Beth's respective preactive plans were based upon an integration of their practical knowledge, content knowledge, and prior student interaction. As proposed by McCutcheon (1992), Schon (1983), and Ross (1992), these classroom teachers relied upon multiple assumptions of practice and theory to implement the microbiology curriculum. In turn, Ann and Beth continually
personalized and re-evaluated their individual theories of action through student interaction and reflection.

3. How do teachers' interactive decisions influence the effectiveness of learning in the classroom?

In accordance with Clark & Peterson's (1986) research, interactive decisions were defined as deliberations made by the teacher during instruction (i.e., during interaction with their students). Ann and Beth demonstrated their ability to interpret multiple student cues during instruction. From these cues, the teachers deliberated upon possible courses of action to either spontaneously modify their original lesson activity or to continue as planned. Both teachers related that they relied upon their past classroom experiences to decide upon an action. Such patterns of reciprocal reliance upon reflective and interactive thinking correlates with the interactive research theories of Peterson & Clark (1978) and Buchmann (1990). The overwhelming majority of both the observable and teacher-reported interactive decisions focused upon learning comprehension.

Innumerable student cues in both classrooms repeatedly stemmed from content confusion, a lack of background knowledge, or an increased interest in a particular topic. The senior students in both classes were well behaved and normally on task, which may explain the lack of interactive decisions involving student misbehavior.

As the classroom observer, interactive decisions in both participating classrooms had a noticeable impact upon student learning. Both teachers were
proficient in accessing and applying various lesson modifications based upon their previous teaching experiences and familiarity with their students. A difficulty did arise in the investigation of interactive thinking. Often, Beth and Ann would underestimate the frequency of their daily interactive decisions. From my perspective, this factor may be due to the sheer number of teacher interpretations and interactive decisions made during each class session. In addition, the teachers often did not report interactive decisions that did not result in a major lesson modification. As such interactive decisions are not apparent to an outside observer, the research plan of classroom observations and teacher interviews most likely did not accurately represent the whole picture of interactive thinking. Future teacher-thinking investigations also may need to consider this complication. Teacher thinking is a complex set of individualistic deliberations and an increased understanding of the practice will require further study.

4. **What role does reflection play in curriculum decisions? When is reflection practiced during curriculum implementation? Is there evidence that reflection that occurs during and after the lessons/units guides future action in the classroom?**

Reflection played a major role in the curricular decisions of both teachers participating in the case study of this investigation. Ann and Beth routinely practiced short-term and long-term reflection on a continual basis throughout the microbiology implementation process. Their short-term reflections focused upon
daily and weekly classroom experiences, and often resulted in modifications to their preactive plans. In accordance with the research findings of Schoen (1983) and Zeichner (1994), Ann and Beth utilized reflection as a problem-solving technique. Their deliberations connected their teacher-thinking practices to the everyday world of the classroom. Often an observable change or improvement in student learning was the result. Such use of reflection correlates with the early research theories of Dewey (1933).

From the researcher's standpoint, both teachers practiced reflective deliberations in conjunction with the two other major teacher-thinking activities, preactive planning and interactive decisions. Long-term reflection of previous years of teaching greatly influenced the preactive plans of Beth and Ann. During the initial planning phases prior to the school year, each teacher devised a course of action for implementation under the guidance of long-term reflections. Their interactive, spontaneous classroom decisions also relied upon reflection of previous successful lesson activities. Both teachers explained that they lacked such interactive-reflective practices as novice teachers. Overall, reflection was employed in combination with interactive and preactive thinking, based upon the teachers' environments and interactions with their students. Also, the reflective practices of Ann and Beth were not limited to any specific timeframe. Rather, reflection was utilized before, during, and after classroom instruction throughout the entire implementation process.
5. Using the classroom as the unit of analysis, would a statistical difference in student achievement exist between the classes of science students?

Eight Tech Prep senior science classes at different high schools participated in the quantitative portion of this study. The pretest indicated homogeneity between the eight classes. The overall posttest class means were compared with an ANOVA at .05 alpha. The $F_{(7,175)} = .171$, $p<.05$ was not significant and resulted in a failure to reject the null hypothesis. There was no significant difference in the microbiology posttest means of the eight science classes. Due to low correlations indicated by Pearson coefficients and Cronbach’s alpha, the decision was made to compute a separate ANOVA on each posttest subsection. The Immunology, Bacteriology, and Pathogenic subsection ANOVAs indicated that there was no significant difference between the class means. The Culturing posttest subsection $F_{(7,175)} = 3.41$, $p<.05$ was significant and resulted in a rejection of the null hypothesis. A statistically significant difference between the eight classes existed in the Culturing posttest means. However, the Scheffe’ post hoc analysis did not identify the pairwise source of the omnibus $F$.

Recommendations for further, future analyses included a repeated measures ANOVA and a MANOVA. In addition, a future pretest-posttest correlational analysis may prove beneficial.

As this study was quasi-experimental in design, the research findings were not generalizable to any other student populations. In addition, the interpretation of the results must be completed with caution. The ANOVA assumptions of random assignment and independent observation were violated. Therefore, the
power of the ANOVA could very well be unrealistically high. In addition, the violation of the independent observation assumption often results in a positively biased F test, meaning that the resultant F value can be unjustly high (Kennedy & Bush, 1985). Therefore, the possibility of a type I error in this study was greatly increased. Keeping the aforementioned design imperfections in mind, the overall purpose of this quasi-experimental portion was to provide supplementary information to the case study findings. The possible correlations between the quantitative analysis and the case study are discussed in the following section.

6. In conjunction with the findings from the qualitative case study (i.e., Ann and Beth’s classrooms), can any differences in student achievement be linked to distinctions between the case study teachers’ preactive planning, interactive decisions, and reflective practices?

In the quantitative analysis of class posttest means, a negligible statistically significant difference was found in the Culturing subsection of the posttest. The overall Culturing subsection mean at 17.91 (S.D. = 2.17) was the lowest mean of all four posttest subsections and also had the lowest standard deviation. Two of the eight participating classes were taught by the teachers, Ann and Beth, in the qualitative case study. The Culturing subsection class mean for Ann was 18.40 (S.D. = 2.21) and was 16.36 (S.D. = 2.04) for Beth’ class. The findings from the case study indicated a possible relationship between the teacher decisions in the classroom and posttest achievement on the Culturing subsection.

The Culturing unit of the new microbiology course included a large section of
calculations and mathematical estimations of microbe replication times. Both Ann and Beth expressed initial concerns about the math prior to the start of instruction. In addition, both teachers stated that they themselves were not familiar with the application of the equations, and they agreed that the book did not offer much explanation or practice. Ann and Beth also individually voiced concern over their students’ familiarity with logs/antilog calculations, which were involved in the Culturing replication equations. From their initial perspectives, the lower Culturing subsection overall mean of 17.91 was not a surprising finding.

The difference between the Ann and Beth’s class means on the Culturing subsection also was not unexpected from an observer’s perspective. As the researcher, I observed both Ann and Beth’s classrooms on a daily basis for the entire ten-week microbiology unit. Both teachers started the Culturing unit around the 5th-6th week of the microbiology course. From examination of each teacher’s preactive planning records, Ann and Beth both expected to spend two to three days on the mathematical equations. Their written preactive plans were similar, although Beth’s planning notebook was more detailed. However, the interactive and reflective decisions made by the teachers during and after instruction widely diverged.

After the first day of instruction, Ann remarked that the students were “understanding the underlying concepts” of microbial replication times, but were not able to correctly use the equations. Ann spent half of the first day at the marker board, going over practice problems. She then put four problems on the
board for the students to solve with their seating partners. Within a short time, each table of four students had asked for individual assistance with the calculations. Ann then made the interactive decision to list the variables for each problem on the board and to list the answers for the questions in a random fashion. (Note: Ann later stated that she thought the students were having trouble identifying the variables from the word problems. She wanted to see if they could “do the math” if they only had to “plug in” the variables. From an observer’s viewpoint, most the student groups still could not generate the given answers from the equations on that day.) The next day, Ann had varied her preactive plans to include a short lab. This lab, which took half of the class period to set up, involved culturing the E. coli microbe. The second half the period, Ann worked out practice problems on the board based upon the E. coli microbe’s known replication time. The last ten minutes of the class, Ann handed out a worksheet that she had prepared the night before class. The worksheet included two completed problem examples at the top of the page. The students worked in groups at their tables, and Ann made her way around the room to answer a few questions. Ann extended the timeframe for the calculation section from her originally scheduled 2-3 days to five days. While she did introduce new topics during the week, each day included class time and/or homework with the equations. Ann ended the Culturing unit by returning to the growing E. coli cultures. The students performed the equations with their own lab data. A twenty-minute quiz was also given on this last day.

As an observer, Ann made several interactive and short-term reflective
decisions that most likely influenced student achievement. After the first day of the unit, Ann abandoned the textbook examples and problems, choosing to develop her own worksheets, labs, and homework assignments. As she later explained during the end-of-the-week interview, Ann tailored these lesson plans based upon her interpretations of the students’ prior math knowledge and experience.

Beth spent most of the first day at the overhead, explaining the concept of microbe replication estimations and providing multiple examples. During the last third of the period, Beth assigned a few problems from the book for the students to attempt in their groups. As with Ann’s class, Beth’s students had trouble completing the calculations. Many of the students needed individual attention to learn the correct function keys on their personal calculators. Beth later stated that she had planned to go over the textbook problem solutions, but ran out of time that day. The following day, Beth continued with additional problem samples for the first half of the period, spending a majority of the time showing students how to translate and apply the word problems with the given equation formulas. Beth assigned practice problems from the book for both days. The third day of class, Beth had the students correct their own homework as she went through the problems on the overhead. She then discussed the applications of microbial replication times in the field of microbiology and medicine, focusing on the replication time of anthrax and tying that information into the progression and prognosis of the disease. From the end-of-the-week interview, Beth explained that she made a deliberate decision to remain true to preactive plans on the
Culturing unit, even though she “sensed” that her students could use more practice. She related that she was concerned with the lack of time to address the remaining chapters in the book. Beth voiced concern that a delay would result in an omission of other several topics on the posttest. While Beth made numerous interactive decisions during instruction of the culturing unit, upon reflection she chose to continue with her preactive plans/schedule.

Due to the quasi-experimental nature of this investigation, the differences in class means on the Culturing posttest subsections cannot be directly correlated to teacher-thinking practices. Although Ann’s class mean at 18.40 (S.D. = 2.21) was higher than Beth’s class mean at 16.36 (S.D. = 2.04), the statistical significance between the means was minimal, at best. However, during member checking at the end of this study, the teachers both agreed with the researcher’s analysis. Ann felt that her students did better than they would have if she had continued with her preactive plans without major modifications. Ann also stated that next year she planned to request that the students’ math teachers briefly introduce or review logs/antilogs at the beginning of the senior year. Ann believed that the majority of the unit problems stemmed from a lack of math, not microbiology, comprehension. Beth also agreed that her class could have performed better on the Culturing subsection of the posttest with additional instruction time. Beth’s reflective plans included the proposal of extending the entire microbiology course to a high school semester.

An additional consideration in this study involves the format of the posttest assessment instrument. The community college instructors most likely selected a
multiple-choice format to ease grading of a large number of students. However, many of the posttest questions did not require application of microbiology knowledge, instead focusing upon factual recall questions. In addition, the multiple-choice format did not assess the students’ hands-on microbiology lab techniques. Such an assessment would quite possibly shown a difference in student comprehension and ability between Ann and Beth’s classes, as Ann purposively focused upon lab activities in the microbiology curriculum. A possible recommendation to the community college would be to include a lab practical in the microbiology final, as well as essay or short-answer questions.

7. What are the future implications of research into teacher thinking? In what ways might this research reveal and direct instructional procedures?

As indicated by the findings of this study, teaching is a complex process that demands constant planning, interactive, and reflective deliberations. During new curriculum implementation, countless decisions must be made that directly impact student learning. Therefore, research into teacher thinking can be complicated in itself. In general, why is teacher-thinking an important area of educational research? Who can benefit from curriculum implementation investigations?

One possible benefactor of teacher-thinking research is the novice teacher. As an increased number of teacher-thinking studies are completed, the intricacies of the deliberative processes of a ‘teacher-in-action’ are unraveling. A clearer picture of teacher thinking is emerging, with the resultant potential to impact teacher education programs. For example, both case study participants in this
investigation, Ann and Beth, indicated that their planning, interactive, and reflective practices improved dramatically over time in the classroom. They shared that as novice teachers they did not have the background knowledge to interpret student cues and make beneficial interactive decisions. Ann and Beth also independently related that during their initial years of classroom teaching, they solely relied upon the textbook for curricular guidance and direction. Neither felt they had the knowledge or experience to rely upon their own deliberations and reflective practices to guide future student-learning activities. From this information, teacher-thinking and curriculum implementation research may have an important role in the improvement of teacher education programs. For example, how often are teacher-thinking practices modeled and analyzed for undergraduate education students? Is the connection between reflective practice and curriculum modifications emphasized? Would classroom experiences with veteran teachers, in addition to standard student-teaching assignments, be valuable? Does a mentoring program for novice teachers promote an earlier development of teacher-thinking skills? Such questions may be addressed through additional, future investigations.

The area of professional development for teachers can also benefit from teacher-thinking research. In particular, professional development in the area of teacher reflection may be valuable. The consequence of continual reflection for teachers can be an increased awareness of their personal pedagogical beliefs and classroom practices. In turn, such reflections can result in constructive lesson modifications and an increase in overall student comprehension. Reflection can
also serve as a problem-solving tactic after classroom instruction, with the consequence of lessons that better relate to students’ background knowledge.

The area of curriculum development may also be improved through teacher-thinking research. From this study, a connection was demonstrated between teacher thinking and the teachers’ background experience, content knowledge, and pedagogical beliefs. Ann and Beth implemented their curricular decisions based upon their own unique interpretations of the course of study and their interactions with respective students. Such knowledge should influence the practice of curriculum development. For example, are predetermined course objectives (i.e., a packaged curriculum) a realistic approach to curriculum development? In this case study, Ann’s school included teachers as part of the curriculum development process. While the teachers at Ann’s school referred to a district course of study, teachers within each academic area wrote a personalized course of study in a collaborative process. In contrast, Beth’s school provided teachers with a pre-developed course of study. From the current teacher-thinking research, perhaps the contribution of teachers as curriculum developers will be recognized. In addition, such research may discover methods to increase the success of new curriculum implementation, as well as curriculum innovations.

Teacher-thinking research has revealed many of the intricacies involved in the act of teaching. An emerging awareness of teacher deliberations has increased the understanding of teachers’ preactive, interactive, and reflective practices. Such practices have a major impact upon the opportunities for student learning in the classroom. Thus, the knowledge gained through teacher-thinking
investigations can guide the direction of future educational innovations and teacher modifications.

**Significance of This Investigation**

The findings of this investigation are significant in two areas of educational research: curriculum implementation and teacher thinking. Based upon the results of this study, several recommendations for further study and action became apparent.

1. Additional long-term case studies with a larger number of teacher participants may reveal additional discoveries not found in this study. Also, this study was limited to two females in suburban, middle-class high schools. A more diverse teacher and student population could add to the current theories in teacher thinking.

2. An increased number of teacher participants would also increase the overall power of the quantitative portion of a future, similar investigation. In this study, only eight classrooms were used as the means for analysis (i.e., n=8). Also, the modification to include random sampling of teachers and students could decrease the number of confounding variables and increase the external validity of a future study.

3. The conclusions of this study suggest the benefit of additional teacher-thinking case studies designed in conjunction with quantitative analysis. A common qualitative methodology in teacher-thinking investigations is the teacher interview. However, interviews represent the teachers’ perceptions, which may not reveal the numerical reality of student
achievement. In turn, singularly quantitative studies may reveal a statistical difference in student achievement, but may not include classroom practice information to explain the cause or effect of any identified difference. Future investigations with quantitative/qualitative research designs may better illuminate the connection between teacher thinking, classroom practice, and student achievement.

4. In this case study the participating Tech Prep teachers, Ann and Beth, were permitted flexibility in interpreting and implementing the new microbiology curriculum. However, none of the Tech Prep high school teachers were involved in the development of the microbiology course of study. While both Ann and Beth were asked for feedback about the new course of study, they were not invited to participate in the major curricular decisions. Instead, the college Tech Prep instructors at the local community college developed the course of study for the participating high schools. Ann and Beth individually and collectively expressed their concern over the proposed ten-week timeframe of the new unit. Neither teacher felt that ten weeks was an adequate amount of class time for the microbiology course. Additionally, both high school teachers recognized the potential problems with the math in the culturing section prior to implementation. A recommendation from this study for future action in the development of additional Tech Prep courses would be to include the classroom teachers in the curriculum development. Their expertise with
both the content material and their students’ background knowledge could have benefited the overall microbiology design prior to implementation.

5. This study also could have implications for curriculum publishers, supervisors, and developers. Classroom teachers, such as Ann and Beth, have practical knowledge about student comprehension, student motivation, learning activities, lesson planning, and classroom time limitations. Teachers’ contributions during curriculum development could prove invaluable and ease the transitional stages during educational innovations and curricular changes.

6. During the final group interview of the case study, Beth and Ann voiced a common sentiment about a lack of planning and collaboration time. From an observer’s standpoint, both teachers practiced preactive planning and reflection in isolation, without the benefit of group deliberation or teamwork. For example, although Beth and Ann were members of the local college’s Tech Prep consortium, they did not have the opportunity to meet and reflect upon the microbiology implementation process until the concluding group interview. For an hour after the group interview, Ann and Beth remained to talk about their implementation experiences. In that time frame, they discovered common problems and co-developed possible solutions. In addition, they made an arrangement to share lesson plans in the summer during the yearly Tech Prep anatomy teacher meeting.

7. A potential result from this study could be the recommendation for such collaborations throughout the school year. Since all eight Tech Prep
science teachers use the same courses of study and curriculum materials, more frequent problem-solving meetings could be beneficial. Ann and Beth stated they would gladly attend such meetings once per quarter each year.

8. Curriculum theory naturally revolves around the teacher. Therefore, curriculum theory should include applications for classroom practice. In turn, the gap between educational theory and classroom practice could be diminished, and theoretical discoveries would become concrete applications to benefit the students.

9. In accordance with their personal theories of action, teachers have different fundamental perceptions about curriculum implementation and the role of the teacher in the learning process. The two teachers in this case study implemented the microbiology course of study based upon multiple factors, including their interpretations of the new unit, their pedagogical assumptions, and their reflections upon past student interactions. Although both teachers were presented with the same course of study, textbook, curriculum supplements, and lab supplies, their individual deliberations resulted in two unique implementations of the same course.
**BIBLIOGRAPHY**


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Appendix A: Informed Consent/Confidentiality Letter

Informed Consent- Confidentiality Letter for each Participant

Thank you for your consideration as a participant in the study entitled Teacher Thinking: Planning, Interactive, and Reflective Practices During New Curriculum Integration. The purpose of this study is to investigate the planning, interactive, and reflective decisions of secondary anatomy teachers while implementing new curriculum material. Teacher planning, interactive decisions, and reflections represent the majority of teacher thinking in relation to classroom instruction. The interpretation and personal application of the curriculum directly influences teaching methods and student learning. Research on teacher thinking eventually can have relevant implications in curriculum development, instructional improvements, and teacher education programs.

As a participant, you will be asked to permit classroom observation and researcher note taking during your lessons. The classroom observations will be limited to five hours per week for a total of eight to nine weeks. This time period will coincide with the incorporation of the new microbiology unit. My role in the classroom will be limited strictly as an observer, and should not interfere with the learning process in your classroom. You also will be asked to participate in several audiotaped interview sessions: A prelesson individual interview on curriculum planning, post-lesson stimulated-recall individual interviews, and a group reflective interview. In addition, you will be asked to share your daily or weekly lesson plans in either a written or oral format.
The confidentiality of you, your school, and your students will be protected during and after the research project. The interviews will be audiotaped solely for the purpose of transcription and analysis. At the conclusion of the research project, all audiotapes will be returned to the individual teachers.

Your participation in this research project is entirely voluntary. You may refuse to answer questions you do not wish to answer, and you can withdraw your participation at any time without penalty or repercussion. You will be provided with several options in which to contact me should any questions or problems arise. You also will be provided with an Ohio State University contact, under whose guidance the research will be conducted.

Thank you for your participation and support,

Mary West

Date: ________________

Signed: ______________________ (Participant)

Signed: ______________________ (Researcher)
Consent Form for Participation in Research

I consent to participate in the research entitled: Teacher Thinking: Planning, Interactive, and Reflective Practices During New Curriculum.

Mary West, Principle Investigator under the guidance of Dr. Gail McCutcheon at Ohio State University, has explained the purpose of the study, the procedures to be followed, and the expected duration of my participation. Possible benefits of the study have been described verbally, as have alternative procedures, if such procedures are applicable and available.

I acknowledge that I have had the opportunity to obtain additional information regarding the study and that any questions I have raised have been answered to my full satisfaction. Furthermore, I understand that I am free to withdraw consent at any time and to discontinue participation in the study without prejudice to me.

I also understand that my confidentiality and the confidentiality of my students and high school will be protected during and after the research project.

Finally, I acknowledge that I have read and fully understand the consent form. I sign it freely and voluntarily. A copy has been given to me.

Date: ________________

Signed: __________________________ (Participant)

Signed: __________________________ (Researcher)

Witness: __________________________ (H.S. Principal)
Appendix B: Teacher Background Open-ended Interview Schedule

1. Can you briefly tell me about yourself and how you decided to become a teacher?

2. How many years have you been teaching? I’d like to know about any previous teaching assignments you have had.

3. Can you tell me about your current teaching assignments? How long have you been involved with the Tech Prep students?

4. What is it like teaching at this school? Do you feel the administration is supportive of your work?

5. How would you describe your classroom?

6. Would you describe your students this year? For the most part, do you feel they are well prepared for your lab and academic classes?

7. Do you sense that most of your students have parental support at home in regards to their education?
Appendix C: Individual Semi-Structured Interview Schedule on Planning

1. The microbiology section is a new unit that will be incorporated into your current curriculum. What planning have you done so far?

2. What instructional goals from this unit do you have for your students?

3. What curricular resources do you plan on utilizing in the classroom?

4. Do you plan on incorporating technology into the microbiology curriculum? Will this be in the form of purchased microbiology software or the use of the Internet?

5. How accessible is this technology for your students? Do you plan on using the technology during lecture with the entire class, or will the students be using the technology independently?

6. How much time have you/will you spend on the planning stage of implementation?

7. Do you spend more time on long-range plans or daily plans? Have you planned a rigid timeline for completion of the material?

8. How will you decide the amount of time to devote to each topic in the microbiology unit?

9. Do you anticipate being able to complete all topics in this unit? As this is new material being incorporated into your curriculum, will you have to revise your teaching schedule for the other anatomy topics? How will you decide what lessons/topics to modify or delete in order to accommodate added subject matter this calendar year?

10. What planning system has worked well for you in the past?
11. Planning: Are you permitted flexibility in planning activities and learning objectives from the administration? Does the administration support your instructional decisions?
Appendix D: Individual, Post-lesson Stimulated-Recall Interview Schedule on Interactive Decisions

[Note: Many of the questions for these end-of-the-week interviews were developed around specific events that occurred in the classroom and are presented within the case study section on interactive decisions in Chapter 4 of the thesis. However, I did develop a very general list of possible interview questions.]

1. What type of changes did you make from your original lesson plans? What guided you in making these curricular changes (i.e.: time limitations, student achievement scores, student interest, student previous background knowledge...)?

2. How did you gauge student understanding during your teaching? In what ways did this influence your teaching during that specific lesson? Did student feedback cause you to alter your subsequent lessons plans for this week?

3. How and when did you measure student comprehension from the classroom technology? Were any changes in your lesson plans necessary?

4. Did any unexpected problems arise about the content material? How did you handle the situation?

5. What were some significant reasons that caused any modifications from your original lesson plans?

6. Were your instructional goals met for the lessons this week?
Appendix E: Individual Semi-Structured Interview Schedule

on Reflection

1. In general, how do you think the microbiology implementation progressed? Do you feel the unit was constructive in terms of student learning?

2. What changes do you think could be made in the course of study to enhance student learning?

3. Would you recommend changes in the curriculum materials for next year?

4. Did you students like the topics and show interest and motivation in the classroom?

5. Were your expectations met in regards to your students’ overall achievement?
   You can include their accomplishments in the labs, homework, quizzes, posttest, etc.....

6. Will you make any changes in your preactive planning for next year? How will you decide what needs modification and what can remain unchanged?

7. Will you make any changes in your selected learning activities for next year?
   If so, can you describe how you have come to the conclusion that some changes may be necessary?

8. What do you think was the best benefit that came from the addition microbiology to your existing anatomy curriculum?

9. Do you have any reservations about the new micro unit? Was there a downside to implementing the new curriculum – either for you as the teacher or for your students?
Appendix F: Concluding Group Interview on Reflection

1. What are your impressions of the new microbiology unit? Do you feel the incorporation of microbiology was beneficial to your students?

2. Looking back over the school quarter, were your planning time estimates accurate? Did you spend more or less time in the planning process than you predicted?

2. Do you feel the assessment accurately measured student achievement?

3. Overall, were your original instructional goals met?

4. Do you plan to make any changes next year in the assessment instruments?

5. In what ways did the technology add to student achievement? Do you plan to revise any portions of technology application next year?

7. What overall changes will you plan prior to next year? How do you predict these changes will improve the lessons? What factors influenced these curricular decisions?
### Observation Date/Page:
1/362 - 0

### Teacher:
WJ

### Lesson:
Final Practice - game

<table>
<thead>
<tr>
<th>Notes</th>
<th>P, I, R Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Table pushed back 3 groups (as usual)</td>
<td>P</td>
</tr>
<tr>
<td>2. Students came in and took their books/pens/pencils/props</td>
<td>P</td>
</tr>
<tr>
<td>3. Sit down - Teach went around &amp; gave out</td>
<td>P</td>
</tr>
<tr>
<td>colored paper, envelopes &amp; colored pens</td>
<td>P</td>
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<tr>
<td>each student placed themselves into 5 color-coded groups &amp; sat in seats</td>
<td>P</td>
</tr>
<tr>
<td>5 min past bell is rung.</td>
<td>P</td>
</tr>
<tr>
<td>5 min &amp; students settle. Bell rung</td>
<td>P</td>
</tr>
<tr>
<td>4:05 today.</td>
<td>P</td>
</tr>
<tr>
<td>1 val/k - front/mid - started game</td>
<td>P</td>
</tr>
<tr>
<td>game began &amp; pulled mid</td>
<td>P</td>
</tr>
<tr>
<td>Groups of 7, 7 got</td>
<td>P</td>
</tr>
<tr>
<td>6.</td>
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<td>7.</td>
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<td>9.</td>
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<td>10.</td>
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<tr>
<td>11. Pete asked 7x1 groups (as usual)</td>
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<tr>
<td>12. Students sat down.</td>
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<tr>
<td>13. Students sat down.</td>
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<td>14. Students sat down.</td>
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<td>15. Students sat down.</td>
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<td>21. Students sat down.</td>
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<td>24. Students sat down.</td>
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<td>25. Students sat down.</td>
<td></td>
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<tr>
<td>26. Students sat down.</td>
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Observation Date/Page: 1/9/02 (2)
Teacher: A
Lesson:

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<th>P, I, R Codes</th>
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</thead>
<tbody>
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<td>1st Q: A handout stapled, typed pages. Atten -</td>
<td>I</td>
</tr>
<tr>
<td>-ment help needed - focusing on physics?</td>
<td></td>
</tr>
<tr>
<td>A: &quot;ok. Let's try. What is most common poll -</td>
<td></td>
</tr>
<tr>
<td>-ing part? (P), future exam, meet, parents</td>
<td></td>
</tr>
<tr>
<td>2nd Q: - told our answer in group</td>
<td></td>
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<tr>
<td>- right now?</td>
<td></td>
</tr>
<tr>
<td>20 questions 1st 25 min of class</td>
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<tr>
<td>Yellow pen by 4 - quiet missed a few</td>
<td></td>
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<tr>
<td>A: &quot;I think need to make it handly. Don't</td>
<td></td>
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<tr>
<td>staying in pur. answer. It not give chances now. 1st quiet answer - St&quot;</td>
<td></td>
</tr>
<tr>
<td>do we get a chance? A: &quot;Alright let's st -</td>
<td></td>
</tr>
<tr>
<td>2nd?&quot; A repeated quiet - 2nd team won</td>
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<tr>
<td>A: &quot;keep your head down tell in asking</td>
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<tr>
<td>question. If everyone miss, next team get</td>
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<td>chance</td>
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<td>Beve cont. 5 more min. A stopped</td>
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<td>7 min before bell. green team won</td>
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<td>St helped replace T. Then</td>
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<td>A: &quot;Quite down everyone that was green.</td>
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<td>you get a few on credits for winning</td>
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<tr>
<td>Hand in homework</td>
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</table>